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THE MODERN METHOD OF SEWER VENTILATION

OUTLINE OF ESSENTIAL FEATURES OF THE MOST POPULAR SYSTEM—IMPORTANT CONSIDERATIONS TO GOVERN STORM AND DRY WEATHER FLOW.

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THE modern method of sewer ventilation consists of numerous openings to the sewers from the atmosphere. This system has met with great success in Germany and in the United States of America, as it promotes an ample circulation of fresh air in the sewers.

This system is the direct opposite of that in which the circulation of air or the ventilation is promoted by using, artificially, individual factors as motive powers for the process, as it favors the co-operation of all the factors which have any influence on ventilation by a continual motion in all parts of the sewerage system through numerous openings, and the resulting continuous circulation of air tends to restrict the formation of obnoxious gases.

If the sewerage system is properly designed and constructed with grades sufficient to ensure a self-cleansing velocity, the sewage will always be in a fresh condition, and thus the generation of gases would be reduced to a minimum, for in spite of the best designed systems there will be, to a certain extent, a small deposit of sewage adhering to the walls of the sewers caused by the constant fluctuation of the flow and with it the generation of gas, but by proper ventilation this danger is overcome, as the oxygen contained in the atmosphere destroys all substances adhering to the walls or otherwise deposited in the sewers by oxidation, thus by the strong dilution of the sewer air with the fresh air the nuisances caused by sewer gases are avoided.

This system of ventilation consists of the installation of two groups of connections between the sewer and the atmosphere, the one at the lowest possible point (such as the openings in manhole covers) and the other at the highest possible point (such as the rain water and soil pipes on houses). The differences in the levels of inlet (the lowest point) and outlet (the highest point) form the main movement of the current of air.

First we will consider the high level group. If the down pipes are connected directly to the sewer, that is without any trap, there would be created a series of highly located connections with the atmosphere, which, in combination with the manhole orifices, would present favorable conditions for the forming of such a considerable difference in levels. To produce an upward current in the down pipes, it is necessary to have a source of heat so that the air in these pipes would exceed the temperature of the atmosphere. In cold weather the source of heat is promoted from heated buildings, and a very small excess of temperature is necessary to promote a velocity sufficient to influence the process of ventilation. Even in winter the co-operation of these down pipes can be relied on for the circulation. In summer the conditions are much more favorable, as are also those times during the action of the sun's rays.

This system of ventilation is much more efficient in streets which are located east and west, and the efficiency extends annually to 2216.2 hours or 25% of the year.

In times of storm, the upward current is eliminated. This condition has often been cited against the use of down pipes for the purpose of the ventilation of public sewers, but when it is considered that the rain duration is only 518 hours annually, or 6% of the total, and the sewers during rain are cleansed by the indraught of air, there is no reason why this should be considered seriously, especially when we consider that this system requires no artificial assistance and, therefore, no expense. However, in residential districts, or in houses where the attics are used for dwelling purposes, it is not advisable to use the down pipes for the purposes of ventilation, so that only the soil pipes could be used.

The pipes most suited for ventilation are those in proximity to the furnace or kitchen chimneys, as the surroundings during the whole of the year have a heat exceeding that of the sewer air, and correctly, soil pipes have been termed the "natural chimneys of ventilation."

The temperature always being higher in the soil pipes causes the motion of the air, and if these pipes were extended to a height above the roof, either of the same or larger diameter, they would form a perfect means of maintaining the continuous current of air from the manhole inlets through the sewers into the atmosphere, and even in times of storm their efficiency is not impaired if a protecting cowl is provided to prevent the admission of rain or air attracted by rain. (Fig. 1.) In draughty locations, the efficiency of these pipes as a means of ventilation may be increased by providing a revolving cowl, but if this is provided, provision must also be made to protect the house traps from their seal being broken, which is done by secondary ventilating pipes. Experiments were made in Cologne by Dr. Unna* with the revolving cowl without protection to the house traps, when it was found that the seal was broken.

In reference to the irregularity of the direction of the current, this is governed by local conditions. Frequently there are special conduits for sinks and bath waste which also partake in the process of ventilation. If these are

*Gesundheits-Ing., 1898, 21 Jahrg., No. 4 and No. 5.

located some distance away from any source of heat or on exterior walls, as is found in conveniences which are placed in a shed or outhouse, a downward motion takes place by which the efficiency is lessened and the ventilating influence on the sewer is reduced considerably. Since the efficiency of house drains is greatest if all pipes are placed in a warm location, provision should be made in local by-laws compelling owners of houses to continue the soil pipe to a sufficient height above the roof, and in the case of new buildings the soil pipes should be placed as close as possible to a chimney. In this manner the irregularity caused by the house drains in cold locations would be overcome, and more house connections would co-operate in the removal of the sewer air. The greater the suction, and the more house connections there are, the better would be the condition of the sewer air.

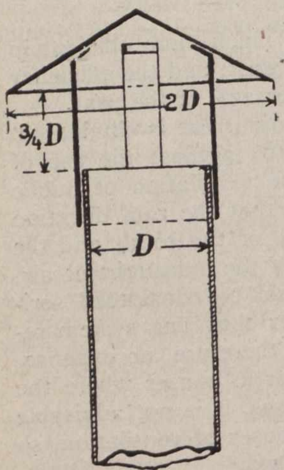


Fig. 1.—Cowl for Soil Pipe.

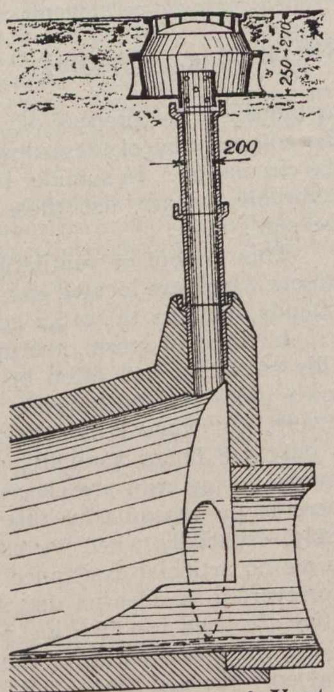


Fig. 2.—Type of Vent Shaft.

It might be mentioned here, that occasionally a downward current of air is caused by waste water from sinks and baths, but this discharge is generally of such short duration that the matter is not worth considering. On the other hand, if the question is raised against the downward current, it should always be borne in mind that a reversion of direction helps to flush the house drains thoroughly, and owing to the large number of remaining house drains it does not interfere with the general process of ventilation and is, therefore, desirable. If the ventilating efficiency of the soil pipes is irregular, the reason can generally be found in the absence of, or defective, air inlet.

We will now consider the second group, viz., the connections between the sewer and the atmosphere at the street level. These air inlets consist principally of perforated manhole covers. The distance separating these covers should range, in small sewers, from ninety to one hundred and fifty feet, and in large sewers from one hundred and eighty feet to three hundred and thirty feet. If the distances are greater than this, the addition of a special shaft would be necessary.

Under normal conditions, in dry weather, a continuous circulation from the manholes through the sewer to the houses takes place and the constant current will only be occasionally interrupted, as stated above. In times of storm, these conditions would be different. On a shower of rain entering a sewer an energetic air current is caused, which has a reverse direction to that during dry weather. A large volume of air is attracted through the down pipes by the accelerated falling velocity of the rain, and is conveyed into the sewers. The mixture of air and water fills the sewer, causing air tension.

Since the house connections, in time of rain, are soon submerged, the air cannot escape from the sewer through these drains, it will, therefore, try to find its way through the sewer to the street gullies. It cannot escape through these gullies owing to the quantity of surface water discharging from them. If the seal in the trap of the gulley is sufficient to resist the air pressure the escape of sewer air is prevented, and thus the only exit would be through the perforated manhole covers. If these covers are not perforated the air cannot escape and the sewers will become air-bound, so that the gullies will not be able to discharge into them, thus causing the streets to become flooded, and the pressure of air in the sewer would still be increasing until the manhole covers are forced and the joints of the sewer blown, causing considerable damage.*

In spite of the provision of perforated manhole covers flooding may still occur unless care is taken to have a sufficient number of manholes and their covers provided with an adequate number of perforations such that they will not be ventilating covers in name only. Many proposals have been previously made on account of the former unreliability to use only the perforated manhole covers or only the house connections for the ventilation of the sewers, but all these have been rejected. No group *per se* could be both inlet and outlet. On the other hand, heavy showers displace the sewer air by completely filling the cross-sections of the sewers, thus promoting circulation as well as in dry weather the differences in levels and temperature. We would not abstract from considering showers as favorable for the ventilation, but it would be better to improve the existing defects so that all trouble which may occur during storms will be avoided. An installation often resorted to is the provision of vent shafts similar to those shown in Figs. 2 and 3. Although these vent pipes are most essential during periods of rain, they also materially assist the circulation during dry weather.

These vent shafts serve two purposes, viz., to assist the manhole inlets when these are a considerable distance apart and to act as outlets for sewer air during heavy rains, when the house connections to the sewer are submerged. Thus, the installation of these vent shafts is recommended as an auxiliary means to promote thorough ventilation.

Since the connections of the sewer with the atmosphere at street level have serious disadvantages in some cases such as the danger to traffic caused by the holes in the manhole covers, the difficulty of cleaning and keeping the holes in the cover open, which is of vital importance for circulation, attempts have been made to substitute the perforated manhole covers by providing air inlets from the sidewalks or by the gullies.

The first method, that of inlets from the sidewalks, would scarcely answer the purpose, apart from the initial cost, as the maintenance would be a prohibitive expense, if adequate circulation is to be constantly maintained, on

*[NOTE.—An illustration of such an occurrence was reported in the Toronto daily press following a severe rainstorm on June 7th last. The pressure became so great in the Garrison Creek sewer that a section 20 feet in length was blown out; flooding Willowvale Park, it is announced, to a depth of 3 feet, with water and sewage.—Editor.]

account of the amount of silt and dirt collected in the pits. Another reason is the complication of the construction of these inlets which is not adaptable to the simplicity which should always be attempted to attain in ventilation and sewerage systems.

The second method is that of using the gullies. The theory is advanced that there are a greater number of gullies on a street than there are manholes, and the perforations of the manhole covers are not nearly the area of the openings in the gulley grating, and that these perforations, if not properly made, are liable to become clogged. This method has its advantages, as in dry weather there would be a greater number of air inlets, but it is questionable whether the gulley as a vent outlet in times of heavy rain accomplishes its purpose. The opinion of the author is that larger quantities of air are attracted by the discharge of the gullies rather than allowing the

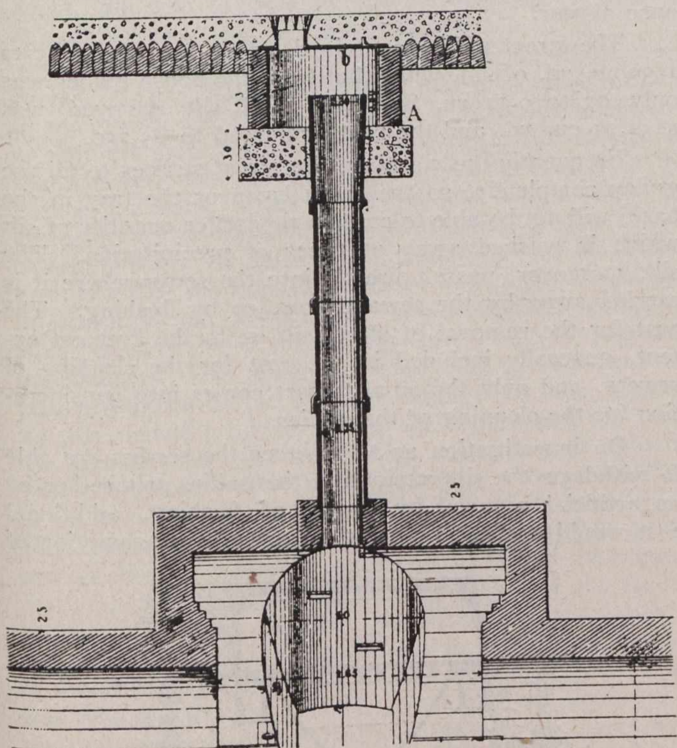


Fig. 3.—Another Type of Vent Shaft.

sewer air to escape. Therefore, the tension in the sewer is increased if gullies are used as ventilators, so that extra precautions must be taken in these circumstances for an efficient ventilation of the sewer. *Per se* there would be no objection to this proposal. On the contrary, by the adoption of the gullies the low level group would be increased by a number of inlets (two gullies usually arranged on a length of street of about thirty yards) thus presenting a double number of low level connections by which, in dry weather, a better circulation would result. It is doubtful, however, if the gulley as a vent outlet during times of storms accomplishes its purpose owing to the house connections being submerged. In the opinion of the author, large air quantities are rather attracted by the discharge of the gullies and the tension of the sewer air is, therefore, increased. If the gullies are used as ventilators, special precautions must be taken for an efficient ventilation of the sewers in these times. This takes us back to the adoption of perforated manhole covers, where in times of rain the displaced sewer air will collect, and by which during the dry weather the renewal, even of the upper air strata, is best obtained.

As already mentioned, the connection of the sewer with the atmosphere at the street level has two disadvantages, the ascending of sewer air during heavy rains, and the danger of the holes in manhole covers to the horses. An emanation of sewer air, however, in a well-ventilated sewer takes place only if the same is filling rapidly. Objection to by-passers cannot occur by this, as a well-ventilated, well-flushed, and above all a properly designed and constructed sewer contains only fresh and no decomposed sewage, and thus no foul air.

It is of absolute importance that the orifices in the manholes should be made small enough to reduce the danger caused by the horses catching the studs of their shoes in the holes. It is a mistake to replace covers with large openings by covers with small ones, as is sometimes done, which are even then ineffective as they become clogged by silt. The author is of the opinion that the manhole covers are the cheapest and most suitable means for low level ventilating orifices, and these openings can be brought into practical form by due consideration. By the suitable selection of orifices in arrangement and construction, accidents would be decreased, but to eliminate them would be practically impossible even with the most approved style of covers. According to an investigation conducted by Herrn Falkenroth with the covers of various designs, he proves that the danger to horses is decreased by the use of large openings and the proper construction of the ventilating orifices. The requirements of an ample air circulation in dry weather and unhindered removal during storms are fulfilled likewise by large openings, which are not so liable to become clogged.

The long segmental, oblong, square, radiated orifices cannot be considered, due to the danger to horses. After Falkenroth's experiments, the manhole covers with circular openings proved to be the most satisfactory. The openings in all cases should be inverted conical so that stones and silt could then fall to the receiving tray placed under the cover, and the selection of sufficiently wide circular orifices (1½-in. or more) will also exclude, or at least restrict to a minimum, the number of cases of traffic troubles or accidents. Simultaneously with the correct choice the requirements of an ample circulation will be fulfilled. Cities that have replaced the former covers with covers having circular openings have succeeded by this innovation, and the openings have met the requirements in reference to favorable circulation, safety to traffic and cleanliness. (See Fig. 4.)

Whilst the most suitable form of ventilation known may be adopted, it cannot be said that the sewer ventilation problem has been solved. In spite of the circular openings it may be necessary to consider the possibility of occasional sewer tension during storms. The great draught in the upward direction retards the adequate air escape. The quick run-off of the sewage requires the installation of sufficient and uniformly distributed openings for the expulsion of the air. Since sewer ventilators are fewer than house drains, comparatively, the ventilating conditions would be much more favorable if a means was found in another group of low level connections to assist the ventilating orifices of the manhole covers during time of storms. This assistance may be obtained by the co-operation of street gullies. The gullies are at present generally constructed in such a manner that the silt washed away by precipitation is retained in special receptacles, and the gullies are trapped from the sewer. This construction has two great disadvantages, viz., the nuisance of foul odors and the danger of silting up. The receptacles of the street gullies, and to a certain extent the house gullies, on hot days and days of atmospherical fluctuations form a source of malignant odors. The deposits washed off by precipitation, consisting principally of paper, rags, street sweepings, fallen leaves, etc., mostly of an organic nature, undergo decomposition during their retention, often lasting for months, and thus pollute the air in the streets. A still more serious danger is caused by the traps. The light matter passing the gulley grating is not naturally retained, but frequently chokes the trap. Catch pits and water traps should be rejected in any case, even if cleaning takes place frequently. Firstly, the removal of the collected silt is neither

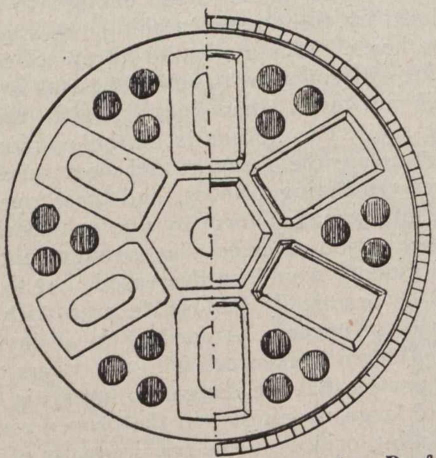


Fig. 4.—Manhole Cover With Circular Perforators (by Falkenroth).

hygienic nor æsthetic, and secondly, the silt retained in the receptacles will decompose and eventually infect the freshly entering flow, which will reach the sewer in a strongly contaminated state. With proper ventilation and flushing arrangements, however, in a sewer with sufficient grade, it would not lead to odorous nuisances, thus there is no necessity for a trap.

Simplicity should be the standard of a sewerage system, also the protection against odors of any kind. Therefore, the catch pits and traps should be discarded. It should always be the endeavor to prevent obstacles in design so as to remove the sewage, in fresh condition, as quickly as possible without any objection to the senses of sight and smell, from any dwellings. For this reason the water trap between the sewer and house drains has been rejected as unsuitable and the catch pits in the manholes abolished, as both have been the cause of a direct offence to inhabitants. Why is this measure not extended to the catch basins of the gullies and down-pipes? Why pin our faith to catch basins and traps in gullies, while close beside them manholes are built without catch pits, and their covers are, without any objection, equipped with ventilating perforations? The contradiction to this condition should be the best argument for the abolition of catch pits and traps. As soon as the catch pits are omitted no silt will be retained which would cause nuisances, and when the traps have been abolished there will be no more choking of gullies. Above all, an exceedingly favorable opportunity for a constant ventilation would be acquired. Indeed, in recent times prominent sanitary engineers were always advancing the advisability of the correct recognition of these advantages for the abolition of the gullies in the present form. Indeed, in recent times prominent sanitary engineers were always advancing the advisability of the correct recognition of these advantages for the abolition of the gullies in the present form. Prof. Ewald Genzmer advanced this desirability in the sewerage of the city of Schwetz (Fig. 5) which was designed by the author, and so did Stadtbaurat Fleck at Dresden. On the other hand, it will always be those who doubt the economy of such an enterprise who will speak against the generalization of the measure adopted in Schwetz. Such views can be discarded if we consider the figures. Generally one meets with the view that the quantity of silt retained by the catch pit would result, if omitted, in considerable additional cost for the cleaning of sewers. A calculation made by the author based on the annual report and the budget of the city of Dresden may lead to this aim.

According to the annual administration report of this city for 1911, the gullies in paved and macadam roads were cleaned in the recorded time, four times a year, in asphalt and wood-paved roads, sixteen times, on account of the bigger amount of silt conveyed into the gullies of the latter by precipitation and the more frequent washing. The catch basins of the down-pipes were cleaned only once a year.

The street gullies contained, on an average, 1/25 to 1/30 cu. yd. of silt, while that from the house gullies was only .07 to 0.11 cu. ft. The total silt removed was 4154.21 cu. yd. and the cost amounted to $5,250.

Frequently the washing of a street suffices to fill the gulley completely, so the catch basin or the tray in the basin will not be able to contain the larger quantity of silt which is washed away at times of precipitation. The silt, moreover, passes directly into the sewer where it is carried away by the sewage flow, or by flushing. The cost for the removal of street silt is, to the greatest extent, generally included in the cost for the cleaning of sewers, and only the smaller part comes into consideration for the cleaning of the gullies.

On investigation as to whether the sewers are able to withdraw the silt retained in the gullies or whether by its artificial removal by means of flushing, additional cost would ensue. Figuring on a water consumption of

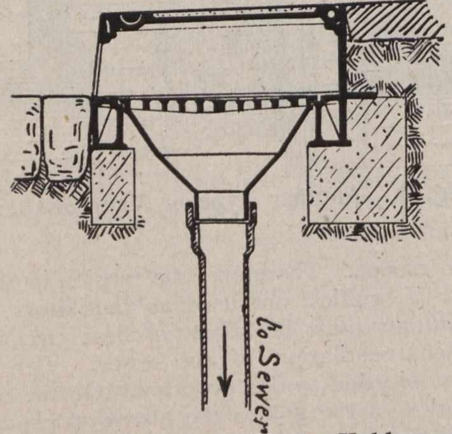


Fig. 5.—Street Gulley (by Kohlmann).

$120 l = 4.24$ cu. ft. per capita per day, it would mean for a population of 550,000 3,139,200 cu. yd. sewage per annum. The annual quantity to be removed from the gullies, however, only amounts to 4154.21 cu. yd. or 1.32 per M. of the D.W.F. (dry weather flow). Considering, further, a solubility of silt matter of 36%, the silt quantity would be able to be reduced to .085 per M. of the D.W.F. This small amount would doubtless be removed without any extra cost for haulage expenses by the uniformly flowing current of the D.W.F.

The conditions during times of storm are quite different. It is generally believed that the increased velocity, and larger flow in the sewers would have a greater clearing capacity. This is not the case. By practice it is shown that during a storm the greatest deposits will occur in the sewer. It was found by the author that the rainstorm of July 10th, 1912, deposited in a trunk sewer on the Terrassenufer at Dresden, a quantity of grit of 52.32 cu. yd., while under normal conditions the weekly flushing operation removes only 2.6 to 5.2 cu. yd. of grit in the same sewer.

Since through the lower parts of the sewerage system, in consequence of abolition of the catch pits, large quantities of silt will pass, there is a danger that in times of storm a greater deposit of silt will take place. The reason is that in times of storm only the suspended matter is attracted, which is taken into eddies, the remaining silt is deposited especially where the velocities vary considerably. The additional cost which the cleaning of the sewers involves would by no means be so great as that required for the cleaning of gullies. According to Herrn Kajet, the cost of cleaning gullies amounts to 30% to 40% of the total cost of cleaning sewers.

There is another reason for the abolition of the catch basins. It has often been stated that it is more rational to remove the silt from the gullies instead of the sewers, as they are more accessable. However, if it is considered that the periodical removal of quantities of silt from the gullies (in some cases weeks elapse before they are cleaned) can be executed only with difficulty and with a certain amount of nuisance, a method would be preferable by which the removal of street sweepings is obtained hygienically and æsthetically unobjectionable condition which is inevitable in the most perfect design of cleansing implements. This advantage offers the odorless and invisible removal of the street sweepings by the sewers. By this method a further advantage is obtained, viz., that the quantity of silt containing organic and mineral matter which is soluble up to 64% on its way, according to the time in which it remains in the sewer, is considerably reduced until eventually in the grit chamber at the sewage disposal plant a complete separation of the organic matter is affected, that is, the separation of the sludge proper from the mineral constituents, the heavier suspended matter. If the cross-section of the grit chamber is designed in such a manner that the velocity is never less than one foot per second, so the grit will settle while the putrescible sludge passes into the settling tanks with the fresh sewage without being affected whatsoever.

