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Contents of this issue on page 775

THE CANADIAN ENGINEER

An Engineering Weekly.

## AN EXAMPLE OF SOUND, ACCURATE AND FAIR PUBLIC REGULATION OF A PUBLIC SERVICE COMPANY.

In these days of increasing agitation in favor of the control or supervision of public service corporations and of large combines, many new problems are developing in regard to the methods of managing and valuing such concerns. It seems that the ultimate end most desirable in all lines of industry is combination to effect economy of operation and public control to prevent the pooling of prices or unfair rate making.

An example of public regulation that is a model in its accuracy, soundness and fairness, is that recently accomplished in Massachusetts by the State Highway Commission and the telephone companies. A record of this investigation contains valuable information for the investor, for the telephone user and for the telephone operating company.

The specific charge against the New England Telephone and Telegraph Co., which was brought in Sept. 1906 was over-capitalization and excessive and inequitable rates. The Commission's handling of the charge of over-capitalization involves the straightening out of a tangled situation that is typical in these days of properties formed by a progressive consolidation of small companies. The New England Telephone Company is the result of a combination of a good many smaller companies, each of which had certain records of construction outlay, operating expense, etc. It was found, however, that the accounts of the final company were entirely inadequate as a basis for valuation. The Commission, therefore, had their engineers make a detailed inventory of all the company's physical property in the six New England States. Every pole, every foot of wire, every instrument, the exchanges and their equipment, lands, buildings, and property of every sort, was properly inventoried and valued.

From this inventory it was found that the Telephone Company had actual property amounting to $100 for every $84 worth of securities issued. To this valuation was added what was considered a just value of intangible or overhead charges, including cost of engineering, salaries, interest, etc., during construction operations. In telephone construction the total charge that should be made against capital account over and above the actual expenditures for physical property has been determined as about 20 per cent., being apportioned as follows: 10 per cent. for preliminary engineering expenses and engineering supervision during construction; 4 per cent. to 6 per cent. for taxes; 1 per cent. to 2 per cent. for insurance; and from 5 per cent. to 10 per cent. for the cost of selling the securities.

The readjustment of the telephone rates might seem at first sight to concern only the telephone using public, but it was clearly demonstrated by investigation of the Massachusetts Commission that this readjustment of rates was of vital interest to the holder or intending investor in public service securities.

The principles upon which the Commission proceeded in fixing the telephone rates were those first applied by Prof. Jackson in his study of the Chicago telephone problem in that city. The whole idea of this system is to make each branch of telephone service stand on its own legs. It developed in the course of the investigation that the actual cost in Boston and vicinity, of handling each call was in the neighborhood of 2½ cents. It was further shown that not infrequently large users of telephones, secured their service at rates as low even as ½ cent a call, the loss to the company being of course made up by the small users. Up to the time of this investigation the system of accounting of the telephone company was such that it could only tell in a lump sum the amount of its income and the amount of its expenses. One of the most important recommendations from the point of view of the investor which was made by the Commission and adopted by the telephone company was the installation of a system of accounting devised by Prof. Jackson and a firm of expert accountants in the Chicago investigation, by which the necessary facts could be obtained to show the exact expense and income of each class of service.

The danger of not knowing where the leaks are occurring is of vital interest to parties holding securities of any corporation. On the extension of the non-paying systems of service the company would immediately commence losing money without being aware of how it was going. This point was very clearly illustrated by the fact that the New England Company installed a new system of accounting as recommended by Prof. Jackson and made a year's trial run, ending in March, 1910. The new accounts show that the company was furnishing certain classes of telephone service at a heavy loss and that the classes of service upon which it was making a profit did not return sufficient to overbalance the losses. Although the company has been paying 8 per cent. dividends upon its stock together with the interest upon its bonds it was found that in order to do this the company had neglected to set aside proper reserves for depreciation, reconstruction, and obsolescence of its plant. In other words, as the company had been conducting its business it was approaching the time when it must face the expenditure of millions of dollars for renewal of plant without having any reserves provided to meet these expenditures. It is evident that it was headed straight for trouble.

The investigation of the Highway Commission has established the company's accounting system upon a sound adequate basis, has made the owner of its securities feel more secure, has removed the probability of mischievous legislative interference, and has established a system of rates which will undoubtedly greatly increase the business of the telephone company, much to the advantage of the user of every telephone owing to the extension of this service. Probably no more sound, judicial and scientific investigation of the sort has ever been carried through in this country and from every point of view it would seem to be a model deserving of close study and of imitation by other communities.

One of the most striking features of this entire investigation has been the spirit of co-operation exhibited between the telephone company on one hand and the Commission and their engineers on the other. The entire expense of the Commission during the investigation was borne by the telephone company by means of a special tax, but this was only a portion of the total expenses borne by the telephone company during this investigation.

## TYPES OF WELLS; THEIR COMPARATIVE COST AND MERITS AND METHODS OF PROTECTION FROM POLLUTION.

(Continued from last week.)

**Safety Distance.**—By "safety distance" is meant the distance from a source of pollution at which a well may be of a "cone of safety," by which is meant an inverted conical sunk with a degree of safety. Some writers have spoken section of earth, with its apex at the bottom of the well and its base a circle of some fixed radius on the surface. The radius taken by some is the depth of the well, by others twice the depth of the well, but such limits are usually fixed without taking into consideration the nature of ground-water movements or the character of the passages in which it moves. The distance of safety also depends to a considerable degree on the quantity and concentration of the pollution entering the ground water. Where coming from the surface the amount is commonly not large, but where entering at a considerable depth, as from cesspools sunk in limestone or in porous sands, which also supply water to wells, it may reach the water stratum almost undiluted. It follows that no absolute radius can be laid down, each case demanding individual consideration. Certain generalizations, however, may be made as to conditions in materials of different types and under different topographic conditions, some of which are indicated below.

Clay and Till.—In ordinary clay and in the pebbly or boulder clay known as "till" the water circulates in part by general seepage through the mass, in part through relatively thin, sandy layers, and in part along more or less open but irregular tubular passages. Seepage through the body of the clay or till is very slow, and polluting matter is rarely carried for any great lateral distance; 100 feet from the

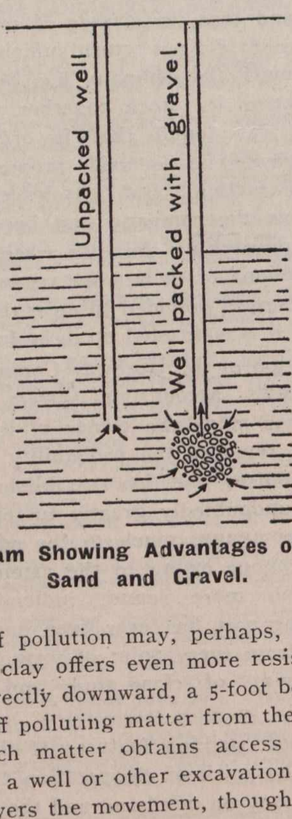


**Fig. 3—Diagram Showing Advantages of Packing with Sand and Gravel.**

nearest source of pollution may, perhaps, be regarded as a safe limit. The clay offers even more resistance to the passage of water directly downward, a 5-foot bed as a rule effectively shutting off polluting matter from the underlying water beds, unless such matter obtains access along the break made in sinking a well or other excavation. When the water follows sandy layers the movement, though much faster than in uniform clay, is nevertheless, not very rapid, rarely exceeding a few feet per day, and pollution does not often extend much over 150 feet, 200 feet usually being a safe distance. In open passages movement is much more rapid, and may amount to several hundred feet a day in extreme cases. Under such conditions there is no purification and relatively little dilution, and if the passage discharges into a well dangerous contamination may result. In a thickly inhabited region a well depending for its supply on passages of this nature is never safe.

Sand.—A bed of sand is among the safer water beds. Being of an incoherent nature, the material rarely contains open passages, the water circulating in general by a slow movement among the grains. The rate, though sometimes amounting to 50 feet or more a day, is usually under 5 feet, and may be under 1 foot. A well 200 feet from the nearest point of pollution is probably safe in fine and medium sands, but in coarse sands and gravel a much greater distance may be essential.

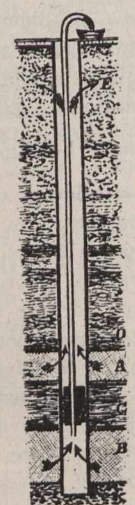


**Fig. 4—Section of Well Showing Loss by Leakage into the Superficial Deposits.**

Sandstone.—The movement of water in sandstone is in part through the body of the rock and in part through small open passages along the joint or bedding planes. Owing to the greater density of the rock resulting from the cementation of the grains the distance to which pollution may extend through the pores of the rock is less than in sand, 100 feet usually being a safe distance. Probably even with the water moving along the joints and bedding planes, 125 to 150 feet from the source of pollution is a safe distance for a well.

Slate and Shale.—In slate and shale the water follows in part the planes of stratification or bedding, and in part the more or less vertical joints by which these rocks are usually cut. Unless certain of the layers are sandy the movement along the bedding planes is generally slow, and pollution is carried for only short distances. The joints, however, are in many places fairly open, and may conduct the water within a short time to considerable distances, possibly many hundred feet, like the granite joints described elsewhere. However, unless the examination of the rock or the behavior of the drill in the well shows the presence of such open joints, a well in slate or shale may usually be considered safe if not less than 100 feet from a source of pollution.

Limestone.—The movement of water through limestone is almost entirely by means of open passages. Some of these are only a minute fraction of an inch in width, being no wider than joint and bedding planes. In such passages the movement of water is very slow and pollution is rarely carried far, 150 feet from a possible source usually being a safe distance. Other passages, however, are of considerable size, perhaps many feet in diameter, and may extend for miles. One chamber in Mammoth Cave is nearly ten miles long, and there is evidence that similar, though perhaps smaller, channels exist at numerous other points. These openings are not uncommonly occupied by flowing streams which, if polluting matter is introduced, may carry it for many miles. Such streams may have connection with surface sink holes. Cornstalks and other refuse from the surface not infrequently appear in wells drawing water from limestone, and the waters are often muddy after storms. Such occurrences are indications of surface contamination, and the waters should be avoided if possible.

Granite.—Practically no water passes through the body of granite, the movement being mainly along joint or fault planes or through pore spaces in the disintegrated upper portions of weathered granite masses. Polluting matter may reach to considerable distances through joint of fault planes, as is indicated by the fact that the salt water of the ocean finds entrance to some wells located 500 feet, and in places even a quarter of a mile or more, from the shore. It is said that in the deep public well sunk in granite at Atlanta, Ga., sufficient polluting matter entered through a joint struck at 1,160 feet from the surface to render the water unfit for drinking.

**Protection from Surface Wash.**—Many open wells are exposed to the same danger of pollution from surface wash as springs, and the same methods of protection should be used. A water-tight curb should be raised a few inches or a foot above the level of the surrounding surface and the earth banked around it, with a slope away from the well. This curb quickly deflects the water and prevents it from collecting and soaking through the ground into the well.

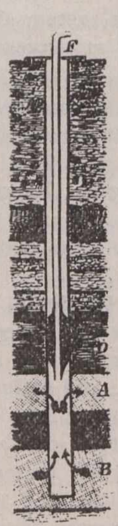


**Fig. 5—Section of Well Showing Loss by Leakage from One Deep Bed into Another.**

**Protection from Stock.**—The chief means in which wells become polluted by stock is through seepage from the surface. Watering troughs are commonly placed close to wells, and usually in such places the hoofs of the animals soon wear holes in which the rain water and more or less of the animal excrement collect and soak into the ground, finally reaching the well. To prevent this contamination the watering trough should be placed as far away from the well as possible, the water being conducted to it by pipes. A well in an open pasture, if it is to be used at all by human beings for drinking water, should be surrounded by a fence at least 20 feet away.

**Protection from Pump Drippings.**—The drip from pumps is a very common and dangerous source of pollution. In the greater proportion of dug wells provided with pumps the well is covered with boards or planks laid or nailed over the top. No matter how carefully these platforms are constructed, cracks through which water can enter almost invariably exist, and it is a common occurrence to have the water dropping or trickling back into the well whenever any is spilled in pumping. The danger of this will be understood when it is recalled that those stepping upon the platform to pump may have just come from the barnyard or from manured fields, bringing with them on their shoes more or less filth, part of which is left on the planking and washed into the well by dripping water from the pump or by the next rain. The wooden platform should be replaced by a water-tight cover made of iron, cement, or other impervious material. Cement covers are coming into use in many localities and afford ideal protection.

**Protection from Small Animals.**—An ever-present cause of pollution in open wells and wells insufficiently protected by coverings is the entrance of small animals. It is a common thing for snakes, toads, mice, and even rabbits, to penetrate through crevices and to fall into the well, especially in dry seasons, when the animals are compelled to make desperate attempts to reach water. The remedy is an impervious well-cover fitted tightly to the curb.

**Protection from Dust.**—Dust is usually less dangerous than other sources of pollution, but in dry seasons, when dirt from the street or barnyard is being blown about, it may become of considerable amount and danger. It is not uncommon to find several inches of black, foul-smelling silt in the bottom of a well on cleaning, even though it may have been cleaned only a year or two before. The dust may be kept out by water-tight coverings such as are used to keep out pump drippings.

**Increasing the Yield.**—The methods of increasing the yield of wells vary according to whether the well is of the dug or drilled type, and whether the existing supply has or has not materially decreased from the original supply. An originally inadequate yield commonly results from insufficient supplies in the water-bearing rock or from the slowness with which the supplies are given up. A decreased yield may be due to some defect in the well itself.

**Remedy for Insufficient Supplies.**—Ordinary clay and the denser varieties of pebbly and boulder clay or till usually contain but little water, and this little is often largely in the form of interstitial water held in the body of the material and given up slowly to a well by general seepage. Under such conditions the amount entering the well is often more or less proportional to the area of surface exposed in the wall. This area varies with the diameter of the well; thus, three times as much surface will be exposed in a given height of wall in a 6-inch well as in a 2-inch well and six times as much in a 3-foot as in a 6-in well. To give a large yield a large-diameter well is very desirable in materials of the character mentioned.

Large wells are also desirable in rocks in which the water occurs in a similar manner; that is, in pores rather than in open passages. In general, however, if water is yielded at all by the rocks, it is given up more readily than by clays, hence a large bore is less necessary. This is fortunate, for the range of size in rock wells is usually rather scant, owing to the fact that most rock wells are of the drilled type. Where the water occurs in bedding or joint planes the diameter is of still less importance, as the entrance of the water is localized and is relatively free. Large diameters, nevertheless, increase materially the likelihood of striking an opening. In the oil regions the increase of the diameter of a bore 2 inches by reaming has been known to open pools not encountered in the original hole, and a similar result is possible in water wells.

The depth of dug wells in material in which the amount of water is relatively small is also important, for increase in depth increases the storage space in which the water can collect during periods when the well is not in use, thereby greatly adding to its total capacity.

In many regions, owing to the removal of the forests and the construction of drainage ditches, the water from rainfall and snowfall runs off more rapidly than formerly and much less sinks into the ground. As a result the ground-water level has been lowered over large areas, and wells which once afforded good supplies are now dry. In many places there is still plenty of water in the ground, the only difference being that its level has sunk below the bottom of the well. In such places the deepening of the well brings complete relief.

In the course of time an accumulation of material entering the well as dust at the top, or washed in through the ground, forms considerable amounts of silt in the bottom and on the sides. In some wells this deposit is sufficient to hinder, to a certain extent, the entrance of water into the well and to lessen its storage capacity. Some relief is usually afforded by cleaning out the well.

### Deep Wells.

Depth is one of the most important factors to be considered in sinking a well. On it both the type and the location often depend. The benefits which the owner expects to realize from a deep well as compared to a shallow well are (1) larger supply, (2) higher head, and (3) purer water.

**Location.**—In the location of deep wells the chief consideration is the obtaining of a supply, slight differences in location seldom seriously affecting the cost, while the prevailing use of casing in soft deposits insures safety from ordinary sources of pollution. The occurrence of deep waters depends on the character and structure of the rocks far below the surface. No indications of these features are usually found at the surface, and the well may as a rule be located independently of surface relief, though where artesian flows are expected the well should be located on as low ground as possible. Information as to the best location for a deep well may often be obtained from a careful study of the records of wells in adjacent regions, which can be made by the more experienced and intelligent drillers, or from a study of the rocks and their structure, which often requires the services of a trained geologist.

**Relation of Supply to Depth.**—It is a widespread, in fact an almost universal, belief, that the amount of water increases with depth, and that water may be had anywhere if one only "goes deep enough." This is, however, far from the truth. Rainfall appears to be the source of at least 99 per cent. of the fresh water found in the ground, the remainder being water included in the rocks at the time of their accumulation beneath the sea, together with a small amount derived from volcanic sources. As would be expected from its atmospheric source, water actually decreases rather than increases in amount with depth, a great many rocks encountered by the deeper wells and mines, especially at depths below 1,000 feet, being entirely destitute of water.*

However, if only the more superficial portion of the crust is considered, there is in general an increase of water with depth. Except in valley bottoms and other depressions the surface soil and rocks, although carrying much moisture, are rarely saturated; but at depths which vary, according to climate, soils, and topography, from a few to several hundred feet, a saturated zone constituting the ground-water body is encountered. Wells starting anywhere above drainage level will in general encounter water in increasing amounts at least down to the drainage level. Again, the surface beds may be of non-porous nature, and may, therefore, be destitute of water, while the underlying beds, if porous and below drainage level, are likely to be saturated.

Of course, there is a constant tendency for the surface waters to penetrate downward and fill the porous rocks below. That these are at present destitute of water may be due, at least in certain rugged regions, to the draining of the deeper and in places relatively porous beds by deep valleys. Elsewhere, and this is doubtless the most common cause, the water is kept from percolating downward by impervious beds near the surface. The deeper rocks are largely of the granitic type and hold but little water. Except where they constitute the surface rock and are somewhat broken by joints it is of little use to penetrate them in search of water.

To speak broadly, it may be said that there is no general increase of water with depth, and that the finding of deep supplies is entirely dependent on local geologic conditions. Unless there is some proof that deep water-bearing beds exist, the sinking of a deep well should be regarded wholly in the light of an experiment, although in sedimentary rocks it has the decided advantage that it may penetrate a number of water strata, which may afford in the aggregate a fair supply where a single stratum might not suffice.

**Relation of Head to Depth.**—As with regard to volume, there is a general belief that the head of water increases progressively with depth. This belief has a better basis than the other, for in some places such a relation of head to depth exists, as in the artesian system shown in Fig. 19, in which the deeper beds outcrop at successively higher levels.

The reverse condition is shown in Fig. 20. Such conditions are not the result of universally prevalent structures, although it is perhaps more common than otherwise that the strata are higher at the rims than they are at the centres of the great structural troughs. In many structural basins, the outcropping beds of the rims, in fact, lie high up on the flanks of mountains, while the beds of the centre constitute low plains.

**Relation of Quality to Depth.**—Another prevailing idea is that the deeper waters are purer. Within limitations this is generally true as regards the shallower waters, which, being close to the surface and without the protection afforded by overlying clays or other impervious beds, are susceptible to pollution. Deeper waters, on the other hand, are almost always overlain by relatively impervious beds that serve to keep out polluting materials, and as a rule they are entirely safe. In many places, however, the amount of mineral matter dissolved in the water shows a general increase with depth, the amount in deep waters averaging several times that in surface waters, which are largely made up of recent rainfall. There are some exceptions to this law, due mainly to variations in the character of the materials in which the waters are found, the waters in a calcareous glacial drift or in an alkaline flat, for instance, often being very much harder than those in underlying beds. Limestone waters, too, are generally harder than sandstone waters. The maxim of certain drillers, "The harder the rock, the harder the water," is based on the prevailing softness of the sandstones in many districts as compared to the hardness of the limestones.

