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KEELE STREET SEWER SYSTEM, TORONTO

ONE OF THE MOST RECENT EXTENSIONS TO THE SEWERAGE WORKS—A STORM OVERFLOW SEWER SERVING THE EXTREME WESTERN PART OF THE CITY.

AMONG the problems that confront the engineering department of a city upon the rapid annexation of outlying areas, that of sewerage is probably the most formidable. The speedy growth of these districts has invariably had connected with it a decreasing efficiency and sufficiency of sewerage service. In this respect the city of Toronto, the land area of which has increased in round numbers from 17 square miles to 32 square miles in the past decade, with a corresponding increase of population from 238,600 to 470,000 in that time, has had to cope with some intricate and interesting sewer problems, varying from the needs of large and sparsely populated sections to the requirements of a veritable city, *viz.*, West Toronto. Ward 7, as the extreme western portion of the city is now known, has a population of about 25,000. When annexed some few years ago, it was very inadequately served with sewers. The voluminous industrial and residential expansion, which immediately followed, rendered the situation more acute. The industries there include large packing houses, stock yards and innumerable manufacturing concerns with trade wastes of varying nature. These commanded immediate attention, the whole situation overshadowing in importance the numerous extensions which the sewer section of the works department of the city was called upon to make in other parts.

The establishment of an adequate sewer service for the western section has been under way for the past two years and is now nearing completion at a cost approximating $3,500,000. It is one of the most interesting installations in Canada, and its construction has been attended by some unique design and executed by novel methods. One exceedingly interesting part of it is the Keele Street storm overflow sewer and the various lines feeding thereto. The following notes relate to its more important features.

Fig. 1.—Early Construction Operations at Bloor Street and Clendennan Avenue, Showing Piling to Support Timber Trestle to Carry the Bloor Street Line Westward and the Clendennan Avenue Branch Northward.

This overflow system has an outlet in Lake Ontario at the foot of Keele Street, and the relief sewer extends north along Keele Street to Conduit Street, east to Woodville Avenue, north again to Junction Road, west on Junction Road to Mulock and north to St. Clair Avenue.

As the sewer proceeds northward it gets smaller and throws out a number of branches, the chief of which are first those near the corner of Bloor and Keele Streets, one proceeding westward along Bloor to the city limits, and the other proceeding east along Bloor to Dundas to pick up the laterals between Bloor from Keele and Conduit Streets. A branch of the former at Clendennan Avenue proceeds north to Dundas Street and thence westward to

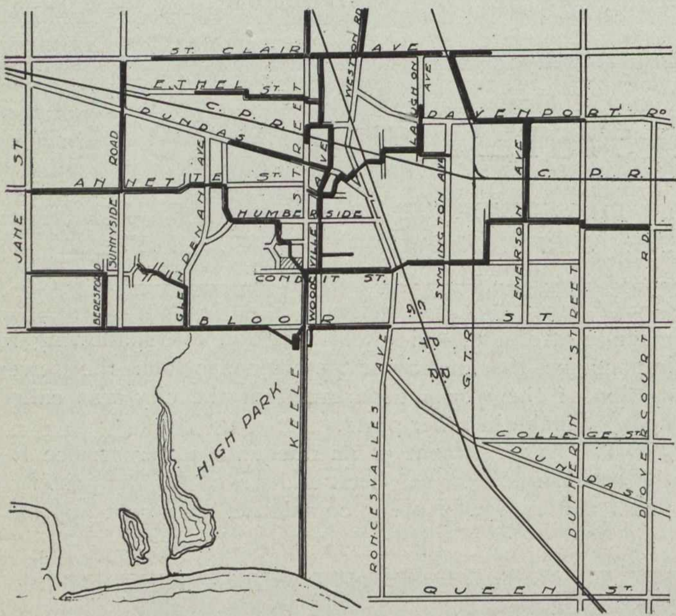


Fig. 2.—Sketch Plan of the Keele Street Storm Overflow Sewer Area, Toronto.

Runnymede Road. Still another extends up Beresford to Colbeck and along this street to city limit.

Another branch from the Keele Street main begins at Conduit Street proceeding west through Utley Park, along Hillsview, Medland Crescent, Humberside and Quebec Avenues and thence west on Annette Street to the city

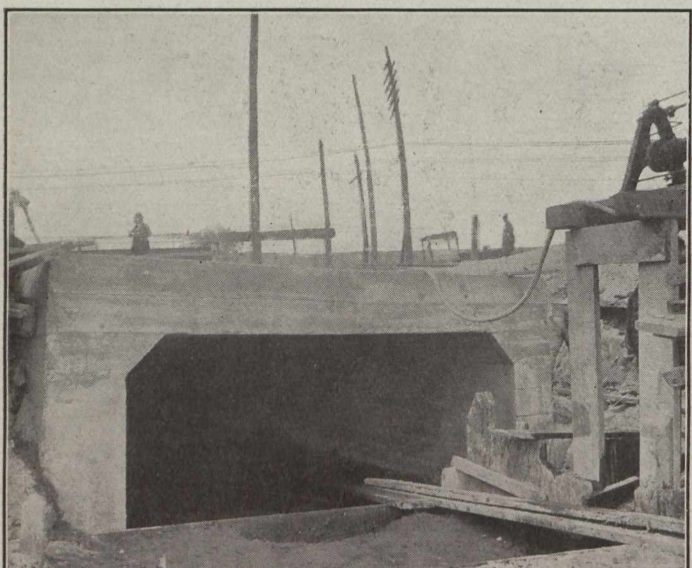


Fig. 3.—Keele Street Storm Overflow Sewer Outlet on the Beach Near Sunnyside.

limit. As before, a branch goes east along Conduit to C.P.R. tracks, across the tracks to Wallace Avenue, along Wallace to Ward Street and up Ward to Lappin, east on Lappin to Emerson, where it divides, one section continuing along Lappin to Dufferin, thence along Hallam to Dovercourt. The other section goes north on Emerson to Davenport Road where it divides, a small branch going east as far as Dufferin and the main section going west to Station Street and north to St. Clair.

The sewer has two more branches, one of which proceeds west to Keele where it joins up with a small branch of the old system. The other, east to Western Avenue north, then to Dundas, thence east to Watkinson Avenue north and across the C.P.R. tracks, coming out at Osler, thence east along Pelham and Kingsley to Symington Avenue. At Dundas and Woodville a small branch goes west as far as Clendennan Avenue. At Junction Road a branch runs west to Keele Street to drain the Keele Street subway, and at Hirons a branch goes west to serve the stockyards. At St. Clair the Woodville sewer branches, one section proceeding east to Station Street and the other west to Cobalt Street, serving the packing houses or

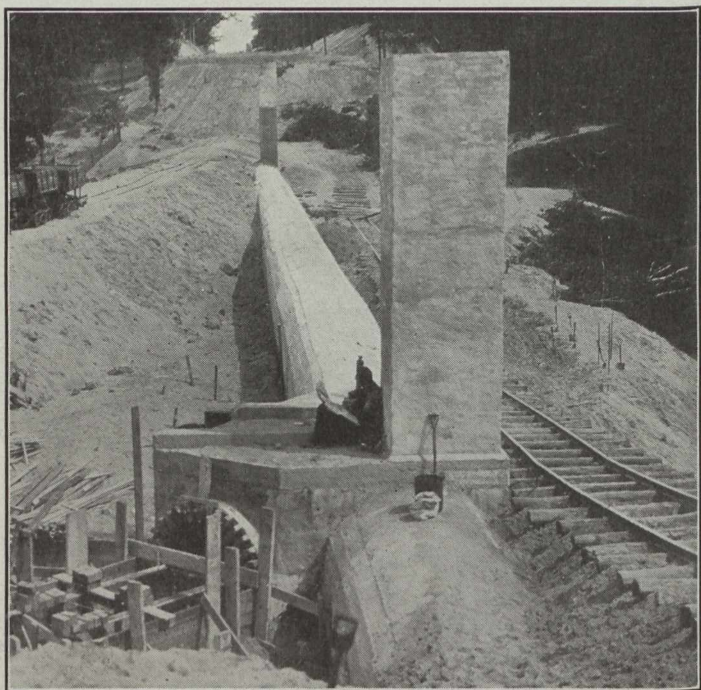


Fig. 4.—The Bloor and Clendennan Junction, Looking East, Showing Manholes to Future Grade of Bloor Street, and the Earth Fill Under Way.

abattoirs. There are other small branches still in contemplation. Each branch in turn serves a certain area, picking up all the small lateral sewers along its route.

As to its design, the storm sewer in its outlet section is rectangular, 6 ft. x 12½ ft. At the southerly entrance to High Park it changes to a 9-ft. circular section, which size is maintained as far north as Bloor Street. At this point there is a standby tank where the dry-weather flow is separated from storm water. This dry-weather sewerage, like that from all other parts of the city, goes to the main sewage treatment works at Morley Avenue for treatment before emptying into the lake. The tank in question is approximately 100 ft. square and is divided into three compartments. During dry weather the sewerage does not enter the tank but passes into a 3-ft. sewer and proceeds southward to the interceptor which conveys it to the sewage disposal plant. In time of storm, however, the increased volume of sewage, both from the northern and western branches, as outlined above, passes over a series of weirs into the first section of the tank, and, if excessive, through the other compartments as well; in which process all sediment is removed and drained into the 18-inch sewer, while the storm water flow, as an overflow from the tanks, proceeds via the Keele Street sewer to the lake. In this manner the standby tank disposes of all storm-swelled sewage entering it by the Bloor Street west and upper Keele Street sewers.

The former, *i.e.*, the Bloor Street branch, enters the tank at the northwest corner with a 6-ft. 9-in. x 5-ft. section, decreasing as it proceeds westward. Near the junction of the Bloor Street and Clendennan Avenue sewers the work necessitated the construction of an unusually large fill. For a length of about 600 ft. the sewer is here supported upon piles which are in some cases 50 ft. in length with framed lumber bents 30 ft. in height above them.

The Keele Street sewer enters the tanks at the northeast corner as a 9-ft. 3-in. circular section with square concrete bottom with brick lining and brick arch. This diameter is maintained as far as Conduit Street, or to its first branching point. The Woodville Avenue section is 8 ft. in diameter. On this portion a ravine is crossed by a timber trestle support, the ravine being subsequently filled in. The 8-ft. circular sewer extends north to St. Clair where it branches, as stated. The eastern branch is 4 ft. 3 in. and the western branch 6 ft. 3 in. in diameter. The Utley Park branch is a 6′ 3″ x 5′ culvert sewer changing at Hillsview Avenue to a 6′ 6″ x 4′ 4″ egg-shaped sewer with square bottom. Along Humberside Avenue it becomes a 5-ft. circular, changing again on

Fig. 5.—In the Keele Street Section, South of Bloor Street, Showing the Nature of Excavation Encountered in This Particular Section.

Quebec Avenue to a 4′ 9″ x 3′ 2″ egg-shaped and later to a 3′ 4″ x 5′ along Annette Street, the size diminishing as it proceeds westward.

The sizes of the sewer on Conduit are as follows: 7′ 5½″ x 5′; 9′ 4″ x 6′; 9′ 1″ x 6′; 8′ 10″ x 6′, etc.

The stockyards branch is a 5′ x 3′ 4″ egg-shaped sewer at Hirons Avenue, decreasing in section to 4′ 9″ x 3′ 2″. The Junction Road branch is smaller still, being a 2′ 6″ x 3′ 4″.

The 450-ft. section of storm outlet was constructed by Jennings and Ross, Limited, contractors. The section north as far as the tanks at Bloor Street, with the exception of a 32-ft. length which is an experimental section constructed of tile segment block with concrete base, and 800 ft. of concrete section with brick lining, is a 4-ring

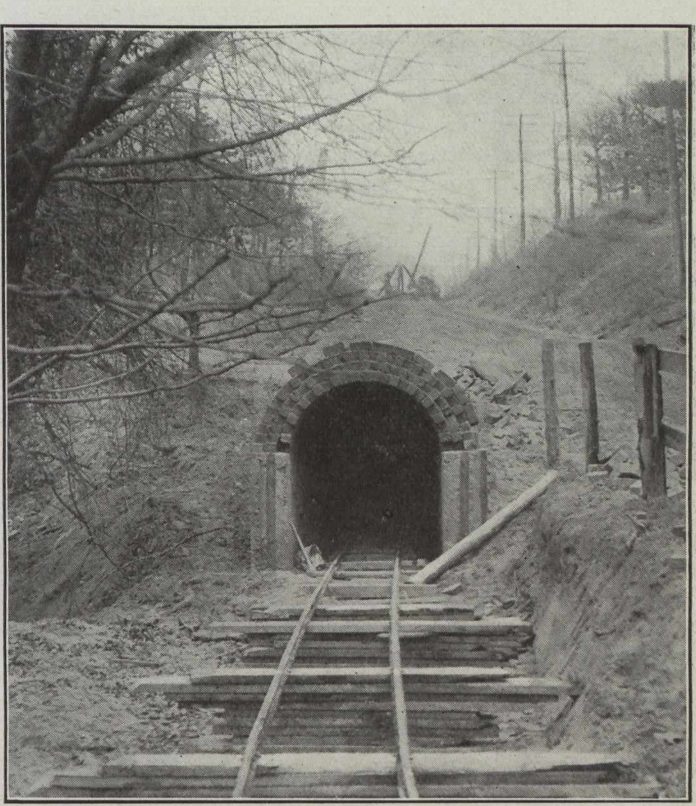


Fig. 6.—End of Bloor Street Tunnel Just Before the Section on Piles Shown in Fig. 1.

brick circular section. This was constructed by Messrs. Fussell, McReynolds Co., Limited. The tanks were built by the McKnight Construction Co. The Keele Street sewer from the tanks north as far as Woodville was constructed by the Orpen Co., Limited. The section up Woodville Avenue to St. Clair was built by Donnelly & Graham, and the St. Clair Avenue branches, both east and west, were built by Fussell, McReynolds Co. The stockyards branch and the Keele Street subway branch were constructed by Jennings & Ross, Limited. The whole Utley Park branch was built by the Godson Contracting Co. and the Bloor Street section by the Orpen Co., Limited, and the Conduit, Wallace Avenue, etc., branch sections by Fussell & McReynolds, McKnight Construction Co., John Maguire & Son, and Connelly & Agnew.

The work was done under the supervision of the Commissioner of Works, Mr. R. C. Harris, Mr. George G. Powell, deputy city engineer, and Mr. W. R. Worthington, assistant engineer, sewer section, while Mr. W. G. Cameron was division engineer on the work.

A few weeks ago the Delaware, Lackawanna and Western Railway completed the Tunkhannock viaduct, a structure worthy of note. It is the largest of its kind in the world, being 2,375 feet long, 240 feet high, and consisting of 10 reinforced concrete arch spans. It is on the Nicholson cut-off in northeastern Pennsylvania, which is a $12,000,000 change of alignment shortening the road 3.6 miles, eliminating 2,440 deg. of curvature and effecting a considerable reduction in the ruling grades.

CANADIAN HYDRAULIC POWER PROBLEMS.

ONE of the Canadian papers read and discussed at the International Engineering Congress in San Francisco, in September, dealt with the radical advances made in Canada in the past twenty years in the field of hydraulic power development. Lack of space prevents a comprehensive review of this valuable paper. Its author, Lieut.-Col. C. H. Mitchell, C.E., now on active service in Flanders, has presented a concise general consideration of the whole field, and in a manner that merits careful study and that invites closer and more detailed investigation. Chiefly worthy of mention are the sections of the paper covering water storage, progress in hydraulic engineering, and the problem of dealing with ice conditions. We make the following abstracts of Col. Mitchell's paper, relating to the first and third of these, with the intention of presenting in an early issue an extended reference to the second.