As the removal of the detritus in the grit chamber is effected principally by machinery, the result is of further economic advantages to this system, indeed a disposal plant will have, by the collection of the soluble and suspended constituents of the street sweepings, an overcharge, but the cost for cleaning would not be materially increased as the amount of soluble and suspended matter is only 36%, and but .085 per M. of the dry weather flow. Applying this to the Dresden conditions means that in the most favorable case, instead of 4154.12 cu. yd. of street sweepings which are carried into the sewer, only 2659.16 cu. yd. of mineral matter will settle in the detritus chamber. The cost of removal of 1 cu. yd. of silt amounts, in the Dresden-Neustadt plant, to about 38 cents, including the wages of men and maintenance of the dredge, while the cost for cleaning the gullies amounts to $1.34 per cu. yd. This example may suffice to dispose of the objections of those who have doubt in the economy of the method to convey the street sweepings directly into the sewers.

If, however, in some special cases, such as mountainous districts or asphalt and macadam roads, larger collections of sand are carried off by the quantities precipitated, and find access into the gullies it may be advisable to arrange small catch basins. In cases of paved roads, however, the arrangement of catch pits must be designated as absolutely obsolete. Together with the catch pits, there would obviate the last installations which would cause the pollution of the air, and thus the air of public sewers and of all connecting pipes to these would lose their offensive odor and character. With the abolition of traps indeed we have gained a further series of low level connections which effect at least as much as the perforated manhole covers and the co-operation of which for the ventilating process, in reference to the overweight of the domestic soil and down-pipes compared with the vent openings at street level restricted by the limited number of manholes, is of an importance which should not be underestimated. Indeed, we had to make certain alterations in construction in order to use the gullies for continuous ventilation.

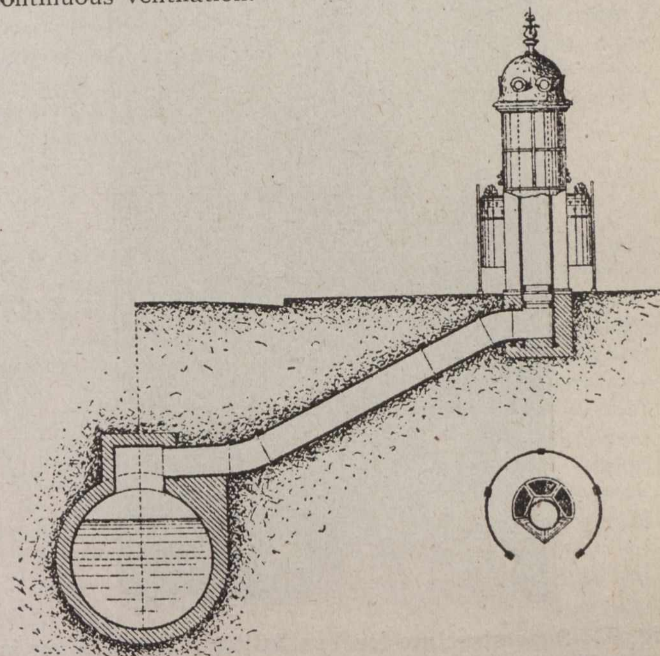


Fig. 6.—Ventilating Device on a Paris Trunk Sewer.

Gullies are generally adopted with cast iron gratings, either parallel or rectangular to the curb line. One may be of different opinion as to the advantage or disadvantage of both kinds. While it has been observed that in some cities gratings with bars parallel to the curb permit a better passage for floating matter, such as pieces of wood, paper, leaves, etc., other cities prefer, for the same reason, gratings with rectangular bars. With regard to the safety of traffic, both designs are not approved. On one side it is stated that horses with their studded shoes have been caught in gratings of the second style and damage resulted therefrom, while the opponents maintain the same gratings of the first design. In both cases the cause is probably to be found in the unsuitable construction of the gratings, too narrow slits, or their unfavorable location in the gutter. In any case, a well-designed grating has proved itself to be a rain inlet in flat streets. With the correct location in the gutter, gratings with sufficiently wide openings and rounded-off corners, which prevent the catching of studded shoes of horses, will fulfil all requirements in regard to safety both of run-off and to traffic.

Regarding the ventilation, it is more difficult to obtain sufficient results with this construction. With gratings, the experience has been found that in times of storm the large quantities of rain running off and extending over the grating, in consequence of the collected floating matter, does not permit the air trapped in the gulley to escape. To overcome this difficulty, the area of the grating should be increased by which the desired results can be obtained. The process performed thus is that the upper part of the grating collects the water and the lower will allow the escape of sewer air. An increase in the grating cannot always be obtained, especially in narrow business streets or steep roads, where the horses are equipped with heavy shoes and long studs; alternations in the design of these gratings have to be made. In steep roads where gratings do not answer the purpose, on

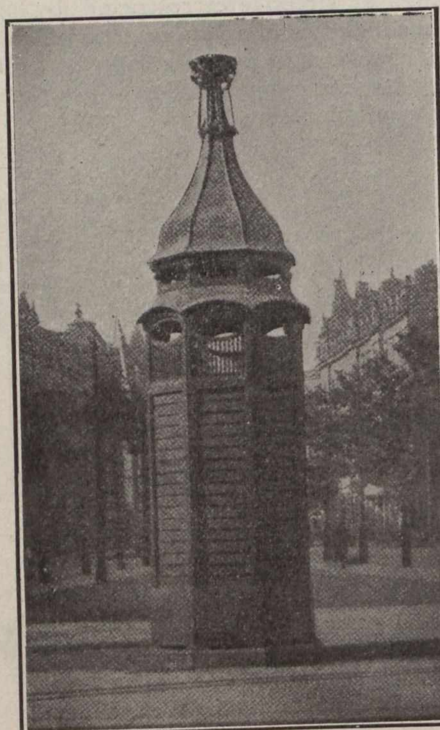


Fig. 7.—Superstructure for Ventilating a Trunk Sewer in Dresden. (The dome is equipped with self-recording rain gauges.)

account of the high velocity of the surface water and especially if the surface water contains much floating matter, it runs over the grating and the expensive and difficult installations of pre-grates have to be adopted so as to prevent the flooding of the streets in the lower districts. In these hilly districts gullies with side entrances have been successfully adopted. The side inlet gulley comprises all the advantages to the safety of run-off and of traffic, as well as ventilation. It carries away all floating matter and particles liable to clog the ordinary grating, and at the same time there is no danger to horses. With this installation the circulation of air in the sewerage system will always remain normal, as in times of storm its inlet is never wholly covered, thus the escape of air is not hampered. For these reasons the side inlet gulley is preferable and the adoption of gratings should only be permitted temporarily as is done in Schwetz, where broad streets with very little traffic are equipped with gratings.

It frequently happens that larger foreign matters are placed malignantly into the side entrance gullies by which the choking of the inlet takes place, which would otherwise be kept clear by the increased clearing power of the water rushing down. The removal of these matters can only be performed with difficulty and at considerable expense. The author considers it advisable to provide a funnel-shaped inlet with a movable grate, the openings of which are so arranged that only such matter is retained by which a choking of the drain is liable. By this method the ventilation would not be impaired.

By omitting the traps in the gullies the advantage is secured of the prevention of tension in the sewer air which is produced by the air adhering to the water in times of heavy precipitation. Even if the surface water discharged by the gullies contains atmospheric air, the ventilating orifices in the manhole covers will be relieved. As in times of storm, large quantities of air enter the sewer, attempts have been made to separate the mixture of air and water by what is known as air separators contained in bends or orifices in the down-pipes or special vent pipes in the down-pipes, but these attempts should not be considered on account of the dangers which may arise by the interruption of the duties required by the down-pipes.

Probably a better means for the conveyance of the air attracted through the down-pipes is by the use of the domestic soil pipes. It is a general practice in a combined system to convey the storm and sanitary flow by a common conduit to the sewer. Thus there would be no reason, in a combined sewerage system, to construct the house drainage on the separate system. With regard to the ventilation, however, there would be objections, and a separate introduction of storm and soil pipes from domestic premises into the sewers would be desired as well as in combined systems. We have already recognized the soil-pipes as the material means for sewer ventilation during dry weather as they are able to maintain by their higher temperature a constant current of air in the direction from the sewer to the atmosphere. It does not seem advisable to exclude these uniformly acting factors from the ventilating process during times of storm and to connect them with pipes which do not act air-ejecting as those do, but air-forcing. By the accelerated falling velocity, the down-pipes convey, during times of storm, quantities of air and water with such intensity that it cannot be of any effect to the soil-pipes on the sewer. If it is further considered that in dry weather the connection of both pipe systems in a common conduit promotes independent currents by the difference in the temperature prevailing between the down-pipes and soil-pipes, which results always in a trouble of the aspiring efficiency of the house connections on the sewer. The author thinks it advisable to introduce down- and soil-pipes as separate conduits. This would show that during dry weather the influence of the soil-pipe on the removal of the sewer air is greater than by the separation of the down-pipes and the trouble in the operation on the ventilating process would thus be eliminated.

During times of storm the sewers are quickly filled so that the house connections, the mouth of which are placed just above the level of the dry weather flow in the sewers, are soon submerged. It might be proposed to effect the introduction of the house drains at the top of the sewer. Thus, the ventilation of the sewerage system by means of the soil pipes would in any case separate again the quantities of air introduced by the down-pipes, and no tension in the sewer would occur.

If the introduction of the house drains at the dry weather flow level was placed so as not to be offensive to the workmen in the sewer by the discharge of domestic sewage, there would be no objection to the carrying out of this proposition for the inaccessible sewers, and as the exceedingly greater number of conduits in each sewerage system consists of inaccessible sewers there would be maintained in this greater part of the system an ample circulation and during times of storm the air quantities introduced by the roof water would easily be removed. With this construction no special auxiliary means, such as vent shafts, would be required. In larger sewers this proposal can scarcely be effected. Here also, a possibly high introduction of house drains would be desired. A higher location of the mouth in height of the springing line could not be attained as already in normal conditions in larger sewers complaints of offences become numerous

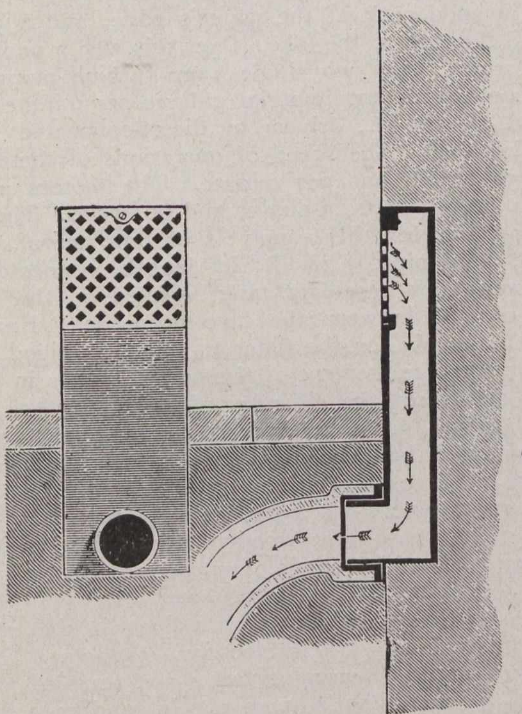


Fig. 8.—Air Inlets.

by the workmen in consequence of the splashing of sewage. Thus in big sewers where the distance between the manholes is greater, the adoption of vent shafts must be introduced.

Every sewerage system has further series of subterranean structures not to be avoided, such as side entrances or shafts with stairs. At these points the air would reach, under circumstances, abnormal tensions. On the other hand, these chambers will flood during times of storm and will be covered with sludge so that in such cases sufficient ventilation should be provided. These should be located at the highest points, as a nuisance to passers-by and neighbors may arise. They should also be equipped with special vent pipes which lead to suitable places in the atmosphere. In Paris, for instance, this is done by the use of the numerous public urinals, and in Dresden special superstructures have been erected over special entrances. (Figs. 6 and 7.) In some cities the efficiency of these vent pipes has been increased by artificial means, and in Brunswick gas stoves were used until recently in the trunk sewer vents. Leipzig used two electric fans to increase the suction through the vents, while in Magdeburg the aspiring ability of houses and high chimneys for the removal of the sewer air has been effective, similar to the ventilating efficiency of the soil pipes. In low-lying districts where manhole covers are air-tight, generally on account of floodings which occur, other means of ventilation must be adopted. In order to effect the circulation by two groups at different levels, a number of inlets have to be installed in lieu of air-tight manhole covers which could be designed in such a manner as is used in England. (Fig. 8.) The removal of the sewer air will then be performed by the soil pipes, or if this is insufficient an additional number of special vent pipes have to be provided.

The question as to the most efficient system of the ventilation of public sewers can therefore be answered thus: By constantly keeping a circulation of air in the sewers during the time of dry weather flow, thus preventing development of gases, and at time of storm to eliminate air tension. Therefore, there must be a constant circulation during dry weather from the perforated manhole and street gullies, without a trap, through the sewer to the soil pipes placed in a warm location and carried above the roof, and in times of rain an air current must be possible in the reverse direction from the down pipes to the manholes. The gullies without a trap and the soil pipes have to perform the separation of the attracted atmospheric air.

In such a manner it would be possible to remove the sewage from houses and premises without creating a nuisance or source of danger to the health of the community by the sewer air, and thus the modern system, that of numerous openings to the air, will have reached the highest degree of perfection.

DRAINING OF KERR LAKE.

An interesting feature of 1913 mining development operations in the Cobalt district was the draining of Kerr Lake in order to make available the ore in the immediate lake bottom, and also to allow prospecting under the lake to be carried on with greater safety. The following notes on these draining operations at Kerr Lake during the summer and autumn of 1913 have been supplied by Mr. Robert Livermore, manager of the Kerr Lake Mine, and appear in the recent report of the Temiskaming and Northern Ontario Railway, prepared by Mr. Arthur A. Cole, Mining Engineer to the Commission:—

After the granting of permission in May, by the Mining Commissioner to dewater Kerr Lake, work was taken in hand at once. All preliminary surveys had been made some time previously, defining the route for the water via a 20-in. pipe line directly from Kerr to Giroux Lake, crossing the Kerr Lake property over the height of land between the two lakes. The greatest elevation of the line above water level of Kerr Lake is 53 feet, the linear distance from lake to lake 2,400 feet, and the difference in elevation between the two lakes 20 feet.

Kerr Lake at this time covered an area of 30 acres, of which 18 belonged to the Crown Reserve, 6 to Kerr Lake, and 6 to the former Drummond Mine. The purchase of the latter acreage by the Crown Reserve and Kerr Lake Companies jointly included the total area of Kerr Lake under the ownership of the latter companies, by whom the entire operation was jointly undertaken and managed. Soundings made of Kerr Lake during the previous winter had established the fact that there were approximately 400,000,000 gallons of water and semi-liquid mud. Giroux Lake covers some 230 acres, and is of great depth, with a large outlet flowing to the Montreal River, so that by using the direct route instead of via Kerr Lake outlet and Glen Lake, to Giroux as at first proposed, there was no possibility of flooding other properties.

On account of the necessity of pumping a certain amount of mud together with the water in order to clear the bottom of the lake sufficiently for mining purposes, and on account of the changing level of Kerr Lake, and the consequent increase of head against which this material must be pumped, a pumping plant capable of great flexibility, not only in the nature of the material to be handled, and efficiency against a varying head, but also in changeability of base, had to be designed. This plant as finally installed consisted of four single-stage centrifugal pumps, arranged in two units. Each unit made a compound pumping outfit of two pumps, arranged one on each end of the base, with a direct-coupled motor between the two. The pump shells were 1½ in. thick, with removable side discs, the runners being of the enclosed type, capable of handling solids up to 4 in. in diameter. Each unit was designed to deliver not less than 3,000 gal. per min. at the highest elevation to be encountered. At the start the four pumps were to work in parallel, each discharging its own stream into the main pipe through specially cast fittings. When the head became so great that the best efficiency was not to be had, a change could be made from parallel to tandem operation simply by connecting the discharge from one pump of each unit to the intake of the other, by which arrangement two units, each of a two-stage tandem pump, could be obtained. The pumps were built by the Morris Machine Works, of Baldwinsville, New York. Their total weight is 28,000 lbs. The motors to run the pumps were furnished by the Canadian Allis-Chalmers Company. They are 250 h.p. induction motors, 2,200 volts, 3-phase, 60 cycles, having a synchronous speed of 1,200 revolutions per minute.

The pumps were mounted on a scow built at the Crown Reserve shops on the shore of Kerr Lake, of western fir throughout. 6-in. x 6-in. frame timbers, and 3-in. plank for sides, deck, and bottom were used. After installing the pumps and motors the scow was housed with a weather-tight superstructure.

Power was obtained from the line of the Northern Ontario Light and Power Company, which passes through the property.

Flexibility of connection was obtained between the pumps and the shore end of the pipe by 20-in. flexible ball and expansion joints, joined by a connecting flanged length of 20-in. pipe. As the level of the lake lowered new lengths of pipe were inserted between the ball joints, and supported by trestle bents, having slings for lowering the pipe as the level changed. The ball joint on shore was firmly bolted to a cement pier, and when the scow's distance from shore became too great for practicable support of the connecting lengths of pipe, the ball joint was moved down to the new water line, and re-established on a new pier. The scow was moored with wire hawsers at each corner passing to shore. These hawsers were manipulated by small capstans set up on shore and on the deck of the scow. In addition, two 30-ft. 14-in. x 10-in. spuds were provided, running in wooden guides at the stern of the scow, which could be raised and lowered at will, but in practice it was found that the mooring lines were ample to hold the scow in position.

The 20-in. pipe line connecting the two lakes was of the spiral, riveted, bolted, joint type, supplied by the American Spiral Pipe Works. This pipe was laid on the ground where possible, but where inequalities of the country made it necessary, on simple bents, two to each length. When the pipe crossed the township highway it was laid in a culvert blasted from the rock, and where it crossed the track of T. and N.O. Railway it was carried over, at a distance of 23 ft. above the rail, by two four-post towers, built of 8-in. x 8-in. timbers, somewhat of the ordinary aerial tram type. The angle of crossing made a span of 90 ft., for which three flanged lengths were used, supported by strap hangers at 8-ft. intervals, hooking over four ⅞-in. cables, passing over the tops of the towers in pairs, and anchored by logs set 6 ft. under a stone fill. The pipe line was carried directly to the water level of Giroux Lake, and later was extended in a long curve by extra lengths of pipe, and by a flume, to a remote cove of the lake, in order to avoid muddying the main body of the water.

As the two operating companies, and the Cobalt Comet Mine, formerly obtained their water for mine and domestic purposes from Kerr Lake, a new supply was necessary to take its place. To this end a permanent pumping plant was installed on the shore of Giroux Lake. A well 10 ft. square and 12 ft. deep was sunk in solid rock at the water's edge, and a 5-ft. cut blasted through to the lake. Over this well a pump-house was erected, and two single-stage turbine pumps, each of a capacity of 500 imperial gallons per minute against a head of 175 ft., driven by direct-connected motors, were installed. The speed of operations of these pumps is 1,750 revolutions per minute. The motors are each 45 h.p., 2,200 volts, 3-phase, and 60 cycles. The water-carrying line for this supply is of 8-in. spiral, riveted, bolted, joint pipe, 1,300 ft. in length, connected with a 46-000-gallon receiving tank, erected on the highest point of land between the two properties. From this tank the supply for the different mines is piped.

By the arrangement of the pump intakes in the well above described, the difficulty of protecting the suction lines against freezing, and of building secure piers, which would have been met with had the lines been carried out into the lake, were obviated. The various distributing pipe lines were securely protected against freezing by water-tight wooden boxes filled with sawdust, and heated by a 1-in. line carrying steam from the boilers.

A signal system, in which a float in the receiving tank, by making various electrical contacts at different stages of water, lit warning lights and sounded an alarm bell at the pump-house, was put in, and was found to work successfully.

The draining pumps were started on August 28th, and operations proceeded steadily until the cold weather in the latter part of November caused suspension of work, until this spring. The clear water was taken out very rapidly, and during the last three weeks of last fall's operations the pumps were handling mud alone. In all, some 325,000,000 gal. of mud and water were removed at an average rate of 6,000 gal. per min. for 38 actual working days.

Although the lake was not totally de-watered last season, a sufficiently large area was cleared to make available for stoping and development the most important blocks of ground of the two companies, and it was demonstrated that the remaining fluid could be pumped without undue difficulty.

Several important veins were disclosed, some of which had not been known before. One of the encouraging features revealed by the exposure of the lake bed was the fact that the top parts of the veins had been little affected through oxidation of leaching by the lake waters.

Allowing for the usual delays in delivery of equipment, and for a few changes of minor importance in the working out of the scheme, the installation was expeditious, and the operation successful from the standpoint of the two companies concerned. The novelty of the undertaking consisted not so much in the mere project of pumping out the lake, as in the working out of the numerous details, to which careful attention was necessary owing to the wide difference in the nature of material to be handled by the pumps, acting from a moving base against an ever-increasing head, and in these respects the problems involved seem to have been satisfactorily solved.

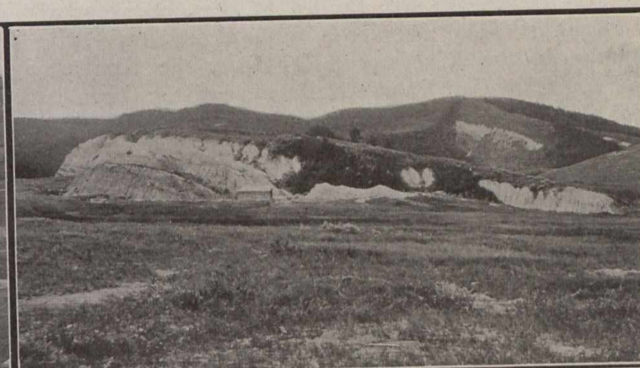
PROGRESS OF INVESTIGATION OF CLAY RESOURCES.*

By J. Keele,
Geological Survey of Canada.

DURING the season of 1913, the writer and two other members of the staff of the Geological Survey were engaged in examining clay deposits in various parts of the Dominion. The western provinces received the most attention, as they are dependent to a much larger extent on clay products for structural materials than the east.

The testing of clays and shales is one of the most important parts of this investigation, and occupies considerable time in the laboratory. An outline of the results of the field and laboratory work is as follows.—

Manitoba.—An examination was made of the shale deposits which are interbedded with the dolomitic limestones at the quarries in Stony Mountain and Stonewall.



White Fire Clay Beds in Dirt Hills, Saskatchewan.

Shale and Sand-stone Beds on Eastern Edge of Porcupine Hills, Southern Alberta.