In addition to the impervious beds mentioned, the casing plays an important part in preventing the access of pollution to deep waters. When the casing has been corroded, pollution from sources near the surface is often admitted through the minute holes eaten in the iron, spoiling the deep waters. Where the casing does not entirely fill the hole, contamination may pass down outside of it, while in uncased rock wells pollution may enter through any of the numerous fissures that usually exist in the upper part of the rocks. Even in such wells, however, the danger of contamination decreases rapidly with depth.

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*Fuller, M. L., "Total Amount of Free Water in the Earth's Crust: Water-Supply Paper, U. S. Geol. Survey, No. 160, 1906, pp. 64-70.

**Protection of Non-flowing Wells.**—Many of the conditions favorable to pollution of the shallow wells likewise favor the contamination of deep wells, but, as the causes and remedies have already been discussed, especially in connection with the section on "Safety Distance," they do not require further consideration at this point.

The water of deep wells when first encountered is usually safe, and rightfully has a good reputation, so that people often go to great expense in drilling for deep rock waters. Unfortunately, however, many fail to realize that, unless care is taken, it is possible for deep wells to become polluted by the entrance of surface waters. In regions where the rock is within a few feet of the surface, for instance, the casing may be carried only to the rock, the fact that pollution can enter the well through the rock crevices being entirely overlooked. The chief precaution necessary against this danger is to carry the casing to a sufficient depth to shut off all surface waters entering through fissures. It is hard to say how deep it must be carried to remove all danger of contamination, but the crevices are usually limited to the upper part of the rock, and every additional foot of casing gives additional safety. Ten feet of casing in the rock would materially reduce the danger, while 25 feet would in most wells probably insure safety. The best plan, however, is to carry the casing from the surface down to the water-bearing seam. The casing should always be set with a tight joint at the bottom to prevent the entrance into the well of surface waters that find their way downward along the outside of the pipe.

Again, it is not unusual to drill new wells in the bottom of old dug wells and to allow the polluted surface waters to mingle with the pure rock waters.

Many towns situated on rock surfaces and using unprotected wells of the type mentioned have been visited by epidemics of typhoid fever, cholera, and other diseases, leading to the loss of many lives.

Another source of pollution, less common and possibly less dangerous than the preceding, arises from the fact that many casings are left open at the top, even when care has been taken to carry them to proper depths.

A fourth and very common means of contamination of deep wells is by leaks in the casing due to imperfect joints or to corrosion. The process of corrosion may be very rapid, the pipe in some wells with acid chalybeate waters lasting only a few years. No one expects a pipe laid in the ground near the surface to last many years, yet many seem to think that a well casing will last indefinitely. Unfortunately, this is far from true.

The detection of leaks is somewhat difficult. In some wells, however, water may be heard trickling in or may be seen by a light ray projected down the well by a mirror when the pump is withdrawn. The admixture of water from outside sources may sometimes be detected by a difference of the hardness of the well water, by an earthly taste or taste of decayed vegetation, or by a cloudiness due to silt brought in by superficial waters.

The remedy is usually to pull out the old casing and replace it by a new one, the length of time the pipe is allowed to remain before replacement being determined by an estimate of its life based on the action of the water on the pump-tube or other pipes. An alternative treatment sometimes employed when the leak is near the surface is to set a packer, designed for the purpose, in the space between the bottom of the pump-tube and the casing and fill the space above with cement.

**Flowing Wells.**—In order that water may have sufficient head to flow out upon the surface it must be confined under some impervious or relatively impervious clay or other bed. This effectually shuts out pollution from the overlying materials, and any contamination that reaches the well must be transmitted laterally for relatively long distances. As pollution rarely extends through the ground to any great lateral distance from its source, it follows that artesian waters are almost never polluted.

In artesian wells the water, being under greater head than that in the surrounding materials, will pass outward through any leak that may develop rather than admit the water of lower head to the well. Suction, such as is developed in the Richards apparatus in laboratories, which might be conceived as drawing in outside water through openings in the casings, cannot take place with the relatively low velocities of the water in the ordinary artesian wells. Even in a well in which the water has a very high velocity, the suction is so slight in proportion to the immense volume discharged that it may usually be neglected.

**Methods of Increasing Original Yield.**—Shooting.—The practice of "shooting"—exploding a charge of nitroglycerine or other explosive in a well—has long been successfully employed in the oil regions, and has in late years been used to increase the flow of water wells, in which dynamite is more commonly used. The action of the dynamite is to shatter the surrounding rock, with the result that connection is frequently established with other crevices, in some wells largely increasing the water supply. (See Fig. 1.) The dynamite is most effective in hard, brittle rocks, such as limestone, which are as a rule completely shattered by the explosion, and is least effective in soft, tough shales, which are bent and compressed rather than broken.

**Steam Jet.**—Shooting, owing to the character of the materials, is not usually practised in unconsolidated deposits, in which the steam jet is sometimes used instead of dynamite. The steam is forced down a small pipe inside of a larger one, and coming into contact with the water at the bottom, turns it quickly into steam, the resulting explosion loosening the material or making a pocket about the bottom of the pipe. Where the materials are dense and clayey, the action of the steam jet may considerably increase the influx of water; in the more porous deposits it has less effect.

Packing with Gravel or Sand.—It frequently happens that where the material is very fine it packs around the well so as to hinder the entrance of water. In such cases it is a common practice to drop a supply of pebbles into the well and with the aid of a drill force them out into the surrounding clay, etc., until a pocket of pebbles is produced through which the water flows freely to the well.

In quicksands, the space between the outer casing and the pump-tube and strainer is often filled with sand through the heavy suction induced by pumping. The sand in many wells keeps back the quicksand while allowing the water to pass through it freely and to enter the well. (See Fig. 1.)

Production of Sand or Other Pockets by Pumping.—Many of the materials yielding water to wells consist of mixtures of sand or gravel and clay. By heavily pumping a new well it is often possible to remove the fine clayey material, leaving the sand grains and pebbles in a sort of pocket about the well (Fig. 2), the result being much like that produced by the artificial gravel pocket described in the preceding section. A similar method is employed in certain stiff clays, in which small, open pockets at the bottom of the well are apparently produced by the heavy pumping.

**Methods of Restoring Lost Supplies.**—When a deep well is first sunk, it usually gives good supplies, but as time elapses the yield is found to decrease gradually until finally it is but a small fraction of the original amount. This decrease is commonly attributed to a decrease in the genera'

**Table I.—Cost of Wells.**
(By O. E. Meinzer.)

| Formation. | Diameter in inches. | Locality. | Explanations. | Cost per foot. |
|---|---|---|---|---|
| Limestone | 6 | Illinois, Iowa, Minnesota, Wisconsin | No casing required | 50 cents to $1. |
| Glacial drift and cretaceous shale | 2 | Iowa and Minnesota | Heavy iron casing furnished; water guaranteed | 55 cents to $0.75 +. |
| Do. | 4 | Do. | Do. | $1, more or less. |
| Glacial drift | 4 to 6 | Illinois | Light casing furnished | 50 cents or more. |
| Do. | Bored, 6 to 36 | Minnesota and Iowa | Casing not furnished; planks or tiles are used. These are expensive per foot, but the wells are not as deep as the drilled wells | 50 cents to $1 +, increasing with depth. |
| Glacial drift and cretaceous shale (mostly soft shale) | 1¼ at bottom | South Dakota artesian basin | Casing furnished; flow of clear water guaranteed | $350 to $500 for a well 900 to 1,000 feet deep. |
| Clay, free from boulders | 1¼ | Utah | Casing not furnished | 20 cents. |
| Clay, sand and gravel | Dug, 3 to 4 ft. | Do. | Not cased | $1.50 to $2, increasing with depth. |
| Quartzite | 6 | Minnesota | No casing required; yield of three barrels an hour guaranteed | $3 to $4. |
| Alluvium | 4 to 12 | California | Casing not furnished. Stovepipe casing costs from 32 cents a foot for 4-in. 16-gauge pipe to $1.40 a foot for 12-in. 10-gauge pipe. | 30 to 65 cents a foot for 4 to 10-in. wells, for first 100 feet, with additional charge of 25 to 35 cents a foot for each additional 50 feet in depth. |

supply of the region or to the drawing off of the water by newer and better wells. In many wells this is a real cause, but in others the failure is due rather to the deterioration of the old well than to the losses caused by new wells, which in reality have a large yield simply because they are new and in good condition. The chief cause of decrease or failure are clogging of the screen, entrance of sand, and leakage.

Re-screening the Well.—Of the causes of failure enumerated the clogging of the screen or strainer is probably the most common. This may result from the filling of the perforations by sand and silt sucked in with the water, but other very common causes are the closing of the pores by the deposition of iron or lime. Where the waters carry acids in solution, the screen is often attacked and corroded, the iron set free being redeposited in the sand about the screen, forming thick, impervious coatings of a sort of sandstone, which, sooner or later, effectually shuts off the water.

When the matter collected about the well point is soft and loose, it can often be removed by back pressure produced by pumping heavily into the well, the outward current forcing back the accumulated silts. When this fails, the usual remedy is to pull the casing and screen, or the pump and well point, and replace it by a new one. (See Pl. XVII.)

Prevention of the Entrance of Sand.—If a well is not properly constructed and screened, sand or quicksand may enter the well in large quantities and greatly hinder the entrance of water. In some wells this is remedied by substituting a finer screen, and in others by packing gravel about the bottom of the well, or around the screen or strainer, as already described. The packing of sand about the strainer has enabled many wells to draw on quicksands that ordinarily would have choked and ruined the wells.

Prevention of Leakage.—Leakage in wells affording acid waters is very prevalent, the pipes becoming rapidly corroded until holes appear in their walls through which the water from the well may escape. The only way to prevent leakage of this type is to recase the well

In uncased wells there is much leakage into other non-saturated beds, as is clearly shown by the accompanying diagrams (Figs. 3 and 4). Fig. 3 shows the water from two deep-lying beds being lost into one near the surface, and Fig. 4 shows a loss from one deep bed into another. The remedy for either condition is to carry the casing down to the principal water bed and not try to draw on two beds of different heads.

## STATIONARY ENGINEERS, TORONTO.

**Stationary Engineers, Toronto.**—The twenty-second annual banquet of the Canadian Association of Stationary Engineers was held in the Walker House, December 2nd, with Mr. W. C. McGhie in the chair. Addresses were given by Hon. Thomas Crawford; Hugh Clark, M.P.P.; W. D. McPherson, M.P.P.; Aldermen D. Chisholm, and D. Spence; Prof. W. S. Kirkland, M.A.; Mr. W. McKay; Mr. Coates; Mr. Alexander; A. M. Wickens; Mr. Keith; J. J. Heeg (Guelph); W. A. Crockett (Hamilton); W. A. Norris (London); H. Wickens (Brampton); W. A. Sweet, (Hamilton); and W. Robertson, of Stratford.

# CONCRETE SECTION

## CONCRETE AND FIRE LOSSES.

**Outbuildings Destroyed, But Silo Attached Thereto Escaped.**

One of the principal arguments in favor of Concrete is its fire-resisting qualities, as was illustrated recently at the Boys' Farm and Training School, Shawbridge, Quebec. This institution had just completed a circular concrete silo, when a fire wiped out all of their farm buildings with the exception of the concrete silo.

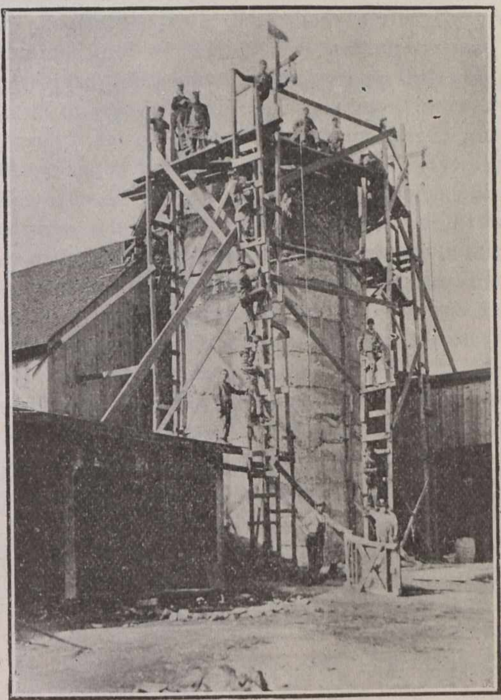
Photographs are reproduced herewith, showing the silo just before it was completed, and also showing it after the fire. Careful examination reveals the fact that this silo is to-day as good as when built. There were found in some places slight fire cracks, but these were only on the surface In a few places the heat has peeled off the surface concrete to a depth of from one-fourth to one-half inch, but in no place has the damage extended beyond that. Experts aver that the strength of the concrete has not been in the least impaired, nor has it become in the slightest degree more porous. One expert gives it as his opinion that a plastering coat would make it a perfect silo in every respect.

Spectators who witnessed the fire say that the concrete walls were heated to such a degree that after the fire was extinguished the silo stood aglow against the dense background of the night and that it was visible for miles around the country.

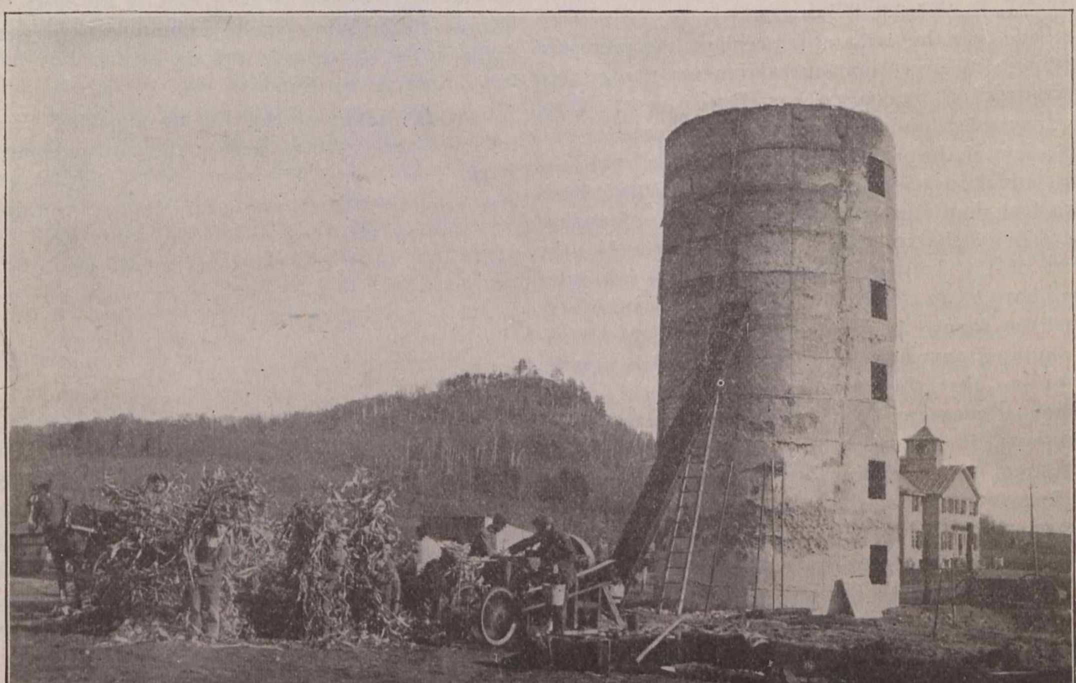
As may be seen, by reference to the photographs, the silo stands within a few feet of what were very large buildings. These buildings furnished an abundance of excellent fuel, and in addition to these the scaffolding that had been in use during the building of the silo was still in position at the time of the fire, which brought the flames closer to the silo than would ordinarily be the case.

This whole incident demonstrates, in a manner seldom equalled, the value of concrete as a fire-resisting medium.

A corroboration of these facts may be obtained from Mr. G. W. O. Matthews, Superintendent of the Boys' Farm and Training School, at Shawbridge.



**Before the Fire.**



**After the Fire.**

## PRODUCTION OF CEMENT.*

**W. S. Mallory, President of the Edison Portland Cement Co.**

Mr. Frederick A. White, Chairman of the Associated Portland Cement Manufacturers of England, in his annual address to his shareholders made on September 22, 1910, in connection with the statement that business conditions have been such that the cement plants of England could not operate to their full capacity, says: "For it is to be noted that the factor which works against our industry is not exactly, as is often predicated, overproduction. It is doubtful if over-production ever exists for long periods. Warehouses get full and production does decline with decreased demand, even though, as has been the case of late, the effort to sustain the demand depresses the price abnormally. But what we really suffer from is excess of capacity over current production when that is at a low level, because this prevents the natural rebound in prices when the demand revives. Each manufacturer puts, or can put, his surplus plant to work and not until this is employed, are sellers emboldened to stand firm and resist the pressure of customers, who threaten to divert their orders if concessions are refused." Judge E. H. Gary, Chairman of the United States Steel Corporation, has expressed the same thought in connection with the steel industry.

As is well known to all who are active in the cement industry of the United States, the same condition which has existed in England has maintained in this country since the panic of 1907. During 1908, of the total annual producing capacity about 63 per cent. was in operation; in 1909 about 67 per cent., and it is estimated for the year 1910 it will be about 75 per cent.

Naturally, this problem of over capacity has received much study and efforts have been made to solve it along several lines with indifferent results, so that the average selling price, during the past couple of years, has been the lowest ever known in our industry.

While it is true that the demand for cement has increased every year without any exception, our shipments are getting so large (estimated at 73,000,000 barrels for 1910) there must come a time when they will temporarily cease to increase, and in view of the uncertain conditions for 1911, the record for an annual increase may be broken. Many business observers feel that until the decisions in the Standard Oil and American Tobacco cases are rendered by the Supreme Court of the United States, that nearly all lines of business will have to go slowly. If I am correctly informed, these cases will be argued in January, 1911, and the decisions may be rendered anywhere from three to twelve months later, but assuming that they are given by June 1st next, and are of such a character that they are favorable to business conditions, it will take an appreciable time for business to respond to the more favorable conditions, and it can hardly be expected that the railroads and other large users of cement will be able to make the necessary plans and financial arrangements to enable them to largely increase their construction work during the latter half of 1911. With the recent decided falling off in building permits and the recent change in the political situation, it would seem prudent to assume that for the year 1911 the consumption will not increase over that of 1910 any more than the capacity of the new plants which will be put into operation during that year, so that relatively all the plants will be about in the same position in relation to the maximum capacity as they are this year.

During 1906, when there was more demand for cement than the mills could supply, every plant ran to the maximum capacity, and on account of the lack of sufficient stockhouses to store the full output of the mills during the winter season when shipments are light, the lack of sufficient capital by some companies to finance very large stocks of cement, and the usual break-downs incident to any industry that operates twenty-fours every day, the plants averaged in operation only 83 per cent. of the possible annual operating time.

If we assume that during 1911 we operate about 75 per cent. of the possible operating time, same as we have during 1910, and that the maximum percentage we could operate is 83 per cent., there would seem to be a surplus capacity of about 8 per cent. and the question is, how can we dispose of it?

Gentlemen's agreements are illegal and not effective. Some manufacturers believe that it is legal to maintain prices under patents, while others do not, so united action along this line seems impractical. If plants are shut down for a period of a month of more they are under the additional burden of shutting down and starting up expense, beside the breaking up of their manufacturing organization, and the hardship to their employees and families when they are laid off during the winter, and also the added general expense for those employees who are carried during the shut-down period, all of which makes it a serious problem, and I am now going to give you what seems to me to be a perfectly normal solution of it.

All cement plants of which I have knowledge, run their kilns twenty-four hours per day seven days each week, and with very few exceptions they operate all departments on Sunday. It has for many years been a tradition in the cement industry that the kilns must be kept in continuous operation, for the reason that if the heat was cut off the linings of the kilns would become damaged and the average daily output decreased, and so, as far as I know, all cement kilns operate on Sundays.