Water Storage.—Storage of water for power purposes by no means presents a new problem, but the application to the immense power projects now existing or under way demands a systematic conservation of water quite beyond the requirements of the past and introduces many new phases into the question.

The seasonal changes in river flow are very pronounced, as the winter discharge is, in general, retarded by freezing and in the late summer the combined effect of low precipitation, excessive evaporation and depletion of natural storage again creates low water; the lesser flow of the two periods definitely determining the economic value of the water power. The enormous flood flows following the winter seasons are available for but a very short period, but if properly conserved and further augmented by the storage of the surplus of the subsequent rains, the minimum flow can be materially increased and the value of the benefited power developments correspondingly raised.

The condition is general in Canada, that hydro-electric developments have approached or exceeded the unregulated capacities of their respective rivers, and while very few extensive storage systems are as yet constructed, the activity of industrial expansion now demands that the power developments must anticipate the very near future and fully provide for the securing of maximum available outputs and that every advantage be taken for complete conservation and storage. It is remarkable that practically all Canadian rivers are naturally provided with excellent storage possibilities.

Pondage, differentiated from storage as being the day-to-day storage of water immediately available at the turbines, is an essential in Canadian water powers as providing an insurance against ice, which is a factor commanding the full respect of the engineer. The river flow due to the controlled discharge from remote storage reservoirs may not correspond to the variation in power demand during the day, thus, further necessitating pondage as an important component in the economic regulation.

The investigation of storage and pondage requirements must fairly establish the load factor of the power supply imposed on the system, the load distribution over the twenty-four hours, and, further, the seasonal variation of load as dictated by the nature of the market. The study of the unexploited field demands an approximation of loads, whose character may be assumed by comparison with other existing loads, and it is essential that the inherent load factors applicable to the respective types of loads be fully recognized.

It must be appreciated that effective storage requires relatively large acres of land for flooding purposes and such lands, by growth of population and by the establishment of permanent improvement, increase in value at a rapid rate; at the present time, however, it transpires that the majority of the Canadian storage schemes now under way involve remote forested Crown lands readily adaptable for storage purposes. The multitude of interests involved in extensive storage developments makes the accomplishment of storage, in most cases, quite beyond the capabilities of the power developing companies and requires concerted action in the obtaining of the necessary rights. In Canada, the respective Government, Dominion or Provincial, which has jurisdiction over water powers, acts as the intermediary, and this has been a very substantial factor in the notable success of the power situation throughout the country.

The author then describes a number of Canadian storage developments, in service or projected. These include the Northeast and Indian Rivers scheme in Nova Scotia, the Saguenay River and St. Maurice River projects in Quebec, the contemplated storage scheme on the Winnipeg River, the Bow River and Athabaska River storage possibilities in Alberta and the Stave Lake and Coquitlam Lake systems in British Columbia.

Ice Conditions.—As before stated, ice conditions have been a serious factor against the continuous operation of hydraulic plants.

The ice problem is one which has engaged the hydraulic engineer throughout the whole history of development of Canadian water power plants. The low temperatures of winter are responsible for the diminution of run-off, the reduction of river areas and the entire freezing up of small streams. The retention of the greater portion of the winter's precipitation leads to spring flood flows of magnitude many times greater than the normal discharge, while the breaking up of surface ice in spring readily becomes a menace to be guarded against in protecting constructed works. The accommodating to small winter water supply is an economic problem, and the controlling of floating ice and of flood water is a problem of routine operation. The great difficulties, however, in the handling of water under winter conditions are due to the slight changes in the temperature of the water, when varying but a small fraction of a degree about the freezing point. It must be realized that the temperature of the water, even in the most severe weather, does not appreciably vary from the freezing point; indeed, it is only by the most delicate thermometers that the variation can be detected, but within a small range of temperature the most distracting troubles may arise.

There are three kinds of ice which are generally recognized: First, surface ice or sheet ice, which forms on still or comparatively still water; second, anchor ice which forms and grows on the beds of rivers which are not protected with surface ice; and third, frazil ice, which forms in the agitated water of rapids, falls and high velocity channels and accumulates in great masses in adjacent undisturbed water.

Surface ice may or may not be harmful. The chief trouble is experienced by the total freezing up of small streams and the diminution of the cross-sectional areas of the rivers. The ice floes and broken sections, when loosed in spring, are frequently troublesome through the forming of jams in the water channels, thus cutting off water supply or raising the tail-water to an extent sometimes disastrous. Further, it must be realized that surface ice in an open stream converts the waterway into a closed channel, and by the friction imposed by the surface covering transfers the cross-sectional area of maximum velocity to a greater or less depth, according to conditions. The velocity factors in stream gauging under such circumstances must, of course, be correspondingly changed.

Anchor ice most often causes trouble by its rising in masses from the river bottom; even rising and carrying stones and boulders of considerable size which have been embedded in the mass. While anchor ice is first formed by the radiation of heat on a cold, clear night, this will probably be accompanied by the forming of frazil, the anchor ice becoming the nucleus for the accumulation; such active masses are to be included among the operator's greatest trials.

Frazil ice is the most troublesome, but it is only to be expected where the air temperatures are hovering slightly below the freezing point. This is a condition to be met at the beginning and end of the winter season or during a changeable period, and after a short experience with it, its vagaries may be readily anticipated and the necessary precautions taken. The ice crystals formed by exposure to the cold atmosphere grow rapidly and adhere to one another to form lumps and spongy masses, attaching to every cold body they encounter; racks or screens, penstocks, turbines and all essential parts of water power equipment are readily affected by enormous accumulations capable of completely closing down the plant. The great majority of power plants have suffered; the modern plant, however, has become more immune from the effects, now that a full understanding of the problem is possible.

In selecting the site for power works on a river one must bear in mind the chances of ice troubles. Naturally, it is preferable to have large still-water pondage immediately above the water intakes; such a provision assures surface ice, which will obviate the formation of frazil and anchor ice adjacent to the power works. Unruffled water in the river supply for several miles above the pondage may be expected to reasonably free the lower waters of frazil; this condition is usually readily obtained, as in the damming of the river the adjacent rapids or falls are drowned out and the consequent head taken advantage of. The tail race and lower river must be viewed from the standpoint of ice discharge and the river course eased sufficiently to preclude any possibility of ice jams. Floating ice may be discharged from the forebay by booms arranged to deflect the ice to ice overflows and runways, which may carry it to the tail race. Ice which may be carried under the boom or screen house curtain so as to accumulate in front of the intake racks has generally to be poled out to the main ice overflow or to a separate runway adjacent to the screens.

It has been found by experience that the source of trouble from frazil ice is its great adhering power to cold bodies in the water. Iron screen racks are much affected when, in the presence of frazil, their temperature is but a fraction of a degree below the freezing point. The precautions are obvious. The submerging of iron racks below the surface will insure their being at the same temperature as the water and they will not act as conductors of the cold from the air; the top screen section which may extend above the water level may be of wood, which will act as a comparative insulator to the transfer of cold. Iron racks rising above the waterline may be fitted with a housing containing heat supplied by electricity or steam, so that the iron will conduct a small amount of heat throughout its length; the wider application of this is the screen house which is sheltered completely from outside air and may or may not be heated.

Iron penstocks, and turbine cases, have been known to be completely blocked by frazil ice, due to the colder temperature of the iron. The housing in of all water-carrying equipment is essential where frazil is encountered. The covering of surge tanks to protect against excessive freezing where the surface water is undisturbed for a sufficient period, such as may occur with a continued steady load, is essential.

The problem of housing of penstocks has evolved several practical and economic methods, when burying them is not possible nor desirable. The most common and possibly the cheapest arrangement is by means of a continuous wooden sheeting, having two vertical sides and a sloping or peaked roof, all on a simple wooden framing. A better arrangement, and undoubtedly a more desirable method, is by the application of metal lath or wire netting on metal or wooden framing plastered over by cement gun or by hand; the same scheme of covering may be used on surge tanks; these, however, are generally of such magnitude that it is preferable to include them in the architectural featuring, along with the power plant buildings.

The necessary exposure of gates, sluices, stop-log guides and seats, racks, etc., has required, in several cases, the installation of steam-heating plants supplying permanently placed steam piping for maintaining freely working equipment, and in the notable case of the Shawinigan plant, heated air is blown onto the protruding racks and onto the incoming water in the screen house.

LEAD COATING FOR IRON AND STEEL.

A patent has been granted in the United States for a process of coating iron or steel surfaces with a continuous and uniform film of lead. The object of the process is to provide a substitute for zinc and one less costly than tin for a protective coating.

After the iron or steel surface has been cleaned of scale or oxide, it is subjected to a suitable flux, such as zinc chloride, and submerged in a melted bath of lead containing a little cadmium. Ordinary commercial lead possesses but little affinity for iron, but in the presence of metallic cadmium, even in very small quantities, it will amalgamate with the iron surface so as to coat it with a very thin film. In the process, which is the subject of patent, there is used as small an amount as 0.17 per cent. but there can be used as high as 1 per cent. of cadmium. The smallest possible amount is recommended, as cadmium is expensive. Since it tends to oxidize and pass into the flux, causing a loss, the addition of about ½ per cent. of zinc to the lead bath prevents this, as the zinc oxidizes first and passes into the flux in preference to the cadmium. Cadmium, being more positive than iron, its presence in the lead tends to protect the iron the same as zinc. It also is claimed to promote and subsequently maintain the adherence of the film of lead.

Railroads operating 41,988 miles of line in the United States, and having a capitalization of over two billion dollars are now in the hands of receivers. This is said to be a larger number than ever before in the history of the country.

RURAL HIGHWAYS.

At one of the municipal engineering sessions of the International Engineering Congress, Mr. Arthur Gladman, engineer and surveyor, Eton rural district, England, read a paper on rural highways, from which we reproduce the following portions:—

Foundations.—The lack of proper or adequate foundation structure, which is one of the outstanding features of most rural highways, presents an important initial difficulty, and one which (in view of the increased traffic strain all roads are now subjected to by reason of the rapid and increasing growth of mechanically propelled traffic) will become from year to year more important, and at the same time less easy of solution.

It is almost a stock phrase that one cannot be expected satisfactorily to maintain a road unless such road has a good foundation; yet practical road engineers have to get along as best they can in this connection by maintaining year after year, in good condition, roads the chief characteristic of which is the lack of the very foundation which is said to be indispensable to their satisfactory maintenance.

The practical road engineer realizes that it is economically impossible to refound even a small proportion of the badly founded roads which already exist, and that he must take them for what they are and make the best of them. It is in this connection that there exists a large field for the exercise of the ingenuity of the highwayman in producing on, and in connection with, the surface of an existing road an element of strength which shall, in some measure at all events, take the place of the foundation which ought to be there, but which never was there.

The necessity for a thorough remodelling of method in road repair and maintenance which may be said to be the outcome of the revolution in uses to which roads are being subjected, has given birth to many ideas, and resuscitation to others; but the consensus of practical opinion appears to point to bituminous products of various kinds as forming a range of available material readily applicable as a binder or flux for use in conjunction with ordinary road stone as the aggregate.

Bituminous Construction.—There can be little doubt that a properly prepared tar or bituminized macadam forms one of the best, most practical, and ultimately economical preparations for road surfacing work; one of the difficulties, however, attending the use of this material is that if the tar compound with which the aggregate is coated is sufficiently distilled and dehydrated, and otherwise properly prepared for road work, the mixing thereof with the stone aggregate must be carried out at the time it is required for use, and preferably in situ, owing to the fact that a properly prepared tar compound, especially if in its composition material of an asphaltic nature is introduced, sets off quickly, and possessing, as it does, only one setting moment, it is incapable of being kept or stored for an appreciable period after incorporation with the stone aggregate, and must be applied to the road soon after its manufacture.

But while the author is satisfied that bituminous-bound roads are superior in every respect to those constructed under the water-bound system, he is also satisfied that economy—not only initial, but ultimate—could and would be effected by a more modest use of materials. It seems such a waste of good material and labor to resurface a road to a depth of 5 in. or 6 in. when an equally good result could be obtained by the application of a surface coat of 2½ in. in thickness. It does not appear to be sufficiently realized by road engineers that (assuming a reasonably good foundation exists, thus providing for the dead-weight resistance of the traffic to which the road is subjected) the wearing surface need not be of great thickness, and indeed need be but a thin one, always assuming that it is composed of properly selected and prepared materials suitably and intelligently applied.

It has been said that one of the functions of a civil engineer is that of being able to do for a penny what any fool could do for twopence; and if this comparative statement could be said to apply to the civil engineer in general, it could most certainly be said to have a special application to the work of the road engineer, since it is so very easy to throw away good money on poor materials and unskilful work in the practice of road maintenance.

The advent of the automobile has undoubtedly brought the road question in all its bearings into prominence, and has rendered the question of the construction, reconstruction, administration and maintenance of highways one of extreme importance in the economy of modern-day life, and it behoves all those engaged in the management of public highways to bring to bear on the subject all the powers of skill and sound judgment of which they are capable. There is still a great field for the exercise of skill and ingenuity, as well as of high administrative talent on the part of those engaged in the practice of highway engineering.

Road engineers have had in the past few years enormous difficulties to contend with; the great expansion of road traffic has not been accompanied by a correspondingly great expansion of financial means whereby roads could be prepared and fitted to bear such increased and increasing traffic, and the wonder is, not that so little has been done to meet the exigencies of the case, but that so much has been accomplished under circumstances of such difficulty.

The original idea of a paving material for roadways was a hard, rigid-wearing surface, the foundation under it being often considered as a secondary matter; experience has, however, now demonstrated that for heavy traffic a tough and slightly resilient surface material on an unyielding foundation is essential.

Of course, the above can only be regarded as a general principle, and must be considered in conjunction with other requisite qualities—such as impermeability, ease in cleansing and repairing, initial cost, etc., as well as local climatic conditions.

In considering the character of materials to be selected for road construction, it would appear that the safety of the resultant road should be the first consideration, after which consideration of cost may be permitted to find a place.

It is to be feared that in far too many instances the question of the safety of the travelling public is thought of far too little by those who have the selection of materials; thus we find in many cases hard, brittle, non-absorbent furnace slag coated with tar is used which wears to the smoothness of glass, and is cruelly dangerous in damp weather owing to the fact that the material formed by the wear of the road is in the form of a fine powder, which, when wet, forms a slimy, slippery mess upon which it is next to impossible for animals to retain a foothold, and which, on the recurrence of the slightest frost, presents a surface positively inimical to life and limb to essay to travel.

Methods of Macadam and Telford.—In the United Kingdom road making with broken stone will always be identified with James Loudoun Macadam, from whom this form of road construction received its name in England. The honor is somewhat unmerited, as the main principles of Macadam's construction are now largely discountenanced, and the methods of his contemporary, Thomas Telford, are more generally followed. The differences between the methods of Telford and Macadam may, however, be briefly summarized as follows:—

Macadam.

Foundation.—None.

Metalling.—Uniform coat, 11 in. thick, of stone broken to a 2-in. gauge.

Binding.—None.

Drainage.—Through cross drains, side channels and ditches; made his roads above level of surrounding country whenever possible.

Telford.

Foundation.—Hand-pitched rock, 7 in. deep, tops not to exceed 3 in. in width; interstices filled and consolidated with small stones, and levelled off to a cross contour of 1 in 60.

Metalling.—One coat, 7 in. deep, of broken stone, no stone exceeding 6 oz. in weight, and all passing through a 2½-in. ring.

Binding.—1 in. of gravel.

Drainage.—Nine stone cross drains to each mile length, delivering into side ditches; channels delivering into cross drain on each side.