White Clay in Edmonton Formation, Near Alix, Alberta.

Although these shales are hard and gritty, they become fairly plastic when finally ground and mixed with water, and capable of being moulded in clay-working machinery. Their lime content, however, is so high that they burn to a porous chalky body at all temperatures up to Cone 3 (1,190° C.). They could not compete with the surface clays of the district, which require no grinding and burn to a dense body at lower temperatures.

Samples of dark grey shales from Mafeking, sent to the laboratory for testing, were probably taken from the Benton division of the Cretaceous, which outcrops in this locality. These shales contained so much carbonaceous matter, as to be practically useless for the manufacture of clay wares. The carbon burns out of these shales with a bright flame, when they become heated to about 500° C., behaving in this respect like oil shales.

A plant for the manufacture of clay products is under construction at Carmen, this point being selected on account of the distributing facilities it offers for the manufactured wares. It is proposed to use the Niobrara shales from the Pembian Mountains near Leary, on the Carmen-Hartney branch of the Canadian Northern Railway. A carload of this shale was brought to Toronto during the winter and tested on a commercial scale in a sewer-pipe plant. The working and drying qualities of this shale were good, and a fairly satisfactory product with a bright salt glaze was turned out of the kiln.

Owing to the carbonaceous matter, and gypsum which this shale contains, the burning of wares made from it will be attended by some difficulty, until they are overcome by experience.

A mixture of the Niobrara and Pierre shales, both of which will occur abundantly in the Pembina mountains, will be found to give better results for sewer pipe.*

A consignment of clay samples from Sprague were tested in the laboratory. These, on testing, were found to be very similar to the surface clays at Winnipeg. They consist of an upper buff burning brick clay and a lower red burning clay. It is impossible to use the lower clay on account of its defective working qualities, but the upper clay makes an excellent common building brick.

Saskatchewan.—An examination was made of the clay deposits in the vicinity of the city of Saskatoon, and several samples were collected for testing. The results of the tests were not encouraging, as the materials present certain difficulties for successful working, and when these are overcome only the common grades of clay wares can be made from them.

Clay deposits at the town of Kamsack were investigated, the materials available at this point being buff burning surface clay overlying Niobrara shales of the Cretaceous formation.

The surface clays will make good building brick if burned sufficiently hard, but there is a tendency toward underburning and the consequent production of soft, porous wares.

The Niobrara shale in this vicinity is unworkable by wet moulded processes, owing to its excessive shrinkage and cracking in drying. This shale might be used for

*Published by permission of R. W. Brock, Deputy Minister, Department of Mines.

*Clay and Shale Deposits of the Western Provinces, Part II., page 93.

red dry-pressed bricks if the losses through fire checking did not run too high.

There is an extensive shale deposit almost precisely similar to this at Swift Current, an examination of which proved it to be subject to the same objections.

The Laramie formation in southern Saskatchewan contains clays which are the most valuable in the province.

The most important materials of this formation are the white or light grey, often sandy fire clays, and other deposits of a similar nature, but containing impurities which, for want of a better name, are called semi-refractory clays.

The fire clays of this region have fusing points between Cone 27 (1,670° C.) and Cone 32 (1,750° C.), while the latter fail in the fire test at Cone 15 (1,430° C.) to Cone 25 (1,630° C.).

Certain deposits of these types have already been described in published reports,* but their occurrence at a number of additional localities were recorded during the season of 1913, by Mr. B. Rose, of the Geological Survey and the writer, brief notes of which are as follows:

Fire clay occurs on sec. 14, tp. 11, Rg. 28, west of the 2nd meridian. This deposit is situated near the north end of Lake of the Rivers, not far from the Expanse branch of the Canadian Pacific Railway, and the Avonlea branch of the Canadian Northern Railway. Lignite also occurs in this vicinity.

Greyish white, soft clay, which is very gritty, was found in sec. 30, tp. 6, Rg. 18, west of the 2nd meridian. This clay has good plasticity and drying qualities. It burns white to grey, vitrified about Cone 10, and fuses at Cone 20. This deposit is situated near Brooking, on the Canadian Northern Railway lines.

A deposit of greyish white clay with rusty lumps, which farmers in the vicinity use as a plaster, occurs on sec. 31, tp. 3, Rg. 24, west of the 2nd meridian. This clay is very plastic, stiff and sticky. Its shrinkage is rather high, and its drying qualities are unknown. It burns to a buff color, vitrifies at Cone 10, with numerous dark fused spots on surface of test pieces. It fuses at Cone 20.

A bed of light grey, highly plastic clay was found about 7 miles south of Mortlach, on sec. 17, tp. 16, Rg. 1, west of 3rd meridian. This clay is said to be about 9 feet thick. It is overlain by a thin seam of lignite, and a bed of brown clay, containing gypsum particles. It burns to a cream color at lower temperatures, and becomes grey at high temperatures. It is vitrified at cone 9, and fuses at about cone 20. It resembles a stoneware clay, being very smooth and plastic, but the shrinkages in air-drying and burning are rather high.

Some samples of semi-refractory clay from southern Saskatchewan were sent to the clay-testing laboratory for examination. The amounts of clay sent were small, and no data was given regarding quantity or distribution of the deposits. One from the banks of the Frenchman River, near Eastend, resembles a stoneware clay, as it has good plasticity, rather smooth and burns to a grey vitrified body at cone 5. It fused at cone 15.

A small sample of clay was received from one of the smaller areas of the Laramie formation, north of the south branch of the Saskatchewan, sec. 17, tp. 21, Rg. 10, west of the 3rd meridian. This is the first specimen to be recorded from this area. It is a greyish white, rather sandy clay, with good plasticity and working qualities. It burned to a grey vitrified body at cone 9, and fused at cone 20. No information was received regarding the extent of the deposit or its distance from the nearest railroad.

Several samples of easily fusible, red burning clays were also collected at various localities from the Laramie formation in southern Saskatchewan. Most of these are open to objection on account of their poor drying qualities, and excessive shrinkages. It is possible that some of them can be used when mixed with the grey burning semi-refractory clays to produce bodies suitable for sewer pipe, face brick or fireproofing.

A sample of Pleistocene surface clay was received from Davidson, on the Regina branch of the Canadian Northern Railway. This clay cracked so badly in drying that it cannot be used for brick-making by any of the ordinary processes.

An effort will be made to use this clay by what is known as the ante-fired process, which consists in first calcining the clay in heaps as it comes from the bank. The calcined clay is ground in dry pans, mixed with a small percentage of lime, pressed into brick shapes, which are hardened in cylinders under a pressure of 120 pounds of steam. The method of procedure after the burned clay is ground is the same as in making sand lime brick. This process is in the experimental stage at present, but it may provide a way for using those clays which crack in drying.

Drying defects in clays are a serious difficulty in many of the Saskatchewan localities, and is one of the reasons that there are no brick plants along the main line of the Canadian Pacific Railway in this province. The probable cause of this defect, and a method of treatment to overcome it, was given in one of the reports of the Geological Survey.*

Alberta.—Our investigations up to the present time, have succeeded in recording the occurrence of fire clays only at one locality in this province. It is possible that fire clays, similar to those in Saskatchewan, will be found in the small area of the Laramie formation which extend into the southeastern portion of Alberta when the line of the Weyburn-Lethbridge branch of the Canadian Pacific Railway, now under construction, reaches that locality. Only a few places in Alberta were visited during the limited time at my disposal this season, which will be referred to briefly.

The occurrence of white clay near Nevis on the Lacombe branch of the Canadian Pacific Railway, was brought to my attention earlier in the season by Mr. J. O. Williams, of Camrose. This deposit was visited and samples collected for testing.

The material is a hard white or light grey shale about 4 feet in thickness. It is overlain by impure brown clay and underlain by grey shale impregnated with "bentonite."

The white shale is extremely plastic when ground and mixed with water, and cracks on drying.

It burns to a white to grey body, vitrifies at cone 9, and fuses at cone 16. It is not a fire clay.

The margin of the Porcupine hills nearest to the town of Macleod was also examined, and samples taken from 3 outcrops of shale at different levels. None of these proved to be refractory when tested.

A further examination was made of the shale deposits at Didsbury. The samples collected at this point were

*Preliminary Report of the Clay and Shale Deposits of the Western Provinces, Chapter III.; Part II. Clay and Shale Deposits of Western Provinces, Chapter III.

*Clay and Shale Deposits of the Western Provinces, Part II., Chapter VII.

satisfactory with regard to their working and burning properties, but a complete section of the beds could not be obtained.

It is impossible to state whether there is a workable body of shale or whether the sandstone beds were in excess.

These shales are in the Paskapoo formation, which yields the best material so far found in the province for the manufacture of wire cut brick, face brick or fireproofing.

Four samples from the clays and shales of the coal measures at Castor, sent to the laboratory for examination, were found to be defective in their drying qualities. These were from the Edmonton formation.

Drying defects in the clays of both the Edmonton and Belly River members of the Cretaceous are quite common. A drying test should always be made in the preliminary examination of these materials. A chemical analysis of a clay or shale is useless, the physical tests are the only guide to their value.

Athabasca River.—The following notes refer to some samples of clay collected by Mr. Sidney Ells, who examined the deposits of tar sands in Northern Alberta during last summer.

It may be noted that the clays secured were merely small samples from the surface of outcrops. During the warm weather bitumen and lighter oils seep out of the overlying tar sands, and run down more or less over the underlying strata. It is, therefore, possible that the body of these clays may be free of the contamination that exists on the outcrop from this cause.

An effort will be made during the coming field season to secure larger and more representative samples of these clays.

Lab. No. 187.—Dark grey, nearly black clay underlying bituminous sand on Moose River.

This clay is very plastic, fine grained, and smooth. It works up rather stiff and slightly sticky. Dries very slowly, with a drying shrinkage of 6.5%. This clay contains such a large percentage of asphaltic carbon that it is very hard to burn without swelling, unless burned very slowly during the oxidation stage. The density of body, due to the extreme fineness of grain, interferes with the expulsion of carbon, so that the oxidizing process of this clay is tedious.

The clay burns to a light red color at the lower temperatures, and to a buff or grey at higher. It vitrifies about cone 5, and is fused at cone 20.

This clay is of the stoneware type, but the carbon it contains is a detriment.

Lab. No. 188.—From east bank of Athabasca River, ⅓ mile above McMurray, Alta.

A dark grey clay, exceedingly plastic, and smooth, smelling strongly of asphalt when damp.

It burns to a light red color at a low temperature, becoming grey when heated up to cone 5 or thereabouts.

It fuses at cone 16.

Owing to its fineness of grain, and the fact that it contains a certain percentage of asphaltic carbon, this clay is very hard to burn. It could not be used unless a certain amount of it were calcined, ground, and added to the raw clay. This would improve its working, drying and burning qualities.

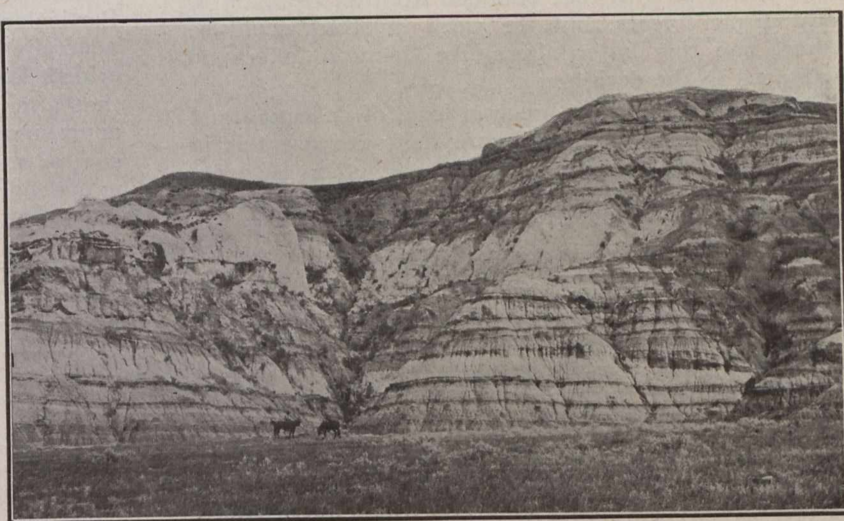
Lab. No. 190.—From point on N.W. shore of Muskeg River, between head of portage and mouth of river.

A light grey, very plastic clay, with good working and drying qualities. It burns to a cream colored, dense, steel-hard body at cone 3, with a total shrinkage of 9%, and softens when heated up to the temperature of cone 27. This is a good example of a stoneware clay, and is also a fire clay. It is the most refractory clay at present known to occur in the province of Alberta.

Lab. No. 191.—From Moose River, interbedded between bituminous sand and Devonian limestone.

Dark grey, very plastic, smooth, fine grained clay of the stoneware type. Burns to a salmon colored dense body at cone 3, with rather high shrinkage, and fuses at cone 18.

Summary.—These four examples of clay are alike in many of their physical characteristics, and appear to occur in the same geological horizon, viz., underlying the tar sands, on the Athabasca River, and its tributaries.



Typical example of clay and lignite beds in valley of Big Muddy River, South Saskatchewan.

They are very fine-grained sediments, and low in fluxing impurities, No. 190 being exceptionally so, hence they are more refractory than any of the Cretaceous clays from the southern part of the province.

The samples were too small in size to allow of complete determinations concerning their working and drying qualities, but they appear to be free from the drying defects so common to the western Cretaceous clays.

These clays are of the stoneware type, being exceedingly plastic, and burning to a light colored dense body at cone 5, while they retain their shape without softening when fired to much higher temperatures. Their most serious defect is due to the presence of asphaltic carbon, which renders the safe burning of wares made from them a difficult process. Nos. 190 and 191 appear to be free from this impurity, as far as could be told from the small samples, and these clays would be valuable for many purposes.

Owing to their position under heavy overburdens, and the remoteness from transportation at which these deposits occur, it is doubtful if they can be included in the economic resources of the region, at least for some time to come.

CRITICAL LOADS FOR IDEAL LONG COLUMNS.*

By Arthur Morley.

THE usual process of obtaining Euler's value of the critical load for the ideal case of a long, straight, axially loaded column of uniform cross-section is well known. It consists: (1) In writing from the simple theory of flexure the differential equation to the curve of bending in terms of the load, dimensions, modulus of elasticity of the material, and an arbitrary deflection at some selected cross-section of the column. (2) In solving the equation in conformity with the assigned end conditions of the column, thus deriving a general expression for the deflection. (3) In equating the appropriate value of this general expression to the arbitrary value previously assumed at the selected cross-section and solving for the value of the load.

For the third step we may, of course, substitute the method of equating the elastic strain energy of the column to the work done by the load in producing the deflection. If we use the correct form of curve, the result will be identical with that obtained from an equation of lateral displacements, but the work involved would be greater, and this latter alternative therefore offers no advantages to the designer.

Now, if we assume a general form of deflection and represent it by an algebraic expression, and use this in an equation of displacements or in the equation of work, we shall obtain a value of the critical load. Whether the value so obtained is, or is not, a good approximation to the true critical load depends mainly on whether the assumed form of deflection is, or is not, a good approximation to the true curve. For example, taking the fundamental case of a column of length l, fixed in direction at one end and quite free at the other, the deflection at a distance x from the free end bears to that at the free end a ratio of $1 - \sin \frac{x}{l}\frac{\pi}{2}$; this curve lies fairly close to that taken up by a corresponding cantilever transversely loaded at its free end, which gives a deflection $\frac{(l - x)^2\ (2l + x)}{2l^3}$ of that at its free end, and if this latter form be assumed for the column deflection, a good approximation to the critical load will result. But in the case of a column which tapers from the fixed end to a very much smaller section at the free end, the corresponding assumption is not a safe one, and will lead in some cases to an enormous over-estimate of the critical load. The assumption of a curve flatter than the true form leads to over-estimates of the load, and that of a form of exaggerated general curvature leads to under-estimates.

Method of Successive Approximation.—The following method may be applied to struts of any kind, whether uniform, in cross-section, or otherwise; for the purpose of explanation, the case of a column fixed at one end and free at the other will suffice, but there is no limitation to the type of end condition in the application of the method.

As a first approximation, assume any deflection of the free end, and any simple form of flexural curve connecting the free and the fixed ends—even a straight line, however impossible as a final result—will serve in the first instance as a good starting-point.

*Reproduced from April 24th issue of Engineering (London).

Secondly, use the assumed form of deflection in place of the unknown form in the differential equation to the curve of bending. Thirdly, by two integrations, with due regard to the end conditions for the determination of the constants of integration, obtain a general expression for the deflection at any cross-section of the column. Fourthly, equate the resulting deflection at the free end to that previously assumed, and solve for the load. This is the approximate solution previously described, and may be called a first approximation. Next write the general expression for deflection in terms of the derived value at the free end; this is a second approximation to the true form, and if treated in the same way as the first approximation will yield a third approximation, and so on indefinitely, each step yielding in general a new flexural form and a new value of the critical load. Successive values, after a few repetitions, tend noticeably towards a fixed limit, and this is the true critical value. It is quite easy to obtain a good approximation from a straight line as a first approximation; this gives a linear distribution of bending moment corresponding to a cantilever with a transverse end load, so that the second approximation starts with a curve corresponding to the cantilever curve. Particularly with such a simple initial assumption, it will generally be noticed that the successive coefficients in the critical loads are falling into an ordered sequence, and that after a few integrations the coefficients for further approximations may be picked out by inspection from the sum of a series. By proceeding to the limiting value for an indefinitely great number of repetitions, which may be

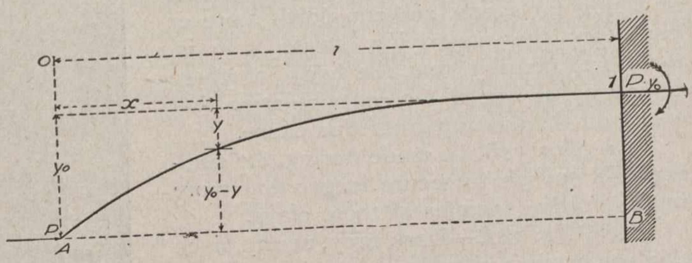


Fig. 1.

quite easy to determine, we may be able to write down an exact, instead of an approximate, value for the critical load.

For a strut, the cross-section of which changes from point to point along its axis by any but a simple continuous law, the determination may conveniently be carried out graphically. Any deflection curve initially assumed constitutes on a base-line through the free end parallel to the original direction a curve of bending moments ($M = P\ (y_0 - y)$, Fig. 1) for the strut under the action of the thrust, and well-known graphical processes give the resulting deflections. An equation of displacements then gives the first approximation to the critical load. The resulting curve of deflections may in turn be similarly treated to give a second curve, and so on until reasonable constancy is attained. Whether the treatment be graphical or algebraic, if the arbitrary choice of a first deflection curve should happen to correspond to the true form, the second form will exactly correspond to the first, and exact repetition will follow as often as the process is carried out.

The following examples illustrating this method are worked out for the case of a column fixed at one end and quite free at the other; from this case other important ones can be simply deduced by well-known relations. The first example is worked in some detail.

Notation.—Let o, Fig. 1, be the origin at the undisturbed position of the free end of the strut, x be the distance along the strut, and y the deflection. Let the suffix 1 refer to the fixed end, and the suffix o to the free end. Let l be the length of the column, I the moment of inertia of its cross-section about a central axis in its plane, and E be Young's modulus of elasticity for the material, and P be the axial thrust at the free end.

Then, in all cases the equation of simple bending is:

$$E.I.\frac{d^2y}{dx^2} = P\,(y_o - y). \quad . \quad . \quad (1)$$

EXAMPLE I.:—

Let the column be of uniform section—i.e., I = constant.

First Approximation.—Assume the deflection to be along a straight line 1 A (Fig. 1)—i.e.:—

$$y = \frac{l-x}{l}\,y_o, \text{ or } y_o - y = \frac{x}{l}.\,y_o. \quad . \quad (2)$$

Then equation (1) becomes:—

$$EI\frac{d^2y}{dx^2} = Py_o\frac{x}{l} \quad . \quad . \quad (3)$$

Integrating twice under the condition $\frac{dy}{dx} = 0$, and $y = 0$ at the fixed end—i.e., when $x = l$.

$$EIy = \frac{Py_o}{2l}\left(\frac{1}{3}x^3 - l^2x + \frac{2}{3}l^3\right) \quad (4)$$

and at $x = 0$,

$$EIy_o = \frac{P.y_o.l^3}{3} \quad . \quad . \quad (5)$$

from which the first approximation is:—

$$P = \frac{3EI}{l^2} \quad . \quad . \quad . \quad (6)$$

Second Approximation.—Dividing (4) by (5),

$$y = y_o\left(\frac{1}{2}\frac{x^3}{l^3} - \frac{3x}{2l} + 1\right) \quad . \quad . \quad (7)$$

which is the form for a cantilever with a transverse end load, as might be foreseen from (3), in which the bending moment is proportional to x; when known it might be chosen as a starting point instead of the simpler form (3), which does not comply with the condition $\frac{dy}{dx} = 0$ for $x = l$. Using the form (7) in (1),

$$EI\frac{d^2y}{dx^2} = Py_o\left(\frac{3}{2}\frac{x}{l} - \frac{1}{2}\frac{x^3}{l^3}\right) \quad . \quad (8)$$

whence, proceeding as before,

$$EIy = \frac{Py_o}{40l}\left(10x^3 - \frac{x^5}{l^2} - 25l^2x + 16l^3\right) \quad (9)$$

and

$$EIy_o = \frac{16}{40}Pl^2 \quad . \quad . \quad (10)$$

$$P = 2.5\frac{EI}{l^2} \quad . \quad . \quad (11)$$

Third Approximation.—Dividing (9) by (10),

$$y = y_o\left(\frac{5}{8}\frac{x^3}{l^3} - \frac{1}{16}\frac{x^5}{l^5} - \frac{25}{16}\frac{x}{l} + 1\right) \quad . \quad (12)$$

And again substituting in (1),

$$EI\frac{d^2y}{dx^2} = \frac{1}{8}Py_o\left(\frac{1}{2}\frac{x^5}{l^5} - 5\frac{x^3}{l^3} + \frac{25}{2}\frac{x}{l}\right) \quad (13)$$

from which,

$$EIy = \frac{1}{32}Py_o\left(\frac{1}{21}\frac{x^7}{l^6} - \frac{x^5}{l^5} + \frac{25}{3}\frac{x^3}{l} - \frac{61}{3}lx + \frac{272}{21}l^2\right) \quad (14)$$

$$EIy_o = \frac{1}{32}Py_o \times \frac{272}{21}l^2 \quad . \quad (15)$$

$$P = \frac{42}{17}\frac{EI}{l^2} = 2.4706\frac{EI}{l^2} \quad . \quad . \quad (16)$$

The successive approximations are $EI \div l^2$ multiplied by 3, 2.5, 2.4706, 2.4677 . . . etc., where the true coefficient is well known to be $\frac{1}{4}\pi^2 = 2.4674$ . . .