At the plant of the Edison Portland Cement Company for the past eighteen weeks, the entire plant, including the kilns, has ceased operations every Saturday at 6.00 p.m., and has resumed at 7.00 a.m. Monday morning, and during the months this year when the kilns were operated seven days each week, the average output per kiln was 654 bbls. per day. Since the Sunday operations have ceased the output has been as follows:—

| | | | | | | |
|---|---|---|---|---|---|---|
| August, | Average | daily | output | per | kiln | = 667 Bbls. |
| September, | " | " | " | " | " | = 677 " |
| October, | " | " | " | " | " | = 680 " |
| November | " | " | " | " | " | = 691 " |

and there has been no trouble with the lining, due to the fact that the kilns are stopped with the full load and about every four hours from Saturday night until Monday morning, each kiln is given a half revolution, which transfers the heated material to the other side of the kiln lining, and so prevents it from cooling off too rapidly and becoming damaged. The increased output, I believe, is due to two reasons. The men in charge of the kilns, on account of their rest, are in condition to do more efficient work, and because we further believe the output of our kilns depends on the area of the inside cross section at its smallest point. When the kilns are down on Sunday, one gang of men, numbering from three to five, cut off the lining at its highest

*Read before the Association of American Cement Manufacturers.

points and increase the area of cross section, and the average output is increased. This operation cannot be done when the kilns are in continuous operation.

I have corresponded with many of the largest plants in other lines, who use kilns and furnaces of various types, and find that outside of blast furnaces, which produce pig iron, that none of them such as open hearth furnaces, puddling furnaces, cupolas, heating furnaces, brass furnaces, air furnaces, copper furnaces, operate on Sundays, although in some cases light heat is kept on the furnaces over Sunday. Kilns for the manufacture of brick and similar material are kept under heat on Sunday, but are seldom loaded and unloaded on that day. Therefore, if all these allied lines of manufacture can successfully operate their kilns and furnaces only six days per week, why is it necessary, in view of the results obtained at the Edison plant, to operate cement kilns for seven days each week?, and if an arrangement could be made by which every cement plant in the United States would discontinue Sunday operations, the problem of over capacity for 1911 would be solved, and over thirty thousand employees would have their rest on Sunday and be in a position to do much more efficient work the other six days. While there can be no argument as to the moral right of these thirty thousand employees to have their Sundays for their own uses, I am nevertheless considering the question almost entirely from a practical standpoint to show that it is feasible to give them one day's rest in seven.

Now what as to the legal aspect of an agreement to close down on Sundays? I am advised by what I consider good legal authority, as follows: "In my opinion an agreement among the various cement manufacturers to close down their plants on Sundays would not be a violation of the Sherman Anti-Trust Law," and it would hardly seem probable that the government would undertake any action which might deprive over thirty thousand employees of their Sundays.

With every good thing there are usually some points which must be guarded, and in this case care must be observed as to the Sunday repairs, as it has been our experience that many small repairs that could be made during the week are left for Sunday, which necessitates calling out quite a repair gang. We now make it a rule that only emergency repair work is done on Sunday, all other repairs being done during the operating days. This is necessary if the operating cost is to be kept down to the minimum, and it is my judgment that in most plants the annual average manufacturing cost per barrel of cement will be no greater under the six days schedule, than under the seven days plan with the winter shut-down expenses added.

In suggesting such a radical change in existing practice, I do not for one moment expect that the manufacturers will accept my conclusions without question, and all that I ask is, in fact, I urge it to the utmost, that every manufacturer will try this experiment for himself. If he does not care to try on all his kilns at first, let him try it on one and watch the results carefully. There are two facts, however, which should be remembered, and the first is that all men are largely creatures of habit and nearly all of us object to changing existing conditions of long standing, and if the first test is not fully satisfactory, try it the second and third time, and I fully believe the same results can be obtained generally as have been accomplished at the Edison plant. The second fact is, that in every plant individual kilns are shut down for changes and repairs and the heat taken off from time to time, and when these repairs are completed the heat is put on and the kiln produces clinker same as before. All I am suggesting is that you shut down all your kilns at a regular time every week, instead of individual kilns at irregular times.

If this plan were adopted by all the plants, I believe it would solve the problem of over capacity, give continuous work to our employees, who would be more efficient and better satisfied, less capital would be tied up in large stocks of cement, and probably better average selling prices could be obtained. Surely such a condition is much to be desired, so that I again urge you all to very carefully consider this suggestion and to try it out.

## THE UTILIZATION OF CONCRETE ON DIFFICULT REPAIR WORK.

In designing the additions and the reconstruction of the Monterey Plant of the Janesville Electric Co., of Janesville, Wis., Messrs. D. C. & W. B. Jackson found it necessary to tear out an old stone flume and penstock and replace same with concrete. The adaptability of concrete for repair work of this sort is well illustrated on this job, as to replace the old stone flume with another one of masonry would have been almost as expensive as the building of an entirely new plant, whereas, the pliability of concrete rendered it possible to make the necessary repairs at a reasonable expense.

The old stone flume had been in service some fifteen years. It is 97 feet long from the penstock gates to the bulkhead wall and 54 feet wide between the side walls. The most interesting feature of the work was the rebuilding of the bulkhead wall. This was originally about three feet thick and carried a portion of the exterior wall of the old mill, which is a two-storey brick building of heavy mill construction. This wall had been worn down until it was hardly more than 6 inches thick at some places. It was found to be necessary to tear out the old wall entirely and replace it with a reinforced concrete bulkhead.

It was decided to tear down the entire outside wall of the brick mill, which was supported by the stone bulkhead wall, and to rebuild it on the new reinforced concrete bulkhead. It was necessary, however, to make provision to support the floors and roof of this side of the mill while this repair work was going on. This was accomplished by inserting a heavy I-beam on top of each one of the stone division walls which extended from the penstock gates to within 7 feet of the bulkhead wall. These I-beams acted as cantilevers, the inner end being firmly braced between the stone division and the girders above.

The new bulkhead wall was designed of reinforced concrete with four buttresses on the outside which would take the place of iron tie-rods, which formerly anchored the stone bulkhead wall to the division walls between the wheel outlets. A sheet pile coffer dam was constructed around the discharge pits to give an opportunity for pumping them out and it was made of sufficient size to give room to install the new construction. A guyed derrick mounted on a scow was used to handle the stone removed from the building wall, which was deposited to form a breakwater in such a manner as to protect the plant from the current of the river and to give a slight ejector effect and thus increase the head acting upon the water wheels.

The old bulkhead wall rested upon a stone apron extending the full length of the wall and it was found upon pumping out the coffer dam that it was in a good state of preservation. It was, however, too narrow to satisfactorily support the buttresses for the new construction, so it was decided to extend the apron out a distance of two feet and at points where the buttresses were located. to carry this concrete apron out a distance of 11 feet from the face of the new concrete wall.

Gravel for the concrete was obtained from a nearby pit and a mixture of one part cement to five parts gravel, run of the bank, was used for the work throughout. The concrete wall. is 2 feet thick and extends the total width of the flume or 54 feet. It is supported from beneath by the iron supports formerly used for the stone wall and is prevented from overturning by four buttresses each 18 inches thick. The concrete wall and buttresses are steel reinforced.

At each end of the bulkhead wall the old stone walls forming the sides of the flume were removed for a distance of a couple of feet behind the line of the bulkhead wall and where the concrete was to come into contact with them they were thoroughly washed down and cleaned with a wire brush before the concrete was placed. This gave a good binding contact between the concrete and stone.

This work of reconstruction is noteworthy, on account of the fact that the large bulkhead wall of an old stone flume which had been supported by tie-rods and which carried a building of no mean size and weight was removed and a concrete bulkhead wall supported by buttresses installed in its place, the remainder of the old construction being preserved. This combination gives a hydraulic installation at comparatively small cost, which is as satisfactory as though the entire flume had been built new.

This reconstruction work was entirely planned by and carried out under the supervision of D. C. & W. B. Jackson, Engineers, of Boston Mass., and Chicago, Ill.

## THE ECONOMY OF THE PREVENTION OF CONVEYANCE LOSSES OF IRRIGATION WATER*

### And the Use of Concrete for the Economical Construction of Irrigation Structures

**By Professor Etcheverry, of the University of California.**

It was with great pleasure that I accepted the invitation to come from California to present a paper to this body. I have selected for discussion topics which I believe are of general interest to those engaged in irrigation work. In the first part of my paper I shall discuss "Seepage and evaporation losses in the conveyance of water, and their prevention."

All irrigators are well acquainted with the fact that the losses in conveying water in earth canals are in many cases very large, and with newly excavated canals are often so great that it is difficult to deliver any water at the lower end. The water lost by seepage disappears through some underground channel below. or raises the water table of the lands adjacent to and below the canal. This causes either the waterlogging of the land or the accumulation of alkali salts on the surface. This effect. combined with wasteful irrigation. has been the cause of over 10 per cent. of the irrigated lands of the West becoming unfit for crop production. These damages alone, in many cases, justify the expense of lining the canals. This was forcibly brought to my attention on a private project which I visited in the Yakima Valley in Eastern Washington. Although it had been in operation only one season, a large percentage of the land had become waterlogged. To remedy this several miles of concrete lining and the improvement of drainage were recommended. The lining has recently been constructed. and will, no doubt, prevent the waterlogging to a large extent

But even if these damages to the land are neglected, there are many localities where water is sufficiently valuable to make the lining of canals to prevent the loss of water a paying business. The amount of money which one is justified in spending will be in proportion to the extent of the losses, which depends on local conditions, such as porosity of the soil, the size of the canal, the number of seasons the canal has been operated, the amount of silt in the water, the velocity of flow, the form of cross-section. the depth of water table, etc.

The most valuable general observations as regards the amount of these losses are those of the Irrigation Investigations Bureau of the United States Department of Agriculture. From series of measurements on seventy-three ditches in the Western States, they have found that the average loss per mile of ditch is 5.77 per cent. of the entire flow; the measurements range from a maximum of 64 per cent. per mile to a slight gain in a few cases. Large canals in general lose less in proportion than small ones. The measurements show that the loss per mile averages about 1 per cent. for canals carrying 100 cubic feet per second or more; about 2½ per cent. for canals carrying 50 to 100 cubic feet per second; 4¼ per cent. for canals carrying 25 to 50 cubic feet per second, and 11¼ per cent. for canals carrying less than 25 cubic feet per second.

These losses include seepage and evaporation, but, contrary to the general belief, the losses of evaporation are insignificant compared with those of seepage. An unusually large rate of evaporation is half an inch a day. and is only reached occasionally. In the San Joaquin Valley, in California, the mean evaporation measured for the hottest month was .37 of an inch in 24 hours. Seepage losses are usually greater than 1 foot in depth per 24 hours, and usually average not less than 2 feet. These losses are 25 to 50 times the maximum evaporation of half an inch per day. A good illustration is obtained from measurements and computations made on one of the largest systems in the San Joaquin Valley. The total length of canals is 165 miles; the average evaporation loss was .9 of 1 per cent. of the flow diverted, while the total seepage losses were 28 per cent., or 30 times greater than the evaporation losses. These and other numerous experiments show the evaporation losses in the conveyance of water to be so small as compared with the seepage losses that they are of no importance.

To prevent the losses of water in conveyance, lining the canals with different kinds of materials has been tried. The materials used or experimented with are concrete, wood, asphalt oils, and clay puddle.

A good lining should fulfil the following requirements: It should be watertight, prevent the growth of weeds, stop burrowing animals, be strong and durable, and not affected by frost or the tramping of cattle. A few years ago I had the opportunity to investigate for the Government the different types of canal linings in California, and to make experiments to determine their water-tightness. From these and from more recent experiments I believe the following results can be anticipated:—

First, a good oil lining, constructed with heavy asphalt road oil, applied on the ditch sides and bed at the rate of about 3 gallons per square yard, will stop 50 to 60 per cent. of the seepage. A well-constructed clay puddle lining is as efficient as a good oil lining. A thin cement mortar lining

(Continued on Page 773.)

* Read before the Fourth Annual Convention of the Western Canada Irrigation Association, Kamloops, B.C.

# ROADS AND PAVEMENTS

## THE BENEFIT OF GOOD COUNTY ROADS TO CITY DWELLERS.

The keen interest felt by the business men of Toronto in the question of good roads was manifested in the rapt attention with which they listened to the address given at the Board of Trade Luncheon, Dec. 14th, by Mr. George C. Diehl, of Buffalo, County Engineer of Erie County, New York State.

The building of good roads, said Mr. Diehl, is a purely business affair. He pointed out how the improving of all roads, whether railroads, waterways or highways, tends to the assistance of all good causes and to the restraint or checking of evil things. They facilitate the schools in their work of teaching, the churches in their influence over the morals of the community and the constabulary in keeping order, and they lessen the cost of living. The great interest in the subject was indicated by the holding of an international congress recently at Brussels, attended by 2,600 delegates, representing more than thirty countries.

**The Old Way.**

Until twelve or fifteen years ago the question of improving county roads was left to the township or local municipalities, the work being done under the statute labor system, a relic of the old English feudal law. On the principle that the taxes, no matter for what, should be borne by the people and property to be benefited, so as the cities benefit greatly from the improvement of highways in the territory around their borders they should bear a fair, just and equitable portion of the expense. The way for the business men of Toronto to help themselves in their individual businesses, he said, was by helping the city of Toronto.

The rural communities cannot, of course, bear all the cost of bettering their roads, and the city man, who has a frontage of only perhaps thirty feet, ought to share in the expense of road improvement which will benefit him equally with the rural man who may have half a mile of frontage.

Thirty-two States, said Mr. Diehl, have adopted a form of State aid law. New York has expended to date $26,000,000, and proposes to spend $24,000,000 more, having made a new appropriation to that amount. When that is all gone the State intends to put $50,000,000 more into highway improvement. The cities bear ninety per cent. of the whole cost. Pennsylvania has spent $25,000,000 and proposes to expend as much more. New Jersey has spent $20,000,000; Massachusetts, $15,000,000; so on with Connecticut, Ohio, and others, which have spent many millions and intend to lay out many millions more on their roads. The Southern and Pacific coast States work under a county-aid system. Los Angeles county has spent $3,000,000. Minnesota has adopted a tax of $1 per thousand for this purpose.

**What Erie is Doing.**

The county of Erie has expended to date on roads around the city of Buffalo $2,000,000, and Buffalo itself has spent $700,000; the county proposes to spend $3,000,000 more, to which the city will contribute $1,000,000, making the total expenditure by the city of Buffalo one and three-quarter millions.

The construction of roads leading to and from Toronto, said the speaker, meant increased business. If the main radial roads were built, farm products carried to the city would more than quadruple in volume and tonnage. In New York State the average yield of garden truck raised in the neighborhood of Buffalo, which had been one ton per acre before the roads were improved, had increased to ten tons an acre after they were improved.

Mr. Diehl argued that from the 50,000 acres around Toronto, a tract eight miles by ten, there would be a saving by improved roads of twenty cents per ton per mile haul, which would mean $100,000 a year saving, as much every year as the city is now being asked to expend for this matter. And that saving would not all go to the farmer, but half of it would be for the benefit of the city. The working man would draw out the money the city would put in, nothing would be sent away, the stone would be broken and the labor performed by local people. It was up to the business men to advocate this proposition, but it would be carried not by their votes alone, but by those of the people. The average ordinary man would be in favor of this expenditure on the roads when he saw that it would reduce his cost of living and conduce to his prosperity.

**Money Well Spent.**

Before any improvement was made, said Mr. Diehl, the people would naturally want to be assured that the money would be wisely expended under a proper plan. He assured his hearers that they might fully expect the best results from the county road system, which would be prepared or approved by the Provincial Engineer of Highways, Mr. W. A. McLean, who had an enviable reputation among highway engineers in the United States, where he had recently addressed their convention in Minneapolis.

## STREET LIGHTING AND ELECTRIC LAMPS.*

**By Haydn T. Harrison.**

After recounting the circumstances which led to the adoption in the streets of Marylebone of tungsten lamps in place of gas lighting, the author said that in the case of arc lighting it was difficult to arrange for the arc when erected on posts to be higher than 25-ft. from the ground, and the distance between them was rarely less than 150-ft., and was sometimes as much as 300-ft.; therefore the light rays which reached the point of minimum illumination were those which emanated at 10 deg. to 17 deg. from the horizontal. Some tests which he had lately conducted in Oxford street, Oxford circus, and Regent street proved these rays to be of the following candle-power:—10-ampere Union flame arc lamp, opalescent globe, 10 deg. to 15 deg., 1,100 to 1,200 c.p.; 10-ampere Union flame arc lamp, dioptric and opalescent globe, 10 deg. to 15 deg., 1,750 to 1,800 c.p.; and 12-ampere Union flame arc lamp, dioptric and clear globe, 10 deg. to 15 deg., 3,700 to 4,400 c.p. This indicated the advance that one firm—namely, Koerting and Matheson—had made in the introduction of the dioptric globe; for example, if these dioptric globes were used the increased illumination was 60 per cent., without appreciably increasing the cost of maintenance. If a clear outer globe were used the illumination was more than doubled. Messrs. Crompton, with the Crompton-Blondel lamp, and the Jandus Arc Lamp Company, with their regenerative flame lamp, had both made great progress in this direction. In connection

*Abridged from a paper read before the Institute of Electrical Engineers of Great Britain.

with high candle-power units of light, the relative results obtained by the use of high-pressure gas lamps were of interest. Tests made by Professor J. T. Morris, of the East London College, indicated that the candle-power of a high-pressure gas lamp varied 50 per cent., depending on the quality and pressure of the gas. His figures showed that from 30 to 34 c.p. per cu. ft. of gas consumed hourly was an average result when working at a pressure of 4-in. of mercury. As the author's tests corroborated this, he would take as an example a nominal 1,500 c.p. Keith lamp, which gave on test between 720 and 780 c.p. with a consumption of 23 cu. ft. hourly. This, when compared with a flame arc lamp giving 5 c.p. per watt at 1d. a unit, would have to be supplied with gas at 7d. per 1,000 cu. ft. in order to produce the same light for an equal cost, and thus it was obvious that even high-pressure gas lamps did not compare favorably in cost with the high candle-power electric arc lamps, which embodied the improvements of the last few years. With the exception of very important streets, the tungsten lamp would give a better result at lower cost than the ordinary open type of arc lamps; but, of course, where the arc lamp had been used in the past, and the question of improving the illumination and of reducing the cost was under consideration, it would be unwise to incur fresh capital charges by replacing the existing arc lamps with a large number of small posts and fittings. At Croydon the borough electrical engineer, realizing that certain classes of road were not of sufficient importance to require that higher degree of illumination obtainable by the use of flame arc lamps, decided to try the experiment of using groups of tungsten lamps contained in one lantern fixed as high as possible from the ground. The improvement in the evenness of the illumination was very noticeable, and the new form of lighting was generally approved. It was found that a group of three 100-watt Osram lamps contained in a suitably designed and constructed lantern, when erected 20-ft. to 23-ft. above the ground, gave a much better minimum and much more even illumination than the arc lamps, with the result that nearly ten miles of road had been converted to this system of lighting. At Harrogate the engineer had replaced the arc lamps by four 100 c.p. tungsten lamps, arranged on spreading arms at a considerable height, the result being excellent both as regards illumination and appearance; the lamps were used without globes, but were provided with prismatic reflectors. It was important that the reflectors should be designed with the object of reducing the effect of "glare." There were many ways of reducing the deleterious effect of high intrinsic brilliancy of light sources, without interfering with the efficiency of the light In Marylebone, for instance, it was done by wedge-shaped white surfaces above the lamps, which were brought down as near the filament of light source as possible. A very ingenious method had lately been invented by Mr. Pragnall, based on the principle that nearly all light sources covered an appreciable area; thus by fixing thin sheets of metal, having white surfaces, adjacent and radially to the light source, it was seen in the midst of an illuminated white surface, and not against the dark sky or distant surroundings, while at the same time practically no light was lost owing to the surfaces being thin and radial to the lamp. Some very interesting work had lately been carried out in the city of Westminster in connection with street lighting by gas, and as at the same time of writing the lighting of Victoria street had been completed, the author had had an opportunity of measuring the illumination and judging the effect of what might be taken as the most modern form of gas lighting. The specification relating to candle-power, under which the electric light and gas companies tendered, read as follows:—"The candle-power shall be arrived at by taking the average of two sets of readings in any position with regard to the light under test—one set at an angle of 20 deg., and a second set at an angle of 50 deg. to the horizontal." It would be noted that there was no statement that the 20 deg. ray should bear any definite ratio to the 50 deg. ray. As it was, the high-pressure gas lamps installed gave about 1.5 times more candle-power on the 20 deg. ray than on the 50 deg. ray, which was, of course, a ratio in the right direction, but not sufficiently so to prevent the illumination adjacent to the post from being 20 times that of the minimum illumination, whereas with the small gas units displaced it was only 16 times as great, and if the height of the small units had been that of the present units it would only have been twice as great, which would have come under the head of even illumination. The units of light according to the specification were to be 90 c.p., 180 c.p., 300 c.p., 1,800 c.p., 3,000 c.p., for which the accepted gas company's tender worked out at £2 16s. 6d., £4 10s., £6 10s., £15 10s., and £22 per annum respectively. Of these the 1,800 c.p. unit fixed 20-ft. high was selected.

