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MISSING

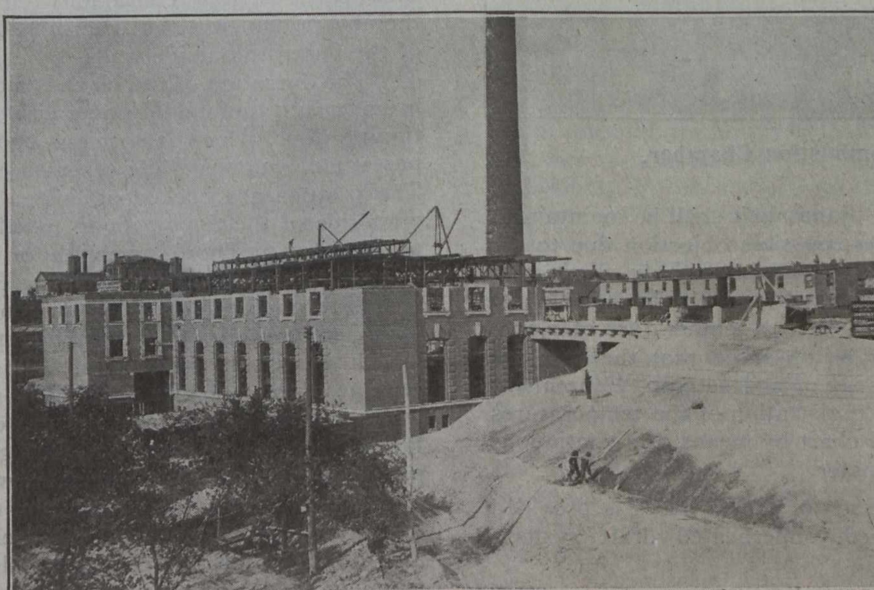
The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

DON INCINERATOR—TORONTO

DETAILS OF CONSTRUCTION AND METHODS OF OPERATION OF PLANT—CAPACITY OF ONE HUNDRED AND EIGHTY TONS OF REFUSE PER DAY WHEN FULLY OPERATED

BUILDING operations in connection with the Don incinerator plant are rapidly drawing to completion. It had been hoped that the plant would have been in operation long before this. Unavoidable delays, however, incident to the scarcity of experienced labor and the delivery of materials have resulted in the estimated time for completion being exceeded. At present the main part of the building is completed, and the furnace contractors are now engaged in the drying-out operations on the furnaces, so that it is expected that the testing out of the furnaces will take place at an early date. If these prove satisfactory the city will accept the plant, and proceed with its operation immediately.



Looking from Wilton Avenue Bridge.

The main building was constructed under a general contract, and was designed and supervised by the city architect's department. Contracts for the pile-driving, concrete foundations, furnaces and appurtenances, radial brick chimney and foundations for same were awarded and supervised by the department of street cleaning. The excavations, grading, etc., were carried out by day labor.

The pile-driving and concrete foundations for building and furnace contracts were completed by the end of December, 1915, as was also a portion of the furnace contract. Owing to delay in the delivery of steel, all work was practically held up until March 1st, 1916, when erection was started on the steel framing for the building. From that time to the present, work has progressed slowly but continuously.

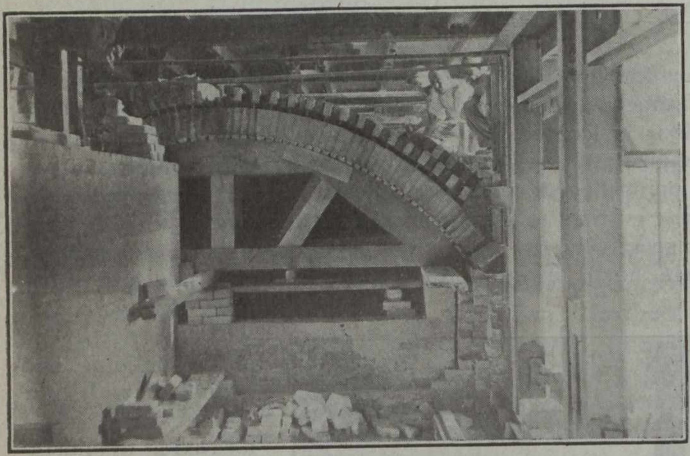
The building, which is of fireproof construction throughout, is built of brick, steel, stone and reinforced concrete. It is located on the east side of the River Don, immediately north of Wilton Avenue, and consists of five floors at various elevations, *viz.*, tipping, charging, stoking, main and ash run floors.

The elevation of the tipping floor is on a level with Wilton Avenue, the main floor being some 33 feet below on a level with the Don Roadway, while the intermediate floors are known as charging and stoking, from which floor the furnaces are charged and fired respectively. The ash run floor is located on the west side of the building and is immediately below the stoking floor. The building at the tipping floor level is connected at the northeast and southeast corners to Mount Stephen Street and Wilton Avenue respectively, by means of reinforced concrete bridges. The north bridge at the building extends in a westerly direction parallel with the north end of the building and connects with the ash section which is located at the northwest corner of the building. Its purpose is to receive the residue from the furnaces as well as ashes, etc., collected from the districts in the vicinity of the plant. This building has two floors, *viz.*, tipping and bin, the tipping floor being level with the like floor of the main building. The bin floor is located some few feet below, and has laid thereon a narrow-gauge track with turntables, the arrangement being similar to that laid in the ash run. On the west side of the ash building a steel bin of large dimensions is suspended, which is equipped with a series of steel adjustable chutes. These allow the ashes, residue, etc., to be loaded into cars on a railway siding below. The railway siding is laid parallel with the west side of the building and passes through the ash building. The main building is 151 feet long by 81 feet 6 inches wide.

The plant is equipped with three high-temperature "Sterling" furnaces of modern design, which have been installed by the Canadian Griscom-Russell Company, Limited. There are three furnaces of four units each. Each furnace has a grate area of 25 square feet, and a guaranteed burning capacity of 50 lbs. of refuse per square foot of grate area per hour, and is therefore capable of totally incinerating 5,000 lbs. of refuse per hour or a total capacity of 180 tons per day of 24 hours with the three furnaces in operation. It is reasonable to assume that the burning capacity will be exceeded, when operating under normal conditions, as the contractor's guarantee is undoubtedly based upon the plant operating under the worst possible conditions.

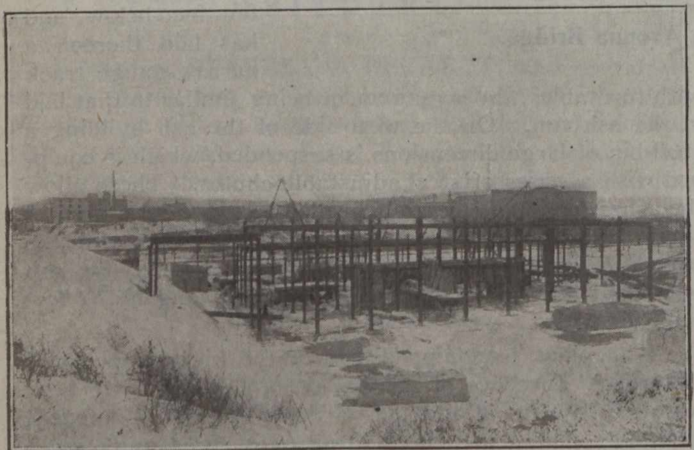
It is the intention to operate the plant on a two nine-hour shift, two unit basis, the third unit being held in reserve. By this mode of operation it is anticipated that approximately 100 tons of refuse will be disposed of each day.

The specified requirements of the furnaces are such that the temperature in the combustion chamber shall not fall below 1,250° Fahrenheit for a greater duration than three minutes in any one hour, and that an average temperature of at least 1,400° Fahrenheit shall be maintained. At the above temperatures, possible objection due to the presence of obnoxious gases will be entirely eliminated, inasmuch as all gases generated from the incineration of garbage are rendered odorless at a temperature of 1,050° Fahrenheit. It will thus be observed that the specified temperature affords a leeway of at least 200° Fahrenheit. Provision is made for the registration of the temperatures of each furnace on a daily chart by means of a continuous electrical recording pyrometer.



Detail of Combustion Chamber.

Blowing System.—Each of the furnaces is provided with an effective, induced, superheated draft system, generated by means of a direct-connected motor-driven fan. The air being drawn from the top of the furnace front by the fan, is forced into the regenerating chamber of the furnace, and whilst passing through this chamber it is raised in temperature. From the regenerator it passes into the airduct of the furnace at a temperature of not less than 300° Fahrenheit. The admission of air under the grates is regulated by means of valves operated conveniently from the furnace front.



Early Stages in Construction.

The furnace charging devices are placed on the furnace tops, and consist of a steel container for each cell, into which the material is fed, the containers and charging doors being opened and closed mechanically by the use of hydraulic rams which are also placed on the furnace tops. These rams are operated under water pressure, controlled from the stoking floor level.

The furnace and flues are lined throughout with fire-brick 9 inches in thickness; the outside walls being of suitable thicknesses, are constructed of common brick, faced with the best quality of salt-glazed brick. These bricks, being of a non-absorbent nature, were specified so as to permit of the brickwork being washed down, their glazed surface conducing to the maintenance of the furnaces in a clean and sanitary condition. Heavy buck-stays of structural steel are spaced at frequent intervals throughout the furnace and flue structures and are rigidly tied together with steel tie-rods. An air space of at least ¾ inch between the lining and outside walls has been maintained throughout and vented at frequent intervals, thus permitting a continuous circulation of free air, thereby minimizing the transmission of the temperature of the lining to outside walls.