The fame of Macadam and Telford as road makers was not due so much to original ideas on their part as to their adaptation of existing methods, combined with great administrative capacity. Thus, the broken-stone method was already in vogue on the Continent, and had been adopted by John Metcalfe, a predecessor of both Macadam and Telford. Tresaguet, the French engineer, was laying roads with hand-pitched rock some thirty years before Telford adopted the method, and it is curious to note that the engineers of the ponts et chaussées abandoned their own excellent idea for a while to take up the less-sound one of Macadam.

Macadam's theory that the elasticity afforded by the natural road bed was of advantage in giving the property of resiliency to the road bed, and that therefore no distinct or separate foundation was required, does not now seem to be accepted, while Telford's elaborate and expensive hand-pitched foundation is only followed, if at all, in road building for heavy traffic, or for the purpose of ensuring adequate under-drainage on clay or other heavy soils.

For the most part, where foundations are put in, they consist of hardcore, such as broken bricks, clinker, pottery refuse, etc., rolled, preferably in layers, to the required thickness and formation. The cross-sectional contour of the road surface should be reproduced in the foundation, care being taken to ensure that the shoulders of the road (in the absence of stone or other curbs and channels) are built up of large material so as to form buttresses calculated to resist the lateral spread of the road material.

Steam Rolling.—Steam rolling has now become an internal part of the operation of both the construction and maintenance of roads, and few roads are now resurfaced or extensively repaired without its aid. The advantages to be derived from the use of steam rollers may be said to include (*a*) a saving of metalling as well as time, inasmuch as a thinner coat of metalling (being more effectively consolidated) will suffice than would be necessary if consolidation was effected by the traffic; (*b*) a smoother surface, affording easier traction, can be obtained; (*c*) the saving of material over the old method of traffic consolidation, as well as the avoidance of damage to vehicles; and (*d*) economy in binding materials.

The disadvantages of steam rolling are, (*a*) that very often a much too heavy roller is used, and rolling is carried beyond the effective point, resulting in loss of material by crushing action. Contrary to opinions often expressed to the effect that the crushing of road stone indicates that the stone itself is of poor quality, the author has found it possible to damage the best and toughest basalt or porphyritic granite considerably by rolling quite dry with even a 6-ton roller, and considers that an 8-ton roller is quite heavy enough for any but heavy town work, and that the use of a roller heavier than 10 tons does more harm than good on almost any class of work.

The question of the position and depth of sewers, drains, or gas and water pipes also has an important bearing on the question of the use of steam rollers, inasmuch as many hundreds of miles of these pipes were laid at an insufficient depth years before rollers were in common use, and although it is comparatively easy to require that all new pipes be laid so as to have at least 3 ft. of cover, the road engineer is, in numerous instances, still confronted with the difficulty of rolling over pipes which are laid at a less depth than 3 ft.

The number of times a roller must pass over a given point to secure effective consolidation varies, first, in proportion to the hardness of the stone; secondly, according to the thickness of the layer, but not in proportion to it; and thirdly, if the stone is dry.

Mr. Rockwell estimates that with a layer of 3 in. in thickness a 10-ton or 12-ton roller must pass over limestone fifty times, granite fifty to seventy-five times, porphyry ninety to one hundred times.

Watering should be resorted to in the early stages of consolidation, and is best applied by means of a spraying apparatus attached to the roller (so as to spray water on the wheels), which, besides economizing the use of water, renders it possible to apply the required quantity, and no more, in an effective and perfectly controlled manner.

Binding Materials.—On no account should a binder of mud or old road scrapings be used to complete consolidation of the road-crust by filling the voids. If a bituminous binder is out of the question (the initial cost of such a binder is its only drawback, as its use is undeniably an ultimate economy), loamy sand, used either alone or in conjunction with granite dust or chippings, is the best binder. All binding agents should be used in correct relative quantities to the weight of stone to be consolidated, the quantity of binder being about one-fourth of the weight of the aggregate, or less if possible.

Mr. G. Tillson advocates fine limestone screenings, and considers trap rock screenings and sand in the proportion of 3 of screenings to 2 of sand gives good results. Trap and other igneous rock screenings have little cementition value, and if the binder is solely composed of these it will require a considerable amount of rolling.

Mr. Deacon, formerly city engineer, Liverpool, carried out some experiments bearing on this matter, the result of which is stated as follows:—

"Under a 15-ton steam roller, preceded by a watering-cart, 1,200 sq. yds. of trap-rock macadam, without binding, was only moderately consolidated by twenty-seven hours' continuous rolling. If trap-rock chippings are used, the same area may be moderately consolidated in eighteen hours. If siliceous gravel, from ¾ in. to the size of a pin's head, mixed with one-fourth part of macadam sweepings, obtained in wet weather, be used, the area may be thoroughly consolidated in nine hours. Macadam laid by the last method wears better than that laid by the second, and that laid by the second much better than that laid by the first."

Experiments conducted by Mr. W. H. Grant, superintending engineer of the New York Central Park, in the construction of his park roads demonstrates the necessity of using binding material.

Mr. Grant in these experiments followed Macadam's "no-binding" theory. The bottom layer of stone was, under a 12-ton steam roller, sufficiently consolidated to form and retain (after the compression had reached its practical limit) an even and regular surface, but it was found impracticable to solidify the top layer and reduce it to such a surface as would prevent the stones from loosening and being displaced by the action of wheels and horses' feet. No amount of rolling was sufficient to effectually bind the metal, although the rolling was persisted in until the metal was damaged by the extensive crushing action of the roller.

It is generally agreed that any description of binder which is used in conjunction with water should be used sparingly, with a view to filling the voids only, as an excessive quantity of binding material will have the effect of keeping the units of stone apart, and will be washed out in wet weather or exuded as the result of traffic pressure in damp weather, thus causing the road crust to lose its even surface.

Scarifying.—The question of the scarifying of existing road surfaces previous to partial or entire resurfacing is one concerning which road engineers entertain somewhat divergent views, but it may be stated, as a general proposition, that scarifying is only justifiable when the existing road surface or crusts consist of sufficient thickness of one grade of material to ensure that the foundation of the road shall not be disturbed by the operation. In such cases the surface may be safely scarified and cleaned by screening out the binder and small aggregate, adding such a quantity of new material as will bring the road up to the required strength when re-rolled; but if the structure of the road is at all weak, a new coating of material should be superimposed on the whole work and the edges and ends only should be picked up or scarified to ensure a satisfactory join between old and new work.

If scarifying is necessary, it will be better and more economically done by machine than hand, always assuming that the extent of the work to be so carried out justifies the employment of a machine scarifier. In works of small character hand picking or scarifying may be judged to be more economical.

Repairs.—Concerning the important detail of road maintenance, which is comprehended under the general term "repairs," much may be written. When dealing with "water-bound" roads the methods of repair adopted appear to be very largely governed by the personal predilections of individual surveyors, one section of whom rely principally on what may be termed the continual-patching methods, while others prefer the complete re-coating method. Possibly a system which includes both methods is the more to be preferred. On the one hand the patching method requires a fair amount of skill for its proper performance, and, if carefully and consistently carried out, will render a road more comfortable for traffic; but it will not entirely eliminate the necessity for occasional re-coating, inasmuch as it is next to impossible to restore by this method the exact amount of wear to which any given road is subjected. On the other hand, it often becomes necessary, even when a road has been resurfaced, to undertake repairs to weak places or potholes which may show themselves from time to time.

It has often been a subject of conjecture as to why a recently resurfaced road should develop potholes on its upper surface, when the whole of the resurfacing material is, theoretically at all events, of similar texture or hardness, and the author has arrived at the conclusion that this may be due to the fact that, where potholes do occur, the granite or other material has been originally spread rather more thickly at those places than on the general body of the work, and in the subsequent steam rolling the material on these high places has been more damaged or weakened by crushing under the influence of the rolling, thus rendering the road weaker at the very points where, in the first instance, a slight excess of material had been inadvertently or unskilfully applied.

The principal defects connected with the repair of road surfaces may be said to be:—

(1) Unskilful application of materials.

(2) Application of unsuitable materials.

(3) Inadequate amount of materials employed, resulting in the "starving" of the road.

(4) Insufficient supply of labor and consequent neglect.

(5) The employment of unskilled or unskilful labor.

(6) Neglect of proper consolidation of materials even in small patching work.

It is as perfectly possible to over-metal a road as it is to jeopardize its condition by a too sparing use of material; a surface over-coated will be less likely to be strong and homogeneous in structure than one to which has been applied a sufficient but not too generous a coating. It should never be forgotten that the principal strain to which the average road is subjected is that of the frictional and attritional wear on its surface, and therefore if a just sufficient thickness of resistent material is applied to the surface the under-coating or sub-structure may be quite properly formed of a softer or cheaper material, as it has only a dead-weight load to sustain and transmit to the earth foundation, and is not subjected to the other influences above mentioned.

The suitability or adequacy of foundation, and the character of the sub-drainage of a road are other important elements which cannot be overlooked or neglected in considering the question of road maintenance or administration, as it would be of little use to look for successful results with whatever skill or care a road had been repaired if its foundation or drainage was either insufficient or unsuited to its purpose, and no hard-and-fast rules can be laid down in this connection which would be appropriate to all circumstances.

With respect to the general question of foundations to ordinary country roads, it often happens that one is not bound to observe such fixed surface levels as it would be necessary to observe in towns or places where curbs and channels are already laid; therefore, it will often be found sufficient in order to strengthen a weakly founded road to leave what foundations may already exist, and apply a coating over the same of a thickness sufficient to render the road strong enough for the work it is called on to do.

The author has also on many occasions strengthened a weak road (especially on clay sub-soil) by strengthening or buttressing the shoulders. This is done by excavating trenches of, say, 1 ft. 6 in. wide and deep on each side of the road next the edge or verges, and filling these trenches to the surface of the road with gravel or chalk flints of 4-in. to 3-in. gauge, well rolled down. These side buttresses not only serve to drain the soil under the road (outlets at intervals and in low places being provided), but are of considerable assistance in counteracting the lateral "spread" of the subsoil, which is very often the cause of collapse of the road surface.

For the better protection of the surfaces of roads constructed under the water-bound system the application of a surface coating of distilled and dehydrated tar will be found to be ultimately economical, especially if a dressing of fine granite chippings is spread over the surface immediately after the application of the tar preparation and rolled in; but before this surface coating is applied the road should be brought up to a proper surface contour. This treatment, however, can only be said to have a relatively temporary effect, and it will be found to be more economical, so far as the ultimate result is concerned, to incorporate the tar compound in the structure of the road surface once and for all than to apply it repeatedly to the road surface.

CANADIAN SOCIETY OF CIVIL ENGINEERS, NOMINATIONS FOR 1916 COUNCIL.

Announcement has been made of the following nominations for the Council of the Canadian Society of Civil Engineers for the year 1916:—

Mr. G. H. Duggan, First Vice-President, Dominion Bridge Co., Montreal, has been nominated as President. Mr. J. G. Legrand, Bridge Engineer, Grand Trunk Pacific Ry., Winnipeg, and Mr. T. H. White, Chief Engineer, Canadian Northern Pacific Ry., Vancouver, have been nominated for the vice-presidency. The following nominations have been made for councillors: District 1—J. Duchastel, Walter J. Francis, H. R. Safford, Chief Engineer, Grand Trunk Ry., J. C. Smith, Montreal. District 2—J. L. Allan, Halifax and Eastern Ry., Dartmouth, N.S.; H. Donkin, Halifax, N.S. District 3—A. E. Doucet, ex-District Engineer, National Transcontinental Ry., Quebec; L. A. Vallee, Engineer and Director of Railways, Province of Quebec. District 4—E. D. Lafleur, Chief Engineer, Public Works Department, Ottawa; W. P. Wilgar, Kingston, Ont. District 5—J. R. W. Ambrose, Chief Engineer, Toronto Terminals Ry. Co.; A. L. Hertzberg, Division Engineer, C.P.R., Toronto. District 6—C. H. Dancer, D. A. Ross, Winnipeg. District 7—D. O. Lewis, District Engineer, Canadian Pacific Ry., Victoria, B.C.; A. O'Meara, Victoria, B.C. Two members of Council are to be elected for District 1, and one member for each of the other districts.

We have received from Logan Waller Page, director of the office of public roads and rural engineering, United States Department of Agriculture, a copy of his letter of resignation addressed to the American Road Builders' Association, of which he has been a director for several years. Mr. Page, in his letter, recalls that the agreement underlying the Pan-American Road Congress was entered into by the American Highway Association and the American Road Builders' Association on the understanding that no other congress or convention would be held by either association this season. He points out that the contemplated convention of the latter association, to be held at Pittsburgh or Cleveland, in January or February, 1916, constitutes in his estimation, a breach of faith, as the plan would simply mean that the association is merely deferring its usual convention a month or two, and not giving it up as agreed.

EARTH RESISTANCE TO ELECTROLYSIS.

The United States Bureau of Standards has recently published a paper prepared by Messrs. Burton McCollum and K. H. Logan which presents the results of investigations into electrolysis and its mitigation. The resistance of the soil in which metallic structures are buried is shown to be of much importance with respect to electrolysis of these structures. Three methods of measuring the specific resistance of the soil, two of which do not require the removal of the soil from its original position, are described. Results of soil-resistance measurements by each method are compared, and it is shown that any of the described methods is satisfactory for practical purposes, although each has advantages over the others under certain conditions.

The results of a large number of measurements of resistance of soil samples from widely-separated points in the United States have been tabulated. These data show great variations in soil resistance and indicate the desirability of a study of local soil conditions in connection with any complete electrolysis survey. The majority of soils tested show resistivities of between one thousand and five thousand ohms per centimetre cube.

A number of factors have been found to influence the resistivity of the soil. Increasing the pressure on a sample of soil under test tends to increase the conductance of the sample slightly, especially if the original pressure is low. Increase in moisture increases the conductance of the soil if it is not saturated with water. The amount and kind of soluble material in the soil affects its resistance. The resistance of soil is found to increase as its temperature falls, especially when the freezing-point of water is reached. The flow of current through the soil has been found to produce an apparent temporary increase in soil resistance in the neighborhood of the electrodes.

The relation of soil resistance to electrolysis is considered from the standpoint of leakage from street railway lines using the track as a return current. The importance of good rail bonding and of well-drained roadbed is pointed out.

The relations of the various factors affecting leakage resistance (namely, character of the soil, pressure, moisture, freezing and polarization, and surface films) to the electrolysis problem are described, and it is shown that a knowledge of the resistivity of the soil is of importance in estimating the danger indicated by potential difference and potential gradient measurements. It is also shown that the moisture and temperature of the soil materially affect the amount of current escaping from a grounded track used as a return circuit and that these factors must be given due consideration in the interpretation of data obtained during an electrolysis survey.

In the Mining and Engineering World is described an electric blasting machine so small that it can be carried in the pocket, the dimensions being 4½-in. by 3⅝-in. by 2⅛-in., while the weight is only 4½ lbs. It can fire from three to five blasting caps, and is worked by giving a sharp twist to a handle, which generates the current and fires the shot. The handle is removable so as to make the machine foolproof.

Real dust prevention begins with the construction of the road crust. In this work it is necessary to minimize the subsequent production of both superficial and internal dust—the latter rising eventually to the surface—by selecting road metal of a hardness appropriate for the traffic, by providing drainage for the removal of excessive water from the road crust, and by securing in the macadam the firmest angular bond that the metal permits.

SOOKE LAKE WATER SUPPLY, VICTORIA, B.C.

SOME FURTHER DETAILS OF ITS DEVELOPMENT, INCLUDING COSTS, AS PRESENTED AT THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS CONVENTION.