The cost of public lighting by electricity naturally depended on three factors—(1) cost of electrical energy; (2) cost of lamp maintenance (lamps or carbons burning, cleaning, lighting, repairs, &c.); and (3) capital charges and repayment of same. Item (1) would apply to every type of electric lamp in proportion to the energy it took, and as opinions varied as to the right charge to make for electrical energy when used in public lamps, the author proposed to consider this item from a consumer's point of view, arguing that it could make no difference to an electricity supply authority for what purpose it supplied the energy, excepting only that in the case of street lighting a certain amount of credit should be given on account of the advertisement. All-night street lighting had a load factor of 40 per cent. It was true that it overlapped the peak of the ordinary lighting load, but, on the other hand, it helped to fill up the depression which occurred in the load curve of nearly every station between midnight and sunrise; therefore, as a consumer, it had more value than a power load consisting of motors used during ordinary factory hours. On this score alone it should rank as better than a motor load, and should be charged less, in which case the large number of electricity undertakings which were supplying power at 1d. a unit for motors could well afford to supply the public lighting at less than that rate. It was very rare that the big supply companies or large municipal undertakings asked more than that sum, which they found paid them, as it resulted in a profit on their generating costs and also covered the cost of repayment of capital in services, &c. The latter should be spread over at least ten years, for there was little doubt that when once the electricity department had obtained the street lighting it would retain it. Treating the street lamps as an ordinary consumer, a remunerative price per unit might be taken as 1d. for large undertakings and 1.5d. for small undertakings, including, as in the case of consumers, the cost of service to the ordinary distributors, but not of fittings, &c., which would come under the same heading as the consumer's wiring and fittings, which were part of the installation. It would be noted that even with this rate of charge the revenue per 60-watt lamp was nearly eight times the average revenue derived from lamps installed in consumers' premises. The total cost of candle-power per annum, exclusive of capital charges, but inclusive of renewals, lighting, extinguishing, carbons, trimming, and current taken at 1d. a unit, was:—

| Candle-power of Light Unit. | Cost per Candle-power per annum (total). Naked Lamp. d. | Cost per Candle-power per annum in Special Lantern. d. |
|---|---|---|
| 50 tungsten | 10.50 | 7.0 |
| 100 " | 8.20 | 5.0 |
| 200 " | 7.00 | 4.3 |
| 300 " | 6.66 | 4.1 |
| 400 " | 6.50 | 3.8 |
| 500 " | 6.40 | 3.5 |
| 300 open arc | 10.20 | — |
| 1,000 flame arc | 3.65 | — |
| 3,000 flame arc (dioptric and clear outer) | 1.32 | — |
| 2,000 to 4,000 regenerative flame | 1.0 to 0.8 | — |

In order to obtain even illumination, the lamps should be placed as high as possible; for instance, if the lamps in Baker street had been 20-ft. high the minimum horizontal illumination on the ground would have been 0.11 c.p. instead of 0.08, or an increase of nearly 50 per cent., but the author doubted whether the lighting committee or the public would agree that the illumination of the street had been improved by that amount, and he was certain that there would be no hesitation in their choice between increasing the height of the lamps 8-ft. and increasing the candle-power 50 per cent., provided the increased candle-power cost no more. This demonstrated clearly one of the objections to horizontal illumination as the gauge of street lighting. It was so important that the difference between the maximum and minimum illumination at any point of a street should be as small as possible, that it was gratifying to note the comparatively low candle-power when measured near the vertical of the tungsten and modern arc lamps, especially when the former were in correctly designed lanterns. For example, maximum illumination with the inclined carbon flame lamps was as high as 10 cu. ft. in Oxford street, with a minimum of 0.11 cu. ft., or a diversity factor of 90. In Baker street the maximum illumination on the ground was 0.5 cu. ft., with a minimum of 0.08, a diversity factor of only 6. Again, in Regent street, where Excello lamps with dioptric globes were in use, the maximum illumination did not exceed 3 cu. ft., the minimum being 0.23 cu. ft., or a diversity factor of 13. The average man who was asked to compare brilliant and powerful lamps with the less brilliant but increased number of light sources would generally vote in favor of the powerful light, regardless of the result; but the fact that the Marylebone lighting had given satisfaction to all concerned did prove that in the long run even illumination was appreciated. The eyesight of the present generation was suffering from the indiscriminate use of large glaring light units, unsuitably placed. Therefore it was important that those who were called upon to illuminate streets, where the minimum illumination could not exceed 0.1 of a candle-foot, should not be tempted to accentuate this low figure by producing a few patches of bright light. It was noticeable that in the past the small-light units derived from gas had been more economical for outdoor lighting than those produced by electricity. The reverse was now the case; therefore electrical engineers should be able to compete favorably, considering that the light they were able to supply was constant, capable of correct distribution, and easily manipulated.

## THE ECONOMY OF THE PREVENTION OF CONVEYANCE LOSSES OF IRRIGATION WATER.

(Continued from Page 770.)

about 1 inch thick, made of 1 part cement and 4 of sand, will prevent about 75 per cent. of the seepage. A first-class concrete lining 3 inches thick, made of 1 part of cement to 2 of sand and 4 of gravel will stop 95 per cent. of the seepage. A wooden lining when new is as efficient as a concrete lining, but after two or three years repairs and maintenance will become an important item, and by the end of eight or ten years it will require complete renewal.

The cost of an oil lining where oil can be bought at California prices is about 1.2 cents per square foot. Cement mortar lining 1 inch thick costs about 3 to 4 cents a square foot. Cement concrete 2 inches thick costs about 6 cents, and 3 inches thick about 8 cents a square foot. The cost of clay lining depends greatly on the nearness of the canal to suitable clay. If clay is close at hand it can be hauled and spread on the canal, then either tramped in by cattle or worked in by dragging chains over it, at a cost of less than 1 cent a square foot; but there are many localities where I have seen enough money spent on clay linings to put in a good concrete lining. Wooden lining has been used in a very few cases, and the cost of such a lining built of 2-inch lumber nailed on sills and side yokes will not be less than that of a 2-inch concrete lining, and not nearly as durable.

The disadvantages of the cheaper linings are the following: An oil lining stops only a fraction of the seepage losses, and, while it will resist erosion well, it probably will not prevent the growth of weeds for more than one season unless a high velocity is used, and it will not stop the burrowing of gophers. Another objection is that suitable oil is often hard to obtain at a reasonable price. Oil linings have not been sufficiently tested to determine their durability. To my knowledge, the only examples are two canals and one reservoir in the San Joaquin Valley of California and two reservoirs in Los Angeles. Clay puddle will not prevent the burrowing of gophers, and weeds grow rapidly, especially since the velocity of flow must be small in order not to erode the lining.

A concrete lining has none of the above disadvantages, and it meets the requirements of a good lining better than any other material. The only objection is its higher first cost. This, however, can be partly balanced where a new canal is to be constructed by using a higher velocity and smaller cross-section.

The earliest use of concrete linings was in Southern California about 1880, when the increasing value of water made it necessary to do away with losses. Since that time practically all of their canals, which are comparatively small, carrying usually less than 100 cubic feet per second, have been lined with concrete, and in some cases replaced by concrete pipes. Until recently very little concrete lining has been done outside of that region; but during the last few years concrete-lined canals have been constructed on many of the projects of the United States Reclamation Service and on numerous private projects. As examples: The Modesto System in California has lined portions of its main canal, 64 feet wide at the top and 5½ feet deep, with concrete lining 2½ inches thick. The Lower Yakima Irrigation Company, of Eastern Washington, has completed seven miles of concrete lining. The Burbank Power and Irrigation Company, also of Eastern Washington, has recently constructed one mile of concrete lining. There are also numerous examples in California, Oregon, Nevada, Idaho and other States.

While there are many ways of building the concrete linings, they are generally constructed according to two methods. The first method is used where the side slopes of the ditch are flatter than 1 to 1; the second method is used for steeper side slopes.

To construct linings according to the first method the canal is trimmed ready to receive the lining; then the mortar or concrete is spread on the sides and bottom and plastered on in a manner similar to sidewalk work. To obtain the right thickness guide-strips are used. The thickness ranges from three-quarters of an inch up to 3 or 4 inches.

To construct the lining according to the second method, the canal is first trimmed, then the wooden form for the side lining is placed in position and the concrete mixture poured or thrown in the space between the form and the sides of the earth ditch. For canals less than 10 feet at the top, usually the form is a wooden trough made of the same cross-section as the finished concrete-lined ditch. The thickness of lining is usually from 2 to 6 inches.

The very thin linings of 1 inch or less have been used extensively on many systems of Southern California, and have been very satisfactory. As an instance, the Gage Canal has been lined with three-quarters of an inch of cement mortar for almost its entire length of twenty miles. After ten years of use, during the last four years of which water was run continuously, giving no opportunity for repairs, the total cost to repair thoroughly all sections was for these four years less than half of 1 per cent. There is no doubt in my mind that such thin linings, while helpful, are not strong enough to be satisfactory, especially where the extremes in temperature are as great as in the North-West. There is only one example, to my knowledge, of a thin lining built in a region where the ground freezes. That one is in Eastern Washington, where four miles of canal were lined with a lining varying from ½ to 1½ inch thick. When I examined the lining I found it rather badly cracked; but, because of poor workmanship, it was impossible to state how much of the cracking was due to frost. Although this lining was not, in my opinion, very satisfactory, it was nevertheless helpful in preventing seepage losses, for before its construction it was impossible to carry water over this stretch without losing most of it.

As a guide for the proper thickness for concrete linings in the North-West, I would recommend usually not less than 2 inches for small canals, and preferably 3 inches. There are many localities where 3-inch concrete linings have been used with entire success, even where subject to frost. No matter what the thickness is, unless the concrete is reinforced with steel, or expansion joints provided, cracks are to be expected. These will usually be fine cracks occurring at more or less regular intervals, and the leakage through them will be small, the cracks often silting up. For better appearance, and also to distribute the cracks at uniform intervals, the lining should be laid in sections 6 to 8 feet long.

To decide intelligently what canals should be lined with concrete, and to know what expenditure is justifiable, it is necessary to know the extent of the seepage losses and the value of the water which is lost, also the damage done by seepage water. If the value of the water only is considered, then one is justified in expending, for the improvement of the canals by lining, a capital whose interest added to the depreciation is equal to the annual value of the water loss. Accompanying benefits are the prevention of land waterlogging, the minimum danger of breaks and the prevention of damages to crops, because of interruption in flow. As an instance, if a canal carrying 100 cubic feet per second loses 1 per cent. per mile by seepage, the water lost in one irrigation season of five months is 300 acre feet per mile of canal. This water represents a value of $450 on a basis of $1.50 an acre foot. To save this water we would be justified in spending a sum whose interest added to the depreciation is equal to the above sum. As depreciation on a good concrete lining and interest would not exceed 7 per cent., the value of the water lost would represent an investment of $6,400 per mile. Since a 3-inch concrete lining for an average canal cross-section of this size, assuming a velocity of flow of 3 feet per second, could be constructed for $6,000 per mile, the above sum is more than sufficient.

The assumed seepage loss of 1 per cent. is often exceeded with small canals, and on most irrigation systems there are always some sections of canals which would warrant concrete lining. With the increasing price of water, and with the development of water by storage and pumping, which is most always expensive, I believe the time will soon come when many of our irrigation canals will be concrete-lined.

Concrete pipes for the conveyance of water, where the quantity of water is not large, have some advantages over canals. They do away with the road crossings which are necessary with canals; they do not occupy any land which is wasted, and they do not collect the dirt and rubbish that fall in open canals. They can also be used under light pressures, and take the place of canals all-in-fill or flumes on low trestles. The argument that they also prevent evaporation has not much weight, for we have seen that the losses due to evaporation are negligible. These advantages have led to the use of concrete pipes up to sizes of 3 or 4 feet in preference to concrete-lined canals. This is the case with many of the canals and laterals of many of the irrigation companies of Southern California. For large quantities of water the cost of concrete pipes is prohibitive.

Concrete pipes are especially valuable for the conveyance of small quantities of water over rough lands, but the largest use of them is for the smaller laterals of the irrigators. In Southern California hundreds of miles of cement pipe have been used for the distribution systems to prevent the losses in conveyance, to facilitate the distribution of water, and to prevent waste in its application to the land.

The measurements of the United States Irrigation Investigations Bureau show that the losses in conveyance are much greater for small ditches than for large canals. For this reason the largest losses are often in the ditches of the irrigator after he takes the water from the canals of the company. Other important losses are in the spreading of the water on the land.

I shall not discuss the different methods of application to the land, but will confine myself to furrow irrigation and show the economy of the use of concrete pipe distribution systems over older methods. I do not intend to infer that it is the only method of irrigation to which pipe systems are adapted, for where water has to be handled in small heads, as in Southern California, it is equally well adapted to alfalfa and other crops.

Where furrow irrigation is practised, the crude method, which has been largely abandoned in Southern California, is effected by means of an earthen ditch located along the higher boundary of the farm, which carries the water to the upper end of the furrows, where an equal division between furrows is attempted through openings in one bank of the ditch, or through iron or wooden spouts. This method requires constant attention, and a uniform distribution is impossible. For this reason in many localities the earthen head ditch has been replaced by wooden flumes with one opening in the side of the flume for each furrow; the

(Continued on Page 776.)

# The Canadian Engineer

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## CONTENTS OF THIS ISSUE.


**Editorial:**
- Iron and Steel Output ...... 775
- Misleading Advertisement ...... 776

**Leading Articles:**
- Public Regulation of Service Companies ...... 761
- Types of Wells ...... 762
- Concrete and Fire Losses ...... 767
- Production of Cement ...... 768
- Concrete on Repair Work ...... 769
- Economy of Irrigation Water ...... 770
- Benefit of Country Roads ...... 771
- Street Lighting ...... 771
- Cost of Pumping ...... 781
- Cleaning Streets ...... 782
- Construction Materials ...... 786

**Sanitary Review:**
- Testing Sewer Joints ...... 779
- Hypochlorite Treatment ...... 780

Engineers' Library ...... 788
Railway Orders ...... 787
Construction News ...... 52
Market Conditions ...... 60


## IRON AND STEEL OUTPUT IN CANADA DURING 1909.

It is very unfortunate that the interesting pamphlet by John McLeish, B.A., of the Department of Mines, on the "Iron and Steel Output of 1909" has been so long delayed. During the last month of 1910 we learn of the state of the industry during 1909. Late as the report is, yet it contains much important information.

The iron and steel industry in Canada in 1909 shows a very satisfactory and steady growth as compared with previous years.

There was a larger production of iron ore than in 1908; an increased output of pig iron from Canadian blast furnaces and a larger production of steel ingots and castings; while the imports of pig iron and of iron and steel goods more or less highly manufactured were greatly diminished.

About 17 per cent. only of the iron ore used in Canadian furnaces during 1909 was of domestic origin. Much of the coke and limestone was also imported, so that our iron industries are now, and have been for a number of years, largely dependent on imported raw materials.

The total production of iron ore in Canada to the end of 1909 has probably only slightly exceeded 5,000,000 tons, while our present rate of production varies from 300,000 to 400,000 tons per annum.

Developments are in progress, however, which may in the near future furnish a much larger supply of domestic ore. Active operations are in progress at Torbrook, N.S., and extensive preparations being made to ship from the large magnetite deposits near Bathurst, N.B. The Moose Mountain mine, north of Sudbury, of which much has been expected, shipped an important tonnage during 1909, and development work is being continued. Operations have been started on a deposit twenty-four miles east of Port Arthur, the first in this district, and some initial shipments made. A magnetometric survey was made of the old Bristol mine, Pontiac county, Quebec, by an officer of the Mines Branch, resulting in the discovery of the probable existence of a considerable ore body apparently not previously known.

The production of pig iron and steel is still confined to the eastern half of Canada, chiefly in the Provinces of Ontario and Nova Scotia. There are sixteen completed blast furnaces, with a total daily capacity of about 2,735 tons. Of the sixteen, twelve have a daily capacity of 100 tons or over. The production of pig iron and steel in 1909 was the highest year's production yet turned out by Canadian furnaces. The bounty which has been paid on iron and steel production ceases at the end of 1910, although provision is still made for the payment of bounty on pig iron produced by electric process to the end of 1912.

**Statistical Summary of Iron Ore and Iron and Steel Production, 1908-9.**

| Material. | 1908. Short tons. | 1909. Short tons. |
|---|---|---|
| Iron ore shipped .......... | 238,082 | 268,043 |
| Canadian iron ore charged to furnaces .......... | 209,266 | 257,502 |
| Imported iron ore charged to furnaces .......... | 1,051,445 | 1,235,000 |
| Pig iron made .......... | 630,835 | 757,162 |
| Steel ingots and castings made .......... | 588,763 | 754,719 |
| Finished rolled iron and steel products made (a)........ | 566,099 | ....... |

| | | |
|---|---|---|
| Canadian coke charged to iron furnaces ............ | 492,076 | 412,016 |
| Imported coke charged to iron furnaces ............ | 325,670 | 507,255 |
| Pig iron imported .......... | (c) 212,290 | (c) 58,591 |
| Iron and steel goods imported | (c) 866,710 | (c) 487,003 |

(a) Statistics collected and published by American Iron and Steel Association

(c) Twelve months ending March. (The figures given do not show the total quantities of iron and steel goods imported, as in many cases the quantities are not given in the trade returns.)

The total shipments of iron ore from mines in Canada in 1909 were 268,043 tons, valued at $659,316 at the shipping point, as compared with 238,082 tons, valued at $568,189, in 1908, and 312,856 tons, valued at $666,941, in 1907. By provinces, the production during the past three years was as follows:—

During the past fourteen years the iron smelting industry in Canada has had to draw more and more upon imported supplies of iron ore, a large portion of these supplies being, however, derived from Newfoundland, which should hardly be looked upon as a foreign source, though for purposes of commerce it has to be so considered.

The total consumption of iron ore in Canadian furnaces in 1909 was 1,492,502 short tons, made up of 257,502 tons of Canadian ore and 1,235,000 tons of imported ore. The Canadian production was, therefore, only about 17 per cent. of our requirements. Previous to 1896 the furnaces were supplied altogether by Canadian ores.

The quantities of Canadian and imported ores annually charged to blast furnaces since 1887 are shown. The Department of Customs does not separately publish statistics of iron ore imports.

Since the opening of the Helen mine at Michipicoten, and more recently the Moose Mountain mine in Hutton township, considerable quantities of iron ore have been exported to the United States. The statistics of exports for both calendar and fiscal years are shown in the statistics for the fiscal year having been added, to compare with the record of imports of iron ore into the United States from Canada, as published in the "Foreign Commerce and Navigation of the United States, Washington, D.C." It so happened that from 1901 to 1906 the figures in the Canadian reports were inaccurate, owing to reasons explained in footnotes to the tables.