Each successive approximation for y approaches more nearly the true value—viz., $y_o\left(1 - \sin\frac{x}{l}.\frac{\pi}{2}\right)$.

Thus the true value at $x = \frac{1}{2}l$ is $y\left(1 - \frac{1}{\sqrt{2}}\right) = 0.293\,y_o$, whereas (2), (7), (12) give respectively $0.5\,y_o$, $0.3125\,y_o$, $0.295\,y_o$. The successive curves are each flatter than the true curve, and give a value of P in excess of the true value.

An alternative to the form (2) would have been to assume a parabolic curve:—

$$y = \frac{(l-x)^2}{l^2}.\,y_o \quad . \quad . \quad (17)$$

which satisfies both $y = 0$ and $\frac{dy}{dx} = 0$ for $x = l$. In this case the successive approximations are $\frac{EI}{l^2}$ multiplied by the factors 2.4, 2.4590. These are below the true value $\frac{1}{4}\pi^2$; correspondingly the values of y indicate more curvature than in the true sine form. For $x = \frac{1}{2}l$, (17) gives $y = 0.25\,y_o$, and the second approximation gives $y = 0.2875\,y_o$, as against the above true value $0.293\,y_o$.

The form (17) is the curve taken by the column under the action of a couple at its free end. This will, with any type of column, give a curve of exaggerated curvature and an approximation on the safe side, to the critical load. It will also provide a starting-point for approaching the true limit from the safe side. By starting from both sides it is more easy to judge the value of the limit from a very few trials when the limit is approached slowly.

EXAMPLE II.:—

Let I vary as the distance x from the free end—i.e.:

$$I = \frac{x}{l}I_1 \quad . \quad . \quad (18)$$

First Approximation.—Assuming the form (2) equation (1) becomes:—

$$EI_1\frac{d^2y}{dx^2} = Py_o \quad . \quad . \quad (19)$$

which gives:—

$$y = \frac{Py_o}{2EI_1}(x-l)^2, \text{ and } y_o = \frac{Py_o\,l^2}{2EI_1} \quad . \quad (20)$$

Hence

$$P = \frac{2 E I_1}{l^2} \quad . \quad . \quad (21)$$

Second Approximation.—

$$y = y_0 \frac{(x - l)^2}{l^2} \quad . \quad . \quad . \quad (22)$$

when substituted with (18) in equation (1) gives:—

$$E I_1 \frac{d^2 y}{d x^2} = P y_0 \frac{2 l - x}{l} . \quad . \quad . \quad (23)$$

Two integrations then give:—

$$y = \frac{P y_0}{E I_1 l} \left\{ - 1/6\, x^3 + l x^2 - 3/2\, l^2 x + 2/3\, l^3 . \right\} \quad (24)$$

$$y_0 = \frac{P y_0 l^2}{E I_1} \times 2/3 \quad . \quad . \quad . \quad . \quad . \quad (25)$$

$$P = 3/2 \frac{E I_1}{l^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (26)$$

The successive factors of $\frac{E I_1}{l^2}$ in the values of P are 2, 3/2, or 1.5, 16/11 or 1,45, 495/341 or 1.4516. . . . The assumption (17) is identical with (22), and leads to the same series of approximations.

The limit is in this case approached so rapidly that $P = 1.45 \frac{E I_1}{l^2}$ may be taken as a good approximation.

EXAMPLE III.:—

Let I vary as the square of the distance from the free end—i.e.:—

$$I = I_1 \frac{x^2}{l^2} \quad . \quad . \quad . \quad . \quad (27)$$

Following the method of the previous examples, the successive coefficients of $\frac{E I_1}{l^2}$ in the values of P are 1, ½, 2/5, 5/14, ⅓, 7/22, . . . etc.

Here the limit is approached much more slowly, and evidently the first two approximations are very bad and yield very incorrect value of P on the unsafe side. From the way in which the coefficients develop in the integrations (which would take too much space to reproduce in full) it becomes evident that successive values may be written from the numbers in Table I., overleaf. These numbers are interesting and very simply related; the constitution of the first two lines is obvious, and the lowest number in each column is a repetition of the one above it. All rows after the first may be written by making each number the sum of that above and that to the left of it.

Successive approximations to the coefficient of $\frac{E I_1}{l^2}$ are obtained by dividing the sum of any column by the sum of the succeeding column; for the word "sum" "last number" may be submitted, since the last term in any column is equal to the sum of the previous column. To reach any degree of approximation is now only a question of simple arithmetic, but we may algebraically proceed to the limiting value of the coefficient. The successive numbers in the $(n + 1)$th column are:—

$$1,\ n,\ \frac{n(n+1)}{1.2} - 1,\ \frac{n(n+1)(n+2)}{1.2.3} - 2,$$

$$\frac{n(n+1)(n+2)(n+3)}{1.2.3.4} - \frac{n(n+1)}{2} - 2n - 3, \text{ etc.}$$

The nth number is

$$\frac{n(n+1)(n+2) \ldots (2n-3)(2n-2)}{n-1} - \frac{n(n+1)(n+2) \ldots (2n-4)}{n-3} - 2\,\frac{n(n+1)(n+2) \ldots (2n-5)}{n-4}$$

$$- 3\,\frac{n(n+1)(n+2) \ldots (2n-6)}{n-5}, \text{ etc.},$$

$$- \frac{(n-5)(n+2)(n+1)n}{1.2.3} - \frac{n(n-4)(n+1)n}{1.2}$$

$$- (n-3)\, n - (n-2).$$

Taking the ratio of the nth number of the $(n + 1)$th column to the $(n + 1)$th number of the $(n + 2)$th column, and proceeding to the limit in which n is indefinitely great, we find the limiting value of the coefficient to be ¼.

If we assume the form (17) as a starting point, the successive approximations to the coefficient of $\frac{E I_1}{l^2}$ are ⅔, 6/13, 26/67, 134/381, etc., for which a table may be constructed to give further approximations by arithmetic; the table is not quite so simple as Table I., but gives, of course, the same limiting value, and the alternative offers

TABLE I.

	1	1	1	1	1	1	1	1	1	1
		1	2	3	4	5	6	7	8	9
			2	5	9	14	20	27	35	44
				5	14	28	48	75	110	154
					14	42	90	165	275	429
						42	132	297	572	1,001
							132	429	1,001	2,002
								429	1,430	3,432
									1,430	4,862
										4,862
Totals	1	2	5	14	42	132	429	1,430	4,862	16,796
Coefficients of $\frac{E I_1}{l^2}$	1	$\frac{1}{2}$	$\frac{2}{5}$	$\frac{5}{14}$	$\frac{14}{42}$	$\frac{42}{132}$	$\frac{132}{429}$	$\frac{429}{1,430}$	$\frac{1,430}{4,862}$	$\frac{4,862}{16,796}$
Coefficients as decimals.......	1	0.5	0.4	0.3571	0.3333	0.3182	0.308	0.300	0.2941	0.2894

no advantages. By modifying a numerical coefficient in, say, the second approximation for y, we may bring the resulting value of the coefficient of $\frac{E I_1}{l^2}$ near or exactly to $\frac{1}{4}$, but the succeeding values will go away from the true coefficient, and then gradually approach it again, so that the simplest assumption (2) appears to be as good as any other. This example scarcely represents a type of practical column, but it illustrates well the method of successive approximation and the entire unreliability of the early approximations in certain cases of columns of variable section. Its exact solution may be obtained from the differential equation (1), which, with (27), becomes—

$$x^2 \frac{d^2 y}{d x^2} + \frac{P l^2}{E I_1} \cdot y = \frac{P l^2}{E I_1} y_0 \quad . \quad (28)$$

The solution under the assigned conditions is—

$$P = \frac{1}{4} \frac{E I_1}{l^2} \text{ and}$$

$$y = y_0 \left(1 - \sqrt{\frac{x}{l}} + \frac{1}{2} \sqrt{\frac{x}{l}} \log \frac{x}{l} \right) \quad . \quad . \quad (29)$$

a value which will, of course, repeat itself after a succession of integrations of equation (1). How greatly the second value of y, which is—

$$y_0 \left(\frac{x}{l} \log \frac{x}{l} - \frac{x}{l} + 1 \right) \quad . \quad . \quad (30)$$

corresponding to the end loaded cantilever curve, differs from (29) is evident by comparing the values of y for, say, $x = \frac{1}{3} l$; the form (29) gives $y = 0.105 y_0$, while (30) gives $y = 0.301 y_0$.

The weakness of this column lies in the flexibility of its free end, which would also reach the elastic limit before the critical load, unless modified in shape.

(To be continued.)

A NEW ELECTRICAL DIRECTORY.

The McGraw Electrical Directory.—The last semi-annual issue of the McGraw Electrical Directory has been received. This very useful book contains a list of central stations in the United States, Canada and Mexico, giving for each station full particulars of equipment, personnel of operating force, ownership, etc. This issue gives the details of 434 Canadian companies, including municipal systems. This list includes nine companies that have been organized since the publication of the last half-yearly list. The total number of generating stations in Canada is 402, not including substations. The number of companies purchasing energy is 28, while there is an equal number of municipal systems purchasing energy. There are 175 municipal lighting systems. In Canada, electrical supplies are carried by 244 of the firms or municipalities. Much other useful information is also contained in the volume, which is 726 pages, size 4¼" x 8½". The price of the Directory is $5.00, and it can be ordered through the Canadian Engineer Book Department.

A Chicago report of June 6 states that the plans for that city's new west side terminal railway station have been approved by the Illinois public utilities commission.

A recent report from New York states that the New York Central lines have contracted for 7,300 freight cars. This order is the largest since the purchase of 12,000 cars last year by the Pennsylvania lines. The New York Central has divided its order between the American Car and Foundry Company and the Standard Steel Car Company, the former to supply 4,300 cars, and the latter 3,000 cars.

UNIT PRICE vs. LUMP SUM CONTRACTS.

MANY arguments have been advanced to uphold the advantages and disadvantages of the various methods in vogue by which the contractor receives his remuneration for work which he has undertaken to do. It is generally understood that there are imperfections connected with each, but that under certain conditions one may be considerably better than another. In a paper which he read last fall at the 10th annual convention of the American Road Builders' Association in Philadelphia Mr. H. C. Hill brings forth a number of arguments in favor of the unit price method, and attempts to prove that in the majority of cases contract work on this basis is the correct method. He argues that percentage work is nothing more than day labor, so far as the cost of manual work is concerned. It differs in total cost only in that there is at the start an organization with a certain knowledge of how the work should be laid out and executed, directed by a man or firm whose reputation for doing work at a reasonable cost is at stake.

The following is a portion of Mr. Hill's paper:—

Contract work has every advantage that percentage work has, and something in addition, namely, an incentive, which constantly spurs every man, to a more or less degree, depending upon his nature, to do the work set before him in the most economcial manner and with the least expenditure of energy. Some will say that this is too true and leads in a few cases to poor work. If this is so, it is not the fault of the method, but the fault of those doing the work, more particularly those having supervision; for it is possible to eliminate entirely those contractors who desire only to make as large a profit as possible, irrespective of the class of work done—and it has been done.

An attempt has been made to instill "incentive" into percentage work by establishing a price on each unit of work and paying a bonus on a sliding scale if the work is done at a cost less than that first agreed upon. This is a very delusive point, and those familiar with the variable factors in cost data will readily see the futility of it. Furthermore, it will not take much of a mathematician to figure that it is the percentage and not the bonus that gives the contractor his profit, unless the agreed price is considerably higher than the actual cost should be. It being true, then, that percentage work tends to increase the cost of the work, there remains the question of under what method of payment contract work shall be done.

In comparing the advantages and disadvantages of lump sum and unit price contracts, it is possible to consider them under two heads, namely, the engineering feature and the moral aspect.

The point upon which the advocates of the lump sum method lay the greatest stress is that the cost of work is reduced by having the engineering charges a minimum. Those of this opinion are wont to tell how much cheaper work is done, basing their comparison on an average cost—as in highway construction the average cost per mile—instead of basing the comparison upon the actual amount of material moved or used. The truth or falsity of this statement is not subject to any specific proof, for it is impossible to have the same piece of work done by both methods, but it is subject to proof in a general way. A very close approximate might be obtained, if desired, by procuring bids for the same piece of work on each method, then after the completion of the work comparing the average of all the lump sum proposals with the average total of the unit price proposals, using, however, as a basis for the latter, not the actual unit quantities as shown by a final estimate, but the bidding schedule quantities. This is, perhaps, more theoretical than practical, but satisfactory proof that under lump sum contracts the work costs more is furnished by the fact that no reliable, experienced contractor will bid as low on a lump sum proposal as he will if the work is to be let on a unit price proposal. This is a definite statement, but one which a majority of contractors will agree to, and for this reason: Contract work in any form contains certain factors the exact nature of which it is impossible definitely to determine until after they are encountered, and every contract, except it be a percentage contract, must necessarily be more or less of a gamble. Therefore, no contractor overlooks this factor —and you can rest assured that the larger the risk the higher the bid. This element of risk is less on a unit price contract than on a lump sum; for under the former, should a certain class of work increase over the estimate, the contractor gets a corresponding increase in pay, and should less work be done he gets a corresponding decrease in pay. Under the lump sum method such changes have no effect upon the amount of money received by the contractor for doing the work.

In some cases under lump sum bids, estimates for the various quantities are prepared, but the general practice is for the bidder to ascertain these for himself, either by his own engineer or by guess based upon general knowledge. Even in cases where careful estimates are prepared, the final quantities are not the same as those upon which the bid was made out; therefore, as far as payment is concerned under this method, estimates are of no positive value. The fact, however, that there is a variance between the preliminary and final estimates is not the fault of an engineer, for it is impossible to determine accurately the exact quantities until the work is completed.

The theory of the unit price method is a very simple and just one. Expressed in a few words it conveys this idea: The contractor is to be paid for just what he does and to do just what he gets paid for. Nothing could be more equitable than this. However, like everything else, it has its imperfections, but not of a very serious nature. Its weakness lies not in itself, but in the hands of inexperienced men, incapable through ignorance of properly preparing unit quantities. This weakness causes what is known as unbalanced bidding, and consists of bidding high on items the estimate of quantities of which in a contractor's judgment is lower than will be used, or vice versa, and so regulating his bid on these items that he will lower his total bid and at the same time increase the aggregate amount he will receive for doing the work. This results sometimes in putting an engineer in an embarrassing position. Those who condemn this method should ask themselves if an unbalanced bid is any worse than an unbalanced bidding schedule prepared by engineers, and if criticism of unit price contract methods is not primarily due to those who make the estimates and not to the contractors. If engineers were as careful not to leave any loopholes in preparing estimates for contractors to bid on as they are making out specifications for doing the work, unbalanced bidding would become almost an unknown quantity.

Another advantage of having work done by unit prices is that it enables changes to be made while the work is in progress with the least possible chance of any dispute, and as a rule at a less cost than by the lump sum method. Oftentimes such changes are to the disadvantage of the contractor, but the majority of them realize that the changes are necessary for the proper execution of the work; and so much more satisfactory to them are unit prices that they prefer to do work by this method, submitting willingly to such additions or deductions as may be found necessary while the work is in progress. While changes are, of course, possible under the lump sum method, so much is involved that only as the last resort is any change made. This is unfortunate, for often during construction it is possible to make some alteration that will improve the work and perhaps save more than the total engineering expense of having the work done on a unit price basis.

Great as are the advantages of the unit price contracts, viewed from the engineering standpoint, they are even greater from the moral standpoint. To make money is obviously the principal object of every contractor who earns a living by his work. The word "principal" is used instead of "first" to differentiate. His first object should be to do as good work as is intended by the specifications. It is, however, the nature of many people not to do the task set before them in as careful, thorough and complete a manner as desirable. In this respect contractors, and more particularly their employees, are not unlike others; hence the importance of any method of payment that will remove the temptation to do poor work. It needs only a superficial examination of a lump sum contract to see that not only is the incentive to do faithful work absent, but there is also a premium for not doing it.

STEEL DIRECT FROM ORE.

Now that modern conditions demand such severe specifications for steel, it is an undoubted fact that the steelmaker is experiencing greater and greater difficulty in meeting these demands. The difficulties experienced in eliminating such impurities as oxygen, phosphorus, sulphur and silicon, and the practical failure to eliminate nitrogen and hydrogen, have naturally led to a search for a method of manufacture with which a purer steel could be more readily obtained. An account of some experiments to this end were given at a meeting of the Iron and Steel Institute of Great Britain recently. An electric furnace was selected, the ease with which it can be controlled, and oxidizing and reducing conditions obtained at will, being the chief factors influencing this decision. Three series of tests were made—viz. (a), direct reduction of silicious Swedish iron ore; (b) direct reduction of Swedish and a silicious Swedish iron ore, with 30 per cent. of scrap mixed in the charge; (c) direct reduction of Brazilian iron ore. The result was the production of a steel of great toughness, and having regard to the fact that so much is heard of the baneful effect of nitrogen and hydrogen in steel, it is claimed as a distinct advantage of the process that these gases are never introduced into the charge. The result is that the conclusion has been arrived at, by those who carried out the experiments, that with the aid of the modern electric furnace, and given satisfactory conditions, the economic manufacture of steel direct from ore is a practical possibility. It is suggested that a special type of Héroult furnace will be developed for the purpose, and probably the best use for the process will be found in countries which possess readily available sources of water power, together with deposits of pure rich ores. There is considerable scepticism, however, on the part of many as to the possibility of making any such process a commercial success. That steel can be manufactured in this way is not denied, but its manufacture on a competitive commercial scale, except for very special purposes, is seriously doubted. The fact that it has been tried before and failed, however, does not necessarily prove conclusively this argument.

The annual report of the Department of Mines of the Dominion Government declares that "the district between Regina and Moose Jaw, and the district along the Alberta boundary in Saskatchewan is reported to offer a chance for oil operations." It is rumored in Regina that an oil expert will investigate the matter in the near future.

Editorial

MECHANICAL TREND OF ROAD CONSTRUCTION.

The problems which the development of mechanical traction upon our highways has occasioned are manifestly well distributed. The financing, engineering and construction phases of road building are each effected in relatively proportionate ways. Greater expenditure upon construction and maintenance for the first, changes in design and materials attended by new forces, and to be solved under more stringent conditions than formerly, for the second; and changes in the method of carrying out these plans and designs, in the case of the third, have produced three-cornered problems coincident and interdependent upon each other.

The greatest changes, however, have transpired in the methods of construction. The production of labor-saving machinery and equipment, in evidence wherever there is a road development or organization, has created a necessity for expert attention and care, in order that this machinery may be efficient of operation and long of life. The situation has been well explained by Mr. H. T. Routly, well-known for his road building in Northern Ontario and in Quebec, in a paper recently presented to the University of Toronto Engineering Society. He states: "Once a system of roads has been located, designed and laid out by the civil engineer his work is practically over—except for passing the estimates of work done. The business of actual road *construction* is a question of machinery in three phases: (1) selection and purchase, (2) operation and care, (3) maintenance and repair. And here is an ever-widening and remunerative field for students and graduates in mechanical engineering, with suitable positions as stepping stones all along the line and at its best during the students' vacation season. Few of them are taking advantage of the opportunity. The positions are filled mostly by men who have graduated from a threshing engine in one season. Many have to be trained on the work without previous experience. As a matter of fact, these latter men are usually the more satisfactory, for they come admitting their inexperience and readiness to learn. They are usually very careful, and while ambitious for advancement, are more willing to earn it by strict attention to duty. But their lack of technical education is so serious a handicap that they can rarely reach the higher ground and are unable to render themselves as useful to their employers as they otherwise might.

"It is seldom that a road outfit is found under the charge of a first-class practical mechanic or engineer, and yet nowhere are his services more urgently needed. The man in charge of all such outfits, whether owned by municipalities or by contractors, should be first of all a manager of men, after that a first-class machinist, and lastly, a practical road builder. Others may arrange these essential requirements differently; all will agree about the first requirement, being the ability to handle his men; I maintain that it is easier for the machinist to acquire a thorough knowledge of practical road building than for the road builder to acquire a thorough knowledge of the machinery he is required to use. Without that knowledge he is only half efficient and is always at the mercy of and dependent upon his various machine men, his lack of such knowledge detracting from his prestige not only with the machine men themselves but with the other men as well.

Ordinarily a road outfit will be working at some distance from any machine shop where repairs can be readily obtained. The building season is short at the best, and delays for machinery repairs very expensive. The superintendent who can detect and remedy faults before they become dangerous and who can repair on the ground the ordinary breaks, is able to keep his plants working a much greater percentage of the possible working time and to save a larger proportion of maintenance and depreciation charges than the superintendent who lacks the thorough knowledge of his machinery.

"PRACTICAL" AND "THEORETICAL" DESIGNING.

In *The Canadian Engineer* for June 4th, 1914, appeared an article entitled "Practical Design of Steel Structures." The writer, as the title suggests, is emphatic in his estimation of the value of "practical" compared with "theoretical" design. Some interesting comments upon the paper have appeared in a recent issue of "Engineering and Contracting," which will be found interesting, no doubt, by many who had read the article referred to. Our contemporary emphasizes the absurdity of any division of the subject into two classes: "practical designing" and "theoretical designing," as follows:

One is just as "practical" as the other, and neither is "theoretical" (which means not practical or depending on theory). The making of preliminary plans most certainly should be in charge of a man who is essentially practical. . . . We believe that it is a mistake to attempt to set apart, arbitrarily, one branch of engineering design as "theoretical," and assign to it men who have received training in our engineering schools, and another branch as "practical," and to place in charge of it men who have gained their entire knowledge of engineering from the school of experience. Either type of man may become eminently successful in any branch of engineering, provided he has the proper desire and ability to learn and the necessary application. To be successful in any branch of engineering one must be essentially practical, and this quality cannot be measured by the fact that a man has or has not received training in an engineering school. Such a training, however, we believe is advisable.

The field of engineering has broadened so much in the last twenty years, that it is no longer possible to say just what it includes or excludes. It has no hard and fast line of limitation, nor yet are the lines of division between its various branches quite distinct. This is a condition which has had to be met, in the education of the young engineer, by drafting into the university, as teachers, men of high professional standing from the world without. Such men are best capable of giving useful instruction in theory, and demonstrating, by live examples from the field, how and where theories apply in practice. They have come to possess, moreover, through the ups and downs of their experience, a keener and warmer sympathy for the student in the profession.

ROAD PRACTICE IN BIRMINGHAM, ENG.

SOME interesting references to methods of road construction and maintenance in Birmingham, Eng., were brought out by Mr. H. M. Lawson, Deputy Road Surveyor for that city, in a paper read on March 5th, 1914, at a meeting of the Institution of Municipal and County Engineers. Mr. Lawson's paper dealt with water-bound macadam, tar-spraying, asphalt macadam, sett-paving, sheet asphalt, and street-cleaning. The following notes, dealing with several of these, are abstracted from his address:—

In many instances water-bound macadam roads are condemned as useless under average traffic conditions; the chief reason for this is that in many cases these roads have no foundations or proper drainage. Therefore it is of great importance to get a solid and well-drained foundation, and adequate surface drainage; also to ascertain that every care has been taken to decide the wearing qualities of the stone employed, and to ensure that it is of one uniform quality. It is obvious to any road engineer that, wherever one has stones of different qualities (and this applies also to stone-sett and wood paving), the softer stone soon begins to show itself by wearing down below the harder, resulting in a series of up and downs.