The operation of the plant is simple. The material is brought into the building over either of the bridges to the tipping floor, which is spacious enough to allow the free passage of wagons while others are dumping their loads. The wagons are backed against a bumper beam on the west side of the tipping floor and the material is dumped to the charging floor, some eight or nine feet below, where it is charged into the containers. From the containers it passes through the charging door on the furnace top and drops, at the will of the firemen, to a firebrick drying hearth located at the back of the furnace. A large percentage of the moisture is here absorbed from the material, which is then drawn over the grates, where incineration takes place. The flame and hot gases from the refuse pass into the combustion chamber, where total combustion is effected. From the combustion chamber a portion of the gases pass through the cast-iron regenerating tubes, and discharge into the connecting flue at the top; the remaining gases are carried through a by-pass flue and enter the connecting flue at the bottom of the uptake. The amount of gases passing through the regenerator is controlled by a damper. From the connecting flue the total products of combustion pass into the main flue, and thence into the chimney. Clean-out doors are placed at convenient points and afford ample means of removing dust accumulations from all parts of the furnaces and flues.

The clinker or residue from the grates is removed from the stoking floor level through the doors at the front of each furnace, and is dropped through a series of trap doors on the stoking floor into dump cars which operate on the industrial track in the ash run below. These cars are conveyed to the north end of the run where they are elevated by an electric elevator to the bin floor level of the ash building, where its contents are dumped into the ash bin, from which they may be loaded into cars or wagons as desired.

The radial brick chimney is located some 25 feet distant from the east wall of the building. The sub-foundation which supports the concrete foundation and structure consists of piles driven "to refusal," approximately 40 feet into the ground. Upon this foundation the octagonal base 25 feet in height is constructed of brick of the same quality and laid in a manner similar to that used in the main building. The radial portion of the chimney is built upon the base, and towers to a height of 150 feet, thus giving an over-all height above the foundation of 175 feet. The outside diameter of the radial portion at the base is 16 feet 9 inches, and from that point to the top it tapers to an outside diameter of approximately 10 feet 2 inches. The firebrick lining, which is 7 feet 6 inches inside diameter, is constructed in four sections, varying from 13½ inches to 4½ inches in thickness. It is self-supporting, and is constructed with four pilasters and extends from the foundation to the top of chimney. At the base of the chimney a large damper is provided. Each furnace is also provided with individual dampers, which may be closed when desired.

The estimated cost of the plant complete is approximately $200,000.

The furnaces and appurtenances and the radial brick chimney and foundation for same are guaranteed for one

Front View of Furnaces.

and five years respectively. In each case percentages of the contract prices are retained for the period of one year, and bonds satisfactory to the city treasurer have been furnished to cover the above-mentioned periods.

The services of two foremen and twenty-eight men are the estimated labor requirements necessary to operate the plant on the basis as previously stated.

Despite the fact that the ownership of the site of this plant has been vested in the city for a period exceeding 30 years, during which it remained an unkempt weed-bestrewn waste, affording a dump for all sorts of refuse material, violent objection was encountered by the department in securing it for the legitimate municipal purposes for which it is so naturally adapted.

The department's contention that the plant would in no way detrimentally affect the neighborhood, but would, on the contrary, improve the locality, has been amply demonstrated.

The once veritable waste, with its rugged refuse-bearing banks of slimy mud, has already given place to symmetrical slopes and terraces on its southern aspect and similar treatment will be accorded the lands to the north of the building as soon as weather conditions permit of the work proceeding.

The building itself, from an architectural standpoint, is unsurpassed, if not unequalled, by any industrial structure in the city, and reflects credit on the city architect and those of his department more immediately concerned in its erection.

An effective surface drainage system has been laid around the building for the purpose of disposing of the vast amount of surface water that is shed from the surrounding banks and yard area.

From the ideal location and the many points of access to the plant, the traffic on any individual street leading thereto will be reduced to a minimum; the approach bridges and tipping floors are to be paved with wooden blocks, thus the noise of wagons entering and leaving the plant will be greatly reduced.

CANADIAN SOCIETY OF CIVIL ENGINEERS, TORONTO BRANCH.

At a meeting of the Toronto Branch, held in Engineers' Club, Friday evening, March 9th, 1917, Capt. Mathieson, of the Canadian Engineers, gave what proved to be an exceptionally interesting address on "The Work of the Canadian Engineers in France." Capt. Mathieson left Canada with the first Canadian forces as a subaltern in the 2nd Field Company, and is now in Canada on sick furlough. He was at the front for over seventeen months, and won the Military Cross for his good work in a number of the engagements in which the Canadians took a prominent part.

Capt. Mathieson told in a very graphic way of the importance of the engineer's work in this war. In the first few months the Royal Engineers in the British Expeditionary Forces carried on the prescribed work of the engineer in battle, i.e., the construction and demolition of bridges, etc., helping the infantry in preparation of field works, etc., but it was not until the settling down to trench warfare that the real importance and value of the engineer became apparent, and when the first contingent of the C.E.F. landed in france, the Royal Engineers were beginning to receive adequate status in the British army. This did not extend to the Canadian divisions at first; but because of the excellent work done by the Canadian engineers from the start, they soon established for themselves a very enviable status in the C.E.F., so that at the present time not a stick of material can be secured by the Canadian army in France without the O.K. of an engineer officer; and the sapper (private in engineers) is a foreman of "working parties," each party consisting of from 50 to 150 men.

Capt. Mathieson described the make-up of the line of trenches stretching from Belgium to Switzerland, and pointed out that the system of trenches practically constituted a city, and eliminating luxuries, all the engineering work handled by a works department of a city was duplicated in some way at the front, the work having to be done under very adverse circumstances, as well, of course, was the work necessitated by the activity of the enemy. For instance, the water supply for troops was one of the big engineering problems. The speaker told of one of his personal experiences in estimating the water supply in a certain section. He went round with an interpreter trying to determine the water consumption in dry season; and one French woman said that there would be plenty of water for the troops if those Englishmen didn't wash so much.

The organization of the Canadian Army Corps was outlined, and also the Canadian Engineer organization. The following outline of the Engineer organization gives a good idea of how engineering work is taken care of:—

The chief engineer, Canadian Corps, is a Brigadier-General. He has under him the four Colonels in command of the four units of Divisional Engineers, each consisting of 1 Divisional Engineer Headquarters and 3 Field Companies. He also has directly under him all corps troop companies and independent engineer officers attached to his staff who do the miscellaneous engineer work required behind the G.H.Q. lines.

Corps troop companies and the engineer officers attached to chief engineer's staff, look after the installation of water supplies for all units billetted behind G.H.Q. lines; look after the construction of G.H.Q. lines, construction of strong points between G.H.Q. lines and subsidiary lines; look after special railroad construction immediately behind G.H.Q. lines for the use of artillery; construction of all roads in the corps area up to the G.H.Q. lines, and all main roads from there forward to the most advanced point of motor transport; look after the construction of artillery route roads (both highway and railway) for supplying the heavy artillery with ammunition.

The C.R.E. (or Colonel of Divisional Engineers) has at his command divisional engineer headquarters, three field companies, the ordering of the work of one pioneer battalion and one tunnel company. He usually attaches one field company to each infantry brigade to aid them in carrying out the work in their area. The work in their area consists of the maintenance of the front line; communications to the support line; the support line; communications to the subsidiary line; and all strong points between the subsidiary line and the support line. In some instances they are given the maintenance of the subsidiary line to look after. The working parties for this work are supplied by the brigade in the line and are directed by the field company attached to the brigade, but, in addition, this field company looks after the construction of all new lines in front of the subsidiary line which may or may not be built by working parties supplied by the brigade; the construction of the subsidiary line, which is usually constructed by troops supplied by division; the construction of strong points immediately behind the subsidiary line by working parties supplied by the division; the digging of wells in the billeting area of the brigade; the construction of roads in the brigade area which are not main roads looked after by corps, and the construction of huts for billeting reserve battalions of brigade; construction of routes for the use of working parties in dry weather; and all the innumerable drainage schemes required in the rear brigade area, also the construction of light railroads in the brigade area. At the same time, considerable portion of the personnel of this company may be working under C.R.E. for construction of such things as divisional bath-houses, Y.M.C.A. recreation huts, etc.

The C.R.E. usually splits up his pioneer battalion by keeping one company to work directly under his own orders and attaching each of the other three companies to a brigade to work under the orders of the respective field companies. The tunnelling company works directly under the orders of the C.R.E., and is supplied with material and working parties by the field company in whose brigade area the tunnelling company may be operating. The C.R.E. for the construction and maintenance of the works looked after by him also gets working parties from corps troops, such as battalions in corps reserve, dismounted cavalry, and any other units who may be at the disposal of corps and lent to division.

The lecturer emphasized the point that engineering work at the front was carried on by "working parties" drawn from the infantry and pioneer battalions, a "sapper" from the engineers being in charge of each working party. The sapper must, therefore, be the foreman type—a man who can handle men and lay out work. The engineer N.C.O. has charge of his sappers, and therefore of a number of working parties; and the engineer subaltern in a field company has charge of the engineering work in the front, held alternately by two infantry battalions.

Capt. Mathieson described the interesting features of trench construction, construction of strong points, splinter-proofs, dug-outs, etc.; and told of the large amount of standard engineering material needed in this work, which standard material was made up in the engineer parks in the rear. These standard materials include splinter-proof frames, dug-out frames, "A" frames for trench riveting, bath mats, wire entanglements, etc. This engineering material is made up by working parties of tradesmen under supervision of sappers; and is brought up to the trenches by horse transport and by carrying parties. He outlined some of the difficulties met with by the engineers in siting trenches in ground which had been contested again and again, resulting in the mud being many feet deep and interlaced with miles of wire entanglement, steel beams, corrugated iron, rifles, shell splinters, bodies, trench revettment, etc. To get a line of trenches fightable in ground such as this, doing the work at night in the dark, is no child's play.