The total production of pig iron in Canadian furnaces in 1909 was 757,162 short tons (676,038 long tons), valued at the furnace at $9,581,864, as compared with 630,835 short tons (563,246 long tons), valued at $8,111,194, in 1908. An increased production is, therefore, shown of 126,327 tons, or about 20 per cent., and this despite the fact that the Londonderry furnace was out of commission during the whole year. These figures do not include the output from electric furnaces, making ferro-products, which are situated at Welland and Sault Ste. Marie, Ont., and Buckingham, Que.

Of the total output of pig iron during 1909, 17,003 tons, valued at $371,368, or $21.84 per ton, were made with charcoal as fuel, and 740,159 tons, valued at $9,210,496, or $12.44 per ton, with coke. The amount of charcoal iron made in 1908 was 6,709 tons, and iron made with coke, 624,126 tons.

The classification of the production in 1909, according to the purpose for which it was intended, was as follows: Bessemer, 222,931 tons; basic, 400,921 tons; foundry, including miscellaneous, 116,307 tons.

The American Iron and Steel Association reported the production of Bessemer pig iron in 1908 as 126,348 short tons, as against 173,499 tons in 1907, and the production of basic pig iron in 1908 as 375,659 short tons, as against 382,208 tons in 1907.

The total production of pig iron in 1908 and 1909 is shown by provinces in the following table, the average value per ton being also indicated. In the case of Nova Scotia, a large proportion of the pig iron is directly converted to steel. A nominal value is placed upon this, and does not necessarily represent a market value. The Quebec production is entirely charcoal iron which has for many years commanded a high price.

## MISLEADING ADVERTISEMENT.

Canada's great development is leading more American manufacturers to investigate the Canadian market. Recently a tool company of Buffalo, N.Y., secured concessions at Woodstock, Ont., and is erecting a factory there, according to an advertisement which appeared in a recent issue of the Toronto "Globe." The advertisement suggests that this will be the only company manufacturing pneumatic hammers in Canada. This advertisement conveys an entirely erroneous impression, as for several years the Imperial Pneumatic Tool Company, of Sherbrooke, Que., has manufactured a complete line of pneumatic hammers in their entirety, and has now in operation a thoroughly up-to-date plant for manufacturing these tools. The entire output of this efficient plant is distributed by the Canadian Rand Company, Limited, whose head office is in Montreal.

## THE ECONOMY OF THE PREVENTION OF CONVEYANCE LOSSES OF IRRIGATION WATER.

(Continued from Page 774.)

openings are regulated by slides or plugs. In Southern California the short life of wooden distributing flumes and their leakage have led to the use of concrete flumes. These flumes are constructed by means of a specially-designed machine, or by means of wooden or metal moulds. In the side of the flume are cemented galvanized iron spouts, one for each furrow, and the flow is regulated by iron slides. These small flumes cost about twice as much as a wooden flume, but their durability will more than offset the greater first cost.

The distribution of water in flumes over rolling ground requires that wooden flumes be used, supported on stilts or trestles. These, as often constructed, are weak, and will often blow down with every strong windstorm. Flumes also interfere with cultivation and harvesting of the crop. These objections have led many of the irrigators of Southern California to use underground pipe distribution systems—a supply pipe laid about 2 feet underground along the upper boundary of the tract. At the head of each row of trees the pipe is tapped and a standpipe connected to it. The water flows out of the standpipe into the furrows through spouts cemented in the standpipe. Cement, wood and clay pipes are generally used. Cement pipe is more durable than wood pipe, and is considerably cheaper than either, except where a clap pipe factory is in the vicinity and it has to meet competition. The cement pipe used in

Southern California ranges from 6 inches to 36 inches in diameter, and is made of a mixture of 1 part of cement to 3 or 4 of sand or gravel, well tamped in metal moulds. The moulds are not expensive, and the pipes are often made by the irrigator himself. As the large pipes will not resist pressures above 10 feet and the small ones not over 20 feet, for greater pressures wooden pipes or some other type of concrete pipes are necessary. The cost of this type of cement mortar pipe as compared with wooden banded pipe is about as follows:—

| Diameter, inches. | Wood-banded pipe of Vancouver. | Cement mortar pipe, 1:3 mixture. Built on ground but not laid. |
|---|---|---|
| 12 | .385 | .20 |
| 14 | .44 | .25 |
| 16 | .55 | .30 |
| 20 | .91 | .43 |
| 24 | 1.21 | .60 |

In general, the cement pipe costs about one-half the wood-banded pipe.

While pipe irrigation has until recently been limited to Southern California, it has, to my knowledge, during the last few years been adopted for orchards in Oregon, Washington, Idaho, and no doubt other States, and there are many localities where expensive wooden pipe and iron pipe systems have been installed where a cheaper and more permanent cement pipe system could have been built.

In the above remarks I have attempted to present to you what I believe is the best solution for the prevention of water losses in the conveyance of water. The methods suggested may be expensive in first cost, and no doubt there are localities where water is so plentiful and cheap that no improvements are necessary; but the remarkable growth of irrigation of the last few years has created such a demand on the water supply that the cheap sources have been mostly utilized. In future water will be developed at a greater cost, and because of the large area of arid land, for which there is insufficient available water supply, the high value and scarcity of water will lead to the best form of conveyance of water.

For the second part of my paper I have selected "Concrete and its relative economy as compared with wood for irrigation structures, meaning by concrete both plain and reinforced concrete."

While concrete and masonry have been the standard materials for irrigation structures in the older irrigated regions of foreign countries, the use of concrete on the irrigation systems of the United States was practically unknown until a few years ago, with the exception of Southern California, where concrete has been used during the last twenty years or more for lining canals, for cement pipes, for concrete distributing flumes, and for measuring-boxes and other smaller structures. During the last few years, and especially since the beginning of the work of the United States Reclamation Service in 1902, concrete structures are widely used, not only on the twenty-five Government projects, located in fifteen States and territories, but on many of the new private projects. On some of the older systems wooden structures which have decayed are often replaced by permanent concrete structures. For instance, the Modesto and Turlock irrigation systems in California are replacing many of the wooden structures with concrete as fast as they need renewal. This is also true of the Arkansas Valley Sugar Beet and Irrigated Land Company, of Colorado, which has done some very interesting reinforced concrete work, and of many other projects in the other States.

The obstacles which have in the past prevented the more rapid extension of cement have been its cost and the difficulties of handling it as compared with the lower first cost of wooden structures, which are easily erected by common laborers. The difficulties in the manipulation of cement are not serious. Now that concrete is so widely used in cities and on farms, any observant, careful person can, with a little reading and some practice, learn how to construct the simple structures. As regards its cost in comparison with lumber, the cost of cement has very materially decreased, and it can be purchased for from $2.50 to $3.00 in most regions, while the price of lumber has advanced. Another reason for the increasing use of concrete for irrigation work is the rapid development and improvements in reinforced concrete construction, which is well adapted for irrigation structures.

The one great advantage of concrete over lumber is its great durability. It is true that, as a rule, the first cost of concrete structures is more than that of wooden ones, but almost invariably concrete is more economical. The difference in first cost is not as great as is usually supposed. A few general comparative figures, based on facts collected from different projects, will help to convince those who are still strong advocates of wooden structures.

Omitting the parts of irrigation systems already discussed, the structures most frequently used are gates or turn-outs, or division boxes placed at the heads of ditches; measuring boxes, drops or falls used where the slope of the ground is steeper than the grade that can be given to the canal; pipe syphons and flumes to cross depressions and for side hill work; bridges and culverts.

As regards durability, the wooden structures can be classified into two groups. In the first group are those structures which are partly in the ground, which include gates at the head of ditches, division and measuring boxes, drops, culverts, etc.; and in the second group are those which are all above ground, such as flumes and wooden stave pipes when supported above ground or buried underground. The life of wooden structures depends on the quality of lumber used, on the strength of the structure and the workmanship. For instance, a flume well built and with sufficient strength to prevent springing and settling, so that there will be minimum leakage, will last much longer than a weaker flume.

The short life of wooden irrigation structures is greatly due to the lumber being alternately dry and wet. The life of the structures of the first group is in addition shortened by the wood being partly in contact with moist earth.

The cost of repairs of these structures after they have been constructed three or four years becomes quite an item, and at the end of six to eight years for pine, and eight to ten years for redwood, complete replacing is necessary. The annual cost of repairs and maintenance averages usually about 5 per cent. for the first three years and 15 per cent. for the next four or five years, averaging about 10 to 12 per cent. for the entire life of not over 10 years. In addition to this should be added the cost of renewal, which, if distributed over ten years, will amount to 10 per cent. per year. The life of well-constructed redwood flumes and of wooden stave pipe is greater, and may be as long as 20 years, but is usually 12 to 16 years, with practically no repairs the first five to eight years, but with considerable repairs afterwards, averaging not less than 8 per cent. yearly for the entire life. The cost of renewal distributed over the 16 years amounts to 6 per cent. per year. If we assume the interest on the capital invested to be 6 per cent., then the total annual cost for the structures of the first group is not less than 26 per cent. of the first cost, and for the second group 20 per cent.

Concrete structures, if properly constructed, will last for ever; but, assuming depreciation and repairs at 2 per cent., gives a total annual cost of 8 per cent. as compared with 26 per cent. for wooden structures of the first group, and 20 per cent. for wooden structures of the second group. Based on these figures, concrete structures are more economical if their first cost is less than 3¼ times the cost of wooden structures of the first group, and 2½ times the cost of wooden structures of the second group. However, the actual cost of many concrete structures is much less than would be given by such ratios, and is often only a little higher than wooden structures. This is especially true of concrete structures built partly in the ground, for they require only simple forms, and when these forms can be used over many times, as where several structures of the same size are required, the cost is greatly reduced. For illustration, on the Orland project, in California, the average cost of several small drops was $32.82; the estimated cost for a wooden structure of the same size is $27.94, or 15 per cent. less. The average cost of 60 concrete turnouts was $25.50, as compared with $19.80, the estimated cost of wooden turnouts, which was 20 per cent. less. On the University Farm at Davis, California, a concrete check gate cost about 50 per cent. more than wooden ones. The Arkansas Valley Sugar Beet and Irrigated Land Company, of Colorado, have during the last few years constructed some very interesting reinforced concrete structures. The cost of two large reinforced concrete drops was $131 per foot of fall, and the corresponding cost of a series of substantial wooden drops was $120 per foot of fall. The wooden structures were built in 1899, but in 1904 were in such poor condition that the operation of the canal at full supply caused some uneasiness for fear of breaks, and they required complete renewal two years afterwards, making their life about seven years.

In a general way it can be stated that, as a rough approximation, wooden structures built in contact with the ground, such as gates, drops, etc., will cost in place, including excavation and backfilling, from $40 to $50 a thousand. Small reinforced concrete structures of the simplest type will cost $10 to $12 a cubic yard, ordinary reinforced concrete structures $12 to $16, and elaborate structures with thin reinforced walls $15 to $20. Usually a structure 5 to 5 cubic yards of concrete, and the concrete structure requiring 1,000 feet of lumber can be built with about will cost from 25 to 50 per cent. more.

With the structures of the second group, that is, wooden flumes and wooden stave pipes, the comparison is not quite so favorable to concrete as with the other structures. This is because of their longer life as compared with the wooden structures in contact with earth, and to the greater difficulty in constructing them of concrete. The cost per cubic yard of concrete is considerably greater, especially for flumes crossing canyons and deep depressions, because this requires expensive forms to support it during construction and some skilled labor. For that reason the cost of concrete flumes may be as great as three times the cost of a wooden flume, in which case a wooden flume or a steel flume may be more economical, at least until the price of lumber increases. But there are conditions which will favor the use of concrete, for instance, the Modesto and Turlock systems of California have replaced all their old bench flumes, which aggregate several miles, running on the side hills, by concrete channels formed by means of a wall on the down-hill side, a slope lining on the uphill side and a concrete floor in between. This not only did away with the high cost of repairs and renewals, but has paid for itself in the additional security, because a break in their main canal has meant the interruption of delivery of water, and has caused great damage to crops. As a rule, a concrete flume supported on columns should not cost over 2 to 2½ times the cost of a wooden flume.

As regards reinforced concrete pipes compared with wooden stave pipes, several of them have been built by the Reclamation Service, and a few on private projects, and their first cost is generally 1½ times the cost of wooden stave pipes. They are, therefore, more economical, and should be used in preference. They are, however, limited to moderate heads. The maximum head to which they have been submitted successfully is about 100 feet. A large reinforced concrete syphon in Spain, 13 feet in diameter and 7 inches thick, is under a head of 97 feet. On the Umatilla project in Oregon reinforced concrete pipes 4 feet in diameter, 3 inches thick, have been tested successfully for pressures equivalent to 100 feet heads. For even these moderate heads careful work is necessary.

To summarize the above remarks it may be stated that, in a general way, with the exception of some flumes, concrete structures will cost from 1¼ to 1½ times the cost of wooden ones. Since the large annual cost for repairs and renewals of wooden structures makes it economical to spend for concrete structures 2½ to 3¼ times the price paid for wooden structures, in nearly every case a concrete structure is more economical, and will cut the total annual cost of repairs, renewals and interest into one-half.

Another advantage of concrete structures which I have not emphasized is the additional security obtained, which is worth considering.

During the last two years some doubt has been cast upon the durability of concrete, because of its disintegration by the effects of alkali. So far, all that has been published can be reduced to the following facts:—

1st. Out of all the many concrete irrigation structures, including those on the 25 projects of the United States Reclamation Service, constructed in 13 States and territories, there are only two projects, one in Montana and one in Wyoming, where the failures of concrete structures have occurred. The only other recorded instances are some sewers in Montana and some concrete drainstiles in Colorado.

2nd. The disintegration seems to take place where the structures are in contact with strong alkali water of a peculiar composition, and occurs where the water permeates the concrete mass and is evaporated, leaving the salts in the pores of the concrete.

3rd. Black alkali seems to have no harmful effect, and the disintegration is caused probably by only some of the white alkali salts. Wherever disintegration has occurred the alkali salts are sulphates, with magnesium sulphate predominant.

As against these few failures there are hundreds of examples of concrete irrigation structures where alkali has had no effect. Nevertheless, where the sulphates are strong it is good policy to experiment on a small scale in those localities before works involving large amounts of money are built, and to take all known precautions in the construction. At present the best known means to prevent disintegration are:—

1st. To make the concrete as nearly impervious as possible.

2nd. To remove the alkali water where practicable by drainage.

3rd. To use some cement which will be most resistant to alkali.

The Reclamation Service is now experimenting with the use of a special cement, and the Geological Survey is carrying on a series of experiments which it is hoped will help to solve the problem.

# THE SANITARY REVIEW

## TESTING SEWER JOINTS.

The application of the hydraulic test, and that sewers must not only stand such a test, but continue to do so, is becoming a generally accepted principle.

The necessity of watertight sewerage has been long recognized from the health standpoint. It is acknowledged that the purpose of sewers is to carry off sewage and not liberate it into the surrounding soil.

With the adoption of sewage disposal methods in this country, the necessity for watertight sewers has assumed paramount importance. Sewage disposal, if efficient, practically demands the separate system of sewerage. Sewage disposal methods which depend upon fixed velocities of flow in tanks to procure sedimentation, and fixed quantities of sewage relative to filter area, demand that the quantity of sewage delivered per day be a practically fixed amount.

This fixed amount is best obtained by the separate system, because the daily discharge is represented by the daily water consumption, storm water being kept out of the sanitary sewers.

Where sewers are made to take both sewage and storm water, overflow and stand-by tanks are required to prevent over-dosing and flooding the works.

The separate system may or may not only take the domestic sewage as represented by the water supply, depending on the presence of subsoil water in the ground and the tightness or otherwise of the sewer joints.

The engineer may lay down sewerage on the separate system, calculate and prescribe tank sedimentation and filtration for a given flow of domestic sewage, and find that, owing to pipe joints being partly open and defectively made, that the volume of discharge he originally provided for is trebled by the addition of subsoil water.

In many cases where the separate system of sewerage has been adopted, and the diametric sizes of sewers calculated to take domestic sewage, such have failed in capacity, not because of erroneous calculations, but simply because the specification and method of supervision called for no proper and efficient test of sewer jointing.

The separate system of sewerage may be rendered useless by want of capacity, and the sewage disposal works entirely inefficient in treatment by inflow of ground water.

The hydraulic test is a practical and efficient method of testing sewers, and if properly applied can be relied upon to provide a watertight sewerage system. Defects in sewer joints may arise from the following causes:—

(a) The shrinkage of the cement in setting.

(b) The difficulty in making cement adhere to the glazed face of spigot and socket.

(c) Kiln-cracks, unobserved until the sewer is filled with water.

(d) The difficulty in making and temptation to scamp the underside and unexposed parts of a joint.

(e) The combined ridgity of stoneware pipes and cement joints to give to any unevenness of trench bottom without breakage.

The hydraulic test consists of plugging up a length of drain between manhole and manhole and filling it with water to its highest level. Special expansion plugs can be obtained for the purpose to suit all diameters of pipes. Given a period of about half an hour, the water should continue to stand without leakage in the sewer length.

The severity of the test depends on the difference of level between the lower and higher ends of the sewer length. Practically, this is just the test that any length of sewer is automatically put to in the case of chokage. If the sewer joints cannot stand a natural choke, then they cannot stand the hydraulic test.

In loose or sand soil a complete chokage may last for a considerable period, the liquid passing off into the soil, while the solids accumulate and partly putrefy in the pipes.

The test should be applied both before and after filling in. Careless filling in will often disturb pipes sufficiently to cause leakage.

Many inspectors are content with such tests to sewers, which simply prove that a ball will run from one end to the other, thus proving a falling gradient and absence of obstruction.

Where sewers are laid in clay with an absence of subsoil water, the question of tight jointing is not so important; but even under such circumstances, in case of a choke, the liquid sewage will force its way out of the open joints and form a channel under the sewers and gradually wear away the ground on which the sewer rests, thus destroying the alignment.

With the adoption of the separate system of sewerage and disposal works depending upon maximum fixed amounts of discharge, the importance of sewer jointing and the application of an efficient test cannot be underestimated.

## CRITICISM OF H. E. JORDAN ON HYPOCHLORITE TREATMENT.*

**By H. C. H. Shenton.**

A valuable paper dealing with the purification of public water supplies by means of treatment with hypochlorite of lime, written by Mr. H. E. Jordan, chemist to the Indianapolis Water Company, appeared recently in The Canadian Engineer. In Mr. Jordan's opinion the use of hypochlorites has extended over a sufficient length of time and under such varying conditions as to make it possible to draw conclusions with reference to matters of practical working. The paper is chiefly valuable as discussing practical methods and devices, and such discussion is, without doubt, useful to the engineer. In Mr. Jordan's view the concrete tank is best for the storage of hypochlorite solutions; "any material such as iron or galvanized iron is destroyed more or less rapidly." Wooden tanks affect the taste of the water owing to the apparent tendency of the hypochlorite to extract certain constituents. It seems strange, however, that any chemist should have used wood for such a purpose, for it must have been clear from the first that chloride of lime would act upon wood, thereby roting the tank and wasting its energy. The stirring of the hypochlorite solution must be done with caution in order that the insoluble lime may not be carried over to the storage tank.

The chemists seem to have had some difficulty in finding a pipe suitable for conveying the hypochlorite solution. We are told that with lead-lined pipes there is a difficulty in

*From the Surveyor and Municipal and County Engineer.

making a perfect joint, which apparently leads to the hypochlorite attacking the iron casing at the joints. Copper alloys are also attacked by the hypochlorite. Mr. Jordan therefore advises the use of wrought or cast iron pipes, and the renewal of these pipes from time to time. This advice is open to criticism. If iron is unsuitable for tanks, still less is it suitable for pipes. On the other hand, if lead is not affected, it would be possible to use lead pipes for small installations and for large installations, concrete pipes could be used, no doubt; but better still would it be in all probability to use an ordinary cast-iron pipe well coated with Dr. Angus Smith's solution. Mr. Jordan advises that in orifice boxes the orifice should be placed at the side, and not at the bottom as is customary, the reason being that "lint and strings from storage sacks, or pieces of wool from barrels, and insoluble matter from the chemical itself tend to shut off the orifice at the bottom of the tank. Why such matters as lint, string and wood cannot be kept out of the solution, mixed otherwise with the greatest care and accuracy, is puzzling. Surely these are masses of organic matter which must seriously upset the strength of the hypochlorite solution.