The city engineer of Birmingham, in dealing with the construction of new water-bound macadam roads carried out by contractors, has a specification which is strictly adhered to, inspectors being appointed for the special purpose of looking after this class of work.

The form of construction is as follows: A layer of clean clinker ashes or broken stone, 6 in. in depth when rolled solid, is followed by a second layer, consisting of hand-pitched slag, 6 in. to 8 in. in depth (according to the nature of the traffic), set on edge, in the manner of a rough pavement. Over this layer a coating of broken slag or other approved material is laid, so as to fill up the interstices to form a smooth surface; each layer is thoroughly consolidated. A row of 4-in. by 6-in. granite setts on concrete is laid outside the channel stone as a margin course. The metalling for finishing the carriageway is then spread with forks in two coats. The first coat having been uniformly spread over, the whole carriageway is then rolled until consolidated. The second coat is then uniformly applied and consolidated, making a thickness of 6 in., the surface then receiving a coating of fine clippings of the same description of material as the metalling used; the chippings are screened through a ¾-in. mesh, and include the finer material, down to dust. The carriageway is then lightly watered and rolled until thoroughly consolidated, two men being engaged in sweeping the chippings into the interstices of the stone. On completion, it is coated with a thin layer of ½-in. chippings of similar material, free from dust. Each layer is laid to a camber or gradient of 1 in 25.

The author has found, in carrying out this work, that at times, unless one has been careful in choosing a sufficiently tough stone (and in some cases the cost prohibits this), the stone is broken and crumbled in the process of consolidation by steam rolling; to obviate this, a little binding material in minimum quantity is spread over the metal and slightly watered. Too much attention cannot be given to the spreading of the stone, which really requires great care and skill, as the evenness of wear of the surface greatly depends upon uniform spreading.

In Birmingham the city engineer pays a small bonus to the spreaders; this method works exceedingly well, as there is competition among the men, and only the ablest men are selected for the work. Great care must be taken to see that very little water is used, as there is a tendency on the part of rollermen to use as much as possible, to expedite rolling operations. The loading of this stone into the carts is done with forks, but in a district formerly under the author's supervision, when carting stone on to a site and tipping it close to the spreading, a difficulty was experienced owing to a thorough turning over of the material being impracticable. This was remedied by tipping the stone on to concrete mixing boards, thereby ensuring that it was properly turned, and so obviating any chance of having larger stones in some parts of the road and smaller ones in other parts, besides preventing all the dust, etc., from settling at the bottom.

The method of recoating is to scarify the crust of the old road, regulating the old material, and then applying a 3-in. coat of new metal. Generally speaking, there are two ways of repairing a macadam road, patching or recoating the whole surface. As soon as any pot-holes or uneven wear appears it should be attended to immediately, the cause ascertained and remedied, and the necessary repairs undertaken. If repairs are delayed it generally means that in a very short time the recovering of the whole surface is necessary, which adds considerably to the cost of repair. Any road, the crust of which is weak, will very soon become bumpy. It is most difficult to keep the surfaces of roads in good condition, owing to the various statutory authorities, such as gas and water companies, interfering with them; also by reason of the fact that in most of the main roads in this city there is a tramway track, and in many parts the sides between the track and the channel is constructed in macadam. This requires constant attention, owing to the traffic causing a rut to form next to the paving. Macadam roads are also being considerably damaged by motor 'bus traffic, and in comparing the repairs to a certain road prior to 'buses running with a corresponding period afterwards, the cost was found to be practically trebled. These motor vehicles do a vast amount of damage, particularly in roads not constructed to sustain their weight and destructive influence.

Tar-Spraying.—In treating road surfaces by the application of tar, the author has found that the life of the roads is prolonged, and also the dust nuisance reduced to a minimum. The chief object is to secure a deep penetration of tar below the surface, so that the metal may be kept together, and a road treated properly in this manner should have the appearance of a tarred-macadam road.

Last year, in Birmingham, 1,771,515 super. yds. of roads, comparable with a length of over 134 miles, were tar-sprayed. The major portion of this work was done by six 1,000-gallon machines, hauled by steam rollers, the cost per super. yard being just under a penny.

To get the best results from tarring, the surface must be thoroughly clean and dry, it being a waste of time and money to treat the surfaces of roads with tar when in a bad condition. The author has observed many failures owing to this alone, and thinks that it is obvious that by tar-spraying a bad road it cannot be converted into a good one.

Tar-spraying should be carried out in a methodical manner, all roads coated or reconstructed in the fall months being tar-sprayed in the early spring, and again, if necessary, in the early autumn. Hills having a steep gradient should be specially gritted if tar is applied to the surface.

Sett Paving.—The author is of opinion that the following describes the most serviceable form of paving for heavy traffic: 5-in. or 6-in. setts laid upon a foundation consisting of Portland cement base concrete, 9 in. thick (6 to 1), on which is placed a bedding of slightly damped cement and sharp sand, free from silt or loam, to a thickness of 1 in. The paving should be laid before the concrete becomes too hard, when sufficiently damp or mellow enough for the 1-in. feed to unite with it. The setts should be damped with a rose water can, and then grouted with a mixture of 3 of sharp sand to 1 of cement, and rammed as soon after as possible, the whole forming a 16-in. seal of solid mass. Great care must be taken to see that the whole of the materials are thoroughly mixed and of the best quality. No traffic should be allowed over the paving for at least ten clear days.

Both cement and pitch have been used for grouting sett paving, but the author favors the former in all cases where possible, although, to meet present-day requirements, pitch grouting has certain advantages inasmuch as roads finished in this manner can be opened to traffic immediately after completion. There is also less tendency for mud to collect on this kind of grouting, which, however, must be skilfully handled to ensure the proper proportion and correct mixing of the ingredients. The method adopted by the writer is to use a grouting mixed to the following proportions: 2 to 3 gallons of creosote oil and 1 gallon of coal-tar added to every 1 cwt. of pitch. (The quantities of oil and tar being determined by the nature of the pitch.) The joints of the setts having been filled about half way up with ⅜-in. or ¾-in. pea ballast or shingle, and then rammed. Great care must be taken to see that this racking is thoroughly dry. The pitch mixture is then poured from a spouted pail into the corner of the setts (this prevents surplus being left on the top), to about half their depth, and the remainder of the joints filled up with racking as before. Sweep with hard broom and squeegee over the whole surface with the pitch mixture as quickly as possible, so as to leave the smallest accumulation on the top. On no consideration should this work be done other than when atmosphere and materials are in a perfectly dry state.

Perhaps here it might be of interest to mention a particular form of paving in which the author is concerned, which consists of specially dressed 5 in. wide by 4 in. deep Grey Royal setts, laid on a concrete foundation. The contractors were called upon to replace a considerable number of setts with broken corners. The stones were paved when wet on bedding which was more than damp, and when the stone was surface dry, boiling pitch grout was poured into the joints, with the result that it attacked the shakes or flaws in the setts, generated steam in them, and this, acting as a wedge, slightly detaching the flaw or shake portion of the sett. Under heavy continuous traffic it became wholly detached, pulverized, and peeled out. The author is of the opinion that had this work been completed with pitch grouting in dry weather this would not have happened, or, under the above circumstances, had cement and sand instead of pitch been used for grouting.

In Birmingham the standard size of setts used is 4 in. by 4 in. by 5 in. deep, laid with a crossfall of 1 in 45 from the crown of the road to channel, and in straight diagonal courses, meeting in the centre at an angle of 90 deg., with the apex pointing downhill, at an angle of 45 deg. with the channel where the kerbs are parallel. The setts are paved on a 1-in. bed of local sand grouted with a proportion of 5 parts of clean sharp sand to 2 parts of cement. The concrete bed is 7½ in. in depth, the ballast for it consisting of clean, non-porous blast-furnace slag with such an admixture of sand sufficient to fill up the interstices of the stone. After completion, a layer of clean sand is spread over the whole surface, and no traffic allowed over it for three weeks.

In this district the most suitable material for paving streets of steep gradients traversed by heavy traffic has proved to be "grit-stone," the steepest gradient paved with this material being 1 in 11. Care should be taken to see that this class of paving is constantly swilled with water so as to prevent an accumulation of mud and dirt on the surface, and if this has proper attention, complaints of slipperiness are practically unknown. In London and other cities specially dressed 5 in. wide by 4 in. deep Grey Royal setts have been laid on steep gradients, with very close joints, with much success. . . .

Cleansing.—It is obvious that road surfaces need systematic cleansing, gritting and watering, but the author would like to emphasize the trouble that has been experienced in regard to sweeping newly constructed water-bound macadam roads, for, if careful attention is not given to this matter, the binder will soon be removed. In a former district under the author's control, machine sweeping brushes were not used on water-bound macadam surfaces.

The watering of streets in any city is also of great importance, especially as there is now so much motor traffic on the roads. The author had steam motors fitted with tanks, and has found that this method is much more economical and effectual than horse-drawn water carts. These machines were fitted with interchangeable bodies, so that the motors, when not engaged for watering, could be utilized for carting stone or any other materials. In addition to these machines, a steam motor vacuum extractor was used for emptying gullies, and a considerable saving was effected, as compared with ordinary gully vans, besides being more hygienic and saving that splashing which invariably takes place when gullies are being emptied.

UNION OF CANADIAN MUNICIPALITIES.

As announced in our columns some little time ago, the 14th annual convention of the Union of Canadian Municipalities will be held in Sherbrooke, P.Q., on August 4th, 5th and 6th. A comprehensive program has been arranged, special provision being included for opportunities of discussing the numerous questions which will be presented by prominent municipal men from various parts of the Dominion. The aim of the Union, which is to afford municipal men a practical means of learning at first hand up-to-date methods of municipal government from men of experience and of affording also an effective link of municipal union and co-operation against influences adverse to the interests of the people, is certainly to be upheld and encouraged.

Among the various subjects that will be brought up for consideration are the following:—

Building Laws, Smoke Abatement, the Housing Problem in Cities, Municipal Reference Library, Playgrounds, Street Lighting, Taxation and Finance, the Wants of Rural Municipalities, Billboards and Posters, the City Manager Question, Public Libraries, Motion Picture Theatres, Street Cleaning, Water Rates, City Publicity.

The general contractors in the city of Montreal have recently formed an organization with the following officers:—President, Mr. J. P. Anglin, of Anglins, Limited; vice-president, Mr. E. G. M. Cape, of E. G. M. Cape, Limited; secretary-treasurer, Mr. W. Clement Munn, of the Atlas Construction Company, Limited; directors, Messrs. W. D. Ross, of Church, Ross and Company; Guy Boyer, of the Laurentian Construction Company; Rene Lessard, of T. Lessard, and C. Ekin, of the Geo. A. Fuller Company, Limited.

THE CALCULATION OF END AREAS.*

By E. S. M. Lovelace, B.A.Sc., M.Can.Soc.C.E.,
Civil and Consulting Engineer, Montreal.

THE following is a method of calculating end areas without any reduction of elevations or plotting of cross-sections, using direct the notes as taken in the field, thus effecting a great saving in time, giving increased accuracy, and at the same time reducing to a minimum the liability to error.

General Proposition.—Let $P_0P_1P_2P_3P_4P_5$, Figs. 1 and 2, be any polygonal figures and OX, OY any two lines at right angles to one another, and let the distances $a_1a_2a_3$.... represent the horizontal distances of the points $P_1P_2P_3$.... from the vertical lines OY, which in the examples given coincide with the sides P_0P_5.

Let $h_0h_1h_2h_3$.... be the vertical distances of the points $P_0P_1P_2P_3$.... from the lines OX giving the + sign to the distances below, and the — sign to those distances above

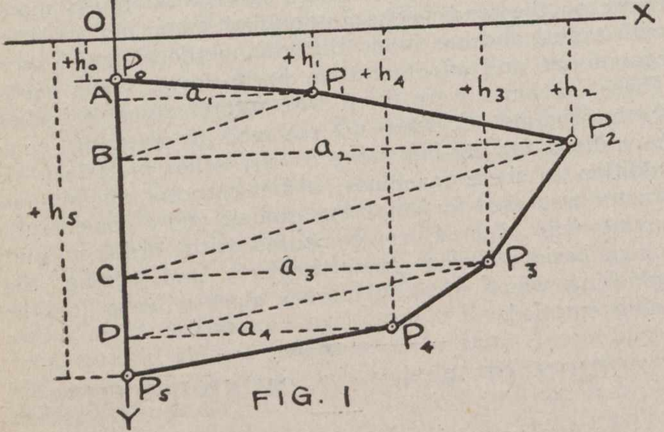


FIG. 1

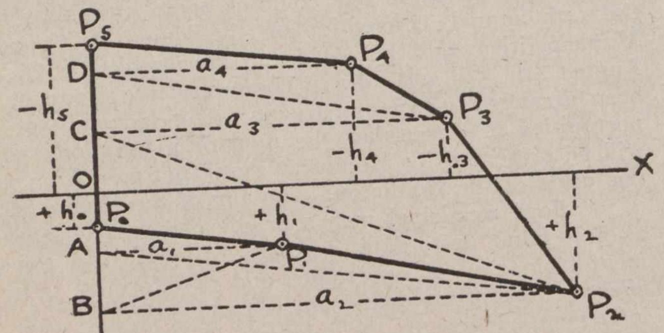


FIG. 2

OX. Then, the areas of the polygons $P_0P_1P_2P_3P_4P_5$ will be given by taking one-half of the algebraic sum of the products found by multiplying consecutively each horizontal distance $a_1a_2a_3$....by the algebraic difference between the ordinates of the points coming immediately after and before such horizontal distance: that is area of the polygon $P_0P_1P_2P_3P_4P_5$ for Fig. 1 will be

$$\tfrac{1}{2}\left[\, a_1(h_2 - h_0) + a_2(h_3 - h_1) + a_3(h_4 - h_2) + a_4(h_5 - h_3)\,\right]$$

and for Fig. 2

$$\tfrac{1}{2}\left[\, a_1(h_2 - h_0) + a_2(-h_3 - h_1) + a_3(-h_4 - h_2) + a_4(-h_5 + h_3)\,\right]$$

or $\tfrac{1}{2}\left[\, a_1(h_2 - h_0) - a_2(h_3 + h_1) - a_3(h_4 + h_2) - a_4(h_5 - h_3)\,\right]$

The proof of the foregoing is easily seen, for drawing the horizontal dotted lines AP_1, BP_2, CP_3, DP_4 and the diagonal dotted lines BP_1, CP_2, DP_3, then for Fig. 1:

$\tfrac{1}{2}a_1(h_2 - h_0) = \tfrac{1}{2}a_1BP_0 = \tfrac{1}{2}a_1(BA + AP_0) = \tfrac{1}{2}a_1BA + \tfrac{1}{2}a_1AP_0$ = area BP_0P_1;

$\tfrac{1}{2}a_2(h_3 - h_1) = \tfrac{1}{2}a_2CA = \tfrac{1}{2}a_2(CB + BA) = \tfrac{1}{2}a_2CB + \tfrac{1}{2}a_2BA$ = area CBP_1P_2;

$\tfrac{1}{2}a_3(h_4 - h_2) = \tfrac{1}{2}a_3DB = \tfrac{1}{2}a_3(DC + CB) = \tfrac{1}{2}a_3DC + \tfrac{1}{2}a_3CB$ = area DCP_2P_3;

$\tfrac{1}{2}a_4(h_5 - h_3) = \tfrac{1}{2}a_4P_5C = \tfrac{1}{2}a_4(P_5D + DC) = \tfrac{1}{2}a_4P_5D + \tfrac{1}{2}a_4DC$ = area $P_5DP_3P_4$ and the sum of these equals the whole area $P_0P_1P_2P_3P_4P_5$.

For Fig. 2 the proof is similar, for using the minus signs for the ordinates (corresponding to a fill or embankment) then

$\tfrac{1}{2}a_1(h_2 - h_0) = \tfrac{1}{2}a_1BP_0 = \tfrac{1}{2}a_1(BA + AP_0) = \tfrac{1}{2}a_1BA + \tfrac{1}{2}a_1AP_0 = +$ area $AP_0P_1P_2$;

$-\tfrac{1}{2}a_2(h_3 + h_1) = -\tfrac{1}{2}a_2(CA) = -\tfrac{1}{2}a_2(CB - BA) = -\tfrac{1}{2}a_2CB + \tfrac{1}{2}a_2BA = -$ area ACP_2.

$-\tfrac{1}{2}a_3(h_4 + h_2) = -\tfrac{1}{2}a_3BD = -\tfrac{1}{2}a_3(BC + CD) = -\tfrac{1}{2}a_3BC - \tfrac{1}{2}a_3CD = -$ area CP_2P_3D;

$-\tfrac{1}{2}a_4(h_5 - h_3) = -\tfrac{1}{2}a_4CP_5 = -\tfrac{1}{2}a_4(CD + DP_5) = -\tfrac{1}{2}a_4CD - \tfrac{1}{2}a_4DP_5 = -$ area $DP_3P_4P_5$,

and the algebraic sum equals the whole $P_0P_1P_2P_3P_4P_5$.

To adopt the above conclusions to field work so as to obtain direct from the level notes the areas of the cross-sections as taken:—

The horizontal line OX corresponds to the height of instrument and the line OY to a vertical line at centre.

The ordinates $h_0h_1h_2h_3$....are the rod readings taken at various points on the section and the horizontal distances $a_1a_2a_3$....the corresponding distances right or left of the C.L.

In the field book these are best noted in the form of a fraction, as shown on the sample page, the numerator being the rod reading, the denominator the corresponding distance:

The areas to the right and left of the centre line are calculated (as they are so taken in the field) separately and their sum gives the total area of the section.

The horizontal distances to the left could of course be given the minus sign and exactly the same final result would be obtained, but in practice it is simpler to imagine the left half section as being drawn on the transparent left page of a book, so that when this page is turned over the left half section would be superimposed upon the right on the right-hand page below, the centre line being represented by the line where the pages join. Thus all the horizontal distances, whether to right or left, can be given the plus sign. Taking the example at the head of the sample page, this section, if plotted, would appear as under.

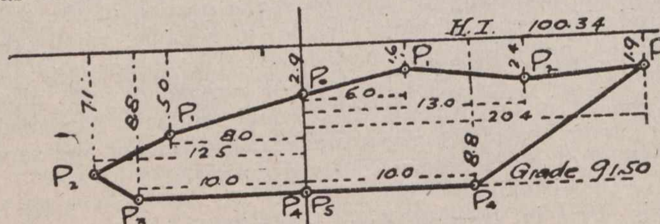


FIG 3

By the formula

area right $= \tfrac{1}{2}[\,6.0(2.4 - 2.9) + 13.0(1.9 - 1.6) + 20.4(8.8 - 2.4) + 10.0(8.8 - 1.9)\,]$

$= \tfrac{1}{2}[\,-6.0{,}0.5 + 13.0{,}0.3 + 20.4{,}6.4 + 10.0{,}6.9)$ .... = 100.23

area left $= \tfrac{1}{2}[\,8.0(7.1 - 2.9) + 12.5(8.8 - 5.0) + 10.0(8.8 - 7.1)\,]$

$= \tfrac{1}{2}(8.0{,}4.2 + 12.5{,}3.8 + 10.0{,}1.7)$.... = 49.05

∴ Total end area 149.28

In working out these areas in the field book the rod readings or ordinates can usually be subtracted mentally and their difference at once jotted down (with the proper sign + or — affixed), as shown on the marginal page.

Should it be found impossible to complete the section with a single height of instrument, proceed as follows: Suppose a section on side hill.

Then, if there be but one or two sections requiring a change in the height of instrument, it would only be necessary after setting up, to find on the upper side the

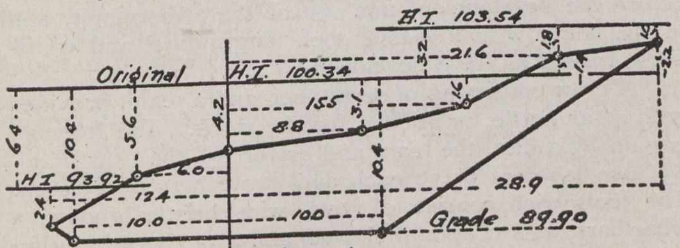


FIG. 4

difference 3.2 between 103.54 the new H.I. and 100.34 the original height, for then the rod readings as taken, subtracted from 3.2, would give the proper readings — 1.4 and —2.2 referred to the original H.I.

On the lower or left-hand side of the section the new H.I. 93.92 being lower than 100.34, the original height, their difference 6.4 must be added to 2.4, the rod reading as taken, giving for this left side referred to the original H.I. a reading of 8.8.

If, however, there are a number of consecutive sections requiring various changes as above, it would be better perhaps to enter on another page of the level book, under their respective H.I., the rod readings as taken, and then on the marginal page before using such for calculating the end areas reduce them as shown above to the original H.I. by adding or subtracting the constant difference.

The original sections could then be completed by bringing back these corrected readings and the section for such a cross-section as that illustrated above would appear in the level book as shown in Table I.

TABLE I.

Station	C. or F.	B.S.	H.I.	F.S.	Elevation	Grade
			100.34			
R	+12.6		3.1/8.8	1.6/15.5	See page.. —1.4/21.6	[—2.2/28.9] 89.90
40	+ 6.2	4.2/0				
L	+ 1.6			5.6/6.0	See page..	[8.8/12.4]

The resulting end area would then be as already shown:

$$\text{area R} = \tfrac{1}{2}\,[\,8.8(1.6-4.2)+15.5(-1.4-3.1)+21.6(-2.2-1.6)+28.9(10.4+1.4)+10.0(10.4+2.2)\,]$$
$$= \tfrac{1}{2}\,[\,-8.8{,}2.6-15.5{,}4.5-21.6{,}3.8+28.9{,}11.8+10.0{,}12.6\,]\;\ldots\ldots\ldots\ldots = 146.15$$
$$\text{area L} = \tfrac{1}{2}\,[\,6.0(8.8-4.2)+12.4(10.4-5.6)+10.0(10.4-8.8)\,]$$
$$= \tfrac{1}{2}\,[\,6.0{,}4.6+12.4{,}4.8+10.0{,}1.6\,]\ldots\ldots = 51.56$$

∴ Total end area 197.71

TABLE II.