By C. H. RUST, M.Can.Soc.C.E.,
City Engineer and Water Commissioner.

VICTORIA, B.C., is situated at the south end of Vancouver Island, and has a population of about 50,000. The consumption of water in the summer is 80 Imperial gallons per head, and in winter, 50. All services are metered.

From 1872 to 1913 the city procured its water supply from Elk Lake, situated in a northeasterly direction about five miles from the city. The writer has been informed that the first open sand filter beds constructed in North America were erected at Elk Lake.

Owing to the growth of the city, and to the capacity of Elk Lake being only about 2½ million gallons per 24 hours, the city was compelled to take steps towards procuring a more ample supply.

Negotiations were entered into towards purchasing the works of a private corporation known as The Esquimalt Waterworks Company, which supplies Victoria West and the District of Esquimalt, and which procures its water supply from the Goldstream Lakes, but the property owners voted against this proposition. These works have a maximum capacity of 13 million Imp. gal. per 24 hours, and are situated about 17 miles north of the city.

In 1911 Mr. Wynn Meredith, western representative of Messrs. Sanderson & Porter, of New York, was called in by the city to advise as to the best method to be undertaken to procure an adequate supply of water. Mr. Meredith undertook a very careful investigation of various projects, and it was finally decided to utilize Sooke Lake, which lies about 18 miles northwest of Victoria.

The lake is about 4 miles in length and its maximum width is half a mile. The area of the lake at 555 ft. above sea level is 978 acres. It was decided to construct a dam at the foot of the lake and raise the level 12 ft. This gives a total area of 1,180 acres. The watershed area is 31½ square miles.

In the scheme for the ultimate development, it is proposed to utilize the Leech River watershed, which has an area of about 31 square miles. This watershed can be used by constructing a 5-mile conduit line to convey the water to Sooke Lake, and, if it should be necessary to do this, it is proposed to construct a dam at Sooke Lake to a height of 45 ft. It is estimated this will give a daily flow of 100 second-feet, whilst the reservoir storage will be 17,358,000,000 Imp. gal. The scheme which has now been completed gives a reservoir capacity of 5,555,000,000 Imp. gal.

The contract called for the clearing of the land around the lake 15 ft. above low water; the construction of a dam at the foot of the lake, with necessary screen house, intakes, etc.; the construction of 27 miles of concrete pipe 40 inches in diameter (this involved the building of 27 miles of railway track 2-ft. gauge); the construction of 6 siphons and the necessary trestles, and temporary wooden trestles to carry the track; the construction of a telephone line; the building and clearing of a reservoir site, and the erection of a dam, screen house, valve chamber, venturi meters, etc., at Humpback, which is about 12 miles from the city; the building of 11 miles of 36-inch steel pipe, leading to the city reservoir. This contract was awarded to the Westholme Lumber Company, of Victoria, and the following are some of their figures: For earth excavation, from 60 cents to $1.50; for rock excavation, from $1.75 to $7.50, the former being the price paid on the concrete pipe line; the price for concrete for the dam at Sooke Lake was $11; for the dam at Humpback the price of concrete, class "c," was $9; class "b," $10, and class "a," $12.50 per cubic yard. The necessary clearing around the lake ranged from $150 to $250 per acre.

Tenders were called for three classes of pipe for the flow-line, namely, wood-stave, riveted steel, and reinforced concrete. The prices submitted were for the pipe laid and installed. Wood-stave pipe was $2.47 per foot, riveted steel pipe $5.50 per foot, and reinforced concrete

Fig. 1.—Concrete Pipe Along Humpback Road, Showing Nature of Country Which the Line Traverses.

pipe $2.53 per foot, and it was finally decided to use concrete pipe.

On the pressure line, tenders were called for lap-welded, riveted steel and lock bar pipe. The prices quoted by the contractors were as follows: Lap-welded, $7 per foot, laid and connected; riveted steel plate, 5/16 inch thick, $5.25, ⅜ inch thick, $6.25; lock bar pipe, $6.80. It was decided to use riveted steel plates.

The contractors commenced operations early in 1912, but the progress made was not at all satisfactory, and in April, 1913, they abandoned their contract.

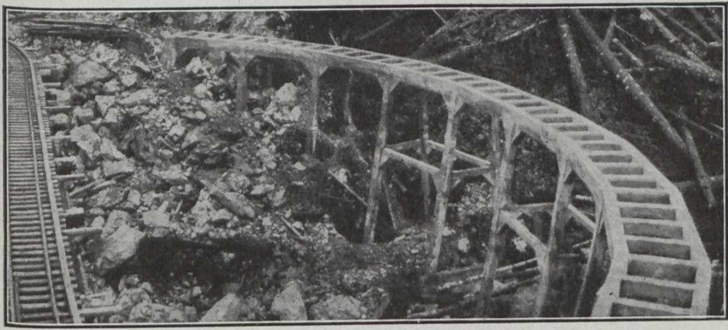


Fig. 2.—Showing Temporary Wooden Railway Trestle and Permanent Concrete Trestle for the Concrete Flow Line.

The writer, as water commissioner, recommended to the council that the work be proceeded with by day labor. This was approved of and the city immediately put on a large force of men at various camps. The laborers were paid $2.75 per day for 8 hours, one dollar a day being deducted for their maintenance. Free medical attendance was supplied by the city medical health officer.

The city completed the clearing of the land at Sooke Lake, carried out the construction of the dam, head-works, etc., at the foot of the lake, and built the dam at Humpback.

It was considered advisable to call for tenders for the concrete flow-line and the pressure pipe-line. The contract for the construction of the flow-line was awarded to the Pacific Lock Joint Pipe Company, and in place of a 40-inch pipe the contractors, having the necessary forms on hand, agreed to construct a 42-inch pipe for the same price, their tender being $2.29 per foot, including laying and installation, but not transportation.

The concrete pipe was made of a shell 3 in. thick and in 4-ft. lengths, except the pipe used for siphons which was more heavily reinforced and the shell was 4 in. thick.

The city awarded the contract for the fabrication and laying of the riveted steel pipe to the Burrard Engineering Company, of Vancouver, for the following prices: 5/16-in., $5.50 per foot, ⅜-in., $6.25 per foot, but carried out by day labor the necessary excavating and back-filling.

The following is a general description of the works as constructed:—

The dam at the intake channel at the lake is excavated 4 ft. below low water, where an intake tower is constructed, controlled by seven sluice gates. The openings of these gates are protected by screen cages. From the intake tower two lines of 40-in. riveted steel pipe are laid to convey the water to the screen house. Only one of these is in service at present. In the screen house is installed a set of 12 screens. The original screens had a mesh of 40 and 60 openings to the inch, but these were found to be too small, and have since been replaced by 16 and 24 openings to the inch screens. Below these screens are the measuring weir and cascade steps. The screen house is constructed of concrete with a concrete roof. The dam is a composite structure, the west end being an earth embankment with a concrete core wall bonded into the natural rock. From the screen house to the east abutment an ogee weir section 200 ft. in length is built, which is generally about 15 ft. above the level of the natural rock.

In the construction of the concrete flow-line a right-of-way 100 ft. wide was secured. All trees were cut down and any tall trees outside this area, which might, in falling, damage the pipe, were removed. The pipe is not covered except immediately in the vicinity of the Humpback reservoir, where it was thought slides might occur. At a distance of 2,000 ft. apart on the conduit line there is an open standpipe, and all inverted siphons, of which there are six, have waste outlets at the bottom controlled by 6-inch gate valves. The deepest siphon is 600 ft. in length and has a maximum head of 90 ft. The whole of the pipe-line was constructed to a grade of one foot in a thousand feet.

One of the difficulties in connection with this scheme was to secure a reserve reservoir at a proper elevation and in fairly close proximity to the city. A suitable site was finally located at Goldstream on the Humpback Road, about 11 miles from the city. This reservoir has a storage capacity of 136 million gallons and covers an area of 33½ acres. This area was covered with a very thick forest. A portion of the reservoir site had black soil of a peaty nature. It was decided to cover this with a 60-inch layer of clean gravel. The dam is 560 ft. long, 60 ft. in height, and contains about 9,000 cubic yards of masonry.

Fig. 3.—Concrete Pipe Line Crossing Sooke River with a Steel Bridge as Support.

The water flows into the reservoir from the flow-line over a series of concrete steps. There is also constructed a by-pass 24 in. in diameter by which the water can be taken direct to the pressure line. There is, in addition, a submerged outlet controlled by a butterfly valve. During the past summer, owing to algae in the reservoir, the water has all been sent to the city direct through this by-pass. Owing to the great pressure, it was decided instead of delivering the water direct to the city, to permit it to overflow into Smith's Hill reservoir, situated within the city and having a capacity of about 15 million Imp. gal., which acts as a standpipe.

It is interesting to record that during the construction of this work, the greater portion of which was of a hazardous nature, no fatal accidents occurred.

The flow-line follows the shoulder of the mountain and the work involved the clearing of a dense forest composed almost entirely of Douglas fir.

The city, in order to protect the watershed from any possible danger of pollution, has purchased the whole area comprised within it, being about 15,000 acres, for the sum of $12 per acre. The city expect ultimately, if they so desire, to more than compensate themselves for this expense by disposing of the very large amount of valuable timber which is on the watershed.

The abandoning of the work by the contractors, the Westholme Lumber Company, led to a protracted litigation. The company entered suit against the city claiming $500,000 damages. The suit was heard in Victoria last

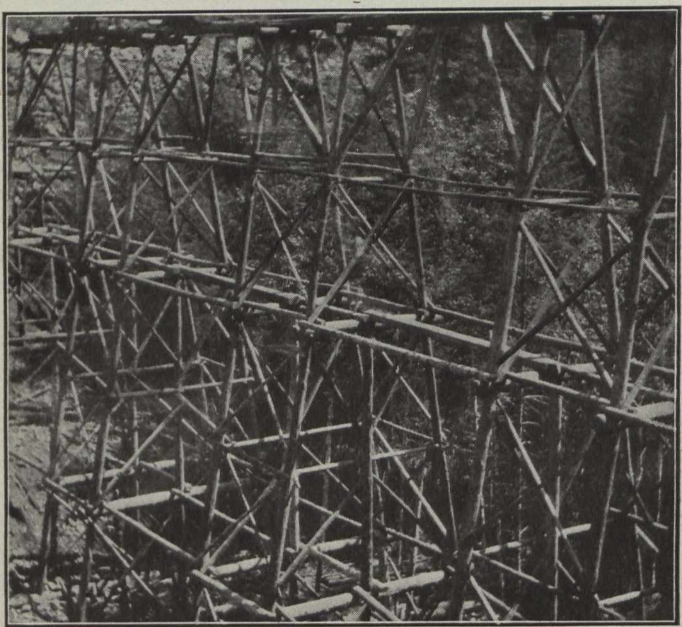


Fig. 4.—Temporary Trestle Used During the Construction of Syphon No: 4, Concrete Flow Line.

winter and the judge hearing the case was assisted by two assessors who were civil engineers. The case lasted six weeks and a verdict was given for the city, but the company have appealed and no doubt the case will be prolonged for some time before a final decision is reached.

The system was completed at the end of May and put into use on the 2nd of June, 1915.

Some interesting tests were made on the concrete flow-line. The original contract called for the delivery of 16 million Imp. gal. per 24 hours through the 40-inch pipe. As previously mentioned, the contractors without any additional cost constructed a 42-inch pipe and the maximum flow from tests through this pipe was 22,400,000 gallons in 24 hours.

One accident has occurred to the concrete pipe-line. During a forest fire a tree came down the side of the mountain and broke one pipe and cracked six more. These repairs, however, were quickly made.

The contractors for the flow-line guaranteed to maintain the pipe for a period of one year. At present there is a leakage in the 27 miles of about 500,000 gallons per 24 hours.

The following is the actual cost of the work carried out by the city:—

Sooke Lake.

Earth excavation in construction of dam at Sooke Lake, per cubic yard	$ 1.42
Rock excavation, per cubic yard	4.24
Concrete in foundation of dam, per cubic yard	15.68

All the cement had to be shipped by rail and hauled by teams about 10 miles over very rough roads. The gravel and cement were procured from the upper end of the lake, and had to be towed to the foot of the lake. This involved the placing of a tug in the lake which had to be transported from Victoria over the mountain, and the construction of scows.

Concrete Pipe-line.

Pipe, per lineal foot	$2.32
Concrete trestles	.18
Railroad	.53
Transportation	.33
Total per lineal foot	$3.36

Telephone Line.

Cost per mile	$426.00

Steel Pressure Line.

Contractors' prices were as follows: 5/16-inch, $5.50 per foot; ⅜-inch, $6.25 per foot.

The city did the earth excavation and back-filling at the following cost:—

Earth excavation, per cubic yard	$1.32
Back-filling, per cubic yard	.55

Humpback Reservoir.

Earth excavation, per cubic yard	$ 2.09
Rock excavation, per cubic yard	12.78
Clearing, per acre	605.00
Placing gravel in bottom, per cubic yard	2.48
Concrete foundations for dam, per cubic yard	9.00
Concrete in dam, per cubic yard	10.05

These prices included plant, tools, equipment, supplies, book-keeping, etc.

As previously mentioned, Mr. Wynn Meredith, of the firm of Sanderson & Porter, of New York, was consulting and designing engineer, and had charge of the construction. He was represented on the ground during the progress of the work by Mr. Boyd Ehle.

The following data in connection with this work may be of interest:—

Area of Sooke Lake at 655 ft. elevation city datum	978 acres
After 12-ft. rise, area	1,180 acres
Land clearing around the lake	300 acres
Length of concrete flow-line, 42″ diam.	144,040 ft.
First pipe made 20th April; commenced laying 16th May, 1914. Finished on 8th May, 1915.	
Length of pressure pipe-line, 36″ in diam.	56,677 ft.
Started to manufacture in July, 1914; finished laying January, 1915.	
Total quantities of earth excavation	180,342 cu. yds.
Total quantities of rock excavation	150,517 cu. yds.
Cost of construction, including engineering, etc.	$2,037,176.00
Cost of land, which includes right-of-way for pipe-lines, site for Humpback reservoir, land adjoining Sooke Lake and the Sooke Lake drainage area	$540,000.00

PILE AND TIMBER TRESTLE BRIDGES.

At the 25th annual convention of the American Railway Bridge and Building Association, held in Detroit last month, the following committee report on pile and timber trestle bridges was presented:—

The sizes of standard parts and the amount of timber used for carrying the same loads under apparently the same conditions appear to be different and a large part of the difference is apparently due to personal equation, and also to a certain extent to the financial conditions of the various roads. For example, standard pile bents vary from 4 to 6 piles under approximately the same conditions. Standard stringers vary from 3-ply 8 in. by 16 in. to 4-ply 10 in. by 18 in. for carrying approximately the same loads on spans of nearly the same length. While, of course, it will never be possible to eliminate entirely the effect of personal equation, a more uniform standard of practice would appear possible.

Open Deck Trestles.—A width of 8 in. appears to be almost universal for bridge ties, the spaces between them varying from 4 to 6 in., placing the ties from 12 to 14 in. centre to centre. The depth varies from 6 in. to 11 in., the great majority of roads reporting the use of a tie 8 in. deep, which the committee feels is the proper depth to use. A great deal of labor expended in the past by all roads and at the present time by some roads for dapping ties to fit down over the stringers can be avoided entirely, either by purchasing the ties surfaced to the exact height (7¾ in. in the case of 8-in. ties), or by gaining them in the field to exact depth. The first method is recommended.

Lengths of 9 ft. and 10 ft. have been reported for bridge ties, but the committee feels that a length of 9 ft. is sufficient except in those cases where a very heavy chord is used for long panels or for unusually heavy loads.