We are told that the amount of hypochlorite required depends to some extent upon the hardness of the water, the taste of chlorine being more apparent in soft water than in hard. Also that if there is any oxidizable matter in the water, such as ferreous carbonate or various organic compounds, it is necessary that enough hypochlorite be used to oxidize these before disinfecting action is obtained. It is difficult to make this statement agree with what has been said elsewhere, or even with the author's following statement, for he immediately proceeds to tell us that it is not clear what proportion of organic matter present in water may remain unoxidized and sterilization be effected, and he advises the addition of hypochlorite to waters before filtration under certain conditions with sand filters. It is remarkable how very undecided the American chemists appear to be on the point in question. They seem to have some reason for thinking that it is desirable to add hypochlorite to water while it still contains a good deal of organic matter before filtration, but their reason is certainly not at all clear. In a paper dealt with recently in these pages one of the limitations of the hypochlorite process was stated to be its inability to remove organic matter appreciably from water. Yet it is equally clear and undisputed that the amount of organic matter present in the water decides the quantity of hypochlorite, and that where there is no organic matter present the amount of sterilizing agent required to remove bacteria is infinitesimal.

The explanation is probably to be found in the fact that if hypochlorite is mixed with water containing organic matter, and is then passed rapidly through a filter, the organic matters are removed by the filter before they have killed the hypochlorite, though they must reduce its efficiency, and what remains of the hypochlorite is sufficient to kill the coli and other bacteria present in the water, because the organic matters have been removed; what the advantage may be in thus using up the hypochlorite or organic matter present in the water or in the body of the filter is unknown.

Mr. Jordan advises the application of hypochlorite to water before filtration in the case of sand filters in order to prevent growths in the filter, and he seems to advise the reverse in the case of mechanical filters, also to prevent growths on the sand layer. With regard to the sand filter we are told "where there is such a proportion of organic matter that serious growths would be produced in the sand layer, it is without question advisable to apply the hypochlorite before filtration," and with regard to mechanical filters that, "should the application be made long enough before the water reaches the filters to insure the completion of all sterilizing action, the application of such sterile water to the filter may, under certain conditions, encourage growths on the sand layer." Also we are told that if the sterilizing goes on while the water is passing through the filter, there will be necessarily a dislodgment of growths, which will be passed into the filtered water with an increase of bacterial content.

The idea that the treated water passing through the slow sand filter will so effect it that growths will be prevented, but that in passing through a mechanical filter it will encourage growths in the sand layer, does not seem to be reasonable. The sand filter must of necessity intercept unoxidized organic matter, and this must accumulate in the filter, otherwise for what purpose is the filter used? If all the organic matter were consumed by the action of the hypochlorite, and the filter itself were sterilized, the application of sterile water might encourage growths quite as much in a slow sand filter as in a mechanical filter, though why a sterile water containing hypochlorite should encourage growths is not explained.

Mr. Jordan dwells upon the need for thoroughness in mixing, and gives an instance where on account of irregular mixing some of the city water had an unpleasant taste, and some had not. It might also be argued that some of the water was therefore over-dosed, and some was under-dosed, and that some was sterile and some was not. **It cannot be said that the American authorities have as yet displayed their wonted ingenuity with regard to mixing and dosing arrangements.** While our engineers have perfected various appliances for the economical preparation of hypochlorite for dosing, mixing and dechlorinating, we still hear of very crude appliances being used in America, **and the reason appears to be that the chemist is acting in the capacity of engineer.** The reports and papers coming daily to hand from America display ignorance of practical engineering facts on the part of the chemists, who seem to have a free hand in doing purely engineering work. The result is contradictory results and irregular working, and sometimes failure in the application of scientific theories, which are quite correct in principle, but are badly carried out.

## NEW INCORPORATIONS

**Lethbridge, Alta.**—J. E. Lussier Construction Company, $50,000.

**Winnipeg, Man.**—Griffith Steel Construction Co., $500,000; J. S. Hough, C. Williams, J. Mahood.

**Niagara Falls, Ont.**—Watson Fire Arm Sights, $40,000; F. H. Silk, Shelburne; T. A. Watson, Creemore.

**Toronto, Ont.**—Joseph Simpson Sons, $1,000,000; R. M. Simpson, T. A. Doherty, J. P. Oakley. Beaver Oils and Polishes, $40,000; L. Fraser, Weston; E. F. Raney, A. Dewar, Toronto. Dominion Gasoline Engine Co., $175,000; A. N. Morine, R. H. Whiteway, M. Yetman. Metropolitan Importing & Manufacturing Co., $40,000; A. Selikowitz, H. Baum, New York; W. Fischel, Toronto. Limousine Motors, $40,000; R. T. Logie, G. A. Browne, C. H. Duncan. W. E. Blake & Son, $75,000; J. E. Day, J. M. Ferguson, E. V. O'Sullivan. Canada Cord & Weaving Co., $40,000; E. G. Long, A. Mearns, F. L. Whatley. Central Canada Power Co., $10,000,000; S. Johnston, R. H. Parmenter, A. J. Thomson.

**Hamilton, Ont.**—Wentworth Gas Co., $500,000; W. H. Yates, Jr., S. D. Biggar, F. F. Treleaven.

# PAGE OF COSTS

## COST OF PUMPING.*

In estimating the cost of the water (for any purpose) it is necessary to take into account the original cost of the wells, pumps, engines, reservoirs, ditches, and other equipment, and the cost of operation, which includes fuel, oil, repairs, labor, and other items. In considering the original cost as a factor in the cost of a unit quantity of water it is most convenient to estimate the amount of deterioration of the plant in one year and to add this to the annual interest on the total amount invested in the plant. The sum should then be divided by the number of units of water pumped in a year. Professor Slichter advises that the charge for depreciation and repairs should be estimated at not less than 10 per cent. of the first cost of the plant.

The following tables give the results of a number of tests of small pumping plants in the Arkansas Valley, Kansas,[b] and in the Rio Grande Valley, New Mexico:[c]

**Tests of Small Pumping Plants, Arkansas Valley, Kansas.**

| Kind of pump. | Horse-power of engine. | Fuel used. | Price of fuel per gallon. | Total lift. Feet. | Yield of well per minute. Gallons. | Cost of fuel per acre-foot[d] of water. | Cost of fuel for each foot that an acre-foot is lifted. |
|---|---|---|---|---|---|---|---|
| No. 3 centrifugal | 6 | Gasoline | $0.22 | 22.1 | 272 | $2.93 | $0.13 |
| Menge | 10 | do. | .20 | 15.5 | 394 | 2.90 | .19 |
| Two vertical, 6 by 16 inch cylinder | 1½ | do. | .22 | 15.06 | 91 | 3.75 | .25 |
| Chain and bucket | 7 | do. | .21 | 17.0 | 540 | 1.37 | .08 |
| do. | 2½ | do. | .22 | 15.8 | 215 | 2.78 | .18 |
| No. 4 centrifugal | 10 | do. | .12¼ | 22.13 | 363 | 2.10 | .09 |
| No. 3 centrifugal | 6 | do. | .12½ | 17.60 | 198 | 1.67 | .09 |
| No. 14 centrifugal | 80 | Coal | [e]4.00 | 23.00 | 2,300 | .85 | .04 |
| Two horizontal, 5 by 5 inch cylinders | 3½ | Gasoline | .12½ | 21.7 | 96 | 1.09 | .05 |
| No. 4 centrifugal | 5 | do. | .12½ | 21.47 | 420 | 1.20 | .06 |

[a]Water-Supply Paper U.S. Geological Survey No. 184.

[b]Slichter, C.S., The underflow in Arkansas Valley in Western Kansas: Water-Supply Paper U.S. Geological Survey No. 153, 1906, pp. 55 and 56.

[c]Slichter, C. S., Observations on the ground waters of the Rio Grande Valley: Water-Supply Paper U.S. Geological Survey No. 141, 1905, pp. 34 and 35.

[d]An acre-foot contains 325,850 gallons of water, which is enough to cover 1 acre to the depth of 1 foot.

[e]Price per ton.

**Principal data derived from tests of Rio Grande pumping plants.**

| Horse-power. | Fuel used. | Price of fuel.[a] | Total lift. Feet. | Yield per minute. Gallons. | Cost of plant. | Interest and depreciation per hour.[b] | Labor and other cost per hour. | Fuel cost per acre-foot. | Total cost per acre-foot. |
|---|---|---|---|---|---|---|---|---|---|
| 10 | Electricity | $0.05 | 38.93 | 378 | $1,200 | $0.108 | $0.050 | $3.43 | $5.75 |
| 8 | Gasoline | .14 | 30.70 | 269 | 800 | .072 | .120 | 2.26 | 6.13 |
| 5½ | do. | .14 | 27.80 | 258 | 800 | .072 | .140 | 1.58 | 6.02 |
| 28 | Crude oil | .03 | 36.70 | 938 | 3,000 | .270 | .180 | .70 | 3.17 |
| 22 | Gasoline | .14 | 41.45 | 1,325 | 2,200 | .198 | .150 | 1.43 | 2.79 |
| 15 | do. | .14 | 35.87 | 658 | 1,500 | .135 | .150 | 1.73 | 4.10 |
| 5 | do. | .17 | 45.58 | 658 | 1,200 | .108 | .120 | 1.34 | 3.47 |
| 12 | do. | .17 | 40.30 | 131 | 1,200 | .108 | .150 | 3.73 | 13.20 |
| 21 | do. | .17 | 40.45 | 725 | 1,800 | .162 | .150 | 2.52 | 4.87 |
| 8 | do. | .17 | 26.85 | 648 | 900 | .081 | .120 | 1.48 | 3.16 |
| 12 | do. | .17 | 34.77 | 325 | 1,200 | .108 | .150 | 5.14 | 9.57 |
| 8 | do. | .17 | 36.05 | 271 | 800 | .072 | .120 | 5.10 | 8.95 |
| 10 | Wood | 2.00 | 34.16 | 351 | 1,200 | .108 | .180 | 3.47 | 7.91 |
| 28 | Gasoline | .17 | 43.35 | 464 | 2,000 | .180 | .150 | 4.34 | 8.19 |
| 20 | Wood | 2.25 | 29.55 | 1,000 | 1,600 | .144 | .200 | 2.83 | 4.70 |
| 12 | Gasoline | .17 | 23.89 | 837 | 992 | .090 | .090 | 1.04 | 2.21 |
| 12 | do. | .17 | 35.26 | 191 | 992 | .090 | .090 | 5.80 | 10.90 |
| 12 | do. | .17 | 32.36 | 750 | 992 | .090 | .090 | 1.16 | 2.46 |

[a]The price of gasoline given is for 1 gallon, the price of electricity for 1 kilowatt-hour, the price of wood for 1 cord.

[b]The depreciation and repairs are calculated at 10 per cent. of the original cost and the interest at 8 per cent.

*Arranged from a report by Oscar E. Meinzer, on the Ground Waters of New Mexico.

As near as it can be estimated from rather indefinite data obtained in regard to the plant of E. A. Von de Veld, northwest of Willard, the cost of fuel is about $3.50 an acre-foot. The water is here lifted with a 160-gallon chain and bucket elevator; the average lift is about 30 feet, and the price paid for the gasoline was reported to be 31 cents per gallon. According to these data, for each foot that an acre-foot of water is lifted the cost is about 11⅔ cents and the consumption of gasoline about 0.38 gallon. With the present capacity of the well, one-fifth of an acre-foot can be drawn conveniently in one full day; and on this basis if the plant is operated one hundred days it will consume $65 worth of gasoline and provide enough water to cover 20 acres to a depth of 1 foot or 10 acres to a depth of 2 feet. With gasoline bought at minimum wholesale prices and with more careful adjustments between the capacities of engine, pump, and well, the cost for fuel can be reduced materially, but the above figures are believed to be valuable in giving an idea of what has been done in practical work.

In a discussion of the cost of pumping in Arkansas Valley, Kansas, the following statement is made by Professor Slichter in regard to gas-producer plants:

If plants of from 20 to 50 horsepower are constructed, as I believe they will inevitably be in the near future, the cheapest power will probably be found in the use of coal in small gas-producer plants in connection with gas engines. These small gas-producer plants are largely automatic in action and can be operated by anyone. With hard coal or coke or charcoal at $8 per ton, the cost of power would be less than one-half cent per horsepower for one hour, or only one-fifth of the cost of power from gasoline at 22 cents a gallon. The writer anticipates no difficulty, therefore, in keeping the cost of water below 60 to 75 cents an acre-foot for fuel, or below $1.25 to $1.50 per acre-foot for total expense.[a] Hundreds of such plants have been put in use in England during the past ten or more years, and they are in charge of unskilled labor. These gas-producer plants are used in England for a great variety of purposes, such as power for agricultural machinery and for small electric-light plants for country estates. They are used in as small units as 5 horsepower.

In this country the producer-gas plants have been in use for several years, and at the present moment they are fast taking the place of steam power in new plants. The cost of a producer plant and gas engine is about the same as the cost of a steam engine and boiler of same size when everything is included, but the cost of power from the producer-gas plant is very much less than that obtained from small steam engines.

In producer plants ranging upward from 100 horsepower a style of plant may be installed in which soft coal or lignite may be successfully used. This still further cuts down the cost of power. In fact, large plants of this type furnish the cheapest artificial power that has yet been devised. The saving is not only in fuel, but also in labor, as one man is capable of running a 300 horsepower plant.

In Estancia Valley gas-producer plants should be installed only after sufficiently large supplies of water have been developed to insure the success of such plants. A central power plant which will furnish an electric current for operating pumps on a number of farms may prove the most economical method of lifting water.

## CLEANING AND WATERING STREETS IN THE GREAT TOWNS OF ENGLAND, SCOTLAND AND IRELAND.*

**By T. H. Yabbicom, M. Inst. C.E., City Engineer of Bristol, England.**

Under the above title the author reviews the historical efforts to improve the sanitary conditions of the cities of Great Britain, from the time when, in the fourteenth century, the "black plague" swept away more than half the population of England, down through the various visitations of cholera and other epidemics, to the present. He also gives the results of various laws which have been enacted, some of which were so stringent as to defeat their own purposes through lack of enforcement, and others so loosely drawn as to be inoperative; all, however, working in the direction of final good. He then proceeds as follows:

We will now examine the methods that have been adopted in some of the great towns of England, Scotland and Ireland to keep their streets clean, bearing in mind this principle of laisser passer.

The city of London is a too highly specialized unit for its ways to be used in comparison with those of provincial towns, but five of the boroughs in the Metropolitan district, Holborn, Islington, Westminster, West Ham and St. Pancras, have been selected as fairly typical of work in central and in suburban boroughs, one connected with the most ancient traditions of the kingdom and one the outgrowth of modern industrial enterprise.

The English towns outside the Metropolis, selected as representatives of the ordinary methods of street cleansing, have been Birkenhead, Birmingham, Bradford, Bristol, Cardiff, Huddersfield, Leeds, Leicester, Liverpool, Manchester, Newcastle-on-Tyne and Sheffield. In Scotland, Edinburgh and Glasgow, and in Ireland, Belfast, are representatives.

The populations of these cities and boroughs vary from 55,215 in Holborn to 760,357 in Liverpool; some are seaports, others far inland, so that the types are different, producing various methods of procedure. Their importance may, however, be seen from the fact that the average population of the 20 towns is 360,000, and their total rateable value amounts to £48,000,000, or an average of £2,400,000 each.

The materials employed in the formation of the surface of the streets must to a great extent influence the nature and amount of street cleansing. The number of towns where a large proportion of the streets are paved with granite, or other stone setts, is greater in the north than in the south. This may probably be accounted for by the extensive deposits of granite in Scotland, North Wales and Leicestershire, rendering the material easily obtainable.

The more modern luxuries of wood paving and asphalt have not been adopted to any great extent, the practice being very dissimilar and the north still displaying its conservatism over the south. Thus while Glasgow has been content to lay one mile of wood paving, possibly as a sample, and did not like it, Birmingham has laid 15 miles and Bristol has laid 15½ miles; and if these local authorities could yield to all the demands made upon them, would lay as many more.

The asphalt paved road, probably the most easily cleansed and the most sanitary, does not find much favor outside the Metropolitan district, probably on account of its

*From a report presented at Second International Road Congress, Brussels.

unsuitability for any road not having a flat gradient. Nearly half the street mileage of Holborn is laid with asphalt and a considerable length in Westminster. When the weather is either very wet or very dry, asphalt is at its best, but there are times when the atmospheric conditions are such that horses seem to lose all control over their legs. In the case of this material, more perhaps than in any other, scrupulous cleanliness is necessary, and with its impervious smooth surface this is easily effected with an abundance of water and the squeegee; always provided that the newly washed surface does not freeze; if so, there is trouble.

A street laid with wood, when the joints have been reduced in thickness to a minimum, presents, when new, a surface easily swept and washed, but it must be conceded that by its very nature absorption must take place and that much more in the case of soft woods than in that of the harder timbers, such as Jarrah and Karri. As the surfaces become fretted and the edges of the blocks worn away the evils of absorption are increased, as are also the difficulties of cleaning. Here again, the cleaner the surface the longer it will wear and conduce to the ease and safety of traction.

The phrase "stone sett paving" conjures up before the mind an infinite variety. The modern practice of using carefully dressed stones accurately laid on concrete, with scarcely any thickness of jointing material will produce a surface almost as easily cleansed as wood paving, with the additional advantage of retaining its condition much longer. There are, however, many tens of miles of streets even in the best towns still paved with large, uneven, irregularly laid pieces of granite, with open joints holding and retaining the droppings of the streets, rendering abortive the efforts at cleansing. Fortunately the rotary brush can be passed over these surfaces, dragging out the dirt without injury to the material. One city, out of the twenty mentioned, confesses to still having 145 miles of its streets paved with pebbles, and it is therefore not a matter of surprise that its engineer states that practically all its streets are cleansed by mechanical sweepers; but it is doubtful whether even these can effectually pull out all the dirt or dust from the hollows.

Sixteen of the twenty great towns now under consideration have been able to make definite returns of the mileage of the streets paved with various materials. It has been found that the total length of streets in these sixteen towns is about 3,200 miles. Of these 32 per cent. are paved with stone setts; 3 per cent. with wood paving; 5 per cent. with various materials, including asphalt, and 60 per cent. are still maintained as macadam. Evidently therefore the question of cleansing macadam roads is of very great importance. The quality of the stone of which the surface is composed naturally varies to a great extent with the locality and the material obtainable in the vicinity, but of late years the tendency has rightly been to employ the better classes of granites, basalts and other tough stones, even when the first cost is higher, rather than the softer limestones. The latter are easily crushed under the heavy weights that roads are now called upon to sustain, and by their ready absorption of water are converted into mud to the great increase in the cost of cleansing. A road made of inferior materials causes a large item in municipal expenditure.

Of the twenty towns, horse drawn rotary brushes are used on the streets of fourteen of the number to cleanse the macadam roads; the engineers of the other six being of the opinion that the mechanical sweeper tends to damage the surface. It is thus seen that the majority are in favor of the rotary brush, but it requires to be applied with very great discretion. The author gave up the use of these mechanical appliances, after having been strongly in favor of them, on account of their effective action, because the coarse bass of which the brush is composed, dragged away the finer particles of the surface, if applied heavily. Still it is evident that the concensus of opinion is in favor of their use. Almost invariably they are drawn by horse-power.

Efforts have been made at various times to produce a machine which will not only brush the road, but at the same time raise the sweepings into a cart attached to it. At least six towns have given trials to these inventions, but the unanimous opinion is that not one has proved itself quite satisfactory.