Station	C. or F.	B.S.	H.I.	F.S.	Elevation	Grade	H.I. to Grade	Calculations, Remarks	End Areas Exc'v'n	End Areas Emb'km't
			100.34					Road bed 20 ft. Exc. 16 ft. Bank		
R	+6.9		1.6/6.0	2.4/13.0	[1.9/20.4]			(—6.0,0.5+13.0,0.3+20.4,6.4+10.0,6.9)/2		
41	+5.9	2.9/0				91.50	+8.8		149.3	
L	+1.7		5.0/8.0	[7.1/12.5]				(+8.0,4.2+12.5,3.8+10.0,1.7)/2		
R	+3.7		5.5/8.0	[5.3/15.5]				(—8.0,0.8+15.5,3.5+10.0,3.7)/2		
41+40	+2.9	6.1/0				91.30	+9.0		65.2	
L	+0.7		6.7/6.0	[8.3/11.0]				(+6.0,2.2+11.0,2.3+10.0,0.7)/2		
41+62	0.0		Grade			91.19			0.0	0.0
R	—1.6		11.7/7.0	[10.9/10.4]				(—7.0,1.2—10.4,2.4—8.0,1.6)/2		
42	—2.8	12.1/0				91.00	+9.3			73.2
L	—5.4		14.3/9.0	[14.7/16.1]				(+9.0,2.6—16.1,5.0—8.0,5.4)/2		
T.P.		0.84	89.12	12.06	88.28			On rock 40 ft. Right of 42		
R	—3.0		2.4/9.0	[1.4/12.5]				(—9.0,1.6—12.5,4.0—8.0,3.0)/2		
42+60	—4.6	3.0/0				90.70	—1.6			127.8
L	—6.5		3.1/5.0	4.9/10.0	[4.9/17.7]			(+5.0,1.9+10.0,1.8—17.7,6.5—8.0,6.5)/2		

Table II. is a sample showing manner of keeping the field notes and the method of calculating the end areas direct from these notes as taken.

The section shown in Table III. is on side hill, embankment to the left, excavation to the right, the grade point being as shown 2.5 feet to the right. This must be taken into account in making the calculations so as to keep the excavation and embankment areas separate from one another.

TABLE III.

Station	C. or F.	B.S.	H.I.	F.S.	Elevation	Grade
			89.12			
T.P.	-	9.16	97.52	0.76	88.36	
			Grade			
R	+4.0		7.3/2.5	4.2/6.5	[3.3/16.0]	
43+50	—0.4	7.7/0				90.25
L	—2.2		8.1/6.4	[9.5/11.3]		

Thus, excavation area to the right is given by
½ [2.5(4.2—7.3) + 6.5(3.3—7.3) + 16.0(7.3—4.2) + 10.0(7.3—3.3)]
= ½ [—2.5,3.1—6.5,4.0 + 16.0,3.1 + 10.0,4.0] = +27.9

There would then be to the right in embankment the small area given by 2.5(7.3—7.7)½ = —0.5 and this would have to be added to the embankment area to the left given of course by
½ [+6.4,1.8—11.3,0.8—8.0,2.2] = —7.6 that is a total area in embankment for the section of — 8.1.

It might, however, be considered less confusing in such cases to consider the vertical line as being placed at the grade point instead of at the centre of the section and then all the area to the right of this point would be in excavation and all to the left in embankment.

This would simply mean that in applying the method all horizontal distances taken to the right would be reduced by 2.5 feet and all distances to the left increased by the same amount, that is, area right would
= ½ [4.0(3.3—7.3) + 13.5(7.3—4.2) + 7.5(7.3—3.3)]
= ½ [— 4.0,4.0 + 13.5,3.1 + 7.5,4.0] = in excavation 27.9 as before, and area left would
= ½ [2.5(8.1 — 7.3) + 8.9(9.5 — 7.7) + 13.8(7.3 — 8.1) + 10.5(7.3—9.5)]
= ½ [+2.5,0.8 + 8.9,1.8—13.8,0.8—10.5,2.2] equal as before to a total area in embankment of 8.1.

MONTREAL WATER AND POWER COMPANY

The annual report of the Montreal Water and Power Company for the year ending April 30th, 1914, shows a gross revenue of $783,000, an increase of seventeen per cent. over the previous year. The net operating profit, after paying all expenses, maintenance and bond obligations, was $208,000.

The first half of the new reservoir will be available for use by next September, and the remainder will be ready in a few months thereafter. Mr. Edwin Hanson, the president, stated that the filtration plant continues to be operated in a most satisfactory manner, and that the report of the company's experts indicates that it performs its work with great efficiency. It is intended to increase the capacity of the filtration plant as soon as possible.

A new transformer house has been erected at the main pumping station. It is intended to duplicate the electrically-driven pumps at the Clark Avenue station, and to install a new and large force main from the lower pumping station to the northern territory, eventually communicating with the reservoir in Outremont.

CONCRETE ROAD MAINTENANCE AND COSTS.

At the National Conference on Concrete Road Building, held in Chicago in February last, one of the committee reports dealt with the method and cost of repairing and maintaining concrete roads. This committee reported as follows through its chairman, Edw. N. Hines.

Maintenance work in Wayne County consists in filling the open expansion joint on the roads first built before the development and use of the armor joint, and in the filling with a mastic such longitudinal and transverse cracks as have developed.

A crew consisting of seven men and a team, provided with a tar kettle, is utilized for the work. The foreman is paid $5 a day, the team and driver $5, the "tar man" $3, two laborers $2.50 each and two others $2.25 each. The tools used consist of two wire bristle brooms, a wheelbarrow, a couple of shovels and a tar bucket with a round spout. Tarvia X is now used exclusively. A lighter grade was first tried out, but did not give such permanent results as the heavier grade. Two men are utilized to sweep all cracks clean with the wire brooms, after which the man with the tar kettle fills the cracks with the tar, which is heated to about 225° F. An excess of tar is poured in so that it extends an inch or so beyond the edge of the crack. It is then allowed to stand in the crack for a few minutes to prevent it from "bubbling" out in case the sand is wet. The sand, which should be dry and coarse, is spread with a shovel over the crack and into the tar, and the whole is left for traffic to iron out. The excess tar and sand is worn away rapidly, leaving a smooth, even surface, in passing over which no jolt is apparent.

The work is preferably done on hot, dry days. It has been suggested that the better time to handle this work would be in the late fall when the cracks would be open the widest due to contraction, but the results we have secured in the summer months have been so satisfactory that we have not tried out the latter plan. The small pit holes which are due simply to some foreign substance like clay, wood or some fragment of inferior rock which might chance to be a part of the aggregate, are treated in the same manner. As to the cost of this method, the report contains figures covering 10 pieces of road aggregating 10 miles, the cost of repairs for which, including tar, labor and sand, amounted to $1,300.50 from October, 1912, to October, 1913. Adding a percentage to cover engineering, inspecting, depreciation of machinery and building and other expenses, a total of $1,450 was obtained. The greater part of this mileage was treated for the first time.

The report dealt also with treating the entire surface of a road where the concrete from any cause had not stood the wear. Several pieces of road had not been built up to the standard of the balance of the construction and required surfacing. Others were rough, having been laid in cold weather and opened for traffic before the concrete had thoroughly hardened. The method of repairing one of these is worth noting. The road was first swept by a street sweeper, which was followed by men with wire brooms. About ½ gal. of bitumen to the square yard was used, and the whole covered with coarse sand and rolled with a 10-ton roller. This repair was made early in the summer and was not touched in any manner for a period of two years. By this time it had scaled off in spots quite badly, and was gone over again in the summer of 1913, using Tarvia X and a washed roofing gravel about ¼ in. in size.

WIND LOADS ON BUILDINGS.

THE determination of the distribution of wind loads on buildings has been a subject of a series of tests carried out by Prof. A. W. Smith, and concerning which several articles have been published by him during the past two years. He first obtained data on structures without floors between ground and roof—mill-buildings. The results obtained from these tests indicated that the common assumption in regard to wind loads did not come very near to the actual conditions. The summation of his results in this direction were presented in a paper before the Western Society of Engineers in October, 1912. Since that time Mr. Smith has extended his researches to include larger structures, such as train-sheds and drill halls, the results of which tests were presented several months ago to the same society and appeared in its Journal for April, 1914. From it the following points are reproduced:—

As a model a roof of semi-circular section, 6 ft. span and 10 ft. long, was constructed and covered with tin. This roof was mounted on walls 5 ft. high, made of 2 x 6-in. lumber, tongued and grooved. After each set of observations, the roof was lifted and 6 in. of the walls taken off. The use of tongued and grooved stuff made the walls comparatively tight, and also made them somewhat stiff when an end or side was omitted in the course of the tests. At a middle section of the building, holes were bored about 1 ft. apart in the walls and roof, the row extending from ground to ground. These holes were about ½ in. in diameter, and in the roof a short nozzle was soldered on the inside. A series of holes at various levels were also carried completely around the house.

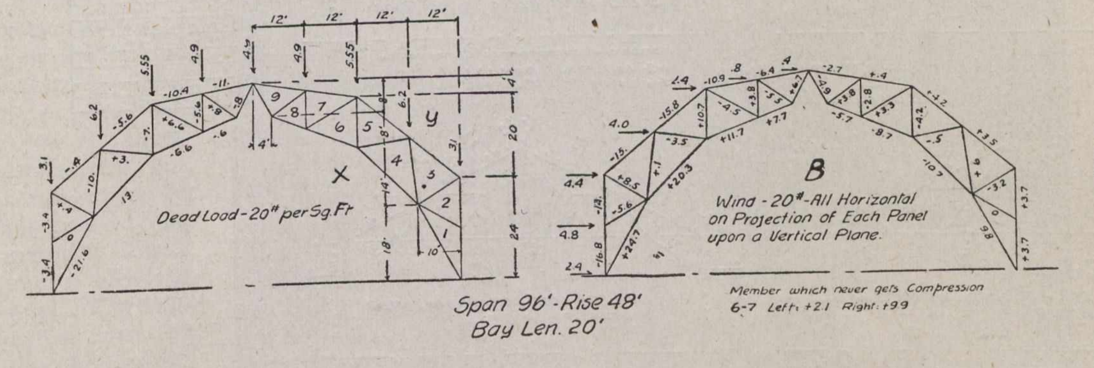
The author describes in detail the pressure-recording instruments and the method of taking the observations, as well as the method of calibrating pilot tubes.

After the readings were taken the pressure or suction inside the house was standardized, and the result was reduced, first to pds. per sq. ft. and then to that for a velocity of 10 mi. per hr. The pressure or suction inside the house was found to be variable, partly because, in a somewhat gusty wind, the pressure condition in the house was found to lag behind the velocity changes outside, and also because small changes in the direction of the wind caused great changes in the conditions of exposure of the various leaks, which were not, of course, symmetrical around the house.

Observations were taken while the house was thoroughly caulked, so that the conditions were nearly ideal. Readings were also made on the model with different sides and ends omitted, as well as with portions of the walls removed. The paper included diagrams of measurements taken at the various observations with the model under usual different conditions.

Mr. Smith found that the forces on the building with one side open, while greater than for one of the same height with the side closed, did not exceed the proposed units. With the wind in the other direction, the pressure on the closed wall would be increased by a rarefaction inside the house, and the suctions over the roof would be diminished. Observations on the model with both sides removed show that the stresses for this case are less in amount, and nearly the same in distribution as for the closed house. A comparison of the stresses in a very simple two-hinged arch from three systems of wind-loading is shown in Fig. 1. It appears that if the wind loads are as shown by the test described, not only are the stresses assumed to be much too large in most cases, but in two cases they gave tension only in numbers which should be designed for compression. This truss is of exaggerated depth, and in a large truss of ordinary depth the discrepancies would be greater. Such arches are now made entirely of compression sections in most cases, but it would be better to adopt a loading system which makes it impossible to do otherwise. In Fig. 2 are shown the same comparison for a mill building bent. As in the arch, all members received compression from the proposed loadings, while by the common method three of these members would be designed for tension only.

Another experimenter, Mr. A. See, recently read a paper before the Industrial Society of Northern France, "The Wind Pressure on Roofs," relating to experiments



Max. Comp. Stresses

	Memb	A	B	C
Top Chd	y-1	-24.9	-20.2	-13.4
	y-2	-22.1	-17.4	-12.4
	y-3	-17.6	-15.4	-8.9
	y-5	-26.0	-21.4	-6.6
	y-7	-24.9	-21.3	-10.4
	y-9	-20.7	-17.4	-11.0
Bott. Chd	x-1	-33.9	-30.4	-21.6
	x-4	-26.3	-23.7	-13.3
	x-6	-17.3	-15.3	-7.1
	x-8	-7.4	-6.3	-4.3
	x-9	-0.8	-5.7	-1.7
Web	1-2	-5.6	-5.6	-2.8
	2-3	-3.5	-2.8	-3.8
	3-4	-16.1	-10.0	-10.8
	4-5	tens.	-.5	-.8
	5-6	-16.8	-11.2	-7.0
	6-7	tens.	tens.	-1.9
	7-8	-5.6	-8.4	-5.6
	8-9	-5.4	-4.7	-1.6

Fig. 1.—Comparison of Stresses in Arch from Different Loadings.

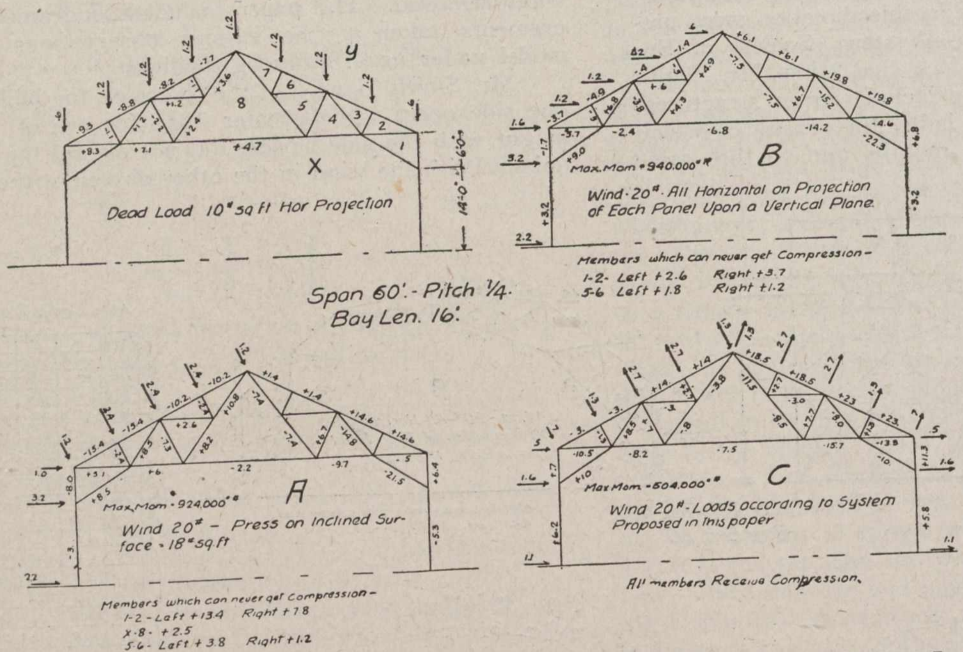
in connection with aeronautics which had raised a good deal of doubt as to the validity of the officially adopted formula for wind pressure against roofs and walls. Abstracts from his paper appeared in the Journal of the American Society of Mechanical Engineers for June, 1914. The results are interesting when considered in connection with the above, and are further abstracted herewith:—

It is usually assumed that the wind pressure on a surface with a plane normal to the direction of the wind is equal to the product of the area of the surface by the square of velocity, multiplied by the co-efficient 0.14.

In the case of a roof it is assumed that the wind moves downwards at an angle of 10 deg. and strikes the roof at an angle $a + 10$ deg., where a is the angle of the roof with the horizon. Under these conditions the pressure is obtained by multiplying the preceding equation by $\sin^2 (a+10)$. This official formula is, however, entirely antiquated and its lack of accuracy is obvious now that the coefficient of resistance of the air is known to be not 0.14, but 0.08. The hypothesis of the wind descending at an angle of 10 deg. is purely arbitrary. The law of sine square has been shown not to agree with experimental data, and finally the formula does not take into consideration the shape and location of the roof.

Experiments have been made recently at the Engineering Aeronautical Battalion of the Italian Army with models of two types of semi-lozenge shaped hangars (Fig. 3, A and B), where the pressure curve and the magnitudes of the pressures, at various points of the profile, are indicated. One sees at once that the pressure curve has nothing to do with either the sine square or simple sine law, or, indeed, with any law based on the angle of incidence. The wind pressures along the frontal surface of the structure rapidly diminish as the curve inflects, and become zero some time before the tip of the lozenge is reached; moreover, they become negative all along the rear surface, a fact which is not shown by the formula. There is, therefore, quite an important partial vacuum, independent of the curvature of the structure, and it appears that the wind pressure on each element depends not so much on the angle of incidence at that point as on the location of that particular element with respect to the rest of the structure.

When, however, one comes to the consideration of the question as to which formula would be more acceptable than the old official formula, one finds that while this official formula is incorrect, any other formula which might be derived at the present time would be just as likely to be based on arbitrary assumptions and involve coefficients of doubtful value. Whether the new formula would give better results is somewhat doubtful, while it is a fact that structures built in accordance with the old formula proved to be quite stable. The author, therefore, rather curiously arrives at the conclusion that while the old formula is admittedly incorrect it should still be followed, at least until an absolutely good new formula can be derived.



Max Comp. Stresses

	Mem.	A	B	C
	X-1	-21.5	-22.3	-10
Top Chd.	y-2	-24.7	-13.0	-12.3
	y-3	-24.2	-13.7	-11.8
	y-6	-18.4	-8.6	-3.2
	y-7	-17.9	-9.1	-7.7
Bott. Chd.	1-2	tens.	tens.	-5.0
	X-4	-2.6	-7.1	-8.6
	X-8	ten.	-2.1	-2.8
Webs	2-3	-3.5	-1.6	-2.4
	3-4	-13.6	-14.0	-6.8
	4-5	-9.5	-6.0	-2.2
	5-6	tens.	tens.	-1.8
	6-7	-3.5	-1.6	-1.1
	5-8	-3.0	-5.1	-6.1
	7-8	-3.8	-3.9	-7.9

Fig. 2.—Comparison of Stresses in Mill Building, from Different Loadings.

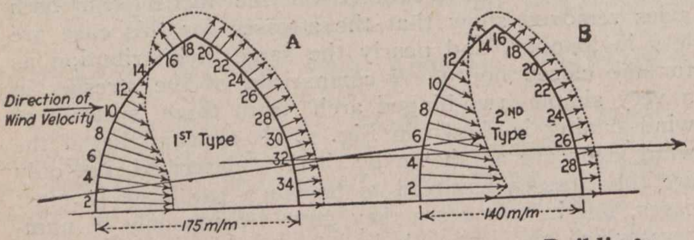


Fig. 3.—Distribution of Wind Stresses on Buildings.

PROGRESS ON DRY DOCK AT FREDERICTON, NEW BRUNSWICK.

Norton, Griffiths & Co., Limited (Canada), engineers and public works contractors, are building a dry dock of considerable magnitude for the Dominion Government at Fredericton, N.B. The dry dock when completed will be 900 ft. long and 100 ft. in width. Up to the present time about six acres of land in the vicinity of the dock have been reclaimed and about nine acres of hilly ground on the site of a proposed ship-repairing plant to be constructed in connection with the dock, has been cleared to the level of the coping of the dock.

Excavation below coping level is in progress, a total quantity of rock and over-burden of approximately 410,000 cu. yds. having been removed to date.

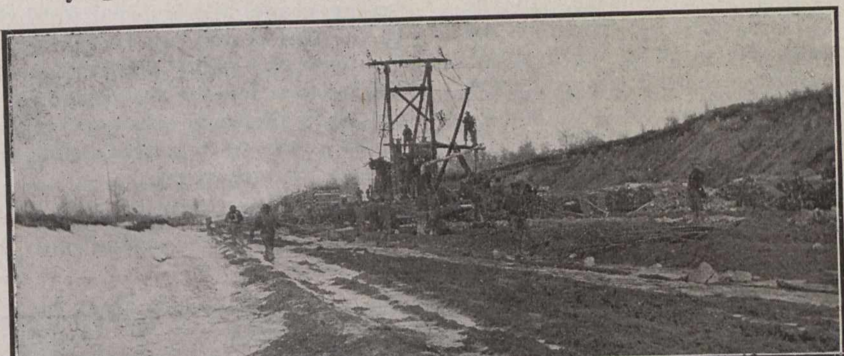
COMPLETION OF TRACK LAYING ON THE GRAND TRUNK PACIFIC RAILWAY.

THE accompanying photographs are illustrative of the enthusiastic manner in which the last mile of the Grand Trunk Pacific Railway was furnished with steel. As the track-laying outfits from east and west approached each other it was decided to have a race for the finish. The west outfit reached the west end of Mile 111, Willow River, about noon of April 6th, and waited there until 11.30 a.m. of the 7th, when the outfit was ready to start from the other end of the mile. The two track-laying gangs then started simultaneously in a race to reach the stake which had been driven at the middle of the distance. The 0.4 of 1 per cent. grade was in favor of the east crew, but it was not expected that this would make any material difference in the speed of such work. Further, the machine from the east was housed in, but with this exception the two outfits were about the same, both being a modification of the Roberts track-laying machine, fitted with an air-hoist instead of a winch for handling rails. The east machine, however, was using a winch, the air-hoist having gone out of commission.

The east gang, in charge of Phil. Egan, made the half-mile in 42 minutes, while the west crew, under Dan Dempsey, reached the stake in 64 minutes. The chief difference between the methods of the two outfits was that Dempsey's machine laid a rail, moved ahead, stopped to lay another, and so on, while Egan did not stop, but moved slowly ahead. By this latter method the tie-buckers were obliged to carry a tie a very short distance only as compared with the other. While one man could handle a tie, in the west gang two men were required to do it. This method was also responsible for the unnecessary loss of several minutes owing to the locomotive on two occasions progressing beyond the desired point and having to back up.

When the last rail was laid, Mr. Kelliher, chief engineer; Mr. Morley Donaldson, vice-president and general manager; Messrs. Brewer and Meehan, superintendents, and Messrs. Egan and Dempsey, superintendents of track-laying, each drove a spike into it. The ceremonies were then concluded by the presentation of gold watches to the two track-laying superintendents. The event was witnessed by 700 or 800 spectators.

Laying the Last Mile of Track on the Grand Trunk Pacific.



West End Machine Prepared for Race.

East End Machine Coming up to the Finish.

Bringing on the last Rail.

This maximum grade against east-bound traffic of 0.4 of 1 per cent. is a striking feature of the new line through the mountains. Against west-bound traffic there is a maximum grade of 0.5 of 1 per cent. with the exception of a single pusher grade of 1 per cent., 19½ miles in length. The Grand Trunk Pacific Railroad traverses prairie country for a distance of over 922 miles between Winnipeg and Edson, Alta. The elevation at these two points is 767 ft. and 2,984.3 ft. respectively, the difference being in the form of a gradual rise. Immediately west of Edson the line encounters the mountains and in the Yellowhead Pass, a further distance of 123 miles, it reaches an elevation of 3,723.11 ft. Then the elevation drops over 1,200 ft. in the next 45 miles including the 1 per cent. grade referred to above. From this point no grades exceed 0.4 of 1 per cent. in either direction as the line traverses the valleys of the Fraser, Bulkley and Skeena Rivers.