Capt. Mathieson concluded his talk with a strong appeal to every one present to get at least one man of the type required as a sapper in the engineers interested, so that he would see Lieut. Armer at the Armouries, Toronto, and enlist in the Canadian Engineers.

RAILWAY EARNINGS.

The following are the weekly earnings of Canada's transcontinental lines during February:—

Canadian Pacific Railway.

	1917.	1916.	Inc. or dec.
February 7	$1,890,000	$1,876,000	+ $ 14,000
February 14	2,180,000	1,912,000	+ 268,000
February 21	2,225,000	2,093,000	+ 132,000
February 28	2,537,000	2,665,000	— 128,000

Grand Trunk Railway.

February 7	$ 928,462	$ 937,937	— $ 9,475
February 14	828,671	957,195	— 128,524
February 21	956,487	949,490	+ 6,997
February 28	1,129,386	1,174,099	— 34,713

Canadian Northern Railway.

February 7	$ 493,600	$ 429,400	+ $ 64,200
February 14	602,000	453,100	+ 148,900
February 21	598,700	559,000	+ 397,000
February 28	664,300	647,700	+ 16,600

Wallace and Tiernan Co., Incorporated, 137 Centre Street, New York City, manufacturers of chlorine control apparatus and scientific engineering specialties, announce the following changes in their organization, and additions to their technical staff: A Chicago office has been opened at Peoples Gas Building, Michigan Blvd. and Adams St., Chicago, Ill., Room 550, with Mr. C. A. Jennings in charge. Mr. Jennings is well known to waterworks men through his connection with the Bubbly Creek Filters of the Union Stock Yards, and his research work in the field of water purification, particularly along the lines of chlorination. Mr. H. K. Davies will be transferred from the New York office to Chicago as assistant engineer to Mr. Jennings. Mr. J. C. Kaelber has been appointed to the technical staff as assistant engineer. Mr. Kaelber is a graduate of the University of Rochester and formerly connected with the Western Electric Co. Mr. R. V. Donnelly has also been appointed to the technical staff as assistant sanitary engineer. Mr. Donnelly is a graduate of Columbia University and formerly connected with the New York Continental Jewell Filtration Co.

AGRICULTURE AND THE ENGINEER

ABSTRACT OF AN ADDRESS DELIVERED BEFORE THE OTTAWA BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS BY HON. MARTIN BURRELL, MINISTER OF AGRICULTURE

WOEFULLY deficient in engineering knowledge, I have a whole-hearted admiration for the work of the engineer and what it stands for. It has been cynically said that a man with a powerful voice, and rapid utterance, no matter what he says, can attain a high authority in politics. I cannot, of course, be expected to subscribe to such a half truth, but, in any case, the engineer does not achieve authority in this way. He is a doer and not a talker, and in the long run it is doing and not talking that counts.

To be an engineer in the best sense of that word a man's whole attitude to his life work must be charged with sincerity, and sincerity is one of the fine things of life. Nature and nature's laws cannot be cheated. Successful achievement is only possible by understanding and co-operating with the eternal laws of the universe. There is, therefore, a continual incentive to clear thought and high endeavor. Difficult problems the engineer must face—as we all have to face, but, in solving them, he has the supreme satisfaction of knowing that his accomplished work abides, a silent and powerful witness that he has not passed through this world in vain.

I think, gentlemen, it must be easier for an engineer than for a man in public life to stick to his ideals. We cling to them as long as possible, but find them hard to attain. Too soon it becomes like the case of the Irishman with his pig. When he killed his pig he said, "It didn't weigh as much as I expected, and I never thought that it would." Nevertheless, it is good to cherish even unattainable ideals.

By virtue of being engineers you are specialists and I envy you the ability and the opportunity of giving undivided thought to the one task which, for the time, is yours. Our fate is different—a kaleidoscopic change of tasks, with no time to concentrate on any one of them. Democracy, as many understand it, implies the right of free access at all times to those who are carrying on the affairs of State. You reach your office in the morning and find a bulky mail, to which two hours' undistracted attention should be given. In half an hour your secretary announces someone who insists, without previous appointment, on discussing a nice, brief, compact little question like that of oriental immigration. Your visitor points out the transcendent importance of this subject to the future of Canada and the Empire. You may have given this subject some careful study, but, convinced of the futility of either giving or receiving anything of real value in a quarter of an hour, you nevertheless give the quarter of an hour. The mental slate sponged clean, you turn back to the correspondence. Ten minutes pass, when another member of the democracy is announced. You fume inwardly, but are told he has travelled 1,200 miles to see you and the matter is urgent and important. He is shown in and at some length, and with great vigor, informs you that in respect to a certain matter he has been treated so rottenly that, unless reparation is at once made, neither you nor your government will last longer than a cat in h——. We are, in a sense, engineers of the State. Gentlemen, don't you think we deserve credit if, under these circumstances, we can still call ourselves "civil" engineers?

And now, as I have exhausted my time and possibly your patience, I turn to my title, "Agriculture and the Engineer." If directly engineering has little to do with agriculture, indirectly its relationship is vital. It would hardly be too much to say that agriculture and engineering are, of all professions and arts, the most important to the world at the present moment. As an agriculturist, my chief contact with engineering work has been in connection with irrigation. In the large western district with which I am especially familiar, the work of the irrigation engineer is indispensable to successful agriculture. Water, the conductor of food to the growing plant and a necessary constituent of the mature plant, whether fruit or vegetable, is a vital factor. In addition to the immense evaporation through plant respiration, 40 or 50 tons of water per acre will be evaporated from the soil itself on a warm and windy day. With a rainfall of only 8 to 12 inches per annum, it is easy to see where the irrigation engineer comes in. I bear testimony to the immense value of his services in those districts where I have had personal knowledge of his work, and if I had time I could indicate what you are doubtless familiar with —the vast areas of the world's surface in India, Australia, Japan, United States and other countries which have been made to serve man's needs by the skill, the efficiency and the integrity of the engineer.

Undoubtedly the engineer's services to agriculture are incalculable. Without his work in the construction of railroads, bridges and roads, the produce of the agriculturist would be unavailable to man. There are many other ways in which the engineer's services are of immense use; I do not think it is necessary for me to dilate on them. Engineers and agriculturists, we are all aiming at the same things; that is, to produce, and to reduce the cost of production. Your function, perhaps, is more concerned with the latter than with the former purpose. I have heard it said to-day—I think it was your chairman who said it—that one of the functions of engineering was that any engineer could make a dollar go farther than a fool could two dollars. One of the functions of agriculture is to make two blades of grass grow where only one grew before. There is an intimate relation between the services that the engineer and the agriculturist can render to the State. When I think of the vast northern country that is familiar to me, all up through Cariboo, for instance, where for something like forty or fifty years men were living and toiling and producing two or three hundred miles away from what we know as a modern system of transportation, and when I come into contact with the people in that region, I get an evidence of what the engineer's work is by the longing they all have for better and easier modes of transportation, and I realize how intensely important the work of the engineer is, even to agriculture.

To one who has lived as I have in British Columbia, the indebtedness to the engineer must be ever present. Again and again as I have travelled through the mountains, at times almost on the roof of the world, looking down from a slender span of steel to the vast depths below, I have paid a silent tribute to the arduous labors and the marvelous skill of the men who had the courage to go out into the wilderness and build those monuments of human enterprise and human activity. I do not think any man who has travelled through British Columbia can help but pay a most unqualified tribute of admiration to the construction engineers who have done that work for the far West.

After all, it was something more they did than to build railroads. When the roar of the first Canadian Pacific train was heard through the canyon of the Fraser, it meant not only that a great highway had by engineering enterprise been built, by which people could transport their produce or go from one point to the other; it had a higher, a moral, a national value, in the sense that the work of the engineer was the great work that bound brother to brother and made the solidarity of this people from the Pacific to the Atlantic an accomplished fact.

I fear, gentlemen, that perhaps I have already talked too long. I desire again, before I sit down, to express my pleasure at being with you to-day and my wish for the greatest possible success to this branch and to the work of your whole Society. At a time like this, when the shadow of a great conflict is upon the minds of all, when we in Canada and the people of the allied countries wake up from morning to morning not knowing what gruesome or terrible thing may happen next, when all minds are tense and all energies are strained, when perhaps at times we get impatient, critical of each other, sometimes not any too wisely, and especially when the demand for service of the highest kind is upon us all, it must be, I am sure, an immense satisfaction to you gentlemen who are engineers, as it is to me, to know that so magnificent a showing has been made by your own brotherhood—that almost 25 per cent., as I understand, of the members of the Canadian Society of Civil Engineers have taken up the burden and are now fighting or otherwise rendering service at the front.

When England to-day is under such a shift that she is ploughing up her beautiful parts, is enlisting the services of women, and disabled soldiers, in the determined effort that if her supplies are cut off, or partially cut off, she may produce more than she ever produced before, we can understand the part that agriculture is playing in this war. But engineering is playing no less vital a part, for without the services of the engineers the advance and the achievements on the western front, or on other fronts, would have been absolutely impossible. We may say almost that this is a war of science and invention. The methods of old-time battles and old-time wars are long passed out of existence, and modern skill, modern ingenuity, modern brains are essential. Those of the engineers have been called into requisition and will unquestionably play a leading part in the triumph which sooner or later must come. I can only say, in sympathizing with you and in congratulating you upon the contribution which your own Society has paid, by the heroic sacrifices that your members have made in direct participation in this war, that there remains for us who are staying behind, who have not gone, whether we be engineers or whatever be our calling and our work in life, there remains for us the supreme duty of doing all we can to strengthen the hands of those who are fighting our battles, and to build up this nation along true and permanent lines. And in such a work, Mr. Chairman, I am absolutely sure that the engineers of Canada will play their part.