It is scarcely necessary to record that in all the great towns the principal streets are cleansed at least once in the twenty-four hours, and still more frequently when necessary; this being independent of the continuous cleansing that will be noticed further on. The amount of traffic and the conditions of the weather must decide what has to be done. The second-class streets are usually swept three times a week. With regard to suburban roads and third-class streets, the practice varies from a daily cleansing in some towns to once a week only in others. Whether the street cleansing is carried out better during the day or night is a point on which the towns are not unanimous; there is much to be said on both sides. During the night there is less interference with the traffic by the machines, and the latter having a fair way can act more expeditiously. During the day it is possible to exercise more complete supervision. In eight towns the streets are swept during the night; in seven others by day, and in the five others on the list both day and night. It is evident, therefore, that opinions on the question are nearly equally divided, and local circumstances probably determine which shall be continued.

After the streets have been swept by night or day, with or without mechanical appliances, it is the practice in the majority of the great towns to employ a number of street orderlies, men or boys, to go continuously through the principal thoroughfares and pick up litter and horse droppings, or as one city engineer expresses it, "tidying up all day." In the opinion of the author this process is so important, not only from the point of neatness, but of health, that he was surprised to find one exception. These collections are small in quantity, and are usually placed in hand carts for conveyance to some known point from which they can be removed by a cart. A very ordinary receptacle is a bin either above ground or sunk below the level of the pavement. Where there is a depot within reasonable distance the contents of the hand carts can be taken there direct. This cleaning by street orderlies is much increased in winter and wet weather, when the slop cart has to take the place of the hand cart for street cleansing; for the best method to be then adopted is more dependent on the changes of the weather than the work of any other department of the municipality.

In each of the twenty great towns under consideration the labor for cleansing the streets is employed directly by the corporation. In two of the metropolitan boroughs the carting away and disposing of the sweepings is in the hands of contractors, but in every other case the removal is effected by the administration. Of course, the contractors provide their own tips and get rid of the material to their own advantage.

The provision of suitable places of deposit in the neighborhood of crowded cities is an increasingly difficult one year by year. The practice is generally to tip slop into tanks from which the water is allowed to drain; sometimes the residuum is taken away for use on land. The sweepings from paved streets have a higher manurial value, and at certain times of the year maintain a ready sale; in fact the author's experience is that at times the demand for sweepings from wood paving is greater than the supply. When the demand is slack much is given away, or is used as dressing on lands belonging to the municipalities. If it were not for the difficulty of transit, land occupiers would find the sweepings most useful and economical, and of late years traction engines are called into use for transporting large quantities into the country. Seaside towns have the advantage of being able to send out the unsaleable portions in barges, and drop them at a point where the tides will not return them. Other towns, having a system of canals, are able economically to send away the sweepings in boats. In some towns the holders of allotment grounds, under the corporation, are supplied with all they desire, gratuitously.

When the streets are dry the usual practice is for a water cart to precede the brush, otherwise a cloud of dust is raised. This is of course more especially the case with the mechanical sweepers, but even the hand broom may make things very unpleasant and unsanitary. Attempts have been made to combine a rotary brush and a water sprinkler in the same machine; various types having been tried by eight of the twenty towns, with different results. The experience of five towns was unsatisfactory; two found the combination a great success, while the remaining one engineer used a petrol water van and sweeping machine combined, and found that it did its work in a satisfactory manner, but was unsuited to city work.

So far the author has endeavored, with the kindly help afforded by very full returns of the practice of his confreres, to give a concise account of the average method of collecting and distributing street sweepings in the large towns of Great Britain and Ireland. Each place has its own peculiarities of situation and environment which dictate largely the methods to be employed, but all are directed to the same end, namely, a thorough endeavor not only to render the streets sanitary and free from effluvia, but to maintain them in a neat and tidy condition, clear of the hourly deposit of the rubbish of a great city. It is not possible to generalize as to the cost, because there is no prescribed method of keeping the accounts of county boroughs, and therefore comparison is impossible. From his own experience the author is of the opinion that a rate of 4 pence or 5 pence in the pound per annum would provide a sum equivalent to the requirements of most places, and may be in excess of that spent by some in the ordinary every day duties of street cleansing. At times all calculations and the most careful estimates are rendered useless by an unusual continuance of severe weather. A heavy fall of snow may occasion an expenditure of hundreds or even thousands of pounds. Coming generally at a time of the year when work is most difficult of obtainment the opportunity of the "unemployed" occurs, and provides for them something to do, which is as, or more, beneficial to the community than much of the so-called relief work. It is not the custom to employ soldiers to clean the streets of the towns of Great Britain and Ireland as has been done in some continental cities.

Snow, a beautiful object on the mountain or country side, is a visitant dreaded by the city engineer; its coming is uncertain, and the amount cannot be foretold. Even latitude is not a guide, for although as a rule the heaviest falls occur in the north and the midlands, yet there have been years when the south of England has been the subject of a blizzard and a snow covering a third of a meter in depth, while the northern towns have experienced complete immunity.

Some towns have local acts of parliament which enable the police to call upon the householders to clear the snow from off footways in front of their premises, and this is the practice in about one-half of the towns noted. But even in those towns there are many miles of footways outside unoccupied premises, public buildings, places of worship and blank walls, bridges and viaducts where the paths would never be cleared at all if the municipality did not do it. The authorities of the other ten towns undertake the whole duty. By whomsoever the snow is cleared from the path it finds its way to the road, and then has to be removed at the public expense.

Every town of any importance makes careful and systematic arrangements in advance to deal with a fall of snow, if it does come. The ordinary sweepers are warned to assemble at given centres where foremen can take charge and direct their labors. If the weather is very severe, many workmen are thrown out of their ordinary employment and take temporary service with the corporation, so that there is not much difficulty in procuring hand labor. It is very important to attack a fall at its commencement, and, if possible, keep the lines of vehicular traffic open. Where there is a network of tramways the stoppage of one car may result in a complete dislocation of the service to a district. All towns employ snow plows of one form or another, a very usual pattern being a diagonal board or plate on wheels drawn along by horses and delivering the snow at one side. This is very trying work for horses and cannot be resorted to unless the snow is newly fallen and before it has been trodden hard. V-shaped plows propelled by an electric motor car are used in some towns to clear the tramway tracks.

Having succeeded in heaping the snow into ridges the duty follows of removing it from the street as expeditiously as possible, but at times and in some places much difficulty is experienced in getting an adequate supply of horses and carts. If the fall of snow has been very heavy, much ordinary work comes to a standstill, and the carts usually so employed are available for snow clearing. The very efforts made for a resumption of traffic, however, make the usual channels of employment again available and this extraneous help disappears. A prudent superintendent makes his arrangements before the winter sets in for a supply of carts to be sent to different points when necessary.

In order to reduce the heavy outlay involved in clearing a town of its snow it is necessary to have as many points as possible to which the carts may proceed to discharge their burdens, the cost of the cartage being a serious item. Vacant sites afford convenient places of deposit, provided they are not too near dwellings. Rivers, especially when they are tidal, are very suitable, as any quantity can be discharged into them without inconvenience, but the length of haulage may be considerable and increase the cost. In some towns a portion of the snow is shot into sewer manholes, but this way can only be resorted to when the sewer is capacious and a strong body of sewage running; then the snow is quickly melted by the high temperature of the sewer air and disappears; but the practice should not be carried out with snow contaminated with a large proportion of street dirt.

The practice of using salt for the purpose of enabling the snow to be cleaned easily and expeditiously is resorted to in many towns, but there the authorities make a sort of apologetic excuse for so doing by stating that the practice is only resorted to in "special cases" or, "only on the tramway track" or, but "very little used." There is no doubt that the use of salt is objected to by a large section of the public, on account of the intense cold produced, resulting in injuries to both man and beast, for which compensation has been awarded against the local authorities in some cases. Some superintendents are of the opinion that it is not possible to cope with a heavy fall without a liberal use of salt; but other equally important towns have found a way out of the difficulty without the employment of a freezing mixture.

It is almost impossible to formulate a scale of the costs of snow removal, the length of the haulage being so different in various places. A fall varying from 4 inches to 6 inches in depth (undrifted) in January, 1909, cost the different municipalities named the sums set against each:

Bradford £802, Bristol £1,660, Glasgow £824, Leeds, £686, Leicester £2,273, Newcastle-on-Tyne £1,100, and Sheffield £1,049.

The fall cost Liverpool £4,000, although large quantities of salt were used and the slush was washed down the sewers.

Street watering, to some extent, is almost a necessity with even the best systems of cleansing which experience has evolved. This is forced upon the local authority, not only by the inconvenience to the inhabitants of having their goods and furniture spoiled by the deposition of layers of dust, but by the irritation caused by blinding particles impossible of avoidance. Still worse is the danger to health by the inhalation of an atmosphere laden with the possible germs of disease. The well-known, and to some constitutions, painful effects of "hay fever" is attributed to the air being laden with the pollen of grasses and possibly other plants in the spring of the year, and it therefore seems equally possible that during an epidemic of some disease the spores may be carried by the winds considerable distances, to find a congenial soil, in which to propagate. Of course the macadam road, with its disintegration under rapid traffic, is the worst source of dust, and determined efforts have been and are being made to reduce the dust nuisance. It is not, however, the province of this paper to deal with the various methods which have been tried with varying success in this direction.

Tar in one form or another has been the most favored remedy, and there are probably few towns in England that have not tried experiments with tar macadam, tar painting and tar spraying. All these processes aim at binding together the surface particles into a waterproof coating, which prevents the formation of mud in wet weather followed by dust on dry days. Doubtless many papers will be contributed on the subject, detailing the experiences of their authors, as was done at the Paris Congress. But, however perfect the road surface may be, and unlikely to be disturbed by wheel action, dust will accumulate on it in towns from a variety of causes. Sweep the street as carefully as possible, let the street orderlies be ever so constantly picking up the refuse, yet on a dry day the rapidly moving vehicles, with bodies within a few inches of the ground, set up a vacuum, causing a rush of air sufficiently powerful to raise and carry a cloud of dust. It is therefore not yet possible to do without "street watering."

In all large towns there is now an ample supply of water and it is the exception rather than the rule for economy to be necessary in its use, even in dry seasons. In the great majority of cases the town supply is owned and controlled by the corporations, or in the London boroughs by the Metropolitan Water Board. In Belfast and Edinburgh the water supply is controlled by trustees outside the corporation. At Birkenhead a portion of the supply is obtained from a company, and in Bristol and Newcastle-on-Tyne, the whole of the supply for all purposes has to be bought from private companies. The result of these various controls is that very different sums are charged to the various corporations for the water sprinkled over the street. Thus in Edinburgh and Sheffield no charge is made for the water used. In Huddersfield, the nominal charge of £150 per annum is made. Where the water is supplied by measure the charges vary from 2½d. per 1,000 gallons in Cardiff; 3d. in Leicester; 4d. in Manchester; 5d. in Newcastle-on-Tyne; 6d. in the London boroughs, Birmingham and Leeds, to 8d. and 9d. in Birkenhead and Bristol. Belfast pays £1,100 per annum for the water used on the streets, or a sum nearly equal to that expended by Bristol where the water is bought by measure. The populations are nearly equal but the length of the macadam streets in the latter is about double that in the former. There is absolutely no rule as to how the charge shall be framed, but probably the London price of 6d. per 1,000 gallons most nearly represents the cost to the undertakers. Edinburgh, Glasgow, Manchester and Liverpool with their magnificent water supplies may afford to be liberal, where the health of the community is the object.

By general consent, the watering season extends from the first week in April to the end of September, although there are no fixed dates on which to commence or finish, and as necessity knows no law it often happens that a dry, boisterous week in March brings out the carts. In like manner it may be desirable to keep some at work in October.

In the majority of the twenty towns under consideration all the important streets and roads are watered when necessary. In Leicester rather less than half the total mileage is regularly watered and in Newcastle-on-Tyne not one-fourth. In Westminster the practice of watering the entire area is confined to macadam roads, while those covered with wood, and asphalt are treated to water the channels only, where the dust generally collects. Macadam roads that have been treated with tar require a minimum of watering, a slight sprinkling before brushing being all that is necessary; the author's experience having been that the expense of tar treatment is nearly recouped by the saving effected in street watering.

## CONDITIONS IN THE UNITED STATES.

An observant writer in Philadelphia, who has excellent means of information, has the following observations on current conditions and indifferent methods in the States:—

"We are going through an important and uncomfortable crisis in our life as a rapidly expanding commercial nation, and feeling the effects of past crude haste and lack of conservative experience. Also our business has grown quicker than our political clothes, in which to do our work. We are like a young man trying to do his work in the suit he wore as a boy, in other words, our financial and political regulations have not grown and expanded with our requirements, and we are in the uncomfortable process of having to enlarge them and adjust them to fit our present needs, and the process being under the management of politicians and not business men, it becomes a slow and unsatisfactory operation. We have changed our tailor, or are about to do so, but it is extremely doubtful if we have hurried our own relief by so doing, or benefited ourselves in the operation. We are in for the experiment, however, and must make the best of it."

## CONSTRUCTION MATERIALS.

### Demand for Brick Shows Considerable Increase — Building Trade in Ontario is Well Served.

As compared with 1908, the output of common brick in Ontario, rose from 222,361 thousand to 246,308 thousand last year, and the value from $1,575,875 to $1,916,147. There was a decided increase also in the value per thousand, the average being $7.78 ,as compared with $7.09 in 1908. The demand for brick was active during the year, especially in the larger cities, building operations in Toronto, for instance, which is essentially a city of brick, being decidedly brisk. A large quantity of brick is manufactured in and around Toronto, many of the brickyards being extensive and well equipped. Reference to the figures published as to the production of brick shows that the average value at the yard has risen from $5.73 per thousand in 1901 to $7.78 per thousand in 1909, an increase of over 35 per cent. The cost of brick constructions has been heavily affected during the same time, since the cost of labor has experienced an advance probably quite as great.

**Quality of Brick Shows Improvement.**

There has, of late years, been a marked improvement in the quality of brick made in first-class yards. Kilns of modern construction burn harder and more evenly, and there is a smaller proportion of soft brick. The present taste in brick houses, too, does not demand the same uniformity of color that was formerly insisted upon; in fact, a variety of shade, instead of being objected to, is rather desired. There is also a much greater range of products than was made years ago. From white and buff to cherry red and up to a dark, even purplish, hue, bricks of all tints and shades are freely used, and pleasing effects are sometimes obtained by employing clinker or over-burned bricks, greenish or yellowish in color. The hard-burned bricks of the present day bid fair to give us durable towns and cities, not perhaps so handsome as those built of stone, but less subject to disastrous conflagrations than those made of wood, so much employed south of the line.

Of all varieties of brick there were made last year $2,480,418 worth, comprising common $1,916,147, pressed $490,571, and paving $73,700. In the brick and tile yards there were 3,166 men employed, earning $961,881 in wages. The brick-making season is for the most part confined to the months of late spring, summer and early fall. This, and not a low rate of wages, accounts for the comparatively small earnings of brickmakers, which last year averaged only $303.

**Building Trade in Ontario Well Served.**

The activity in building operations last year is reflected in the increased output of lime, of which 2,633,500 bushels were made, as compared with 2,442,331 bushels in 1908. The value also went up to $470,858, as against $448,596.

The building trade in Ontario is well served, not only by the abundance of clay suitable for the making of brick, but also by the widespread distribution of limestone, which can be burned into lime. In composition, the rock varies from nearly pure carbonate of lime to dolomite, in structure from crystalline to fossiliferous, and in geological age from Archean to the upper members of the Devonian series, but almost all kinds will make good lime. The idea that highly magnesium limestones are unfitted for lime has been shown to have no foundation.

The value of the building and crushed stone produced last year was $660,000, of which $228,000 worth was limestone used as flux in blast furnaces. The output of the stone quarries in Ontario varies from year to year, not only in accordance with the fluctuations in the building trade, but also in accordance with the demand for large public works. It is also adversely affected by the growing use of cement. which is being more and more applied to uses for which stone was formerly employed. The greater part of the product is limestone.

**Portland Cement Output Increases.**

The only kind of cement now being made in the province is Portland cement, the manufacture of the natural rock variety having come to an end in 1907. Of Portland cement however, the output has been annually increasing since 1891 when the industry began. Last year there were made 2,303,263 barrels, valued at $2,897,348, as against 2,022,877 barrels, worth $2,417,769 in 1908, the average price for last year being $1.257 per barrel at the factory, as compared with $1.195 in 1908, an increase of $0.061 per barrel.

The chief feature of interest in the industry last year was the formation of the Canada Cement Company, Limited, with headquarters at Montreal, a "merger" which united under one management the following plants in Ontario, as well as three factories in Quebec and one in Alberta, namely, Lehigh, Belleville, Marlbank, Port Colborne, Lakefield and Shallow Lake. The following companies were absorbed by the merger: Belleville Portland Cement Company, Belleville; Lehigh Portland Cement Company, Belleville; Canadian Portland Cement Company, Marlbank and Port Colborne; Lakefield Portland Cement Company, Lakefield; Owen Sound Portland Cement Company, Shallow Lake. There now remain outside of the "merger" the following cement companies in Ontario: Maple Leaf Portland Cement Company, Atwood; Grey and Bruce Portland Cement Company, Owen Sound; National Portland Cement Company, Durham; Superior Portland Cement Company, Orangeville; Imperial Portland Cement Company, Owen Sound; Crown Portland Cement Company, Wiarton (formerly Colonial Portland Cement Company); Ontario Portland Cement Company, Blue Lake; Hanover Portland Cement Company, Hanover; Kirkfield Portland Cement Company, Kirkfield; Ben Allen Portland Cement Company, Owen Sound; and Sun Portland Cement Company, Owen Sound. Of these the Imperial, Crown and Ben Allen companies were idle throughout the year, and the Maple Leaf and Grey and Bruce operated for part of the year only. The output of the independent companies was small compared with that of the combine, which produced the bulk of the cement made last year. The industry gave employment to 1,354 men, whose wages amounted to $631,137.

**Drain Tile and Sewer Pipes.**

The number of drain tile made last year was 27,418,000, having a value of $363,550. Tile draining is being more and more practised by the farmers of Ontario, who recognize the advantage of freeing their low-lying lands of surplus moisture, which retards the growth and maturing of their crops and invites early frosts. The production in 1908 was valued at $338,658.

Of four sewer pipe factories, three were in operation in 1909, namely, those of the Hamilton and Toronto, Dominion, and Ontario Sewer Pipe companies. The output had a value of $311,830, as against $344,260 in 1908. The potteries of Ontario turned out in 1909, $43,214 worth of goods.

## COMING MEETINGS.

NEW YORK CEMENT SHOW.—December 14-20, 1910. First annual convention in Madison Square Garden, New York. Under the management of the Cement Products Exhibition Company, 115 Adams St., Chicago.

## ENGINEERING SOCIETIES.

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

Chairman, A. E. Doucet; Secretary, P. E. Parent. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—

96 King Street West, Toronto. Chairman, A. W. Campbell; Secretary, P. Gillespie, Engineering Building, Toronto University, Toronto. Meets last Thursday of the month.

MANITOBA BRANCH—

Chairman, J. E. Schwitzer; Secretary, E. Brydone Jack. Meets first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—

Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 40-41 Flack Block, Vancouver. Meets in Engineering Department, University

OTTAWA BRANCH—

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

**MUNICIPAL ASSOCIATIONS.**

ONTARIO MUNICIPAL ASSOCIATION.—President, Mr. George Geddes, Mayor, St. Thomas, Ont.; Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

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

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

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

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

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

**CANADIAN TECHNICAL SOCIETIES.**

ALBERTA ASSOCIATION OF ARCHITECTS.—President, E. C. Hopkins, Edmonton; Secretary, H. M. Widdington, Strathcona, Alberta.

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

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

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

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

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Vice-President, Gustave Kahn, Toronto; Secretary-Treasurer, R. E. W. Hagarty, 662 Euclid Ave., Toronto.