The lateral stability formerly provided by the shoulders of dapped ties fitting down over the stringers is now secured in some cases by the use of lag screws or drift bolts fastening every fourth tie to the stringers; and in some cases by driving dowel pins into bored holes in the under surfaces of each end of every fourth tie, the ends of the dowels projecting downward into the packing space between the bridge stringers. The latter method is of advantage in eliminating the damage to the stringers caused by the insertion of lag screws, which frequently start decay on the tops of the stringers.

The committee feels that the track rails should be held securely in place on bridges by the use of tie plates having a length equal to the full width of the face of the tie, that is—8 in. wide, but it does not recommend the use of tie plates with claws piercing into the fiber of the tie as such plates are found to reduce more rapid decay of the tie. This does not necessarily require the use of flat bottom plates, as slight corrugations on the bottoms of tie plates will provide sufficient lateral holding power without breaking the fiber of the wood.

Regardless of all that has been said and written with reference to the dapped guard timber, no more effective means of holding the ties in place has yet been perfected. The committee feels that the practice that now prevails to some extent, *i.e.*, the laying of a flat timber on top of the ties near their ends and fastening that timber to each end of each tie by a lag screw will not prevent the ties from bunching in case of derailment as effectively as the old dapped guard timber. The committee feels that the only effective method of preventing the ties from bunching is to provide between them struts having shoulders at the ends, bearing against the sides of the ties. Such struts made of malleable iron castings have been devised and are being used to a slight extent experimentally. Their advantage rests in the elimination of the labor of framing guard timbers, a very expensive procedure. If their experimental use proves successful, they should be used in preference to a flat timber lag-screwed to the ties.

The committee feels that inside guard rails weighing about 60 lb. per yard spiked to every tie and fully and carefully bolted to eliminate any offsets at the joints, should be laid entirely across every trestle ultimately, and that, as a move in that direction, roads not using such guard rails, commence their installations on high bridges, long bridges and all bridges on curves, the exact length and height to depend upon local conditions and the length of time over which the road desires to extend the expense of this improvement. Such guard rails should extend approximately 30 ft. beyond each end of each bridge and there come to a point either by the use of a casting enclosing the ends of the rails or by the use of an old frog point.

Bridge stringers in use on various roads vary from 6 in. to 12 in. in width and from 15 in. to 20 in. in depth. The most universal sizes appears to be 8 in. by 16 in., of which 3-ply stringers are used most universally although 4-ply stringers are extensively used on the longer panels and under the heavier engines. The panel lengths run from 12 ft. to 16 ft., the heavier stringers being used on the longer panels. All roads report the use of stringers twice as long as the panel length, alternate stringers breaking joints at the alternate bents. Stringers are usually framed to exact depth at the bearings. In the past, and to some extent at the present time, stringers have been framed at the packing points to exact dimensions, but the best practice indicates the desirability of using stringers just as they come from the mills as far as width is concerned, thereby eliminating the extra labor and weakening of the stringer caused by cutting into the side to preserve exact dimensions. While the practice of framing the sides of stringers so the chord would pack to exact dimensions was excusable in the past when dapped ties were used, thereby making possible a fit of the dapped tie over the chord, the use of the undapped tie renders the exact width of the chord immaterial and the side framing of stringers should be dispensed with.

The various stringers composing a chord should be packed with spaces not less than ¾ in. clear between them, two chord bolts being put through each end of each stringer, making four chord bolts over each bent.

Although in the past when narrow chords were used, it was quite customary to place the chords outside the rails to give greater stability by the greater width of bearing on the caps, the increase in the width of the chords caused by more and heavier stringers has rendered this generally unnecessary, and, on account of the necessity of distributing the load on the rail equally among the various stringers in each chord with as little danger of over-straining or breaking the tie as possible, it seems desirable to place the centre of the chord directly under the centre of the rail.

To keep the caps and stringers from changing their relative locations at the bearings, many types of anchors are used, consisting of dapped corbels, packing blocks or boxes, drift bolts, through bolts, straps, etc. The tendency of the best practice to-day is toward the elimination of corbels, packing blocks or boxes and drift bolts, although drift bolts are still extensively used. Their use results in serious damage to stringers, as it frequently happens that, after they have been drifted down, they must be withdrawn in connection with relining or other work on the bridge and the pulling of such drift bolts is frequently a difficult operation, sometimes necessitating chopping into the stringers to get hold of them. The same result can be secured and the bolts made more accessible by boring entirely through the stringer and cap and placing at least one through bolt, not less than ⅞ in., entirely through the stringer and cap at each bearing. Although it is desirable for stiffness to have nuts and washers on the lower ends of these bolts, this is not absolutely necessary, as the lower ends extending under the caps provide means of starting them out in case of work on the bridge.

The caps in use vary from 12 in. by 12 in. to 14 in. by 14 in., a few instances being reported of the use of caps composed of several timbers framed over the tops of the piles. The framing of the tops of piles to fit into two or more timbers forming a cap appears unnecessary and has almost disappeared. For ordinary conditions a 12 in. by 14 in. cap 14 ft. long should be sufficient, the 12 in. dimension being vertical and giving a 14 in. width of bearing. There should be one or more drift bolts through the cap into each pile.

Replies indicate the use of four to six piles per bent, some roads using six piles on very low bridges, while other roads use four piles on very high bridges. Most roads report the use of a 5-pile bent. The designs of 5-pile bents submitted almost invariably show the middle pile entirely relieved from load, and the four outer piles of such bents would usually carry the same load per pile if the middle pile were omitted.

A great advantage in the use of a 4-pile bent occurs especially in redriving old trestles when the use of a 5-pile bent would require shifting the chord out of place during the driving of two of the piles under the stringers, while the 4-pile bent can be so arranged that for ordinary conditions the four piles can be driven without interfering with the old chord. This advantage, of course, will not obtain where the largest 4-ply chords are in use on bridges to be redriven.

The same conditions as to the number of posts apply to frame bents as to pile bents, the added requirement being the necessity for a firm, unyielding foundation under the frame bent. This foundation is sometimes provided, especially in new construction, by concrete pedestals, where rock is close to the surface. For high bents footing piles in sufficient number are frequently driven.

Some roads make a practice of cutting off old pile bents and placing frame bents on top of the old pile stubs. While at first glance such construction gives a very rigid support, there are many undesirable features. When frame bents are placed on top of the old piles cut off at low-water line and having a considerable unsupported length in the water there is danger of their buckling out of line. Also the sills and lower ends of the legs of such bents and also of frame bents having the sills at or just below the ground line decay very rapidly and introduce an element of weakness into the bridge. Reports have been received indicating that all the pile bents of long, low bridges are frequently cut off when ready for renewal and replaced by frame bents. In such cases adequate longitudinal bracing should be placed at proper intervals to prevent the bridge from collapsing longitudinally. If floods or other conditions prevent the placing of such longitudinal bracing, a considerable percentage of all the bents should be renewed as pile bents.

The general practice seems to favor the use of 3 in. by 10 in. braces. On some roads the braces are bolted to the posts or piles, while other roads continue to use boat spikes. The committee recommends that the use of boat spikes for such purposes be discontinued, and that not less than 3 in. by 10 in. bracing be through bolted by ¾ in. or ⅞ in. bolts to the caps and piles or posts, double-sash bracing and two sets of "X" bracing being used in bents over 24 ft. high.

All roads reporting use of two or more lines of longitudinal struts or ties, varying in sizes, on all frame or pile bents over 24 ft. in height; these being placed above and resting on the sash bracing, and being bolted or spiked to the posts or piles. The best practice would seem to be that of cutting longitudinals to fit between the posts or piles, obtaining continually by the use of blocks or splices at the post or piles, securely bolted to them.

Ballast Deck Trestles.—The committee feels that the use of ballast deck trestles of treated timber should be given further consideration, as it is believed that very considerable economies can be shown by the use of such structures. The best information indicates that the cost of construction of a ballast deck trestle of creosoted material will be approximately 50 per cent. greater than the cost of a similar open deck, untreated trestle of standard construction. For ballast deck trestles standard track ties may be used. There should be at least 6 in. of ballast, preferably sandy gravel, between the bottom of the tie and the floor of the trestle. The floor of the trestle should be composed of 4-in. plank 13 or 14 ft. long. To prevent water from getting into the floor and timbers below, the floor should be covered with a built-up roofing of about 4-ply felt and pitch. The sandy gravel ballast will make a sufficient bond with this roofing so that other covering over the pitch will be unnecessary. Drainage should be provided by leaving open spaces between the floor of the trestle and the guard timbers at the edges of the ballast by raising the guard timbers 2 in. off the floor and providing a washer at each point, approximately 4 ft. apart, where the guard timbers are bolted through the floor.

The committee recommend that the stringers on ballast deck trestles be not sawed off at the ends, but that they be lapped, the length of stringer to be one foot longer than twice the panel length to provide practically a full bearing at each end of each stringer. It is thought that the equivalent of 4-ply 8 in. by 16 in. stringers under each rail for 14-ft. panels and 5-ply 8 in. by 16 in. stringers for 16-ft. panels will give sufficient carrying strength for any loads now operating. There appears to be no reason for the use of outer guard timbers on ballast deck trestles as the ballast will prevent the ties from bunching on the trestles as well as that service is performed on solid ground. Inner guard rails should be furnished, however, as on open trestle bridges.

It is stated by Mr. H. E. Breed, First Deputy Commissioner, New York State Commission of Highways, that in concrete roads in that state expansion joints are spaced at 30-ft. intervals, ⅜-in. wide. They have tried armored joints, yellow pine plank and tar paper, and have found that the yellow pine plank and in some cases oak plank have given the best results. Better protection to the edges of the concrete is obtained by setting the plank a little high, allowing the traffic to broom the edge. By so doing, the wood being high, there is no impact on the edge of the concrete of the joint to cause it to spall.

THE READ BUILDING FIRE, MONTREAL.

THE fire which took place on the afternoon of November 5th in the premises of the United Photographic Stores, Limited, which is located on the fourth floor of the nine-story Read Building, Montreal, was one of the most severe tests of concrete fireproof building construction of which we have record. The entire stock of this company's materials, which consisted of chemicals, films and general stock of light and inflammable materials used in the manufacture of photographic supplies, was almost completely destroyed by the fire. In fact, the nature of material burned was practically the same as that which caused the hottest fire on record, *viz.*, that in the Edison plant at West Orange, N.J., on December 9th, 1914, a conflagration which brought forth such a volume of comment in the engineering press regarding the fire-resisting properties of reinforced concrete construction.

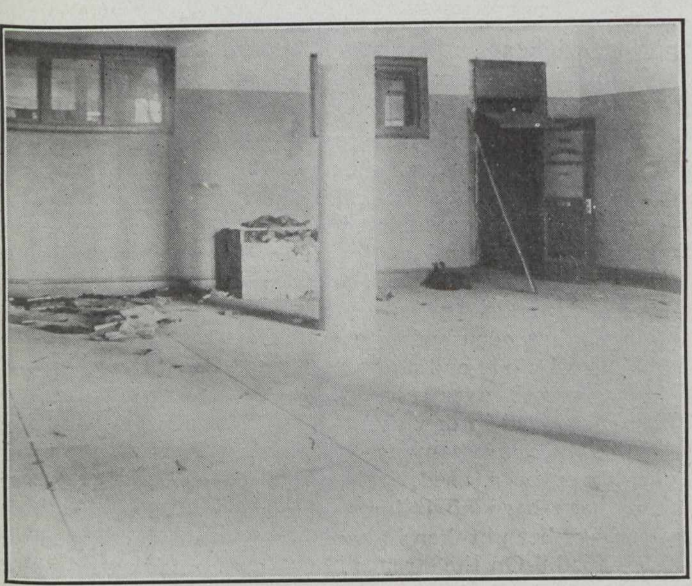


Fig. 1.—Floor Above That Gutted by Fire.

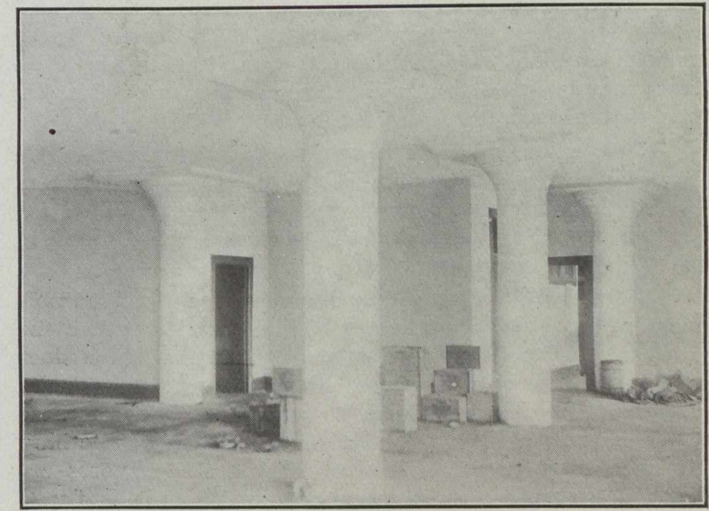


Fig. 2.—The Floor Below That Upon Which the Fire Occurred.

The Montreal fire was discovered about 2.40 p.m. and rapidly spread to all parts of this company's space in the building. In fact, members of the company stated that within a few minutes' time the entire floor was a seething mass of flames. The fire alarm was received at the fire station at 2.44 p.m. and the flames were fought by the firemen continuously for 1½ hours. During this time eight engines were in use and the following streams were used: Twenty-four attached to the engines, one water tower with three streams in one, three turret wagons with two streams in one, one Siamese stream, three streams in one, a total of twenty-nine streams.

A careful examination after the fire showed that there was practically no damage done whatever to any portion of the concrete itself. The plaster coat on the concrete used in the interior finish of the building was peeled off in a very few places and the wooden frames and sash of the windows were destroyed. The fire was confined entirely to the floor on which it started and no damage of any kind whatever was done to any of the floors above, except that panes of glass in a few of the windows were broken out by the water streams from the hose. On the floor beneath, the only damage done was that caused by water flowing down the stairways and elevator shaft. As can be realized from the number of fire streams utilized, a great deal of water was used to extinguish the fire, and yet none of this water passed through the floor into the offices below. The accompanying photographs, which were taken on the following morning, show the condition of the fourth floor and its

Fig. 3.—Fire-swept Floor of the Read Building.

contents after the fire and also show the condition of the floors above and below.

At the time of the outbreak of the fire there were over 350 people in the various offices and factories in the building and all of them succeeded in getting out safely by the passenger elevators and stairways.

The Read Building was finished in May, 1913, by the George A. Fuller Co., Limited, the concrete work being done by Church, Ross Company, Limited. The architects for the building were Ross and McDonald, of Montreal. The type of construction used is the Mushroom system of reinforced concrete. The entire frame and all the floors are of concrete, while the curtain walls and outside finish are brick. No wooden floors are on top of the concrete.

A few days after the fire a personal canvas was made of each of the offices on the several floors, and it was found that everyone of them had been used for business on the day after the fire, with the exception of the floor on which the fire occurred.

While this building has demonstrated the fireproofness of concrete structures, it has also demonstrated the fact that no building is absolutely fireproof which does not have a sprinkler system, steel sash, wire glass windows and metal or asbestos partitions. None of these had been provided in this building, and there was nothing to check the fire in the United Photographic Stores except partitions which were not fireproof. It is firmly believed by members of the United Photographic Stores that if they had had fireproof partitions, the fire would have never passed beyond the room in which it commenced.

CONCRETE IN RAILWAY CONSTRUCTION.