EARTH AND GRAVEL ROAD MAINTENANCE.*

By A. McGillivray, A.M.Can.Soc.C.E.,
Highway Commissioner, Manitoba.

MAINTENANCE, as applied to roads, means the act of preserving or keeping these roads in a particular state or condition attained by proper construction. Repair is the act of restoring to a sound or good condition. Repairs are very often necessitated by the lack of maintenance. Thus there is a wide difference between the two operations. The importance of maintenance cannot be overestimated, because no type of road was ever constructed or possibly ever will be constructed that is entirely permanent.

It should also be thoroughly understood that a road should be built before it is maintained. The necessity of maintenance will usually commence as soon as the road is completed. Especially is this true on earth and gravel roads. Money is often spent under the so-called name of maintenance in an effort to keep open for traffic, an improperly designed or only partially constructed road. There is little or no excuse for this in a well-organized municipality; and it is entirely wrong in principle. There are many agencies, such as the action of the elements, the narrow tires of wagons, the steel-shod hoofs of horses, the driving wheels of heavy automobiles and trucks combining to displace and destroy materials in a road and to hasten the process of deterioration, that the greatest care should first be exercised in forming these materials into a properly designed road and then preserving the structure in good travelling condition. It is only by a thorough appreciation of these facts that older countries have been enabled to attain such excellent roads as they now possess, and which have made them the objects of emulation by other countries seeking to create systems of highways that will meet the requirements of modern-day traffic.

It is generally conceded as good financing to issue long-term debentures (say, for 20 or 30 years) for the purpose of creating a fund to construct roads, but no plan of road improvement is complete no matter how well the many factors entering into its construction may have been considered that does not provide for the inevitable necessity and expense attached thereto of maintaining these roads once they are brought into existence. The futility of not doing so must be apparent to anyone who has given the subject the slightest businesslike consideration. The drainage ditches, culverts of durable materials and the earth road bed if properly constructed are the most permanent features of a road, and can possibly be classed as permanent works. But even these will require certain attention to ensure the continued performance of their respective functions. Gravel, broken stone or any of the other numerous road surfacing materials are directly subjected to the destructive agencies that tend to destroy a road, and the value and usefulness of these materials would soon be lost if left without any care or attention in offsetting these destroying influences. It can be truly said that the amount of road construction undertaken by a township, county, municipality or province should be measured by the ability of such organization, financially and in other respects, to maintain the roads after they are constructed. In this way only can expenditures for this work be safeguarded, and the greatest benefits accrue from money and energy spent.

Good maintenance comprises such works as the cutting of weeds that persist in growing along the roadsides

*Paper read before the Manitoba Good Roads Association.

the removing of silt, rubbish and other obstacles that impede the flow of water in the side ditches and through culverts, the filling up of ruts and depressions that continually develop in the surface of the road. To these may be added, in the cases of earth, gravel and stone roads, the replenishing of the surface at necessary intervals with materials to replace what has been destroyed by traffic and other elements removed therefrom in the form of dust and mud.

Weeds and brush, if permitted to grow along the highway, are, to say the least, unsightly. Their existence is also a menace to the proper drainage of the road surface, as they interrupt the flow of water on the road to the side drains and prevent it from escaping quickly to the outlets. They are also a source of obstruction to the flow of water through culverts and it is a common occurrence on poorly maintained roads to see culverts almost wholly choked up with a heavy growth of weeds and grass. Heavy snow drifts with the well-known results of impassable roads during the winter months, are also attributable to weeds and brush that are permitted to grow unchallenged along the roads. These snow-drifts have also their injurious effect upon the roads in the spring of the year, by the delay caused in the opening up of the drains and by the increased moisture on the road from melting snow. It is important, therefore, to keep the roadsides clear of this rubbish which can easily be done with the assistance of a mower. The encouragement of the growth of some suitable grass, say, white clover, along the roadsides might profitably be considered, as a preventive to the growth of noxious weeds and also as a protection to earth embankment against erosion by water and the continual wash of heavy rainstorms.

When we consider the importance of drainage to the welfare of any road, nothing should be left undone within reasonable bound to keep the system in as perfect a condition as possible. Drains, if neglected, will become filled up and obstruct the free flow of water through them. Very frequently some small obstruction in a drain if not removed will accumulate a mass of debris and sediment behind it, that will in a short time create a veritable dam. A vigilant watch should be kept over the drains to see that they are performing their work. Evidences of silting and the formation of obstructions caused thereby can be detected after the water from a rainstorm has subsided and by the presence of pools of water in the bottom of the drains. The removal of a few shovelfuls of earth will often be all that is required to give the water a free passage through the drains. Road culverts should also be carefully examined, especially before winter sets in, to see that they are free from obstructions and in a position to carry off the spring freshets. A great deal can be done also in the spring of the year in assisting the drainage of roads by opening up the ends of these culverts which become filled with snow and ice during the winter and usually remain in a frozen condition much longer than in the more exposed portion of the ditches.

The effect of traffic on an earth or gravel road is the development of ruts and depressions in its surface. This is considerably augmented on a country road by the drivers of vehicles following one another in practically the same line, thus making a track on each side of the centre of the road. While it seems quite a natural thing for traffic to use the centre of the road, still drivers are sometimes forced to do so on account of excessive crown on the surface which places his vehicle in an uncomfortably inclined position for riding if he drives on either side of the centre line. A road should be given sufficient crown and only that amount to shed the water that may fall on its surface. A fall of one inch to the foot will be enough for that purpose and will also leave the sides of the roadway sufficiently flat for comfortable travelling.

To counteract the effect of traffic on the road by preventing as far as possible the cutting of its surface into ruts and depressions with its consequent injurious results on the whole structure, is the one great problem involved in the maintenance of earth and gravel roads. It must be prevented from lying on its surface until it is absorbed into the foundation soil. If permitted to do so, the destruction of the whole road is only a question of a short time.

The split-log drag or an equivalent drag is a very useful implement for maintaining a smooth surface on an earth or gravel road. It is also inexpensive and easy to handle. It should be light, and hauled over the roadway at an angle of from 30 to 45 degrees with the centre line. The dragging should commence from the sides of the roads, moving only a small amount of earth towards the centre with each operation. The road should be dragged after each shower of rain and at such a time when the earth will move freely and still contain enough moisture to pack solidly. Dragging a road when the surface is dry and hard is of litttle avail and is usually a waste of time and money. No one should know better than the operator the proper time to drag a particular piece of road. Experience is certainly the best teacher in this respect. If he applies good commonsense practice in handling the work, success will attend his efforts and it is only by doing this that the results of his labor will be satisfactory.

A municipality should have in operation some definite policy of maintaining at least its main highway. Without doubt the best system for all roads is one that provides for the continuous employment of men who could have charge of certain sections of roads, and who would become expert at the work. It is obvious, however, that the cost of carrying out such a system would be more than the financial standing of a great many districts will permit. But there is no municipality so poor that it cannot afford to put into practice some form of systematic maintenance on its main travelled roads. A few men working continuously on the roads will accomplish more real good for the same outlay of money than a correspondingly larger number working intermittently for short periods. For instance, the service of one man on a stretch of road for thirty days will be of more real worth than that of thirty men for one day.

In a rural district and especially so in the prairie provinces where the earth road is and will be for many years the predominant type, a method suggested for the care and upkeep of these roads and one that appears to be practical and productive of the most satisfactory results, is that the council of a municipality divide its main highways into sections of at least two miles or at the most three miles in length. Contracts should then be arranged with the nearest resident to each section to drag such stretch of road during the whole open season and until freeze-up in the fall, the council furnishing him with a drag with which to do the work. The contract price should be based on a fixed sum per mile of distance travelled by man and team for each operation. The road commissioner, who in many of the western municipalities is the councillor for the ward, should see that the dragging is done whenever it is required. Information as to the condition of the road, and the need of dragging can be obtained by using the telephone, which system is now so well established in all the settled districts. A record of the work can be kept by the dragger after each dragging. This report would show the number of rounds made over the section of the road, the miles travelled in doing so, and when certified by the road commissioner or councillor would constitute a voucher for payment. This plan has been adopted in the State of Minnesota and in at least one of the municipalities of this province with splendid success. Needless to say, the active co-operation of the resident farmers and their willingness to undertake and perform the work are essential to the success of the scheme. The number of times a road should be dragged varies with the seasons and the nature of the soil. Heavy retentive clays will rut much easier than lighter soils with better natural drainage. The whole drainage system of the road influences in a marked degree the problem of maintaining a smooth, properly crowned surface. On an average, an earth road will require to be dragged about twenty times during the season. One trip over the road each time is usually all that is necessary. At any rate, an effort should be made to keep it from rutting so deep as not to require more than one application to restore an even surface. Should the road become deeply rutted during a protracted rainy season, it will sometimes be necessary to use a blade grader to trim the shoulders of the road and crown the surface into proper shape again before using the drag.