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

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

CANADIAN FORESTRY ASSOCIATION.—President, Thomas Southworth, Toronto; Secretary, James Lawler, 11 Queen's Park, Toronto.

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

CANADIAN GAS EXHIBITORS' ASSOCIATION.—Secretary-Treasurer, A. W. Smith, 52 Adelaide Street East, Toronto.

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

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

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

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 157 Bay Street, Toronto.

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

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

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

EDMONTON ENGINEERING SOCIETY.—President, Dr. Martin Murphy; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, A. D. Campbell; Corresponding Secretary, A. H. Munroe.

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

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

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

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

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

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

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

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, H. W. Selby; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

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

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

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

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

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

## ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

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

12403—September 6—Granting leave to the V. V. & E. Railway & Navigation Company to carry industrial tracks over the British Columbia Electric Railway Company, and over certain streets in Vancouver, B.C.

12404—November 28—Authorizing the corporation of the Town of Oshawa to lay a two-foot sewer across the lands and under the tracks of the G.T.R. Co. where the same crosses Lot No. 7, in the Township of East Whitby, County Ontario, Ont.

12405—November 28—Directing the Central Ontario Railway Company to provide and construct a suitable farm crossing, for Edward Lynch, Maynooth, Ontario, by means of a bridge to be erected under the railway bridge where the line crosses his farm.

12406—November 14—Authorizing the C.N.O.R. Co to cross and divert public road in Lots 275 and 276, in the Parish of St. Benoit, County of Two Mountains, at Station 1283.28.

12407—November 26—Authorizing the James Bay & Eastern Railway Company to construct its railway across the public road between Lots 19 and 20, Range 1, Township of Ashuapmouchouan, County Lake St. John.

12408—November 29—Authorizing the Hydro-Electric Power Commission of Ontario to erect its transmission line across the Tillsonburg, Lake Erie & Pacific Railway (C.P.R.) at Lot 14, Concession 3, Township of North Oxford, County of Oxford, Ont.

12409—November 29—Authorizing the C.P.R. Co. to construct a spur for the Provincial Reformatory, Township of Guelph, County of Wellington, Ont.

12410—November 28—Authorizing the G.T.R. Co. to construct a siding, and spur therefrom to the premises of the Railway Signal Company of Canada, Limited, in the Parish of Lachine, County Jacques-Cartier, Quebec.

12411—November 30—Approving revised location of the C.P.R. Co.'s Bulyea Branch from mileage 0 on Pheasant Hills Branch, to mileage 18.49 at a point in Section 33, Township 20, Range 21, west 2nd Meridian, Sask.

12412—November 28—Authorizing the C.N.Q.R. to construct an industrial spur into the property of the Montreal Steel Works, Limited, Montreal, Quebec.

12413—May 12—Declaring in the complaint of George Taylor, of Winnipeg, that the rate properly chargeable by the C.N.R. Co. on shipment of grain from Buchanan, Sask., to Headingly, Manitoba, was 17c. per 100 lbs.

12414—November 30—Authorizing the Tillsonburg, Lake Erie & Pacific Railway Company to construct an industrial spur for the John Morrow Screw Company, Limited, in the town of Ingersoll, Ont.

12415—November 30—Adding, as a party to the application of W. A. Stewart, of Napierville, Quebec, and the municipal council of village of St. Cyprien, complaining of the inadequate accommodation and the unsatisfactory train service furnished by the Napierville Valley Railway Company, the Quebec, Montreal & Southern Railway Company.

12416—December 1—Extending until June 1st, 1911, the period during which the N. A. Telegraph Co. may charge the telephone tolls which it was previous to July 13th, 1906, authorized to charge.

12417—December 1—Extending until June 1st, 1911, the time within which the contract forms of the National and American Express Companies are approved by the Board.

12418—December 1—Extending until June 1st, 1911, the time within which the contract forms of the Canadian and Dominion Express Companies are approved by the Board.

12419—December 1—Extending until June 1st, 1911, the time within which the forms of money and freight receipts of the Maritime Express Company are approved by the Board.

12420—December 1—Extending until June 1st, 1911, the period during which the Bell Telephone Company may charge the telephone tolls which it was authorized to charge previous to July 13th, 1910.

# THE ENGINEERS' LIBRARY

Supplement to THE CANADIAN ENGINEER. 62 Church St., Toronto, Ont.

## CONTENTS OF ENGINEERS' LIBRARY.

Use of a Scrap Book .... XVII
Book Reviews .... XVII
Publications Received .... XVIII
Catalogues Received .... XIX

## THE USE OF A SCRAP BOOK.

At this time, when there is so much literature on technical subjects produced, it is difficult for the engineer to arrange and file information on various subjects without over-stacking his library. To attempt to provide shelf-room for the magazines and technical articles which the engineer glances over would be a burden. Almost every magazine has an illustration, a half-column article or a drawing which he considers of enough interest to save. Even certain sections of text books and catalogues are very valuable as subjects for reference.

For the systematic arranging and careful consideration of the hundred and one odds and ends that the engineer values we know of nothing better than a loose-leaf scrap book. Here the engineer may take care of the scraps which he has clipped from many sources and arrange them in some systematic order and index and cross-index so that he will have the necessary information close at hand for ready reference. The ordinary scrap book quickly gets out of date, and is usually discarded after a short trial. The attempt to keep it in sections fails, and the indexing becomes vexatious and cumbersome. With the loose-leaf scrap book pages may be inserted or removed at pleasure, and, as the information changes or improves on any one subject, the scrap book can be revised without interfering with the other sections.

Such a scrap book will become quickly the text book, the hand book and a small encyclopædia all in one, and will prove one of the most useful publications found in the engineer's office.

## BOOK REVIEWS.

**"Concrete Wall Forms."**—By A. A. Houghton; published by the Norman W. Henley Publishing Co., New York. A treatise of 60 pages 5 x 7. Price 50c.

This book is the first of a series of treatises by the same author on concrete construction. In this treatise the matter of bracing wall forms and centering and general procedure of wall construction is gone into. A simple method is given of determining what the width of the footing course should be, in order to distribute the load evenly over the foundation. Also the matter of estimating the tensile strength and the shearing strength, or ability to withstand the shearing stress, is dealt with in a practical manner. Useful and practical clamps for forms are discussed and diagrams of the same are shown. Several pages are devoted to the explanation of the manufacture and use of an automatic wall-clamp. The matter of clamp adjustment and operation of forms is a feature to be noted. Some pages of the book are devoted to the construction features which aid in the secure placing of floor-joists, doors, window frames, and all parts of a building, which would depend for firmness upon their concrete wall supports. The general molding processes connected with wall construction and cheap wall construction, as well as fireproof, damp-proof and dust-proof wall construction, are treated with in this book. Some interesting information on the joining of two sections of wall together and in connection with this the acid treatment of old concrete surfaces preparatory to bonding, is well described. Some half-a-dozen descriptive diagrams of retaining walls with information attached concludes the book.

**"Concrete Floors and Sidewalks."**—A. A. Houghton's series of short treatises upon concrete construction is a book of 60 pages containing much valuable information on the construction of concrete floors and sidewalks. In the opening pages of this book the fundamental principles which underlie all concrete floor and sidewalk construction, that deserves the name, are outlined, and the reasons for unsatisfactory work are shown and advice given so that such results may be avoided. General directions with regard to forms, materials for concrete and mixing of concrete, also figure largely in a portion of the book, and drawings of the various tools for laying of concrete. Ornamental concrete work for flooring purposes is treated with in the last twenty pages of the book and the molds for diamond, hexagonal, and other shape blocks are described. Some hints about reinforcements for floors and walks are given in these last few pages.

**Dustman's Book of Plans** (and Building Construction for General Contractors and Home Builders). Published by Charles C. Thompson Company, Chicago. Size 13 x 9; pp. 240; price $2.00.

This book aims to instruct the builder, carpenter, and anyone who desires to construct houses. The book acquaints the reader at the start with the fact that plans drawn by an architect are the only means of binding a contractor and are the best guide to carrying on satisfactory work. Mr. Thompson claims to have a very thoroughly systematized method of furnishing plans and for doing architectural designs at the utmost speed and at a minimum cost. The first few pages of the book are devoted to a treatment of this scheme and to general suggestions, as to the requirements of a comfortably arranged home, as to size of rooms and novelties which add to convenience. Following some floor plans and other sectional plans, a treatment of practical geometrical problems is given such as confront the builder and carpenter: as, for example, a simple method of constructing an ellipse, finding the area of an octagon bay window and similar instructive problems These are given in a most simple and clear manner so that they may be easily understood by anyone. These lead up to more difficult problems in building construction; stair work is gone into quite extensively and a useful table for determining treads and risers is appended, besides a list of terms relative to stair construction. The same procedure is carried through dealing with the construction of window frames, store fronts, brick work, window frames for brick walls and general construction. A page is devoted to each of these subjects, containing in some cases a dozen practical problems, illustrated by a plate of figures 12 x 8 directly opposite and facing and having its figure plainly and distinctively lettered and numbered. A plate on the different kinds of columns and splices with short explanatory notes, also adds to this section of the book. The woods used in house construction and trimming are briefly distinguished by pointing out the characteristic qualities of each. The subjects of plastering and painting are dealt with in a brief and taking manner, as is also roofing.

Following this detailed information on general house construction is a section devoted to the subject of estimating and specifications. These pages would undoubtedly be of particular interest to both the building contractor and the one who intends to build. The pages are well supplied with valuable tables for use in making estimates, as well as with many hints which it is possible to gather only from experience. Not least interesting from a constructive standpoint is the table on safe load of I-beams and the table of rafters. A list of terms used in carpentry is also of interest. Desirable types of blanks for specifications are shown.

Seventy-five pages devoted to plates of plans follow. In most cases each plate contains the floor plan, second-storey plan, and photograph of the house.

A section of the book is devoted to cement concrete work, in this the mixing and use of concrete for construction work is briefly explained. An instructive article, with cuts, on how to build a concrete silo is contained therein. There are in all over one hundred and fifty pages of the book given up to plans and photographs of different types of houses. The plates cover almost the full size of the page being in general about 11 x 6. The book is to be commended for its mechanical arrangement. The topics under discussion are set out from the explanatory material by conspicuous type, thus making it easy to locate the desired information.

**Irrigation Engineering.**—By Herbert M. Wilson, C.E. Sixth Edition. Published by the Renouf Publishing Co., Montreal, and John Wiley & Co., New York. Size 6 x 9, cloth. Price $4.00.

A volume containing 195 cuts, 38 plates, and 589 pages of reading matter, comprising an introductory chapter, six chapters on Hydrography, seven chapters on Canals and Canal Works, and six chapters on Storage Reservoirs.

The section devoted to Hydrography opens with a necessarily concise discussion of precipitation, run-off, evaporation, seepage, absorption and other basic phenomena relating to the subject in hand.

Chapter VI. of this section, on the subject of flow and measurement of water in open channels is of general interest. Chapters IV., V. and VII. deal more directly with the subject of irrigation, covering drainage, cause and prevention of alkali, water-logging, sedimentation, malarial effects and water-duty. Chapter VII. contains very interesting information regarding sewage irrigation, and the fertilizing effect of the same, also useful descriptive matter and cost data in connection with artesian wells.

In Section II. the subject of Canals and Canal Works is treated at some length and with considerable technical detail. Among the many illustrations, a number of detail plans are reproduced which aid greatly in elucidating the text.

In this section questions of canal alignment, survey methods, construction of wires, falls, sluiceways and distributaries, are taken up in detail. Chapter XIV. on methods of applying irrigation water, contains practical information and data which should be of much use to the layman as well as to the engineer.

Part III. on Storage Reservoirs is profusely illustrated and contains much descriptive matter and detail with reference to storage reservoirs of different types now in existence; also a short theoretical discussion on the design of masonry dams and weirs. The important question of choice of site and type of dam is also fully treated, and in chapter XIX., devoted to the discussion of motive power for pumping, is contained some interesting and unusual data in connection with the power of wind-mills and cost of production. The concluding chapter quotes the U.S. Reclamation Law in full, contains a copy of the specifications for the Roosevelt Dam and a summary of unit construction costs, both by contract and force account, on Reclamation Service projects.

Appended to each chapter is a list of books of reference covering the details of subjects discussed.

This volume is not a text-book, but a valuable book of reference for the practising engineer and agriculturist. While it contains much practical information and data of general interest and application, its great field of usefulness is in the Canadian West, where it should find a ready market.—H. G. A.

**Pittsburg Standardized Reinforcement, 1910.**—400 pp., 4 x 6. Published by Pittsburg Steel Products Co.

The purpose of this blue book is to furnish for reinforced concrete, as has already been done for structural steel, a handbook, the use of which will remove the necessity for tedious computation in the designing of modern structures. It has previously been necessary in work of this kind to make frequent use of basic formulae with its consequent tediousness and chance of error, and the manufacturers of the Pittsburg Standardized Reinforcement have succeeded admirably in their endeavor to produce a handbook of this type. To Wm. Barclay Parsons is due the credit for the various computations required; all sizes of material used as reinforcement having been tested under the supervision of the United States Government.

Their system of reinforcement is the commonly accepted one; the reinforced slab taking up most of the compression stresses in the beams. The reinforcing of the beams and girders is delivered in finished rigid units, the shear bars being electrically welded to the upper and lower beaded bars at an angle of 45 deg. The lower member consists of one or two bars per unit and the upper of one bar, and by the use of seventeen sizes of bar varying in section from ¼ to 2¼ in. the company is able to standardize thirty-four sizes of units or frames, and these again with a variation in depth and in the number used per beam give a range sufficient to cover almost all structural work. The slab reinforcement has a fair amount of longitudinal stability and this with the welded beam reinforcement units provides a form of construction so rigid that the bars, etc., will remain in place without trouble during the placing of concrete. Both beams and slabs have been computed principally on the formula B.M. = 1-10 $WL^2$, an exception being made for lintels which are taken as B.M. = ⅛ $WL^2$. This seems reasonable as the B.M. at columns or girders is then only ¼ that at centre and the reinforcement is kept at least 25 per cent. as strong at columns as at centre, but care should be taken to allow sufficient overlap in these upper bars, as there is, at a beam joint, only the friction between steel and concrete to take this tensile strength. There should also be a slight allowance made in the column due to the fact that this B.M. of beams at columns or walls has a lever motion tending to produce horizontal shear in the columns, principally at the corners or walls of a building with large window lights.

The more elementary formulae and information, both for concrete and other substances, are given, including the safe stress for wood. This is accompanied by sketches of typical wood framing. On the whole the architect and engineer will find that all straight line work is well covered, no attempt being made to give computations for the arch or other such obstruse questions.—A.C.O.

**Standard Specifications.**—Carnegie Steel Co., 1910. 65 pp. 4½ x 6½.

This pamphlet gives the standard specifications for steel products as set by the Association of American Steel Manufacturers, the Carnegie Steel Co., and the American Society for Testing Materials.

A comparison with the specifications as given in the most recent whole issue of the Carnegie handbook (1903) may be found interesting. No changes have been made in the specifications of standard structural steel, the manufacturers' specifications of 1903 being merely reprinted. The same is true for special open hearth plate and rivet steel. But a notable addition are the specifications for concrete reinforcement bars, these being given both for structural steel grade and also for the high carbon grade, which is as high as that for nickel steel, namely, an ultimate stress of 80,000 pounds per inch.

The next division has not previously been included in their handbook. It consists of the Carnegie Steel Co.'s own standards for steel car wheels, car and tender axles. The car wheel specifications demand open hearth manganese steel and must conform narrowly to certain chemical standards, but apparently no strength tests are required. This is somewhat curious as a failure to properly anneal the finished wheels might result in low tensile strength and brittle flanges with their resultant danger of derailment.

Some pages are next devoted to the new structural nickel steel and a comparison of its requirements with that of the old railway bridge steel will be found interesting.

| | Railway Bridge Structural Steel. | Structural Nickel Steel. |
|---|---|---|
| Phosphorous, max. % | .08 | .04 |
| Sulphur, max. % | | .05 |
| Nickel, % | O | 3.00—A.00 |
| Tensile strength, pounds per sq. in. | 55,000—65,000 | 80,000 min. |
| Yield point, pounds per per sq. in. | 28,000—33,000 | 50,000 min. |
| Elongation, min. % in 8 inches | 1,400,000 / ult. tens. str. | 1,600,000 / ult. tens.str. |
| Elongation, min. % in 2 inches | | 22 |
| Cold bends without fracture | 180° D=t. | 180° D=2 th. |

The American Society for Testing Materials, Standard Specifications are next given, but conform closely to the manufacturers' standards, but for bridges and shipbuilding purposes open hearth steel only is allowed.

Specifications for steel forgings are also included and it is interesting to note that the oil tempered nickel steel calls for an ultimate stress of no less than 95,000 pounds per sq. in.—A.C.O.

## PUBLICATIONS RECEIVED.

**Practical Road Engineering.**—By several authors; published by St. Bride's Press, Ltd., 24 Bride Lane, Fleet St., E.C. Size 8¾ x 11¼; pp. 140; price $1.50.

**Clarification of Sewage.**—By Dr. Ing Rudolfe Schmeitzner. Published by The Engineering News Publishing Co., 220 Broadway, N.Y. Size 5 x 7; pp. 115; price $1.50.

**Steam Turbines.**—By Rankin Kennedy. Published by Whittaker & Co., 2 White Hart St., Paternoster Square, London, E.C. Size 6 x 9; pp. 104; price 4s. 6d. ($1.35.)

**Electric Wiring.**—Joseph G. Branch; The Branch Publishing Co., Chicago, Ill. Size 5 x 8; pp. 288; price $3.50.

**Conservations on Electricity.**—Joseph G. Branch; The Branch Publishing Co., Chicago, Ill. Size 8 x 6; pp. 290; price $3.50.

## CATALOGUES RECEIVED.

**Water Softeners.**—The Dodge Manufacturing Co., Mishawaka, Ind., are distributing two very interesting catalogues which tell of the waste in heat caused by scaled boiler tubes and make known the merits of their system of water softening. They give several results from plants installed.

**Recording Gauges.**—The Bristol Co., Waterbury, Conn., in bulletin No. 140 displays several different designs of pressure gauges with special attention to their recording pressure gauges. These gauges are designed to show the results of both pressure and vacuum measurements during the twenty-four hours.

**Rotary Engine.**—The Herrick Balance Rotary Engine is fully described in a pamphlet distributed by the Herrick Engine Co., 74 Broadway. This type of engine has been much experimented with and the results will be interesting to users of steam.

**Concrete Mixers.**—The T. L. Smith Co., Majestic Building, Milwaukee, Wis., in a recent catalogue described the advantages of their batch mixer. This is a hand mixer and is said to be very economic in its operating.

**Water Meters.**—The Neptune Meter Co. in a recent catalogue described the Trident Water Meter giving dimensions and full description of this simple disk meter.

**Buckets.**—The Hayward Co., of New York, in catalogue No. 38 give examples of the uses of their orange peel clam shell excavators, dredges, coal handling machinery, travelling derricks, and derrick fixtures. I would be very pleased to send it to those interested.

**Panels and Cabinets.**—The Crouse-Hinds Co., Syracuse, N.Y., has issued what is certainly the handsomest and most complete "letter of introduction" ever addressed to the electrical trade—one that may well serve as an inspiration to agents and others who handle its wares. This "letter" is in the form of a 9 x 12 catalogue devoted to Panel Boards and Cabinets. The book is profusely illustrated in two colors and printed on heavy coated white paper, the 80 pages of catalogue being inclosed in an artistically embossed cover with cloth back.

**Steam Shovels.**—The Canada Foundry Co., Toronto, in Bulletin "37" describe their different designs of Ducyrus shovels. These shovels vary in weight from 95 to 45 tons, and are especially designed for difficult work.

**Pulverizing Machinery.**—Raymond Bros., 520 Laflan Street, Chicago, Ill., in their catalogue No. "10" describe their special machinery for grinding, pulverizing and separating materials that are required in different forms.