It has been announced that on July 1st, a regular train service will be in operation between Fort George and Edmonton and that the company is expected to extend this service to Prince Rupert by early fall.

We are indebted to Mr. S. V. Ardagh, Residency 46, Engineering Department, Grand Trunk Pacific Railway, Fort Fraser, B.C., for the photographs reproduced herewith.

The government at Cape Town, South Africa, has decided to erect a new lighthouse at Cape Point. The old lighthouse, of 2,500 candlepower, has been in existence for half a century, and will be superseded by a most up-to-date dioptric flashlight of 500,000 candlepower. It will stand 300 feet above sea level, and will have a range of 24 miles. The estimated cost is £8,000.

WIRE AND CABLE PLANT OF THE NORTHERN ELECTRIC COMPANY, MONTREAL.

THE new wire and cable plant of the Northern Electric Company, Limited, now nearing completion in the city of Montreal, occupies an area of 178,000 sq. ft. (over four acres). The present plant having been found inadequate, expansion has necessitated the erection of this new structure, which, when completed, will be one of the largest in America for the exclusive manufacture of wires and cables. The E. G. M. Cape & Company, Limited, have the general contract for the building. The foundations for walls and columns are composed of plain and reinforced concrete. In the main building and some of the one-story portions the columns rest on Raymond concrete piles, of which 4,000 have been driven, with an average length of 12 ft. On each group of piles rests a reinforced concrete cap, on which bases for the building columns are placed.

The 6,500 tons of structural steel required for the superstructure were supplied and erected by the Dominion Bridge Company. Bethlehem "H" columns girders and beams were used almost exclusively throughout.

Fireproof construction has been used throughout the entire building. All interior columns are encased in 4¾ inches of hollow terra cotta, and beams in 2⅜ inches. The floors are composed of hollow terra cotta segmental arches with a span of 6 ft. 8 in., and are suitable for a live load of 288 lbs. on the second to seventh floors and 150 lbs. on the eighth floor. A stone concrete fill is poured over the arches, in which wooden sleepers are embedded, and the underflooring is nailed to these sleepers, and over this, the final maple flooring is laid at right angles. The National Fireproofing Company supplied all the fireproofing terra cotta, amounting to 11,000 tons.

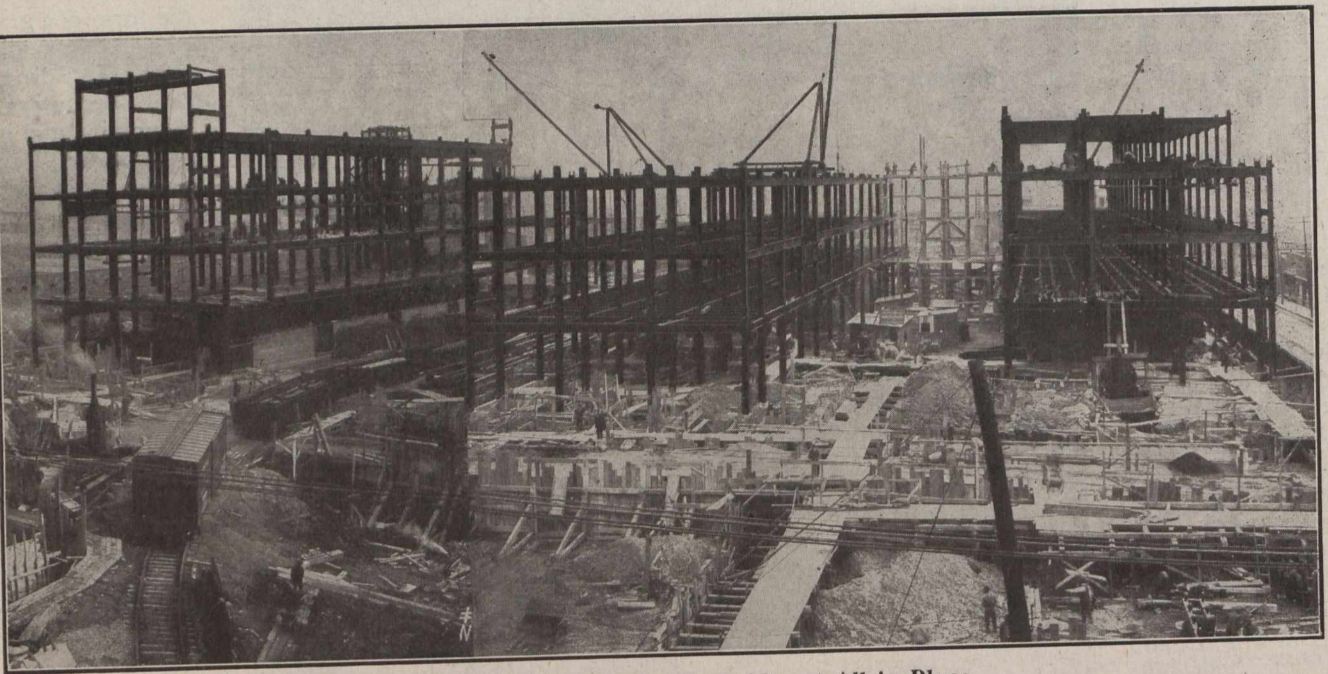
The walls are built of Laprairie Plastic Brick, seven millions being used. All the lintels in the courts and on the street sides, together with the architectural ornaments and copings on the street sides, were supplied by the Atlantic Terra Cotta Company, of Tottenville.

The main buildings, shaped like the letter "E," have two main courts, which serve to provide ample lighting facilities for the 500,000 sq. ft. (over 12 acres) of floor space from the interior, as well as the exposed sides on the streets. These courts have sloping roofs of book tile, with large skylights. The G.T.R. and C.P.R. railway tracks run into one court, which has large platforms for shipping and receiving purposes. Each track is provided with a 150-ton Canadian Fairbanks-Morse Company track scale.

There are four travelling electric cranes, one 50-ton, one 20-ton, one 20-ton with 5-ton auxiliary hoist, and one 10-ton all made by the Case Crane Company. The 50-ton crane will be used for handling reels of armored cable, the 20-ton for the lead-covering department, the 20-ton with 5-ton auxiliary for the turbine room, and the 10-ton for the impregnating tank room. The two 20-ton cranes are arranged so that they can pass material to the 50-ton, which will convey it over the railway tracks, or vice versa.

Fire walls, with automatic steel fire-doors on both sides, divide the building into various sections. Each section has a fire and smoke-proof stair tower, with iron stairs at both ends, thus providing ample and safe means of exit in case of fire on any floor. The fire-doors for the whole building were supplied by the Architectural Bronze and Iron Works, and the iron stairs by John Watson & Son, Limited. All windows throughout the building have steel frames with wire glass. Pivoted sections of these windows can be opened with operating chains equipped with fusible links, thus making them self-closing in case of fire. The 95,000 sq. ft. of steel sash required for the factory was supplied by the Trussed Concrete Steel Company, and the casement sash for the offices by Henry Hope & Son, Limited.

All drains and underground sprinkler mains are being installed by James Ballantyne. The sprinkler and fire hose systems above the first floor level are supplied by H. G. Vogel Company (Canada), Limited, and consist of 6,000 sprinkler heads and fire hose, located at convenient points in the building. These systems are supplied with water from the city mains, steamer con-



New Plant in the Process of Erection: Steel Almost All in Place.

nections on the street, and a 1,500-gallon Worthington underwriter's fire pump, which is connected to a 100,000-gallon concrete reservoir and the canal.

Five 6,000 and one 15,000 lb. freight elevators, with a travel of 100 ft. and 25 ft. per minute, respectively, will be used to handle the transfer of material for manufacturing, and two high-speed passenger elevators, travelling at 350 ft. per minute, will be used to serve the general offices of the company, which are situated on the eighth floor of the building. They are being supplied by the Otis-Fensom Elevator Company. This floor has no columns, the roof being supported by steel trusses with large skylights. The absence of columns afford splendid facilities for the laying out of offices to suit the requirements.

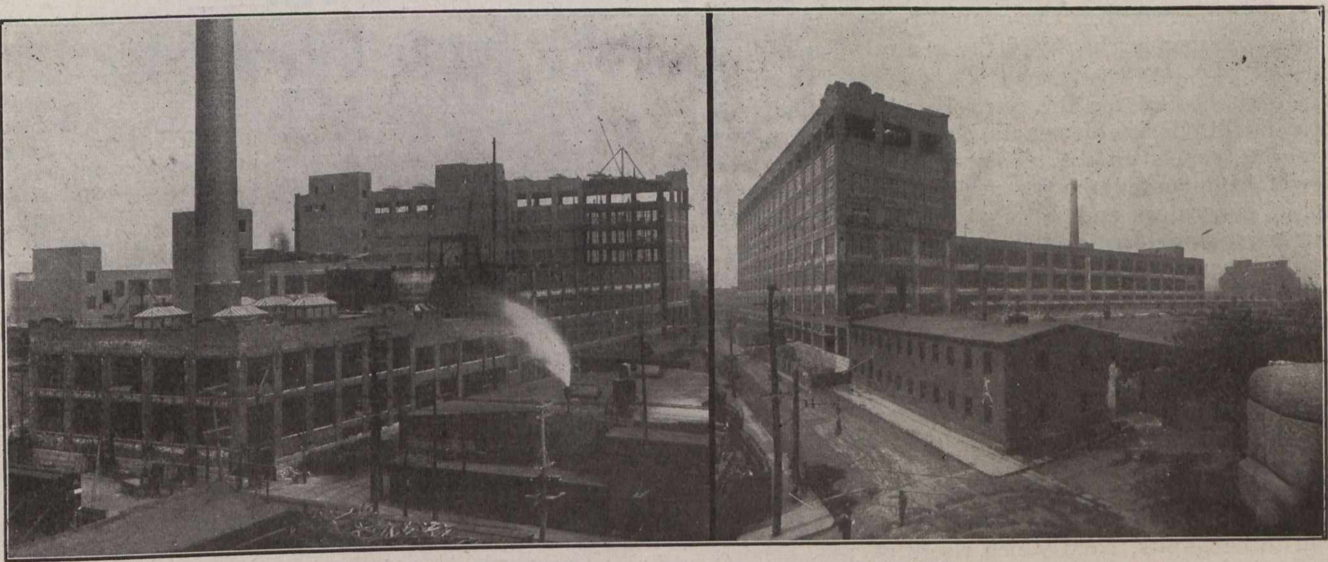
A unique point in the design of the building is the storage space secured on the roof of one section by means of paving bricks. This roof is served by means of one of the 6,000 lb. freight elevators.

Large intake pipes from the canal supply the reservoir and the water used for condensing purposes. An automobile garage and a wagon court are so arranged enough to take care of the whole system. The enclosed heaters mentioned above were built by John McDougall Caledonian Iron Works, Limited.

The water required for the house service system and for manufacturing purposes will be pumped from the 42-in. intake pipe mentioned above by means of Deane motor-driven, single-acting, helical-geared triplex pumps, supplied by John McDougall Caledonian Iron Works Company, Limited.

The Canadian Ingersoll Rand Company are supplying two steam-driven air-compressors, which have a combined capacity of 1,200 cu. ft. per minute.

The power plant is of the most modern design. Coal can be stored in large quantities, and will be transferred to the storage bins over the front of the boiler by means of a Telpher car and clam-shell bucket. Ash-handling equipment takes the ashes directly from ash-shutes under the boilers and delivers them into ash-storage bins, which in turn deliver them into railroad cars or carts for disposal. Ashes can also be handled by means of small cars on an industrial railway running in the basement of the boiler-room. The Telpher car will raise the



Two Views, from Different Directions, of the Buildings.

that the material can be readily loaded for city delivery without having to cross the railroad tracks.

The building will be heated by a forced circulation hot water system. Exhaust steam from one of the main turbines will be passed through closed heaters. The water will be circulated by means of a 4,000-gallon Alberger single-stage volute pump, directly connected to an Alberger-Curtis steam turbine. The vapors and condensate from the exhaust steam will be carried from the heaters by means of an Edwards air-pump with a tail-pump. This makes a very flexible system to suit the changes in the outside temperature, as the vacuum can be increased in warm weather, thereby creating a lower temperature of the exhaust steam and decreasing the amount of steam required by the turbine as the vacuum increases. In extreme cold weather the turbine can exhaust into the heater at atmospheric pressure, and thus increase the quantity and temperature of the stream. When running two turbo-generator units in parallel, one turbine can run condensing, while the other exhausts into the heating system, and its load can be varied to suit the amount of steam required for heating purposes. The power plant equipment for this heating system is in duplicate, either one of the units being large body of each of these cars off the truck, through a hatchway in the main boiler-room floor, and will carry them over to the ash-storage bin. This method of ash-handling will only be used when it is necessary to overhaul and repair the regular ash-handling equipment.

A 225-ft. chimney, built by the Alphons Chimney Construction Company, serves four B. & W. boilers, nominally rated at 650 horse-power, but which will be forced to deliver 1,000 horse-power when necessary. These boilers are fitted with B. & W. chain-grate stokers and superheaters. The exhaust steam and condensate from the heaters, turbines, condensers, and steam-driven auxiliaries are brought to a Warren & Webster feed-water heater, which is capable of raising 107,000 lbs. of water per hour to 210°. From this heater the water is returned to the boilers by means of two Weir boiler feed-pumps, each with a capacity of 6,000 Imperial gallons per hour. General Electric Company Curtis horizontal turbines form the motive power for the generators, and are placed on structural steel stands directly over the Alberger centrifair condensers, thus insuring a high vacuum. The condensers are located over two 42-in. pipes leading to the canal. From one of these pipes the water is drawn by a turbo-volute turbine-driven pump, and after having passed through the condenser is discharged into the other pipe. Tunnels leading from the turbine and pump-room are used to run the power and lighting circuits, the flow and return pipes of the forced hot water heating system, the house service water lines, and the high-pressure steam lines for manufacturing purposes.

The turbine-room has been laid out for two 2,000 K.W. and two 1,000 K.W. turbo-generators, two 460 K.W. rotary converters and two 75 K.W. turbo-driven exciters. Of these, 1,000 K.W. and one 2,000 K.W. turbo-generators and two rotary converters will be installed now. The generators are 3-phase, 60-cycle, 440-volt, star-wound, with neutral connection brought out to the switchboard. The exciters are 125-volt, and generator voltage will be controlled by Tyrrill regulator.

Air for the ventilation of the generators will be taken from a duct in the foundations of the generators and forced through the windings and air passages by fans integral with rotors. Screens will be provided in the pent-house of this duct to exclude dust, etc.

The connected load will be approximately 550 h.p., d.c. at 115 volts, and 4,000 h.p. a.c. at 440 volts. For the supply of the former, two 460-K.V.A. rotary converters, with necessary transformers and starting switches, will be installed, the neutral being brought out from each transformer bank for the neutral of a 115/230 volt, 3-wire, d.c. system.

The switchboard for the control and distribution of this power will consist of a main board of 25 Blue Vermont marble panels on the turbine-room floor. On this board will be mounted the meters for measurements of outputs of generators and loads on the feeders; also the d.c. bus-bars, both for exciters and d.c. factory load, and control equipment for 25 solenoid operated feeder switches for a.c. distribution. These switches will be mounted on Monson slate panels on a mezzanine floor under the turbine-room floor. The a.c. 440-volt bus-bars and generator switches will also be located here.

Generator switches will be non-automatic, with bell-ringing attachment, and feeder switches automatic, as mentioned above. All feeders will leave the turbine-room in a tunnel, from which they will branch off to the various buildings in 3-in. fibre conduits. These fibre conduits will lead to cable-pits, from which risers of 3-in. conduit will be carried to distributing panels. All a.c. cables will be 3-conductor paper insulated, leaded, direct current cables being single-conductor, leaded. For lighting factory area, 4-light clusters, wired in series-parallel, will be used. As mentioned above, the neutral point of generator windings will be brought out. The lead sheath of the lighting feeder cables will be bonded to the neutral bus and lighting circuits will connect one wire to one of the three conductors, the other to the sheath, giving approximately 266 volts across two lamps in series. Lighting feeder cables will lead to distributing boxes on the third floor of each section, from which circuits will run to the panel boxes on the different floors. Power feeders will run to distributing boxes on the third and fifth floors, from which circuits will run to power loops on each floor.

All wiring except that in general offices will be open conduit. The general offices will have outlets for fans, dictographs, annunciator and telephones, all wiring concealed in conduit. A large number of 3-phase, 60-cycle motors will be used for direct-connected, belt and group drives. L. K. Comstock & Company have the contract for wiring the lighting and power circuits.

An artesian well is being drilled by Wallace Bell Company, Limited, and will be used for drinking water and for manufacturing purposes.

In addition to the fibre protection system, a regular watchman's service system will be installed, so that the building will be patrolled at all times outside of the regular working hours. For the convenience of watchmen and to avoid the use of oil lanterns in the plant, a certain number of electric lights will be kept burning all night to form a pilot system, so that in cases of emergency the workmen in the building can easily locate the fire apparatus and also the exits.

The following features in connection with the building are of interest:—

The total excavation amounts to some 50,000 cu. yds. Over 14,000 cu. yds. of concrete have been used for foundations. 1,500 carloads of building material have been received up to the present time. 100,000 sq. ft. of glazing has been used, and approximately 100,000 sq. ft. hot water radiation service will be required.

The work has been executed under the direct supervision of Mr. E. F. Sise, President of the Northern Electric Company, Limited; Mr. J. D. Hathaway, General Superintendent; Mr. J. S. Cameron, Plant Engineer, and Mr. W. J. Carmichael, Architect.

USE OF POWDERED FUEL.

Fuel economy and the intimately associated problem of smoke abatement are receiving much attention. Among the methods discussed none perhaps is of greater interest than the burning of powdered coal The experiments made in this direction are of especial value to all who are interested in the utilization of peat. The work done by Lieutenant Ekelund in Sweden, according to the Journal of the Canadian Peat Society, has already demonstrated that peat has very great possibilities when used in powdered form. Its composition and physical properties make it in some respects superior to coal for this purpose.

The requirements for best results in burning powdered coal are thus stated by an authority.

(1) Coal must be dried to contain not over 1 per cent. of moisture.

(2) It must be pulverized to a high degree of fineness.

(3) It must be projected into a chamber hot enough to cause instant ignition.

(4) It must be supplied with sufficient air for complete combustion.

The standard of fineness given by the same authority is:—90 per cent. through a 400 mesh screen; 2½ per cent. to 5 per cent. through a 200 mesh screen, and the balance through a 100 mesh screen.

The cost of preparation of coal is variously estimated at from 32½ to 36½ cents per ton, with power at 1½ cents per k.w. hr.

It must be kept in mind that there is present in powdered fuel a certain percentage of extremely fine material, depending on the character of the fuel, its moisture content, and method of pulverization. The character of the flame is materially influenced by this impalpable dust which gasifies instantaneously.

The physical structure of peat is such that a large percentage of very fine powder would be more easily obtainable than in the case of coal, thereby increasing the rapidity of combustion.

Another point in favor of peat powder is the usual high content of volatile matters in peat. There is much divergence of opinion as to the amount of volatile matter required in coal to render it suitable for burning as powdered fuel. The majority of writers seem to think that 30 per cent. of volatile matter is a prerequisite, but some report satisfactory conditions with but 20 per cent. The higher the volatile the larger amount of the combustible will be converted into gas by the mere application of heat, and the more rapid and perfect the combustion. Ontario peats examined contain as high as 60 to 70 per cent. volatile matter, and should produce a highly efficient powdered fuel.

As in the production of peat fuel generally the important question is the removal of the moisture at such cost as to render the fuel economic.

Coast to Coast

Fort William, Ont.—The plant of the National Tube Company at Fort William is completed, and the works have commenced operating.

Montreal, Que.—The Canadian Fire Underwriters' Association is urging the inspection by competent engineers of Montreal's system of fire protection.

Regina, Sask.—The provincial highways commission of Saskatchewan is proceeding with a program of road construction work of a more extensive character than that of the past season.

Weyburn, Sask.—Preparatory work in connection with the laying of steel on the G.T.P. Weyburn-Talmage branch began the first week in June, and it is anticipated that the department will have the metal laid into the city by June 15.

Edmonton, Alta—Edmonton has decided to construct a municipally-owned paving plant at a cost of $37,000. It is to be in operation within 30 days, and it is planned to lay at least 100,000 square yards of pavement before the close of the 1914 season.

Winnipeg, Man.—While recently in Winnipeg, Mr. David McNicoll, vice-president of the Canadian Pacific Railway company, stated that the company would spend much money this and succeeding years on railroads in the Okanagan Valley, British Columbia.

Kingston, Ont.—A concrete bridge on stone foundation has been completed at Dog Lake, which has been built by the county and Palmerston township conjointly at a cost of $5,000. The bridge is 300 feet long, and has a central iron span 28 feet wide. It is reported as a very satisfactory piece of work.

Vancouver, B.C.—C.P.R. engineers and surveyors left Campbell River recently in two parties working on the preparation of surveys to carry the line of the Esquimalt and Nanaimo Railway northward along the shore of Vancouver Island. One survey party is working south of Campbell River, and one north, the later proceeding along the trail built by the government into the Salmon River Valley. It is stated that the intention of the C.P.R. is to build eventually to the north end of Vancouver Island.

Moose Jaw, Sask.—City Engineer Mackie has at present under investigation 11 gravel pits which have been offered to the city for purchase. The city intends acquiring a gravel pit with a view to using the gravel therefrom for macadamizing the principal residential streets throughout the city. The city engineer states in the course of an interim report to the works committee that, in his opinion, the cheapest method of securing good surfaces is by the use of some sort of macadam, such as gravel screened and graded; and by the treating of this, in order to yield a satisfactory surface, with some patent road material, such as "Rocmac."

York Township, York County, Ont.—At the recent meeting of the Central Ratepayers' Association of York township, a proposal was submitted by a representative of a United States firm of engineers, whereby the firm will construct a waterworks system in the township and guarantee a water supply to the residents at a fixed price per 1,000 cubic feet, the cost of construction to be borne entirely by the firm and the water to be brought a distance of 25 miles and supplied to all houses. If the ratepayers were to construct their own system, however, the company will undertake to supply the water. Further discussion of the scheme will be held at public meetings of the ratepayers before any decision is announced.

Victoria, B.C.—Mr. J. W. Stewart, president of the P.G.E. Railway company, has made a statement to the effect that the company's entire line is now under contract with the exception of about 34 miles. Grading is in progress along the whole right-of-way from Squamish to Fort George and will practically be finished this year. Also before the end of this year, it is intended to put in operation an accommodation train service between Squamish and Lillooet. Mr. Stewart announced further that, within a few weeks, development work will be started on the Coast terminals of the Pacific Great Eastern at Squamish. This will involve large expenditures for the improvement of the harbor and the laying out of the townsite.