A gravel road will not require as much dragging as an earth road, especially after it has been used for a year, and the gravel has become thoroughly compacted. However, during the wet season, ruts will develop under heavy traffic, and the drag will be found most useful in restoring a smooth surface. Stones, which become loosened, or have not been securely incorporated in the gravel, should be removed from the roadway. If left lying about on the surface, they are most annoying and discomforting to the users of the road. They should be raked in piles and removed to the sides of the right-of-way. They can very often be used to good advantage in rip-rapping the ends of culverts as protection from erosion.

Undoubtedly the best results in the maintenance of a gravel or stone road can be obtained by the continuous employment of labor during the season. The road should be divided into sections about six miles long with each section assigned to the care of one man. This man should be equipped with a rake, shovel and wheelbarrow. Small piles of gravel should be distributed along the road at frequent intervals, so that small depressions or holes can be filled in and levelled up before they assume larger proportions. Once a depression begins to form in a road surface, its growth is accelerated by the action of vehicles bumping into it. Such a place should receive immediate attention by filling in a little fresh gravel and restoring the surface to a uniform elevation. Under no circumstances should the road be permitted to become covered with depressions and bumps. But an even surface should be maintained and the road and vehicles travelling over it thereby protected, and which would also add to the comfort and pleasure of those using it.

A gravel road will require additional material placed on its surface from time to time to replenish that worn off by traffic. The amount required and the frequency of such renewals depends upon the care given to the general maintenance of the road and the amount of travel on it. The best time to place new gravel on a road is in the spring of the year. The seasonal rains and moisture will assist greatly in binding the new gravel to the old surface and consolidating the whole mass. Lighter coatings at one time with more frequent applications will be more economical than allowing the gravel to wear down to such an extent as to necessitate a heavier coating to restore it to proper thickness.

A lively interest should exist in every community in connection with keeping the roads in a properly maintained condition. The awarding of a small prize for the best kept road in a municipality has a tendency to promote this desired effect and to create a friendly rivalry among the residents in keeping their respective roads up to the highest standard. The work of the Manitoba Good Roads Association in carrying out its annual competition for the maintenance of roads with the split-log drag is commendable and has done a great deal to encourage the using of this implement throughout many of our municipalities.

The Department of Public Works has issued regulations whereby a municipality will be assisted financially to the extent of $2.50 per mile of road maintained during the season by the split-log drag under a properly organized system, and also in appointing a demonstrator to explain in a practical manner the best methods of using the drag. More municipalities should avail themselves of these advantages and place their roads under some organized system of maintenance.

The securing of good roads is first the application of the best principles in construction and constant vigilance maintained.

ROAD SUPERINTENDENT SYSTEM TO BE ABOLISHED.

Radical changes in the system of public works construction throughout the Province of British Columbia are foreshadowed in the Public Works Department at Victoria by recent orders coming from the minister, Hon. Dr. King. The road superintendent system will be abolished and the plan which it is said that Hon. Dr. King will bring into effect will mean the appointment of a number of qualified civil engineers, who, with their staffs, will be under the Civil Service Act, and who will each have charge of a section of the province. They will have road foremen for each section. Instead of a road superintendent for each constituency the scheme will mean a road engineer for three or four, or possibly more, ridings. He will be able to do his own engineering work and his road foremen will carry out construction under his direction.

Mr. John A. Traylor, Western Manager of the Traylor Engineering and Manufacturing Co., and the Cement Gun Co., with headquarters at Salt Lake City, Utah, has just opened branch offices for these companies at Spokane, Wash., in charge of Mr. C. H. Adeling, and at El Paso, Tex., in charge of Mr. Robert M. Peabody. The increase in the demand for heavy crushing machinery in the Western territory, and the desire to more thoroughly meet the demand, has made such a step necessary.

In a circular offering a new issue of $1,000,000 first mortgage bonds, George C. Warren, president of Warren Brothers Co., of Boston, states that 41,964,877 sq. yds. of Bitulithic and Warrenite pavements have been laid during the past sixteen years, and 2,233,880 sq. yds. were carried over into 1917. In 1916 there were laid 5,519,765 sq. yds., and there are already in hand orders for 2,584,053 sq. yds. for 1917. "The demand for improved pavements is rapidly increasing, with every indication that the demand will continue for many years to come," says Mr. Warren. The average net earnings of the company for the past five years were $487,626.15, or an average of about $.104 net profit per square yard of pavement laid by the company or by its licensees.

FLUSHING—ITS PLACE IN THE STREET CLEANING FIELD.

By Raymond W. Parlin,
Engineer with the New York Bureau of Municipal Research.

THE various methods of cleaning streets which have been so far developed or which are in the process of development may be classified as: (1) Street sweeping; (2) street washing; (3) vacuum cleaning. Of these three general methods the latter has just begun to emerge in a somewhat imperfect form from the experimental stage. Although vacuum machines are on the market, their value has not as yet been definitely established and this method cannot be considered as being practically available for general adoption.

Fine Dust Problem Forces Changes in Methods.—The extensive use of the automobile has accompanied the great extension of the area of hard surfaced pavements and the increasing demands on the part of the public for clean streets. This high-speed traffic on the smooth street surface has made the fine dust nuisance much worse and more noticeable to the people. The various methods of sweeping both by hand and by machine have, even with the most improved types of sweeping equipment, failed effectively to solve the fine dust problem. Changes in method have been forced upon the officials.

So definite are the needs of the cities for results better than those produced by sweeping that it may be safely prophesied that sweeping in the future will cease to be the primary method of cleaning a modern city and will become an auxiliary to other more efficient methods or used where only rough cleaning is desired.

Sprinkling an Expensive Nuisance.—To reduce the dust nuisance most communities have, prior to the development of satisfactory flushing equipment, systematically sprinkled the street surfaces in the business and many of the residential sections. Sprinkling temporarily sticks fine dust to the pavement. On hot days the effect of this work is so soon lost that numerous repetitions are

Fig. 1.

necessary to prevent the recurrence of dusty conditions. Careless driving of sprinkling carts and poor judgment in the use of water have been common causes of muddy streets or the splashing of pedestrians. Accidents due to the skidding of vehicles on the greasy surface of a wet and dirty street have also occurred.

In general, sprinkling has been considered a necessary evil, but now it can better be termed in all but a few cases an expensive and unnecessary nuisance that should be eliminated by the substitution of a method of cleaning which removes the cause for sprinkling.

Washing vs. Vacuum Cleaning.—The vacuum cleaner presents great possibilities in the removal of fine dust without the use of water. Equipment has already developed which will effectively clean smooth pavements which are in good repair. On rough block streets or wherever depressions exist these machines leave much to be desired. Assuming that entirely satisfactory equipment of the vacuum type is perfected for dry cleaning, and it is believed that such equipment will be developed in the near future, it is questionable whether this type of

Fig. 2.

machine will ever be able effectively to remove mud or wet dust. At present it is obvious that the only practical method available for combatting the fine dust and mud nuisance is some form of pavement washing.

The methods of pavement washing are divided into two main groups: (1) Pavement scrubbing; (2) pavement flushing.

Scrubbing Method Limited to Smooth Pavements.—Pavement scrubbing is almost entirely limited to the use of machine squeegees, although in Europe hand squeegees are used to some extent.

Machine squeegees may be either horse-drawn or automobile-driven. This type of equipment consists of a heavy roller equipped with rubber fins usually attached behind or under a water tank. The roller is rotated against the pavement after the street is heavily sprinkled (either with water from its own tank or from other equipment). It scrubs the surface thoroughly wherever it touches, driving the mud wave or stroke toward the gutter. There the heavy material settles, the water drains off, and it is possible to pick up the dirt from the surface of the street.

This equipment by its very nature is practically limited to smooth pavement in good repair, such as asphalt, asphalt block, wood block and perhaps concrete. On such streets it produces very effective results with a limited use of water.

Motorized squeegee equipment, though in use for a number of years in Europe, has only recently made its appearance in this country.

Flushing Development.—The general adoption of flushing in the last few years is marked. This has been largely due to the introduction of new types of equipment, especially those mounted upon automobile trucks.

Flushing is naturally divided into two classes: (1) Hand flushing equipment; (2) mechanical flushing equipment.

Probably the first flushing of streets in this country was performed at irregular intervals upon restricted areas by the use of the ordinary garden or fire hose. The development of special hand flushing equipment has, however, mainly taken place contemporaneously with that of mechanical flushing equipment.

Hand Flushing Equipment.—Hand flushing equipment may be divided into two classes: (1) Ordinary hose

Fig. 3.

with nozzle and carrier or reel; (2) special pipe lines and other elaborate equipment.

The latter class may best be illustrated by the Buffalo "portable pipe lines," which are characteristic of many of the special developments which have been used both in this country and abroad. (See Figs. 1, 2, 3 and 4.) This class of equipment, as far as can be learned, has the disadvantages of being awkward to handle (very often requiring the use of more than two men and one or more horses), obstructing streets, and resulting in higher costs than is the case with the best types of hose equipment.

A superior type of hose equipment is represented by the type recently developed for use in New York City. This development is given in some detail as it represents an improvement which may be of use even to the smallest city.

Recent Improvements in Hand Flushing.—Early in 1914 Commissioner John T. Fetherston, of the New York

Fig. 4.

Department of Street Cleaning, found it necessary to improve both the equipment and the procedure used in hand flushing. The commissioner formed a committee among his officers to report on the flushing as then done and to suggest changes. Very few concrete suggestions were secured and it was thought best to make a further investigation. At the commissioner's request the department of water supply, gas and electricity, which has charge of the water system, and the New York Bureau of Municipal Research, an organization independent of the city government, both lent their co-operation; the former with the view to finding some way of reducing what it considered an unnecessary waste of water, and the latter as a part of a program of co-operation with a view to assisting the commissioner to discover and install standard procedure in the department.