CONCRETE has been applied to railway construction in many different ways, the most interesting adaptation in many respects being the use of concrete piles and concrete culvert pipe. According to a committee report presented at the October convention of the American Railway Bridge and Building Association the former are used by the railroads for a variety of purposes and particularly for reinforced concrete slab trestle bridges. This use is of particular interest in that the reinforced concrete pile slab trestle type of construction presents a seemingly perfectly satisfactory and economical solution of the pile and timber bridge replacement question in many instances, for those openings which are too large for small culverts of a permanent character. The Chicago, Burlington and Quincy, which was the pioneer road with this type of construction, has constructed about 20 miles of concrete pile trestles, some of which have been in service eight years. The Chicago, Milwaukee & St. Paul started manufacturing and using concrete piles for concrete trestles in 1912 and since that time upwards of 30,000 lin. ft. have been made and driven. On account of the delay to trains that might be occasioned by driving on main lines of heavy traffic, this company has constructed most of its concrete pile trestles on a second track or on lines where the traffic is not very dense.

The Great Northern, the Illinois Central, the Minneapolis, St. Paul & Sault Ste. Marie, the Northern Pacific and the Wheeling & Lake Erie are among the roads that make considerable use of concrete piles for trestles. The Great Northern now prefers, however, in place of concrete pile bents, slim reinforced concrete piers extending one to two feet below the surface of the ground, and supported on piles, with longitudinal struts for heights about 20 ft.

Most of the railroads agree that the premoulded reinforced concrete pile is suitable for use in trestle bents, that they allow loads of from 20 to 35 tons per pile and that the penetration required under ordinary conditions varies from about 2/5 to 2/3 the length of the pile, while the maximum projection above the ground recommended varies from 10 ft. to 30 ft. Several roads agree on about 20 ft. for the maximum projection above ground unsupported, while some limit this height to about 14 or 16 ft. and build slim concrete piers for greater heights.

The premoulded type of pile seems to be preferred by the greater number of roads, which is due partly to the necessity of using this type for trestle work. The octagonal, straight-sided pile about 16 in. in diameter appears to be the most used shape. The steel reinforcement of concrete piles should be designed not only to take a portion of the load that may be placed upon the pile after it is driven, but also to take care of the bending stresses that occur when the pile is lifted either by the middle or by one end and to withstand the shocks caused in dragging it over rough ground to the loads and the jars occasioned in driving.

While a great many different makes and types of piles have been used, it is comforting to observe that there have been no failures reported and that very few piles have been broken in handling or in driving and none under load. On the strength of this record it would seem that there should be no need of hesitation on the part of railroad engineers and builders to use concrete piles where the conditions make this type of construction the most economical.

Concrete Culvert Pipe.—The use of concrete culvert pipe is much more general among the railroads than that of concrete piles. While some of the roads have used this pipe in special instances, or for experimental purposes only, quite a number use the pipe generally for sizes ranging from 24 in. to 48 in. internal diameter inclusive. A few make common use of sizes varying from 12 in. to 72 in. inclusive, while at least one uses as large as 84 in. x 89 in. oval pipe.

It is not the general practice to restrict the heights of embankments under which concrete pipe is used, other than to specify a certain minimum depth of cover over the pipe, which minimum varies from 8 in. between the bottom of tie and the top of the pipe to about 3 ft. from the base of rail to the top of the pipe. The road reporting the 8-in. minimum stated that its only reason for not placing pipe closer than 8 in. to the tie is that a less distance than this does not afford sufficient protection to the pipe from injury from tamping tools. There is involved in this discussion of the restriction of the heights of embankments, of course, the general question of the appropriateness of placing a rather small pipe under a very high fill, even though the drainage requirements are satisfied. Some roads do not place pipe culverts of small diameter under extremely high fills irrespective of the fact that their carrying capacity is ample to take care of the unexpected quantity of water.

It is not the usual practice to have two or more designs of concrete pipe of the same diameter with different amounts of reinforcement and thickness of the walls for use under different heights of embankments. The Chicago, Rock Island and Pacific, however, does make such a distinction, having a design known as Class "B" for embankments up to 20 ft. in height and another known as Class "C" for embankments from 20 to 40 ft. high. The amount of reinforcement and the thickness of the walls are both increased in the class "C" design.

In 1906 Prof. Arthur N. Talbot, of the University of Illinois, tested to destruction several sections of 48-in. and 36-in. reinforced concrete culvert pipe. The results of these tests, which were made under laboratory conditions of bedding and loading, are recorded in Bulletin No. 22 of the University of Illinois. This bulletin recommends certain formulae for the design of reinforced concrete pipe which are pretty generally accepted.

More roads use head walls on one or both ends of the concrete pipe culverts than do not use them. The bell and spigot continues to be the more popular type of joint, while the roads are pretty evenly divided on the question of cementing the joints. All of the joints, no matter of what type or whether cemented or not, seem to be pretty uniformly satisfactory.

The length of time the pipe should cure before shipping shows a very considerable variation ranging in air from 10 days to 60 days, while some roads do not install pipe that is less than 90 days old, although they ship after pipe has cured 60 days. While there have been a few failures of pipe in place and a considerable number have been broken in handling, many of these are due either to poor concrete or to the pipe being used too green. If a rich, dense concrete, which is allowed to cure a reasonable length of time, is provided in reinforced concrete pipe which are intelligently designed and installed, we believe that the railroads should feel perfectly safe in adopting this construction wherever it seems desirable to do so.

NOVEMBER 4th MEETING, CANADIAN SOCIETY OF CIVIL ENGINEERS.

The Cedars Rapids Development.

Mr. Henry Holgate, consulting engineer, Montreal, delivered a paper on the Cedars Rapids Power Plant at the monthly meeting of the Canadian Society of Civil Engineers, held at Montreal, November 4th, 1915. Mr. S. P. Brown, vice-chairman of the General Section, was in the chair. Mr. Holgate announced that his paper was merely a curtain-raiser, and that it would be followed by papers by Mr. Julian C. Smith and Mr. R. M. Wilson, who would discuss the engineering features of the development much more fully.

"Nature," said Mr. Holgate, "has regulated the flow of the St. Lawrence River far better than man could possibly do. It is one of the finest examples existent of uniform regulation, despite the enormous watersheds which it drains."

The Coteau Rapids, near Montreal, are followed by the Cedars Rapids, which have a fall of 32 ft. The total fall between Lake St. Francis and Lake St. Louis is 8½ ft., the distance being about 11 miles. This whole stretch of the river is in Canada, with the exception of a small portion of Lake St. Francis, which is in New York State. As it is a navigable river and forms a boundary, the International Joint Waterways Commission had to be consulted in regard to the application of the power company for right to divert a part of the flow. The Canadian Government would not grant a charter to the company until this Commission reported favorably on the project.

The Cedars Rapids Manufacturing and Power Co. was incorporated in 1904, the Act of Incorporation being amended in 1909. Power was given to expropriate land. About 1½ miles of the north shore of the St. Lawrence was expropriated and 40 landowners were settled with. Three islands in the river were expropriated, $1,700 being offered for one of them, $200 for the second and $2,800 for the third, this being at the rate of about $100 an acre. Two of the arbitrators agreed with this offer, but one signed a minority report setting value upon the islands at $80,000, $34,000 and $62,000 respectively. An appeal was made to the Superior Court to set aside the award, and the Chief Justice allowed the appeal, substituting the larger sums excepting in the case of one property, which he directed to be submitted to new arbitration.

In February, 1914, the Privy Council reviewed the case and reversed the Chief Justice's decision in the case of one island. Regarding the other two, the Privy Council directed that they be submitted again to the arbitrators for the hearing of further evidence. The view of the owners of the islands was that they were vital to the undertaking and should share in the profits. The company offered value upon the basis of agricultural land only. The Privy Council said that the value to be paid should be the value to the owner at the date of taking the property and not the value to the taker. They further said that the value to the owner consisted of all advantages which the land possessed, either present or future. In other words, value merely as agricultural land should not be taken, because value of the islands to a possible hydro-electric enterprise must be considered, but that this value must not be determined by taking a proportional part of the whole value of the immediate undertaking.

In other words, the Privy Council viewed it as a question of probability vs. realized probability, the value of the land being much less if a hydro-electric undertaking were considered merely as probable, than the amounts claimed by the owners on account of the fact that the probability had been realized and that the way had been paved for the actual carrying out of a hydro-electric scheme involving ownership of the islands. The Privy Council viewed the value of the islands as the amount for which they could probably have been sold by auction without the Cedars Company having acquired its powers, but with the probability of some company acquiring such powers.

An agreement was made in 1909 with the Dominion Government and plans were approved permitting 50,000 cu. ft. per second of water to pass through the Cedars plant. Permission also had to be obtained from the province of Quebec, as the bed of a river belongs to the Crown, and the Crown is represented by the Province. The agreement gave the right to construct a structure in the river bed, with the stipulation that navigation be not interfered with. A lease of the necessary portion of the river bed was obtained for 99 years, and the company agreed to pay for the water diverted at a fixed rate per horse-power, the rate to be increased as the output of the plant increases. The approval of the Federal Government was also necessary on account of the river being navigable and a boundary.

The lowest water on record was in 1895, when 185,000 cu. ft. per second flowed from Lake Ontario. With the addition of the water that drained into the river below Lake Ontario, probably 190,000 sec.-ft. passed the rapids. Of this amount 102,000 sec.-ft. passed through the main channel, and 80,000 through the channel which is being used as a headrace by the Cedars Co. As only

56,000 sec.-ft. can be utilized by the company under its agreement with the government, 24,000 sec.-ft. must be diverted into the main channel, and as this would improve the minimum flow through the main channel to 126,000 sec.-ft., it will make navigation better than it was before the work began. The total power available (56,000 sec.-ft. with 132 ft. head) is 150,000 h.p. at the outgoing terminals of the power house.

The conditions attending the construction of this plant were so favorable that they are unique in hydro-electric development: Good railways, good highways and excellent transportation by water were available; there was access to Montreal by two canals; the variation in head is very slight, the greatest variation any season being 4 ft., and the usual variation 2 ft.; the greatest variation on record amounted to 7 ft., and not in any one season; ice blockades do not occur below the power house, as the rapids break up the ice so that the head is practically always constant; when a channel was excavated through Cedars Point, the material encountered was very favorable; the usual flow of the river is 260,000 sec.-ft., of which 80,000 sec.-ft. flow into the Cedars channel, of which only 56,000 sec.-ft. are needed. Mr. Holgate said that such favorable conditions as these would make very envious many engineers who had to design and construct developments in inaccessible places, and where storage work was expensive and difficult.

To obviate frazil, the company built a 1,000-ft. dyke, creating a large pond or reservoir. This is ice-covered in winter and prevents the formation of anchor ice or frazil, which does not enter the pond, the velocity of the river being sufficient to carry the frazil along into the main channel in the upper four or five feet of the stream.

In December, 1914, the plant was put into operation. The turbines are single-runner machines and are the largest of their kind yet made. They will be described in more detail in Messrs. Smith and Wilson's paper, as will also the foundations and unwatering of the site, the methods adopted being new in hydro-electric development, said Mr. Holgate.

The work was completed ahead of time and the estimated costs were not exceeded. The design of the plant and the execution of the work were under Mr. R. M. Wilson and Mr. Julian C. Smith. Fraser & Brace were the contractors.

In the discussion that followed the reading of Mr. Holgate's paper, Mr. Walter J. Francis and other engineers took exception to Mr. Holgate's remarks regarding the arbitration proceedings for the islands, and stated that the decision of the Privy Council was by no means entirely clear, although that was the impression that Mr. Holgate gave, they claimed. Mr. Francis and several other prominent engineers had given evidence differing with the valuation placed on the properties by Mr. Holgate on behalf of the company, and Mr. Francis stated that the matter was not yet by any means entirely clear and settled.

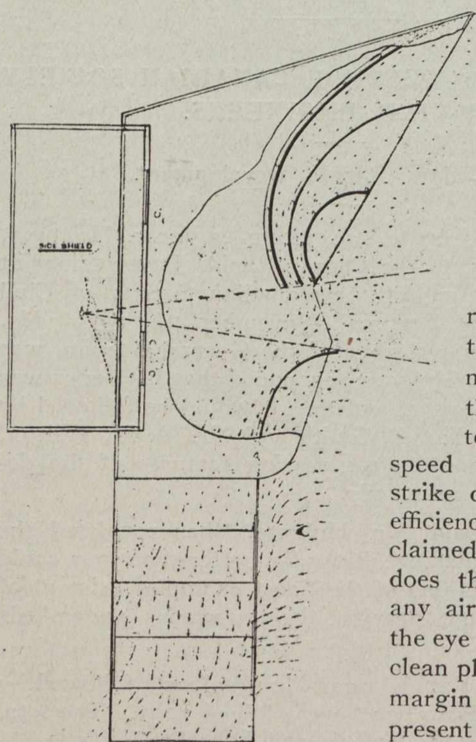
Mr. Julian C. Smith pointed out that conservation is best served by the construction of water power plants. He said that one of the truest forms of conservation is the development of the country's water powers under proper control. Coal is saved, and power which would otherwise be wasted, is obtained for useful purposes. Employment is given, and comfort and luxury are secured which could not be had without these developments. Civilization is advanced. Mr. Smith said that the Society should foster the idea that it is in the public interest that these water powers be developed.

A USEFUL RAILROAD DEVICE.

The accompanying photograph and diagram are descriptive of a lookout mask recently invented by Mr. E. J. McMillan, a resident of Moose Jaw, Sask., which involves a system of double deflection that should meet with

Device as Installed on a Locomotive in Service.

the consideration of railway officials. As the diagram illustrates, the double deflector shield for use on locomotives produces a pressure at one and a suction at the other side of the necessary line of vision, using these forces of the air currents themselves generated by the motion of fast-moving locomotives to gap across sufficient space through which the driver may receive full protection to his eyes without the intervention of glass which gives such unreliable service in sleet, snow or rain.



Double Deflector Shield for Locomotives.

As the air currents presented to the front of the mask always bear the same relation to each other, the speed with which they strike does not alter the efficiency of it. It is claimed that not only does the device prevent any air coming through the eye port but that with clean planes it has such a margin of efficiency as at present constructed that while going the full speed of a train if a match be lit within the eye port the flame will be drawn forward through the port and toward the downward rushing air near the front of the shield. The excess margin of safety is allowed for so that the protection will be full even in the case of a soft snow fall, which is the most severe test to which a device of this kind may be subjected.

Editorial

THE CANADIAN SHELL COMMITTEE.

"D. A. Thomas has left us—with a rather bad taste in our mouths," says a contemporary. This remark preludes serious charges against General Bertram, Mr. Thomas Cantley and Mr. Geo. Watts. Because the Nova Scotia Steel Company and Canadian Allis-Chalmers Limited are both busy, it is insinuated that this is due to the fact that Mr. Cantley and Mr. Watts are members of the Canadian Shell Committee.

Innuendoes of this type are an old story. Many an opposition newspaper has made them. And General Bertram, Premier Borden, General Hughes, Mr. D. A. Thomas and others have issued indignant statements refuting such insinuations.

The Canadian Engineer has been informed by the highest authorities that Mr. Cantley and Mr. Watts had absolutely no say as to what firms should receive contracts. They were not consulted in the slightest regarding such matters. General Bertram himself awarded the contracts, and the other members of the Shell Committee advised merely regarding manufacturing and technical matters.

The country is greatly indebted to General Bertram, Mr. Cantley and Mr. Watts for having given much valuable time to this work. They got no pay and no reward. The orders which their firms received would have undoubtedly gone to those firms anyway, because their vast equipment was needed and was sure to have been utilized. The Nova Scotia Steel Company and Canadian Allis-Chalmers Limited have undoubtedly been discriminated against rather than favored on account of the membership of Mr. Cantley and Mr. Watts on the Shell Committee.