Toronto, Ont.—Mr. C. R. Barnes, expert for the Ontario Railway Board, has recently presented to the Corporation Counsel a report upon the Toronto Street Railway. He finds that the seating capacity of Toronto street cars is inadequate, and recommends an increase of over 50 per cent. The present seating capacity of 29,069 during rush hours should be increased by 10,813, half of this number by the beginning of November next, and the rest a year from that date. Many of the cars in use are found to be out of date, and it is recommended that 37 single-truck cars and 71 closed trailers be replaced by new cars approved by the board by the first of November next. An additional 29 cars should be in service on new lines by the same date. In addition to this the platforms should be lengthened on 200 double-truck cars.

Calgary, Alta.—The latest estimate on the cost of the proposed concrete bridge at Ninth Street West across the Bow river at Calgary is $165,000, or $5,000 more than the figure given some time ago, and $105,000 more than the steel bridge that was voted for by the ratepayers some time ago. The by-law upon the subject has been prepared, and it was submitted to the City Council at the meeting held recently, but no action was taken, the proposal being referred to the Finance Committee for consideration. The figures, which have been revised by City Engineer Craig, provide $150,000 for the cost of the bridge and $15,000 for engineering and contingent account. The bridge which the ratepayers voted for when the three bridge by-laws were before the people some time ago, was a steel bridge to go alongside of the present steel Louise bridge. This bridge would cost $60,000.

Victoria, B.C.—Work is progressing in three tunnel shafts in connection with the Northwest sewer at Victoria. The first two are in the portion open in Esquimalt, the third at Sunnyside abutting on the Gorge waters. Preparations are being made to start a fourth shaft at Smith Street; while a considerable amount of work has been accomplished on the Cecilia road tank. At the first shaft, near the sea at McLoughlin point, 160 feet have been pierced to the south and 180 feet to the north side of the tunnel. The excavation from the outfall to No. 1 shaft has been opened for about 2,000 feet, and steps have also been taken to open a drift towards that shaft in order to increase the opportunities to advance this section. At No. 2 shaft about 160 feet north and 180 feet south have been worked, and the junction with the section of tunnel being worked from No. 1 shaft, should be effected in August. From No. 2 shaft the trench on Smith street has been opened about 500 feet, while on Gore, Head and Dunsmuir streets in trench excavation about 1,000 feet have been opened. At Dunsmuir street, the present terminus of the open excavation, a tunnel will be commenced continuing at a considerable depth under that street. It is possible that another shaft will be sunk at the other end to secure a face to work at the tunnel from that section. At the Sunnyside tunnel, No. 3, a drift of about 120 feet has been made. At the Cecilia road tank, which is rendered necessary by the levels of the land to be drained north of the Gorge, the steel is in place, and the concrete floor laid; and the concrete will be poured for the walls in the course of the next few days.

PERSONAL.

R. W. BROCK, Deputy Minister of Mines, Canada, will, it is announced, spend a portion of the summer on a geological study of the Bulkley Valley, B.C.

WM. C. ROWSE, B.Sc., M.E., has been appointed professor of mechanical engineering at the University of Manitoba. Prof. Rowse is a graduate of Purdue University.

C. F. J. GALLOWAY, M.E., of the British Columbia Department of Mines, is investigating the mineral-bearing areas along the route of the Grand Trunk Pacific Railway, working east from Hazelton.

A. B. GARROW, for several years in the main drainage department, City of Toronto, and now in the employ of the Toronto Harbor Commission, is in charge of the redesigning of the sewer outlets along the city's water front, found necessary in connection with the harbor development scheme of Toronto.

ARCH. CURRIE, City Engineer of Ottawa, has returned from Atlantic City, where he has been recovering from a lengthy period of illness. Mr. Currie is still unable to assume complete charge of his duties, owing to the condition of his health, and will, therefore, act merely in an advisory capacity on the more important matters until his health has been regained.

G. A. McCARTHY has been appointed to succeed C. W. Power (see *The Canadian Engineer*, June 11, 1914, p. 875), as railway and bridge engineer for the City of Toronto, and will assume his duties on July 1. Mr. McCarthy, a graduate of McGill University, Montreal, has had extensive experience in railway work, having been with the International Railway for seven years, followed by a position with the Algoma Central as assistant chief engineer, and from 1905 to 1909 with the Temiskaming and Northern Ontario Railway as chief engineer. Since then he has been with the firm of Smith, Kerry and Chase, which, after the decease of Mr. Cecil B. Smith, became Kerry and Chace, Limited. In addition, Mr. McCarthy has had sound experience on general engineering work, and will be a valuable asset to the works department of Toronto.

OBITUARY.

Notification has been received of the deaths of Robt. and E. S. Morrison in the Fraser river, B.C., at a point about 140 miles north of Kamloops. The latter was resident engineer of construction for the Canadian Northern Railway at Blue river. His brother was also engaged in railway work for the same company as timekeeper.

The death occurred in England of Prof. Robert Crawford, prominent in engineering both there and in Canada, and for a time professor of engineering at McGill University.

Early last week death came with unusual suddenness to Mr. Robt. H. Skelton, who for 6 years has been manager of the Ontario Sewer Pipe Company, Limited, Mimico, Ont. Mr. Skelton was in his 54th year.

The death occurred last week of Mr. William Armstrong, of Toronto, who was connected with early railroad work on the Grand Trunk and old Northern Railways. Prior to coming to Canada in 1851 he was on the staff of the Midland and other railways in Great Britain.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.

The 6th semi-annual meeting of the American Institute of Chemical Engineers is being held this week at Troy, N.Y., June 17th to 20th inclusive. Technical sessions are being held at which the following papers are being read according to the programme:—

"The Application of Physical Chemistry to Industrial Processes." By W. F. Rittman.

"Studies on Filtration." By J. W. Bain and A. E. Wigle.

"Scrubber for Vacuum Apparatus for Laboratories." By Chas. Baskerville.

On Wednesday night, Professor M. C. Whitaker will present his presidential address. This will be followed by an illustrated lecture by Dr. Wm. P. Mason on the Saratoga septic tanks.

On Friday morning the following papers will be presented:—

"Shoddy and Carbonized Waste." By L. J. Matos.

"The Present Patent Situation." By M. Toch.

"Bleaching Cotton Fibre." By J. C. Hebden.

"Ozone in Ventilation." By J. C. Olsen and Wm. H. Ulrich.

The programme for the Friday night session comprises the following two papers:—

"Development of Rotary Furnaces." By R. K. Meade.

"A Combination Water Softener and Storage Tank." By L. M. Booth.

Professor M. C. Whitaker is president and Dr. John C. Olsen, Polytechnic Institute, Brooklyn, N.Y., is the secretary of the Institute.

CANADIAN MANUFACTURERS' ASSOCIATION.

The Canadian Manufacturers' Association held its annual meeting in Montreal, June 9th, 10th and 11th.

COMING MEETINGS.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30th to July 4th, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.—Summer convention to be held at Brighton Beach, N.Y., July 3rd and 4th, 1914. Secretary, J. R. Wemlinger, 11 Broadway, New York.

UNION OF CANADIAN MUNICIPALITIES.—Annual Convention to be held in Sherbrooke, Que., August 3rd, 4th and 5th, 1914. Hon. Secretary, W. D. Lighthall, Westmount, Que. Assistant-Secretary, G. S. Wilson, 402 Coristine Building, Montreal.

AMERICAN PEAT SOCIETY.—Eight Annual Meeting will be held in Duluth, Minn., on August 20th, 21st and 22nd, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

CANADIAN FORESTRY ASSOCIATION.—Annual Convention to be held in Halifax, N.S., September 1st to 4th, 1914. Secretary, James Lawler, Journal Building, Ottawa.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Seventh Annual Meeting to be held at Quebec, September 21st and 22nd, 1914. Hon. Secretary, Alcide Chausse, 5 Beaver Hall Square, Montreal.

CONVENTION OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—To be held in Boston, Mass., on October 6th, 7th, 8th and 9th, 1914. C. C. Brown, Indianapolis, Ind., Secretary.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9th to 13th, 1914. I. S. Pennybacker, Executive Secretary, and Chas. P. Light, Business Manager, Colorado Building, Washington, D.C.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21913—May 29—Directing that C.P.R. install gates at crossing of Hurontario St. in Tp. Toronto, to be operated by day and night watchmen; and file detail plans of said gates for approval of Engineer of Board within 30 days from date of this Order, 20 per cent. of cost of installing gates be paid out of "The Ry. Grade-Crossing Fund," and remainder by Ry. Company. 20 per cent. of cost of maintaining said gates be borne and paid by County of Peel, including wages of gatemen; remainder paid by Ry. Co. Gates be erected and in operation by July 1st, 1914.

21914—June 1—Directing that crossing of C.P.R. by St. John Ry. on Main St., city of St. John, N.B., be protected by half interlocking plant; derails be placed on St. John Ry. and home signals on C.P.R.; derails to be interlocked with said signals. Normal position of signals be at "proceed" for C.P.R. and "stop" for St. John Ry. Co.; in movement of trains C.P.R. to have priority. St. John Ry. Co. to bear and pay cost of installing, maintaining and operating half-interlocking plant.

21915—June 11—Authorizing C.P.R. to open for traffic second main line track between Agincourt, mileage 87.3, and Leaside Jct., mileage 95.6, Toronto Subdivision, Ontario Div., Ontario.

21916—June 1—Authorizing C.L.O. and W. Ry. (C.P.R.) to carry traffic over railway from Glen Tay to Agincourt, mileage 0 to 182.6, Ontario.

21917—June 1—Approving location Montreal and Southern Cos. Ry., from westerly boundary village of Granby, thence easterly upon and along Main Street, Drummond St., Irwin St. and St. Charles St., said village of Granby, subject to terms and conditions contained in said By-Law No. 192.

21918—June 1—Authorizing Nelson and Fort Sheppard Ry. Co., to construct spur into premises of The Benton Pole and Timber Co., five miles west of Erie, Lot 1237, West Kootenay Dist., B.C.

21919—June 1—Approving location Montreal and Southern Cos. Ry., from boundary line between parish St. Cesaire and parish St. Paul de Abbotsford, Co. Rouville, Que., to west boundary of town of Granby, mileage 35.05 to 45.61.

21920—June 1—Authorizing Montreal and Southern Cos. Ry., to construct across public highways between Lots 178 and 179, and between Lots 217 and 48-47, parish St. Paul de Abbotsford, Co. Rouville, Que.

21921—May 22—Directing that Dominion Atlantic Ry. fill in approaches to crossing of Grafton Road, Grafton, N.S., a distance of 300 ft. to south and 400 ft. to north; work be done at expense of Ry. Co. and maintained for period of 1 year from date of this Order.

21922—June 6—Directing that C.P.R. re-establish and maintain train service between Winnipeg and Gimli that existed prior to 1st June, 1914, until sittings of Board at Winnipeg, on Friday, June 26th, 1914, when those interested in matter shall be heard.

21923—May 29—Directing G.T.R. to construct extension of interchange track (between G.T.R. and Hamilton Radial Electric Ry. near Burlington, Ont.), so as to accommodate at least ten cars; work be completed within 60 days from date of this Order. Cost of work be borne and paid ½ by G.T.R. and ½ by Hamilton Radial Electric Ry. Co.

21924—May 28—Dismissing application Board of Trade of Sheho, Sask., for Order directing C.P.R. to remove station at that point from present location to town side of track.

21925—May 26—Dismissing application town of Gladstone, Man., for Order directing C.N.R. and C.P.R. to construct highway over respective lines of said railway Cos., at Dufferin St., in town of Gladstone.

21926—May 26—Refusing request of residents of village of Lac du Bonnet, Man., for Order requiring C.P.R. to build platform at point opposite village, and requiring local train of said Co. to stop at said platform at night and in morning.

21927—June 2—Certifying that correction of C.L.O. and W. Ry. (C.P.R.), plan to show division line between lands of W. A. Beare and Mrs. S. Beare on location indicated in red instead of on location indicated in green on plan dated May 15th, 1914, has been allowed.

21928—June 4—Authorizing C.P.R. to construct, at grade, its Lake Louise Branch Line across highways between mileage 0 and 3.55 of said Branch Line.

21929—June 4—Authorizing C.P.R. to operate its trains over bridge No. 30.5, Temiskaming Subdivision, Lake Superior Division.

21930—June 4—Amending Order No. 21706, dated April 21st, 1914, by striking out word "clearance," in two last lines of operative part of Order, and substituting word "distance."

21931—May 29—Directing that C.P.R. construct subway at crossing of Hurontario St., Tp. Toronto, Co. Peel, Ont.; subway to be 20 ft. wide and have 14 ft. clearance. Work be completed by September 1st, 1914. 20 per cent. cost of construction be paid out of "Ry. Grade-Crossing Fund," remainder as follows:—15 per cent. by Tp. Toronto, and 85 per cent. by Railway Company.

21932—June 1—Authorizing Bay of Quinte Ry. Co., to open for traffic diversion of its line in Lots 32, 33 and 34, Con. 8, Tp. Camden, Cos. Lennox and Addington, Ontario.

21933—June 4—Authorizing V.V. and E. Ry. and Nav. Co., to reconstruct bridges across C.P.R. at Grand Forks, B.C., subject to condition that should any additional tracks be built by C.P.R. at said point, V.V and E. Ry. and N. Co. bear and pay expense of making necessary changes to provide for same.

21934—June 2—Authorizing G.T.R. to construct siding into premises of Siemon Brothers, Limited, Park, Lot 1 and Park Lot 0, town of Wiarton, Ontario.

21935—May 26—Dismissing application Frank Yestran, village of Rosewood, Man., for Order requiring C.N.R. to stop its "Flyer" train at Dufresne, Man.

21936—June 5—Amending Order No. 21913, dated May 29th, 1914, by striking out word "Hurontario," where it occurs in recital and operative parts of Order, and substituting word "Dundas."

21937—May 29—Directing that G.T.P. Ry., file with Board, within 30 days from this date, plans showing location of Standard No. 1A Station with 60 ft. platform at point between Tofield and Deville, Mile Post 759, stock pen with necessary platform and loading chute, also spur to hold at least 4 freight cars; all to be completed before Sept. 1st, 1914. Also that wayfreight and passenger trains, other than through passenger trains, stop at said station.

21938—May 29—Authorizing city of Edmonton, Alta., to open Spruce Ave., across C.N.R. in Edmonton; and it is also authorized to construct its Municipal St. Ry. across C.N.R., at rail level, on Spruce Avenue, subject to and upon certain conditions. Pending installation of half-interlocking plant. City is authorized to operate cars over C.N.R. subject to condition that crossing be protected by watchmen to be appointed by C.N.R.; wages of watchmen to be borne and paid by city of Edmonton.

21939—May 29—Directing that C.N.R. widen loading platform at Vegreville, Alta., to 20 ft. within one month from date of this Order.

21940—May 28—Directing that C.N.R. construct and complete on or before July 1st, 1914, a one-pen stock yard and loading chute at Wiseton, Sask.

21941—May 28—Directing that C.N.R. file plan showing location of a fourth class station at village of Hughton, Sask., station to be erected and station agent appointed on or before July 15th, 1914.

21942—June 5—Authorizing Montreal and Southern Cos. Ry. to construct across parish line between parish of St. Paul de Abbotsford and parish of Granby, and public highways known as Little Road, between Lots 834 and 835; Cannan Road, between Lots 743 and 745; and Robinson Road, parish of Granby, Co. Shefford, Que.

21943—June 5—Authorizing Essex Terminal Ry. Co. to open for traffic its railway from connection with C.P.R. to connection with M.C.RR. and Detroit Tunnel Company, town of Sandwich, Ont.

21944—June 5—Authorizing Lake Erie and Northern Ry. to construct reinforced retaining walls along Jubilee Terrace and Water St., city of Brantford, Ont., and span over its tracks for extension of Lorne Bridge.

21945—June 4—Granting leave to Okanagan Telephone Company to place its wires across Shuswap and Okanagan Ry. Co. at Okanagan St., city of Armstrong, and at Gore St., city of Vernon, B.C.

21946—June 2—Approving agreement, dated May 5th, 1914, entered into between Bell Telephone Co. and Bobcaygeon Rural Telephone Co., Limited.

21947—June 4—Extending collection and delivery limits of Dominion Express Co. in town of Banff, Alta.; and rescinding the Order No. 18740, dated February 20th, 1913.

21948—June 4—Authorizing G.T.P. Ry. to construct main line across Government Road, B.C., at mileages 241 and 245, Lots 2,400 and 7867, Yellowhead Pass West, Cariboo Dist, B.C.

21949—June 4—Approving temporary diversion C.P.R. Main Line at mileage 39.3, Sudbury Subdivision, Lake Superior Div., and construct at grade, for period of 5 months from date of this Order; temporary diversion across North Road, Party Sound, to Byng Inlet.

21950—June 2—Authorizing C.P.R. to construct, by means of grade crossings, Weyburn-Stirling Branch Line across fifteen (15) highways, between mileages 253.35 and 277.78.

21951—June 5—Authorizing C.L.I. and W. Ry. (C.P.R.) to construct, at grade, in town of Bowmanville, two (2) tracks across Scugog St., to proposed freight yard in Subdivision, Lots 145, 178, 179, 184 and 185, Block 1, said town; all switching movements across Scugog St., on said spur, be flagged.

21952—June 5—Authorizing C.P.R. (1) to revise grade of main line, Thompson Subdivision, crossing Lorne St.; (2) construct, by bridge, additional track (double track) of main line across Lorne St., Kamloops, B.C.; (3) to make revision of location of portion from mileage 0.22 to 0.55.

21953—June 5—Approving and authorizing clearances at spur for Crown Feed and Produce Co., at Calgary, Alta., subject to Company undertaking to keep employees off tops and sides of cars when operated over said spur.

21954—June 5—Authorizing C.L.O. and W. Ry. (C.P.R.) to construct, by means of grade crossings, its business spur across C.N.O.R. main line and spur at mileage 1.05 and 0.55 of spur, subject to and upon certain conditions; and rescinding Order No. 21481, dated March 13th, 1914, and Order No. 21740, dated May 4th, 1914.

21955—June 5—Authorizing city of Hamilton, Ont., at own expense, to construct and maintain Burlington St., or Base Line, being original road allowance for road between Lot 7, B.F. Con. and Con. 1, Tp. Barton, Co. Wentworth, now city of Hamilton, across portion of road allowance claimed by Hamilton Radial Electric Ry., as forming part of right-of-way.

21956—May 22—Directing G.T.R. to construct spur into premises of Hepworth Silica Pressed Brick Co., Limited, Hepworth, Ont., subject to certain conditions.

21957—June 8—Authorizing G.T.P. Ry. to construct bridge across Phillips Creek, mileage 102.2 Prince Rupert East, B.C.

21958—June 8—Directing that joint rate on coke, in carloads of a minimum weight of 40,000 lbs. per car, from Consumers' Gas Co.'s siding on Esplanade, Toronto, to sidings of C.P.R. at North Toronto, be reduced from 95 cts. to 60 cts. per ton of 2,000 lbs.; effective not later than June 22nd, 1914.

21959—June 9—Directing that C.P.R. construct, at expense of Damase Goyotte of Lemoyne, Que., farm crossing at point 400 ft. east of west switch of passing siding, parish St. Athanase, Co. Iberville, Que.; work be completed within 30 days from date of this Order.

21960—June 9—Approving location G.T.P. Branch Lines Co. station at Avonhurst, Sask., Sec. 26-19-16, W. 2 M., Melville-Regina Branch.

21961—June 9—Authorizing G.T.P. Ry. to construct bridge across Ksi-Den Creek, mileage 147.3, Prince Rupert East, B.C.

21962—June 8—Authorizing G.T.P. Ry. to construct bridges across Fiddler Creek, mileage 127; Porcupine Creek, mileage 133.5; Lorne Creek, mileage 129; and Kitwanger Creek, mileage 152, Prince Rupert East, B.C.

21963—June 8—Extending, until November 4th, 1914, time within which G.T.R. complete spur into premises of Dominion Stove and Foundry Co., Limited, town of Penetanguishene, Ontario.

21964—June 8—Authorizing C.N.O.R. to construct spur to ballast pit across public road between Cons. 1 and 2, Tp. Pembroke, Co. Renfrew, Ontario, and operate same for 3 years.

21965—June 9—Approving location C.N.O.R. station at Ste. Dorothee (Isle Jesus), Co. Laval, Que., mileage 39, Hawkesbury East.

21966—June 6—Authorizing Edmonton, Dunvegan and B.C. Ry., to construct across thirteen highways in Province of Alberta.

21967—June 9—Relieving M.C.R.R., and Pere Marquette R.R. from erecting and maintaining fences on boundary line between respective rights of way on south side M.C.R.R. and north side of P.M.R.R.) at points west of St. Thomas, Ontario.

21968—June 9—Ordering the Dominion Express Co. to publish and file special tariff applicable to through shipments of milk or cream to Boston, Mass., establishing certain rates.

21969—June 11—Dismissing applications of Sheldons, Limited, Galt, Ont., and the Sirocco Co., of Windsor, Ont., for an Order reducing the carload rating of heating and ventilating apparatus in the Can. Freight Classification from 5th to 6th class.

21970—June 5—Authorizing the Lake Erie and Northern Ry. Co. to construct its railway across the highway between Cons. 8 and 9, Station 914-61.7, at mileage 37.36, Tp. of Townsend, by means of a subway.

21971—June 9—Authorizing the C.L.O. and W. Ry. to construct, maintain, and operate a business spur from a point on its main line in Trenton, Ont., at mileage 87.46 from Glen Tay, equal to mileage 0.00 of the proposed spur, to a point in Lot 1, on the northwest corner of Ontario and Dundas Sts., in said town, at mileage 0.00 and station 42-85.7 which is equal to Station 26-23.2 of the spur as originally located.

21972—June 8—Authorizing the C.P.R. to construct, maintain and operate branch line of railway, or spur, for the Canmore Coal Co., Canmore, Alta., from a point on existing spur in the S.E. ¼ of Sec. 29, Tp. 24, R. 10, west 4th Mer., on C.P.R. main line at Canmore, Alta.

21973—June 9—Approving revised location of a portion of the C.P.R. Co.'s Swift Current North Westerly Branch line from a point in Sec. 2, Tp. 23, Rge. 27, west 3rd Mer., at mileage 94.64, to a point in Sec. 3, Tp. 23, R. 27, W. 3 M., at mileage 97.29, and from a point in Sec. 3, Tp. 23, R. 29, w. 3rd Mer., at mileage 109.10, to a point in Sec. 17, Tp. 23, R. 29, W. 3 M., at mileage 111.95 of Swift Current North Westerly Branch Line.

21974—June 8—Further extending the time within which the C.P.R. complete the sidings for the Godson Contracting Co., Tp. Darlington, Co. Durham, Ont., until September 30th, 1914.

21975—June 9—Ordering the C.P.R. to divert crossing into the highway of the public road just west of Armilla, Sask., about eight hundred ft. east therefrom.

21976—June 12—Ordering the G.T.R. to switch cars, when desired by the municipality, to and from the track on the Esplanade owned by the town of Cobourg.

21977—May 20—Amending Order No. 20507, October 6th, 1913, by substituting the plan marked "A," dated November 1st, 1913, for the plan dated July 10th, 1912, approved under the said Order.