Hand flushing was considered at this time to be one of the most important subjects needing study, for several reasons:—

1. It constituted in the minds of the department officers the only satisfactory means which was immediately available for combatting the fine dust and mud nuisance.

2. No money for special equipment of a more expensive nature could be secured and the commissioner wished to do better cleaning.

3. Complaints regarding the methods of performing this work were numerous, especially from the officers of

Fig. 5.

the water department, who felt that great quantities of water were being unnecessarily wasted and who threatened to forbid the continuance of the work.

4. It was believed that by the development of some simple new equipment and better procedure greater economies both in water and in labor could be secured.

5. It was believed that the use of hand-flushing methods would be especially effective in securing a quick clean-up after snow storms, when mechanical equipment would not be satisfactory.

6. It was not certain that mechanical flushing would really be as cheap as hand flushing under New York City conditions.

New York Formerly Used 2½-inch Hose.—Up to the time of the study the department of street cleaning had been using ordinary 2½-inch fire hose and 1¼-inch nozzles. The equipment was carried on the regular sweeper's can carrier or dragged over the pavement from place to place by sweepers. That this equipment was not only ill adapted to the work, but heavy, unsightly and liable to cause rapid deterioration of the hose on account of the sharp bends which were necessary, can easily be imagined after observing Fig. 5, which shows a sample of this old equipment. Investigation indicated that: (1) An average of 1,800 gallons of water was being used per thousand square yards of pavement cleaned; (2) other cities were using smaller sizes of hose and nozzles with apparent satisfaction; (3) 1½-inch and 2-inch hose and small nozzles would do the work of cleaning properly. Objection was raised to the recommendation that hose as small as 1½-inch be used.

Experiments Lead to Adoption of Two-inch Hose.—Two points of view developed, one looking primarily at the waste of water and the other at the waste of time. It became necessary to run a second set of experiments to determine the size of equipment which would be cheapest to operate from the taxpayers' or general city viewpoint, taking into account both the cost of labor and the cost of water.

This second set of experiments, conducted alternately upon 1½-inch and 2-inch equipment, resulted in the selection of the 2-inch equipment as standard for the city. Attention was at the same time called to the possibility of using the smaller size with equally good results wherever the pressures at the hydrants were in excess of 50 pounds per square inch.

General Principles Established.—As a result of these and further experiments, the following general principles appear to be established:—

1. That the economical size of equipment is dependent upon the hydrant pressures available and the length of hose used.

2. That when the pressure at the nozzle is in excess of 25 pounds per square inch, water is delivered through a ¾-inch or 1-inch nozzle faster than it can be properly used by two men and that it is accompanied by excessive splashing.

3. That when the pressure at the nozzle is less than 18 pounds per square inch, water is not delivered fast enough to keep up with the men nor with force enough to enable them to do effective work.

4. That the smallest size of hose which will give pressures at the nozzle between 18 and 25 pounds is the most economical for use.

5. That better results can be secured by spraying ahead as far as the stream will reach, to give the material

Fig. 6.

on the street a preliminary soaking prior to the direct flushing, than can be secured by the direct flushing of a dry pavement.

6. That larger quantities of water are required to clean rough pavement than smooth, and therefore a slightly larger nozzle may be used to advantage. (It is estimated that a ¾-inch will be satisfactory for asphalt and a 1-inch for rough Belgian block.)

7. That shut-off nozzles are necessary whenever working in traffic, both to save water and to prevent accidents.

8. That where water mains are large enough for

Fig. 7.

proper domestic and fire supply, flushing will not interfere with the ordinary household use.

9. That a hose reel will enable the gangs to do more work with the same expenditure of energy and at the same time lengthen the life of the hose.

10. That by the adoption of procedure which prevents any "back-tracking" of the equipment, over four miles of walking can be saved per gang per eight-hour day in covering a given amount of street, as compared with the procedure commonly used in the past, which saving enables the gangs to do more work.

Equipment and Procedure Improved.—As a result of the studies and conclusions reached, a new hose reel, new hydrant equipment, and improved procedure were adopted by the department and put into effect. (See Figs. 6 and 7.)

The procedure in handling the equipment may be described as starting with the hose reeled so that the nozzle is on top or outside; commencing to unreel when at a distance equal to the length of the hose from the hydrant; unreeling toward the hydrant; placing the reel on the sidewalk near the hydrant; flushing from the point nearest the nozzle past the hydrant and as far as the hose will reach beyond the hydrant; and reeling from the hydrant toward the nozzle; thus completing the area served by a single hydrant. Whenever moving the hose, the "hydrant man" is required to pick it up in loops and drag it ahead in such a way that it will not cross other loops. He is expected to keep a loop at the nozzle end, even with or slightly ahead of the "nozzle man," so that the latter will be free to move without assistance at all times.

Results of New York Studies.—The results of the studies can best be indicated by the illustrations numbered 6 and 7, which show the improved reducer which can be put on the hydrant without the use of a wrench; the improved reel with its tool box, third wheel, and special arrangement for receiving the reducer in winding on the reel; the method of placing the hose along the curb or in the gutter out of the way of traffic; the method of direct flushing; the method of moving the hose from place to place during flushing; the advantage of the shut-off nozzle, and the method of reeling.

The first cost of the equipment is approximately as follows:—

Three 50-foot lengths 2-inch rubber hose at 60c. per foot	$ 90.00
One ¾-inch shut-off nozzle	7.00
One 2½-in. to 2-in. reducer, hand swivel type	2.25
One hydrant key	.15
One hose reel	30.00
	$129.40

(Rubber-covered hose is preferable to cotton-jacket hose for this work.)

THE WORK OF THE ADVISORY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH IN CANADA.*

By Frank D. Adams, F.R.S.

ONE of the most remarkable and perhaps unexpected results of the great war is that there has been in every country of the English-speaking world a sudden awakening to the importance of scientific research, and a recognition of the necessity of applying it to the whole range of problems which present themselves in both war and peace.

The reason for the awakening is quite a simple one—"The Hun is at the Gate." Great Britain developed as an industrial nation long before Germany had achieved any success in this sphere of effort, and the British system of manufacturing and her industrial expansion was developed by the independent and competitive efforts of a multitude of relatively small enterprises built up on the basis of the artificer and trader and in methods of the olden time. In the last decades, however, Germany having realized her national existence through successful war based on study and good organization, became possessed with the idea that she could become equally successful by the application of similar methods to the more insidious warfare of industry and trade. The note of her success was, as has been said, knowledge and organization, both national in extent. By knowledge obtained through research on a most extended scale and by wise organization of all her powers she proceeded to take from the other nations one after another of the productive industries. From the earliest times woad was cultivated in England. It constituted, we learn from the popular histories of England, in these times a not inconsiderable part of the national dress.

With the opening up of trade with the East, the European dye could not hold its own with the cheaper indigo obtained from the Indian plantations, and these until recently controlled the markets of the world. The German chemist, Adolf von Baeyer, however, in 1880 found that indigo could be made synthetically from toluene. What has been the result? In 1896 India exported indigo of the annual value of over £3,500,000. In 1913 her exports of this dye were worth about £60,000, while the export of indigo from the German factories was valued at about £2,000,000. Moreover, in the above period the price of indigo fell from about 8s. to about 3s. 6d. per pound. Forty or fifty years ago, over the whole of southern Europe and eastward to Asia Minor great tracts of land were devoted to the growing of the madder plant. In France alone 50,000 acres were devoted to its culture. From it was made the bright red dye still known as Turkey red. These madder fields have now all disappeared, for the chemists now make it cheaply, and instead of 750 tons of alizarin extracted from madder roots in 1870, over 2,000 tons are now annually manufactured in chemical works.

The glass industry of Great Britain was stolen away slowly but in a large part. At the outbreak of the war there was being made in England only a couple of dozen kinds of optical glass, while over one thousand were being made by our enemies. It was found, in fact, that the very sighting glasses of the British battleships were made of German glass. Many new industries, such as the production of the great variety of new chemical compounds used for various purposes in industry, arts and medicine, were also built up and secured as complete monopolies by the Germans. The most spectacular case of the transference of an English industry to Germany is afforded by the great aniline dye industry. The method of making these aniline colors was first discovered by an English chemist (Perkins) and the manufacture was actually started in England, but was gradually taken over by the Germans and developed to its present enormous dimensions, yielding annually about £20,000,000 sterling, so that at the outbreak of the war it was found that England was hardly producing one tithe of the various dyes needed for her textile industries which have an annual output valued at £250,000,000.

This successful competition, however, was not confined to such products as those mentioned, for in 1895 Germany passed England in the production of steel, and with this advance came the immense development of the manufacture of iron and of machinery of all kinds and sorts.

This devastating war, the hand-to-hand struggle for the actual right to live, has, however, at length aroused Britain to the realization of the fact that we have reached a new age, and the old cannot compete with the new. Now it is the application of science to industry and the organization of the activities of life that tell—the nation which does not recognize this must fall out of the race. "War," as remarked by Sir Wm. McCormick, "is as much an art as ever, but its instruments, originally the work of the craftsman and artist, are now not only forged by the man of science, they need scientific training for their effective use. This is equally true of the weapons of industry. The brains, even the very processes that to-day are necessary to the output of munitions will be needed to-morrow for the arts of peace."

The government of Great Britain having been brought to a realization of these facts, appointed within less than a year after the declaration of war, a committee of the Privy Council for scientific and industrial research, with an advisory committee composed of eight distinguished men of science and engineering "for the development of scientific and industrial research" applicable to the problems of war and the development of the industries of peace to follow the war. This committee has been at work since that time with very marked success.