Mr. Cantley has spent large sums, for which he has not and will not be remunerated, on experimental work, the benefit of which he gave freely to the Shell Committee for the general good. The company of which Mr. Watts is an executive has been one of the foremost subscribers, among our industries, in men and money for war purposes.

Mr. Frank Jones, manager of the Canada Cement Company, is reputed as having "held up" the Premier for a shell contract by threats of publicity. Mr. Jones denies this, and says that the statement which appeared in our contemporary is entirely unfounded. Mr. Jones claims that he got his contract through the regular channels, and has written a letter to Sir Robert Borden repudiating the slur upon the Premier and the Shell Committee.

Regarding prices, it need only be said that the British Government itself set the prices for all contracts, and that General Bertram has saved $14,896,000 out of the prices by awarding contracts at lower prices than those set by the British War Office. And this figure, we believe, is the balance remaining after paying all expenses of the Shell Committee.

General Bertram says: "I am not worrying much about these charges of extravagance and favoritism. I know the British War Office has absolute confidence that we are trying to get the largest possible output at the smallest possible cost."

Early in the war an order for 200,000 shells was placed with the Minister of Militia for distribution in the United States. General Hughes asked a number of prominent Canadian manufacturers whether those shells could not be made in Canada. Although they had had no experience in shell making, the manufacturers thought they would like to try it, and General Hughes urged the British Government to permit him to place the orders in Canada. The British War Office said: "Well, what will the price be?" The Canadian manufacturers quoted $5.15, knowing that they would have to buy a great quantity of new machinery which would have to be scrapped promptly if no further shell orders were to follow, and knowing that a large waste of energy and material would be involved in their initial endeavors to make these shells. The British Government apparently was satisfied with this price of $5.15 and accepted the offer. It is stated that not a single manufacturer made any money on this first order, and that as late as last February every manufacturer of shells was very much out of pocket.

When the first order had been completed, General Hughes urged the War Office to place further orders in Canada, and this they consented to do, but said that the price would have to be lower. The War Office offered a lower price, which was accepted by the Canadian manufacturers. From time to time since then the price has been lowered, but the price was always set by the British War Office until within the last few weeks, when a call for tenders was announced.

An interesting side-light on the matter of prices is that a certain prominent Montreal manufacturer who is turning out about 5,000 shells daily, was offered $1 per shell more than he is getting from the Shell Committee, if he would take a sub-contract for the same sized shells from an United States steel company. And we believe that statistics show that Canadian manufacturers are now selling shells at a cost equal to, and even lower than, the cost of producing such shells for many years past in the Woolwich and other government arsenals.

STRATEGY OF RESEARCH.

No excuse is necessary for reiterating the need for concentrated efforts in the development of Canadian resources, or in adopting the above caption from the Times' Engineering Supplement. Prof. J. A. Fleming recently delivered an address on "Science in the War and After the War" in which, when directing attention to the future, he said: "It must be remembered that after this war is over in a military sense, we shall immediately begin another war of a different kind, in which the weapons will not be bullets and shells, but our national powers of invention, scientific research, commercial organization, manufacturing capabilities, and education, and these will be pitted against those of a highly organized Germany, determined to win back in commerce by any and every means, fair or foul, that which has been lost in war, and that commercial and industrial war will be waged by our enemies with the same ruthlessness and neglect of all scruples as their military operations."

Prof. Fleming pointed out that as yet we have made scarcely any progress in the creation of a disciplined army of workers which shall embrace all the abilities in the Empire. We are still in the stage which by comparison with an army is that of a mob of civilians equipped for war with shot-guns and sticks. Although the individualistic method of research in which each scientific worker takes up whatever kind of research he pleases has produced good results in the past and is in agreement with our national characteristics, it is a serious question whether we shall not have to put limits to it in the future.

Much greater advances might be made in purely scientific research in many departments of knowledge if we were to adopt more extensively the custom of associated work, by forming committees of workers, not too large for expeditious decisions, but charged with the duty of investigating certain formulated problems. It is in this respect that our learned societies might do much more than they do. Their proceedings are mostly a record of isolated, disconnected pieces of work of very different scientific value. But if properly organized discussion were brought to bear on the question, it would be possible to induce investigators of reputation and ability to associate themselves more in conjoint work to the great advantage of our common knowledge.

In our observations on the attitude of engineers towards their national institution we had occasion to point out the demand for a generous contribution of their knowledge for the welfare of the profession generally. This is assuredly the most certain means of advancing the profession as a whole. It means co-operation just as much as Prof. Fleming calls for that element in business. Manufacturers are not free from the tendency to circumscribe the research work of men engaged in the factories by limiting the funds for that purpose and generally refrain from co-operating with those engaged in similar business, lest their rivals might get a step in advance. German firms, however, do not hesitate to pool their knowledge if so doing enables Germany to get ahead of other nations, for they have been educated in the value of co-operation. In our issue of October 7 we drew attention to the need for more co-operation between manufacturers and the universities and pointed out the value of these latter institutions, both for education, experiments and research.

The present destructive war will be short in comparison with the competitive struggle that will take its place, and which will demand that the universities, scientists, engineers, manufacturers, boards of trade, departments of commerce and others interested, join in a determined effort to withstand the onslaught of the intensified scientific research and highly technical training of their contemporaries in Germany. To shelter behind a high tariff may afford some protection, but low wages, conservation of energy, avoidance of waste, utilization of by-products, determination to re-establish international commerce, will render tariffs of slight moment to German business men. Sentiment counts to-day, but when customers can save dollars and cents, sentiment may soon vanish. Business will be run for dividends as usual, and if these are attacked and reduced then prolonged obeisance to sentimentality may be considered as a doubtful virtue.

How, then, are Canadian interests to be preserved? It must be by adopting the same methods as our future competitors. Manufacturers and universities must meet, the former must provide the dynamic force and the latter the knowledge. Manufacturers must sooner or later combine to furnish the pabulum for the universities to digest. The technical societies must encourage investigation by every means and afford incentives to the members to think out and develop new processes, new ideas, and new industries. The Government must offer inducements for the development of Canadian resources; raw materials must receive attention, as bonanzas may be buried in them and only wait to be dug out. Universities and other scholastic institutions must give facilities for their students to carry on researches, and inculcate in their minds that education is not only what they acquire in the class rooms, but also what they themselves learn by common effort in succeeding years. Engineers have their part to play in the international competition, for there is scarcely a process or a development which can be carried on commercially without their aid, intelligence and organizing powers.

WINTER MANUFACTURE OF CONCRETE PIPE.

Since 1909 all sewers in Hamilton, Ont., larger than 24 in. in diameter have been constructed either of reinforced concrete or of sectional concrete pipe. In Concrete-Cement Age for November, Mr. A. F. Macallum, the city engineer, states that in the winter of 1914-1915 in order to give work to the unemployed because of conditions caused by the war, they constructed in the east end of the city a trunk sewer system, using reinforced concrete pipe from 30 in. to 66 in. in size. These pipe were made in an open field during nearly all conditions of winter weather and cured by means of steam, from pipes running under the molds and with canvas tarpaulins over the pipe. Rejections of pipe under these conditions were not greater than would have been the case under good working conditions of the summer season.

These pipe were made on contract by A. L. McAllister, Toronto, who rented forms for the work from the Chicago Concrete Pipe Co. A 20-h.p. portable boiler was hauled to the curing ground and a shed built around it for shelter. Two-inch galvanized pipe were laid along the ground in three parallel lines with T connections and stop cocks at 10-ft. centres. These pipe connections were directly beneath each pipe that was cast. The mixture was brought alongside the mold that was to be filled and hot sand, gravel and water were used. Just as soon as a mold was filled burlap was placed over it and a canvas tarpaulin, 10 ft. wide and 100 ft. long, covering a series of these casts, was placed on top of the burlap. Steam was turned into the interior of the molds and kept on continuously night and day until the pipe had hardened. They also laid last winter some rectangular sewer, 6 ft. x 8 ft., in section having the span of 8 ft., and dry weather half channel in the bottom.

The materials were mixed hot and covered over with canvas tarpaulins until sufficiently set, when fresh manure to the depth of 1 ft. was placed on top and salamanders inside. This worked out in a very satisfactory manner and they had no failure whatever with any part of the work.

In connection with handling the pipe: the 54-in. pipe was used on a street having an electric railway track not in use. It was rolled onto flat cars, hauled to position and by means of block and tackle with rope around the pipe allowed to run slowly down skids to the ground.

DISTRICT HEATING SYSTEM AT WHITBY, ONT.

By J. Lanning, B.A.Sc.

As buildings have developed in size and complexity of construction there has grown up the demand for their artificial heating and ventilation, so that from the antiquated open fire-place and iron stove a science has matured which is now rich with inventive genius and detail of manufacturing skill.

An interesting example of "district heating" over an extended area, and of its importance in the general scheme of construction, is at present being installed as the permanent heating and ventilation system of the Hospital for the Insane, Whitby, Ont., an institution which the provincial secretary's department for Ontario has now under construction.

The circulation of the water will be forced by the operation of two centrifugal pumps driven by 125-h.p. turbines, using steam at 150 pounds pressure, the water being forced through the heaters and through a Venturi recording meter which will measure the exact amount of water pumped.

From this position it will enter the main lines to the buildings, flowing through the various mains and sub-mains and, being collected in the various returns and sub-returns will be delivered back again to the power house and again recirculated.

For the purposes of ventilation there is being placed in each building a supply and an exhause fan which, besides serving as a medium of ventilation, will form, when in operation, an auxiliary to the heating system during seasons when the temperature is extremely low. The supply fan will draw air from the outside which in passing over steam-heated coils will be raised in temperature to 75° F. before it is delivered to the rooms, from which it will be exhausted by the exhaust fan to the open air. At the power plant mechanical coal-handling equipment has been installed with a receiving track hopper beneath a spur line from the Grand Trunk Railway. Coal will be dumped from the cars to the receiving hopper and fed to a cross-conveyer which will deliver to a pivoted-bucket elevator-conveyer in the boiler-room and from there elevated and dumped into overhead suspension bunkers. The coal will be fed from the overhead bunkers to a travelling weighing scale which will in turn dump to the Murphy stokers.

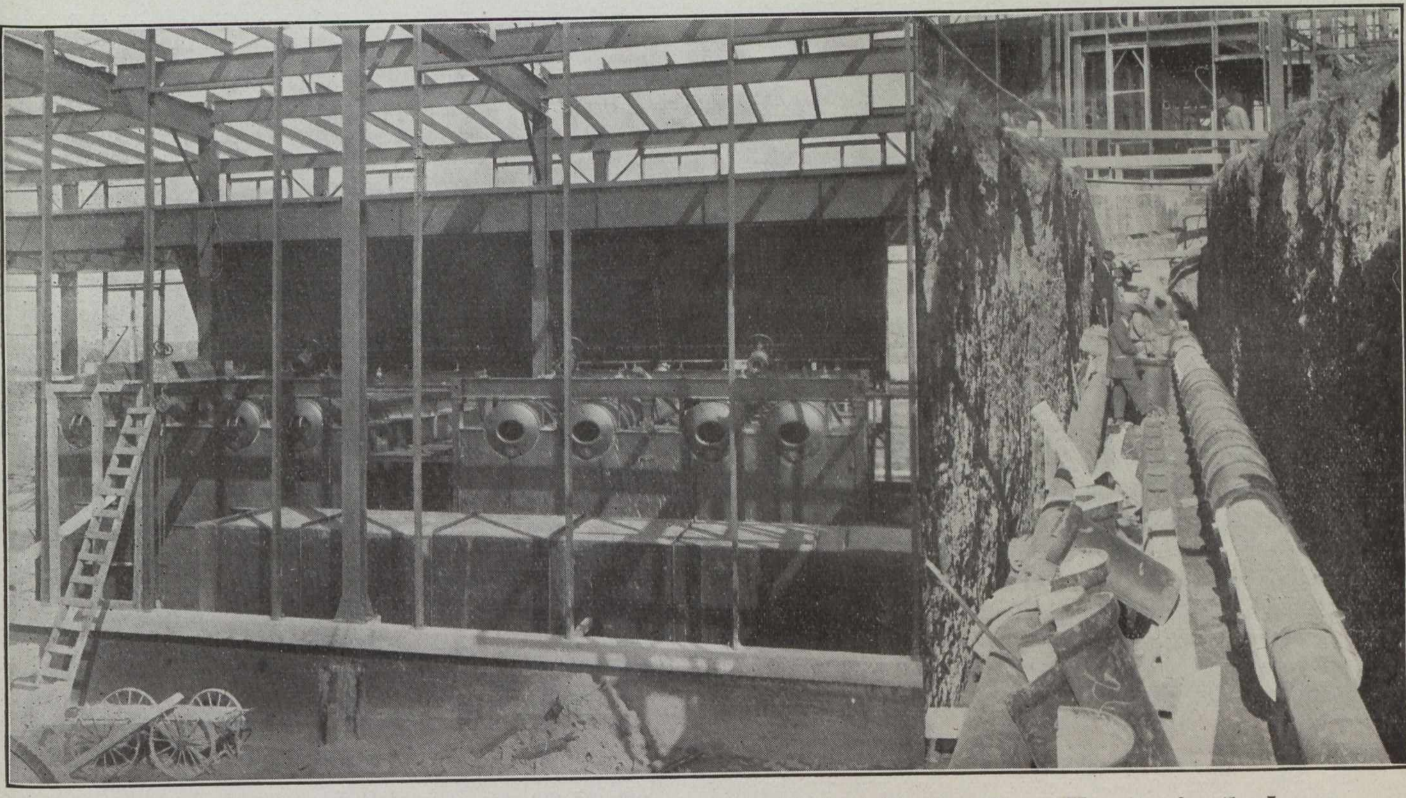


Fig. 1.—(Left) Boiler Installation for the Power House of the District Heating Plant, Hospital for the Insane, Whitby, Ont. (Right) Heating Mains and Returns in One of the Lines During Construction.

This institution in its completed stage will occupy an area over half a mile square and will consist of a combination of seventy or more buildings, comprising patients' cottages, doctors' and nurses' residences, attendants' homes, dining halls, hospitals, convalescent and industrial centres, chapel and concert hall, recreation theatre, general stores, administration offices, infirmaries, power plant, bakery, laundry, workshops, cold storage, and other buildings. The heating and ventilation of the entire establishment will be executed and controlled from a central heating station, installed at the power plant, the primary system of heating employed being the forced circulation of hot water.

The heating of the water used in the system will be effected by two large heaters, one using exhaust steam and the other live steam at 150 pounds pressure. Steam will be generated at the power house by means of eight 325-h.p. water-tube boilers, equipped with Murphy stokers, economizers and induced draft fans.

Ashes will be delivered from the boilers to the bottom of the pivoted-bucket carrier which will elevate and convey to the ash bunker from which they will be discharged direct into a wagon or other means of conveyance to their final disposition.

The construction and installation of mains for the distribution of the hot water and steam to the different buildings forms an important phase of the engineering skill applied to the system.

Throughout the entire area to which the heating will apply there will eventually be spread several miles of iron piping varying in size from 12 inches to 2 inches in diameter and laid underground at an average depth of from 8 to 10 feet.

The preparation of the base upon which this piping is laid, as well as the insulation and protection of the piping itself from the destructive agents that are ever at work below the surface of the ground, has been taken care of by the method employed by the Ric-Wil Underground pipe-covering Company, of Cleveland.