The government of Australia followed, establishing a "Commonwealth Institute of Science and Industry" on similar lines. New Zealand and India have also expressed a desire to co-operate with the Imperial Government in any possible way. The United States has engaged in a campaign for "preparedness." No less than three separate organizations have come into existence in that country to this end—the Naval Consulting Board, the National Research Council, which was organized under the authority of the President of the United States of

*From an address before the Canadian Mining Institute on March 7th, 1917.

America, by the National Academy of Science, and the Committee on Scientific Research of the American Association for the Advancement of Science. A good deal of opposition has been offered on the part of certain congressmen to the appointment of any government committees for the purpose of "research" or "investigation," owing to the fact that the only use of the words with which they were familiar suggested something malodorous and reminiscent of muck-raking, accusation and scandal.

Coming to our work in Canada. On June 6th, 1916, a committee of the Privy Council, consisting of the Right Honorable the Minister of Trade and Commerce (chairman), and the Honorable the Ministers of the Interior, Agriculture, Mines, Inland Revenue and Labor, was formed by the Privy Council to take charge of all measures "to further the scientific development of Canadian industries in order that during and after the war they may be in a position to supply all Canadian needs and to extend Canadian trade abroad."

On November 29th, 1916, there was constituted an Honorary and Advisory Council for Scientific and Industrial Research, composed of eleven members representing the scientific, technical and industrial interests of Canada.

(References to the work of the Council have been made in recent issues of *The Canadian Engineer*. See March 1, 1917.)

Among the various subjects to which the Council will address itself in the immediate future may be mentioned the best method of tabulating the natural resources of the Dominion so that all the information which exists concerning them in various government departments and elsewhere may be made readily available. This is a task which it is one of the functions of the government to carry out, and which can only be accomplished satisfactorily by government agencies.

Another very important subject which the Council had under consideration is the best method of gathering about it and associating with its work, committees of gentlemen who have made special studies or who have expert knowledge in certain special industries in any certain definite subjects, and who will be willing to help forward the development of Canada by affording their advice and assistance in their special lines. The Council also has had submitted to it some 44 separate projects. These are already under consideration, or will receive consideration at an early date. Still other proposals have been submitted, while embodying a cheerful optimism and not altogether devoid of humor, will not require such an extended study.

In conclusion, I would remind you that the encouragement of research and the application of science to all our industries and undertakings is a great national work which must be carried forward along many lines and in many ways. The members of the Council will use their best and most strenuous efforts to secure results commensurate with the importance of the work, and they ask you one and all to aid and assist in every way in your power this great work with which the future of our Dominion is so largely bound up.

A rush order for one hundred carloads of lumber, approximating 2,000,000 feet, has been placed with British Columbia mills by the Canadian Government. The Cameron Lumber Co., of Victoria, will supply about ten carloads, and the balance of the order is distributed among all the coast mills which are capable of turning out a few carloads at short order.

PRINCIPLES INVOLVED IN COMPUTING THE DEPRECIATION OF PLANT.*

By F. Gill and W. W. Cook, M.M.I.E.E.

It is not very satisfactory that engineers should hold such divergent views on so important as question as depreciation. Possibly this is due to the subject being regarded as one for the accountant alone, but in our view depreciation concerns the engineer, the financier, the accountant, and no one of the three is competent to settle the question in any particular case, as, in order to obtain correct results, there must be co-operation between the three.

While this is true in the application of the principles, it is also true that each of the three parties concerned must study the question in all its bearings, and it is just as important that the engineer should understand the financial aspect as it is for the others to follow the engineer's methods in his share of the work.

The depreciation component of cost is very often a dominating one, and it is surely illogical to leave this matter in its present unsatisfactory position while devoting time and money to investigating questions which have far less effect on the total cost.

We can discover no reason why there should not be general agreement on this question; it is so largely a question of fact, and because it is possible to demonstrate the correctness or otherwise of any system, there seems no justification for resorting to mere assertion and appeal to authority in support of any particular theory.

There is no difference of opinion as to the importance of the subject and the necessity for making some provision for depreciation. All plant has a limited life; at the end of its life it is worth nothing, except the value of the material as scrap, and it is clear that, from the moment it is first brought into use to the end of its life, a process of diminution in value is going on continuously.

Although much has been written on this subject, the only points on which all the writers agree are that:—

(*a*) The matter is one of great importance.

(*b*) The term "depreciation" is loosely employed and has various meanings.

A good deal of trouble has been caused by not strictly defining the scope of the subject under discussion, and misunderstandings may be avoided in the present instance if it is made clear at the outset that by the term "depreciation" is intended to be covered: (1) Provision for the diminution in value of plant in place and working (that is, its loss in value to the owner as a continuing plant), by reason of causes *outside* his control, such as age, wear, and accidents; this provision is hereinafter called "renewals." (2) Provision to enable the owner to take plant out of commission before its physical life is exhausted in cases where, from either progress of the art or growth of the business, it is economically advisable to do so (that is, by reason of causes *within* his control); this provision is hereinafter called "improvements."

It should be noted that the expression "renewals" denotes provision in respect of actual expired capital outlay, while the expression "improvements" denotes provision to enable plant to be destroyed while still valuable.

Nothing is further from our minds than any setting up of standard rates of depreciation for all plant or for any sections of plant. There must always be differences

*From a paper read at a meeting of the Institution of Electrical Engineers on January 11th.

in conditions, and it is unlikely that any standard rates can be devised to serve all conditions.

While saying this, however, it must be made plain that the principles upon which depreciation is calculated remain fixed, even though the application of those unvarying principles under different conditions produce varying results.

We propose, then, to discuss the principles which govern this question, primarily from the engineer's point of view, and it is hoped that if this be successfully accomplished it will be found to lead naturally to the financier's and the accountant's viewpoints also.

The function of the engineer in this matter is to provide the information necessary regarding the plant, such as first cost, residual value, and life.

The function of the financier is to provide information regarding the money, the amount available, the rate at which it can be borrowed, and the rate that can be obtained for the loan of it.

The function of the accountant is to provide accurate records based on the decisions arrived at, and to see that the real results are neither disguised nor hidden.

All three must come to a common decision, and each in any calculations he has to make must work to it, otherwise nothing but chaos can result.

Generally, depreciation seems to have been regarded as almost entirely an accountant's question, to be brought into discussion only when desiring to ascertain how much of the proceeds resulting from the trading of an undertaking may be appropriated as profits. But depreciation is very important long before this stage is reached, and it is because of the great difference in opinion between engineers themselves, as well as between them and financiers and accountants, that this paper is written, in the hope that some agreement, or at any rate some clear views of the different opinions held, will emerge from the discussion.

Depreciation as Affecting the Design of Plant.—When preparing a specification for plant to achieve certain definite results, there is usually more than one way of arriving at the desired end, and skilful judgment in the selection from among the alternatives must be exercised.

While the first cost* of alternative plans is highly important, in most cases it is nothing like so important as the annual charges, and generally the decision as to which alternative to use can be made upon consideration of the annual charges alone.

One cannot escape the duty of studying these costs in detail by saying that the capital cost and annual charges must be minimum figures; frequently these are mutually contradictory.

It may be advantageous to spend extra capital to obtain low annual charges in respect of one portion of the plant, and deliberately to incur high annual charges by reducing capital expenditure on another portion.

Again, it sometimes happens that even the annual charges of the whole plant will not furnish the desired criterion, since they are not the same for each year, and in those cases they must, of course, be brought to some common time-base.

Annual Charges.—Annual charges are composed of four principal parts:—

(1) Return on capital outlay, treated as a charge, because no engineer, unless in special circumstances, is justified in putting down plant which will not pay a return on its own capital. Even in cases where a return on the outlay is not looked for, the nominal interest is a measure of the burden.

(2) Depreciation—as already defined.

(3) Maintenance, the cost of keeping the plant in as good condition as is desirable, but not of renewing it.

(4) Operation—the cost of working the plant.

The first three enter into the annual charges of all plant; the fourth does not. For example, a boiler or a tram car requires to be operated before it can perform its function, but this does not apply to a pole.

Assume a situation in which there is as yet no plant installed, and let there be two alternative ways of achieving the results required, A and B as below:—

Alternative A—First Cost, £10,000.

Annual charges—	Return on capital	£ 500
	Depreciation	600
	Maintenance	500
	Operation	900
		£2,500

Alternative B—First Cost, £15,000.

Annual charges—	Return on capital	£ 750
	Depreciation	450
	Maintenance	300
	Operation	600
		£2,100

Annual charges for A = £2,500.
Annual charges for B = £2,100.

It is evident here that, although alternative B requires more capital, it is worth while to expend the greater sum, because the annual charges are less, so that either a reduced sum can be asked for the product, or, since the results achieved are the same, the cash for the product can be the same, and an excess profit made.

At this stage it is desirable to insist upon the importance of the utmost accuracy in the preparation of the annual charges. There is still a great deal to be done in accumulating data regarding these, but so far as is possible they must be accurately founded. When it is remembered that the purpose for which they are required is to enable the engineer by their means to select plant wisely, and so to plan economically, it will be acknowledged that he must use his best endeavors to arrive at annual charges which are as correct in every possible way as he can make them.

If the cost of any plant is to be judged by its annual charges, they must be the true annual charges, and one cannot express these by the single statement that they are, say, 14 per cent. per annum of first cost, unless either the cost is uniform each year, or the rate mentioned is an equated rate taken over the prospective life of the plant.