At the bottom of trench excavation concrete is poured to a depth of 4 inches and laid to grade with its top surface smooth and level forming a solid foundation. On this base and throughout the entire length of trench is laid an interlocking base-drain to provide for under-drainage, upon which feature the life and value of any system of underground heating principally depends, the drainage being accomplished by leaving the end-to-end joints open when the base-drain is being laid. The lower surface of the base-drain is flat and is made to conform with and become a part of the foundation by the use of a thin layer of grout or cement between it and the concrete. The top

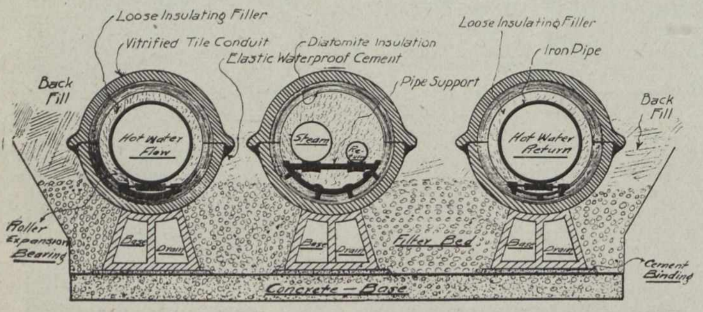


Fig. 2.—Cross-section of Pipe Line System.

surface conforms to the curvature of the tile conduit covering the pipe, for which the base-drain forms a substantial support, besides aiding in the perfect alignment of pipes in the conduit.

For the support of 16-inch conduit the base-drain is provided with a longitudinal centre rib giving additional strength. At the centre of the top surface of the base-drain an opening is left to receive the bell of the conduit, the base-drain and conduit being of the same length and laid staggered. The different lengths of both drain and conduit are thus linked together and rigidity is given to the entire line.

Connections are made from manhole to manhole and the drainage conducted to sewers, the base-drain being accessible to flushing and cleansing when necessary. The conduit, or pipe covering, consists of the Ric-Wil vitrified, salt-glazed tile lined with a mineral insulation. The tile is manufactured from Akron shale, thoroughly ground and mixed, free from foreign substances and withstands perfectly the heat necessary for vitrification. It is supplied for the present construction by the company covering the patents. All the sections are salt-glazed inside and out and are waterproof. The inside surface is serrated or grooved to assist in keeping the insulation in place, insulation and tile making a rigid combination.

The insulating material used inside the tile is a mixture consisting mostly of Diatomite, or infusorial earth, and has for a long time been the standard insulation in European countries where it is known as "Kieselguhr."

Diatomite has proved to be a better insulator, stronger and lighter than magnesia or asbestos. It is insoluble in water, indestructible by acids and high in insulating efficiency. It is unaffected by atmospheric conditions and steam leaks in the pipe it covers have no injurious effects.

The vitrified tile conduit is cut longitudinally during manufacture into two sections, sufficient material being left to keep the two halves intact for handling and shipping. When ready for use the sections are easily separated by means of a chisel or slight taps from a hammer.

On either side of the upper half of the conduit a lip extends longitudinally where the casing is split which provides a protection for the joint throughout its entire length.

After the pipe and conduit have been laid and thoroughly tested previous to the back-filling of the trench a layer of filtering material is thrown down surrounding the base-drain and conduit to a depth of 8 or 10 inches. The material used for this purpose is crushed stone and rejects from the sand screens, readily obtainable and forming an admirable filter bed serving to prevent the clogging of the joints in the base drain.

Expansion and contraction of the pipes in the conduit is provided for by roller expansion bearings made of malleable iron guides, pocketed to support a steel spindle on which brass rollers are free to turn.

Lugs penetrate the insulation in the conduit insuring against any lateral movement of the bearings which are spaced about 10-foot centres throughout the entire length of the conduit.

At the various manholes expansion joints are provided to take up expansion and contraction of the pipe line between manholes.

Fig. 2 represents in cross-section the installation of base-drain, conduit and pipe-lines from power house to first and second cottage centres.

UNCONSCIOUSLY BENEVOLENT.

An electrical engineer recently returned from Europe tells a story of the way in which the Germans furnished electric current to light French headquarters and camps and also probably to charge barbed wire entanglements in front of the French positions.

Soon after the capture of Lille, the Allies continuing to occupy Armentieres close by, the Germans discovered the abandoned Lille electric generating station. The mechanics with the German army soon put the station in operating condition and the town was once again lighted by electricity. But what the Germans didn't know was that the current for Armentieres was furnished from the Lille station.

It was several months before the Germans learned that while they were enjoying the benefits of the operation of the power house the Allies also were utilizing the current for the lighting of their camps, a good share of the energy generated by the Germans going into the lines of the Allies. As soon as this was discovered the transmission lines to Armentieres were promptly cut.

Copper mining in Canada in 1914 was marked by an increased production in Ontario and Quebec, with a falling off in British Columbia and the Yukon, leaving the net result as a very slight decrease. The copper contained in matte, blister copper, etc., produced in Canadian smelters, together with the estimated recoveries or amounts paid for in ores exported, amounted in 1914 to 75,738,386 pounds, valued at $10,310,935.

COAST TO COAST

Vancouver, B.C.—It has been announced that the Canadian Northern Railway and the Great Northern Railway have arrived at an agreement with respect to running rights of each over the roads of the other.

Winnipeg, Man.—The contractors on the Winnipeg-Shoal Lake Aqueduct are preparing to close down their concreting plants for the season. The Greater Winnipeg Water District has spent about $3,500,000 in construction operations this year.

Sarnia, Ont.—A resident has served the city with notice that legal action will be taken to prevent the expenditure of more money on the Point Edward waterworks system, unless a by-law for the same is submitted to the taxpayers, together with plans for the proposed work.

Fort William, Ont.—The new stone and concrete breakwater at the entrance to Mission River was damaged by a heavy storm which swept Lake Superior on November 7th. Portions of the structure were shifted to such an extent that the cost of repair will be considerable. The breakwater was built last summer.

Quebec, Que.—Work is rapidly proceeding on the construction of the new dry dock on St. Joseph de Levis. The contractors, M. P. & J. T. Davis, have between 700 and 800 men at work and operations are proceeding day and night. It is expected that the work will be largely completed before the close of next year.

Winnipeg, Man.—According to a recent report, 12 miles of the Shoal Lake Aqueduct, now under construction for the Greater Winnipeg Water District, have been completed, including the crossing under the Whitemouth River. Considerable new plant is to be purchased, including two drag-line excavators, a dinkey locomotive, another screening plant and 26 dining cars.

Vancouver, B.C.—Reclamation work for the new government wharf and elevator site at Burrard Inlet has been completed. The wharf, it will be remembered, was completed some months ago and the elevator is being constructed. An interesting feature of the wharf is the sheathing of the timbers with concrete, as explained in a previous issue. The wharf itself is 800 ft. in length and 300 ft. wide.

Victoria, B.C.—S. A. Valiquet, one of the engineers of the Department of Public Works, Ottawa, inspected the harbor improvements at Ogden Point last week. Concerning the likelihood of early construction operations on the new dry dock for Esquimalt, Mr. Valiquet stated that the Department of Public Works had not arrived at a decision as to the prospects of its being put under contract before the close of the war.

Quebec, Que.—On November 4th the erection of the north shore cantilever arm of the new Quebec bridge was completed, thus practically finishing the part of the bridge on the north side of the St. Lawrence. The anchor arm on the south shore will be finished in a few days, and the cantilever arm on this side will be completed next summer. There remains the centre span which will be towed to the site and placed next fall, according to present expectations.

Owen Sound, Ont.—Hydro-electric power from the Eugenia Falls development of the Hydro-Electric Power Commission of Ontario reached Owen Sound for the first time on November 12th. As the completion of the local station will take a few days more, the commercial use of the power will not begin until later on in the month. The formal opening of the plant at Eugenia Falls took place on November 15th.

Montreal, Que.—The addition to the Harbor Commissioners' elevator No. 1, which is a concrete structure with a capacity of 1,500,000 bushels, is nearing completion. The contractors, the George A. Fuller Co., have entirely completed the concrete work, and the steel work of the cupola is practically in place. This structure increases the elevator capacity of the city of Montreal to 11,500,000 bushels, the largest capacity of any seaport in the world.

Markham, Ont.—Work in connection with the waterworks system has been commenced, several hundred feet of mains having already been placed. The pipes are being supplied by the National Iron Works, Limited, Toronto. Operations have not been commenced, however, on the construction of the elevated steel tank. The latter is being supplied by F. H. Hopkins & Co., Montreal. Messrs. James, Loudon and Hertzberg, consulting engineers, Toronto, have the work in hand.

Winnipeg, Man.—The Department of Public Works, Ottawa, has recently completed the construction of a new dock on the Red River at Rover Avenue. It is 400 ft. in length and 30 ft. wide. It is constructed of creosoted timber with steel guards and iron moorings. The cost has amounted to $15,000 and it is expected that it will have a decided stimulating effect upon the water freight traffic of the city. Work has been done under the direction of Mr. A. J. Stevens, resident engineer for the Department.

New Westminster, B.C.—The new reservoir for the water system was officially opened to service a few days ago. This reservoir has cost $42,000 and has practically doubled the storage capacity of the city's plant, which was previously 4,000,000 gallons per day. Construction began in November and was carried on by day labor under the direction of Mr. J. W. W. Blackman, city engineer. The reservoir is 400 ft. above sea level and Coquitlam Lake, the source of supply, varies in elevation from 442 to 503.

Winnipeg, Man.—Mr. W. G. Chace, B.A.Sc., chief engineer of the Greater Winnipeg Water District, in his report for the month of October stated that during that month 16,667 ft. of aqueduct arch had been placed, making a total of 59,631 ft. completed up to that time. Backfilling has been completed on 39,036 ft. Records show that 11,807 cu. yds. of mixed sand and gravel were delivered during the month, making a total of 50,124 cu. yds. In the month ending October 25th, 11,029 barrels of cement had been delivered making a total of 80,584 barrels.

Stonewall, Man.—The Union of Manitoba Municipalities will meet at Stonewall on the 23rd, 24th and 25th of November. A large number of resolutions are to be considered and it is expected that there will be at least 300 delegates. The W.S. & L.W. Railway (electric) will transport visiting delegates to and from Winnipeg each day. A banquet and inspection of the penitentiary at Stony Mountain have been arranged for the visitors by Mayor Arundel and Council of Stonewall; Reeve Sutherland and Council of Rockwood, and Secretary-treasurer McFarlane.

Vancouver, B.C.—The contract was let last week for the delivery of 2,500 tons of rails from the yards of the Canadian Northern Railway at Port Mann to Patricia Bay, the terminal of the new line of the company on Vancouver Island. This steel will be used on 16 miles of road between Patricia Bay and Victoria. Work is being started on laying steel on this first section of the Island branch.

It is expected that the line will be completed to Victoria in three months. The line between Victoria and Alberni on the north shore of the Island is 150 miles long and has already been graded. A large wharf has been constructed at Patricia Bay for the accommodation of ferries which will run between the Island and the mainland.

PERSONAL.

Major A. D. LE PAN has been appointed to the position of joint superintendent of buildings and grounds of the University of Toronto after five years' service as assistant superintendent.

J. S. DENNIS, assistant to the president of the C.P.R., and who is in charge of the Department of Natural Resources at Calgary, Alta., has been elected 1st vice-president of the International Irrigation Congress.

A. R. CLUCAS, who has been on the engineering staff of the city of North Vancouver for several years, has been appointed acting city engineer to replace Mr. A. M. West, formerly city engineer, who has enlisted for active service.

H. S. WALLACE has been appointed manager of the Toronto office of the Standard Sanitary Manufacturing Company. He previously held a similar position in Hamilton, and is one of the harbor commissioners of the latter city.

L. W. WYNNE-ROBERTS has resigned his position on the staff of the Board of Highway Commissioners of Saskatchewan and has sailed for England to take up a commission with the Royal Engineers. Mr. Wynne-Roberts has been a resident of Regina for the past three years and was the first secretary of the Regina Branch of the Canadian Society of Civil Engineers. He is a son of Mr. R. O. Wynne-Roberts, consulting engineer, Toronto.

Hon. Col. GEO. G. NASMITH, Ph.D., Director of Laboratories, City of Toronto, who is in charge of the water and sanitation services of the Canadian forces overseas, has been granted leave of absence and is returning to Toronto to conduct official tests on the city's new filtration plant, now nearing completion, and upon the sewage disposal works at Morley Avenue. Dr. Nasmith has done invaluable work at the front, and some of his improved methods of water purification and sanitation have been adopted and applied by the War Office.

OBITUARY.

The death occurred in Ottawa on November 8th of Mr. James O'Connor, contractor. The deceased was connected with the construction of a number of important buildings in the city, and had a contract for the construction of the St. Anne's Canal and locks on the Lower Ottawa, a project which took five years to complete.

From Winnipeg the report has been received of the death of Dr. W. H. Montague, formerly Minister of Public Works for the Province of Manitoba.

BRITISH COLUMBIA L.S. MEN AT THE FRONT.

Mr. G. H. Dawson, Surveyer-General of British Columbia, has announced that no fewer than 69 qualified land surveyors of that province are serving in the trenches or are en route. Of these, four have fallen in action, four have been wounded, two are prisoners in Germany and fifty-nine either are serving at the front, waiting instructions at Shorncliffe to proceed to the continent, or training in British Columbia. Victoria's total contribution is twenty-one. Two of these have given their lives for their country—namely, Captain J. H. McGregor and Lieut. E. K. Colbourne, and two are prisoners, Lieut. R. D. Gillespie and Pte. J. M. Milligan.

OTTAWA BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

Mr. John. Murphy, chairman of the Ottawa Branch of the Canadian Society of Civil Engineers, delivered an illustrated lecture on the Panama-Pacific International Exposition at an open meeting of the members of the Society held November 17th. The lecture was illustrated by many beautiful hand-colored lantern slides and was open to the general public.

The meeting of the Branch on Thursday evening, November 25th, to be held in the Normal School auditorium, will be addressed by Mr. J. A. D. McCurdy, director of the Curtiss Aeroplanes and Motors, Limited, his subject being "Aviation."

MONTREAL METALLURGICAL SOCIETY.

At a meeting of the Montreal Metallurgical Society on November 10th an address was given by Mr. Thomas Cantley, president of the Nova Scotia Steel and Coal Co., on the subject of shell making. Prof. Stansfield, of McGill University, presided. The speaker estimated that during the next fifteen months Canada would export nearly $300,000,000 worth of supplies, the greater part of which would be shells. It was also stated that during the first nine months of the present year some 4,000,000 shells had been exported, and of this amount about 25 per cent. were fixed ammunition.

Another paper presented by Mr. J. N. Hogg, of the Algoma Steel Co., dwelt upon the subject of the production of steel as a national asset.

COMING MEETINGS.

NATIONAL MUNICIPAL LEAGUE.—Annual convention to be held at Dayton, Ohio, November 17th to 19th. Secretary, Clinton Rogers Woodruff, 705 North American Building, Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Annual meeting to be held at New York December 7th to 10th. Secretary, Calvin W. Rice, 29 W. 39th Street, New York.

INTERNATIONAL ROAD CONGRESS.—To be held at Worcester, Mass., December 14, 15, 16 and 17, 1915. General Secretary, Herbert N. Davison, Chamber of Commerce, Worcester, Mass.

AMERICAN FORESTRY ASSOCIATION.—Annual meeting to be held at Boston, Mass., January 17th and 18th, 1916. Secretary, P. S. Ridsdale, Washington, D.C.

CANADIAN NATIONAL CLAY PRODUCTS ASSOCIATION.—Fourteenth annual convention to be held at Toronto January 18th to 20th, 1916. Secretary, G. C. Keith, 32 Colborne Street, Toronto.