With reference to uniformity:—

Return on Capital.—The amount will be uniform if the capital has not been written down—that is, if the sums put aside for depreciation are kept in a separate fund until the sum that is required has been accumulated. If, on the other hand, part of the capital is paid off each year, the sum for return will decrease each year.

Depreciation.—Here, again, the amount required will vary according to the method of making provision and to the treatment of the capital account.

Maintenance.—For the present, let it be assumed that this is constant each year. This point will be returned to later.

*The expression "first cost" is intended to mean any or all of the following as the context requires: (*a*) the original construction cost; (*b*) the estimated original construction cost; (*c*) the estimated construction cost to reproduce the plant new.

Operation.—This is also taken as constant.

It is seen, then, that the sums required for return on capital and depreciation both depend upon the treatment of the capital account and the depreciation fund; in fact, these two are so intimately connected that their costs cannot be treated independently.

Lives, Physical and Economic.—For the purpose of this paper there are two lives which must be defined:—

(*a*) Physical life—that is, the period during which the plant would continue to perform satisfactorily the service to which it is adapted, if allowed to do so, but subject to all causes *outside* the control of the owner, such as wear and tear or accidents.

(*b*) Economic life—that is, the period of physical life shortened by causes *within* the owner's control, such as desire for economy, improvement of service, the taking out of plant because a greater capacity is required.

It is necessary to distinguish quite clearly between these two. The physical life affects the amount to be put aside each year for renewals, and, since by definition the plant can perform its service satisfactorily during the whole time, there is no compulsion to renew before the conclusion of the physical life.

The renewals fund thus ensures that the money invested in plant is always represented by the assets, provided that none of it is voluntarily destroyed.

In the conduct of a business, however, it is often desirable, in the interests of shareholders and consumers alike, to take plant out of commission before the end of its physical life, either because more economical plant is available or because it is no longer capable of meeting new developments of the business.

Since the main cause for these changes is economy, it may be argued that the cost of making them should be defrayed by new capital; but this is not always available, and if this course were adopted the new capital would not be represented by assets until the new plant had earned enough extra profit to pay for the wastage.

In order that the owner of the plant may be always in a position to take advantage of developments, and still be in a sound position, it is necessary to have a special fund available for the purpose, and such a fund is referred to in this paper as the improvements fund.

As such a fund is necessary for the successful conduct and progress of the business, the annual contributions are, in a continuing business, part of the annual charges against the plant.

The distinction between the renewals fund and the improvements fund must constantly be borne in mind.

The charges to the renewals fund represent actual expired capital outlay each year, and consequently are the measure of the diminution of the value of the plant in place considered as a structure, while the improvements fund enables plant to be superseded before its physical life is ended, and ensures that when this is done the value of the assets shall always represent the invested capital.

In a change of ownership where it is a condition that the purchaser should take over the plant as a structure, and the valuation is to be on the basis of physical life, any balance which stands to the credit of the improvements fund represents a reserve out of profits which has not been required and belongs to the seller, but if the business is purchased as a going concern, the desirability of superseding plant in the near future may be one of the factors determining the price, in which case it will be necessary to bring the improvements fund into account.

Method of Arriving at Provision for Renewals and Improvements.—Looking first at renewals, what change has occurred in plant which causes it to diminish in value from 100 per cent. when it is new to, say, 10 per cent. at the end of its physical life?

If one takes one of the simplest possible structures, a creosoted telephone pole, and examines it, say, five years after erection, one cannot say positively that either its weight or strength is less, as there is no perceptible decay in most cases, nor can one say that it is earning less, as it will frequently be earning a larger sum per annum than at first because carrying more wires.

In fact, the only solid ground for saying its value has decreased is that it is five years nearer to the end of its life, and the question is how to find the diminution in value caused by the passage of these five years.

The methods of arriving at the deduction to be made for any plant which has already been in existence some time may be divided into two classes:—

(*a*) Based on a detailed examination of the plant and an individual assessment of values for each item.

(*b*) Based on an estimated life which the various classes of plant will have under a given standard of maintenance, and providing for the diminution in value by writing off or setting aside a proper sum in respect of each expired year (or other portion) of life.

When carefully examined, there is really no sharp dividing line between these two methods.

In the case of detailed examination (*a*), proper weight can be given to condition, but physical examination alone will not enable a proper deduction to be made for the depreciated state of the plant. In some cases, for some years, the plant shows no sign of wear or decay, yet obviously some provision ought to be made for the expired life during these years.

It is usual, therefore, and necessary, to estimate the first cost, life, age, and residual value.

If individual items of plant are dealt with, the life and some times the age can only be judged very approximately.

If, as in method (*b*), the bulk is considered instead of the individual items, the life and age can be estimated with much greater certainty, while consideration of the amount spent on repairs and upkeep, supplemented by inspection, will give the condition.

While expert examination has a proper and most useful sphere in all cases, and is almost essential in determining the economic life, there is no means whereby one can examine plant and by that examination alone estimate what is the value remaining in the plant in place; some method of computation must be adopted.

The measurement of the effects of wear and tear and the passage of time is essentially a financial operation, and no satisfactory solution can be found without going through the steps of establishing the first cost, residual value, life, and age.

It is often said that one cannot say how long a certain plant will last; but this is not a sufficient answer. One must estimate the life if there is to be any attempt towards scientific treatment in planning.

One cannot neglect capital charges—*i.e.*, return on capital and provision for depreciation; and the latter depends very largely upon life.

Those who say the life cannot be estimated, and take, say, 10 per cent. as capital charges, do, in fact, estimate the life, though they do not state the period, and they do so without taking the necessary precautions to estimate it correctly, because for any particular rate of return on money and with a given residual value, 10 per cent. per annum can only be arrived at by one definite life.

LEAKAGE FROM PIPE JOINTS.*

By F. A. Barbour, Consulting Engineer, Boston.

On September 7, 1915,—as a result of a paper read by Mr. Arthur H. Smith before this Association,—a committee was appointed "to investigate experience in the leakage of pipe joints."

The present brief statement is not a progress report from the committee; rather it is made for the purpose of inducing a more active interest in the investigation by the members of the Association, and particularly with the hope that a discussion may result which will be of value in the further work of the committee. Any opinions expressed are the personal views of the writer and not of the committee.

As the best method of obtaining the results of experience in joint leakage, a circular containing 37 questions was mailed to 430 members of this Association, and to 124 members of the American Waterworks Association. From the 554 circulars sent out, 131 replies have thus far been received, 46 of these being from the members of the American Water Works Association. Only 85 replies were received from the 430 circulars sent to the members of the New England Water Works Association. When only one in five members takes any notice of such a circular it is evident that either the subject of the investigation is of little moment, or else the members do not appreciate the value of co-operation if any results of value are to be obtained.

It may be—and in regard to this it is hoped that members will to-day express their opinions—that leakage from pipe joints is not generally an important factor, and that the present type of joints driven and tested, or not tested, as may be the practice, is entirely satisfactory. It also may be, and probably is true, that such leakage from mains as does occur is not general, but is rather located in a few imperfectly made joints; or, in other words, that the average present standard design and workmanship is good enough. While this may be true, it comprehends the subject chosen for investigation, and thus far little information of definite value in reaching any conclusion has been received by the committee.

One fact, however, stands out, namely, that even in the fully metered systems, about 20 per cent. of the total water supply is unaccounted for by sale to the consumers. Thus, of the 131 replies received, 10 per cent. report the services to be entirely metered and 30 per cent. more than 85 per cent. metered, and the average water unaccounted for, as estimated in these systems, is 21 per cent. This loss is chargeable to leakage from mains or services, or to failure of the meters to register. It would seem to be worth while attempting to locate the cause of a 20 per cent. loss of the water furnished. If slippage of meters is the explanation, this simply means that consumers are getting more than they are nominally paying for, but, if leakage from the mains and services is responsible, the result is an absolute loss of water which costs money to develop and deliver to the distribution system.

The average consumption in the 40 systems in which 85 per cent. or more of the services are metered is, as reported, 68 gallons per day per capita. The average estimated unaccounted-for water was, therefore, equivalent to about 14 gallons per day per capita, or a loss of 5,000 gallons per year per capita, which, if the cost is estimated at $25 per million gallons of water delivered to the distribution system, is equivalent to a yearly cost per capita of 12½ cents, or approximately the interest on $2; in other words, a town of 10,000 people could afford to expend $20,000 in order to prevent this loss of 14 gallons per day per person.

If, then, in these fully metered systems, which undoubtedly represent the best condition, only 80 per cent. of the water supplied is sold to the consumers, the question arises as to whether this should be accepted as the highest standard of efficiency which can be reasonably attempted.

If, in any considerable part, the unaccounted-for water is chargeable to slippage of meters, then it would seem desirable that increased attention should be given to the subject of maintained accuracy and sensitiveness of meters.

If meter slippage is not the explanation of the unaccounted-for water, then the loss must be through leakage from the mains or services.

As to the loss from services, 80 per cent. of those replying to the circular estimate this to be small or none. As to the leakage from mains, 99 of the 131 answers received do not attempt to estimate this loss; 18 state it to be very small or none; and 14 estimate it in percentage of the total amount supplied, the average of these few figures being 15 per cent.

From the replies already received, therefore,—and these presumably are from those departments best able to answer the several questions, or most interested in the problem,—it is evident that, while undoubtedly a considerable portion of the water supplied is not sold to the consumer, there is little or no definite knowledge of the actual conditions of the pipe joints. The general impression, as indicated, is that the mains are fairly tight and that the leakage from services is small. It may also be inferred, from various notes in the replies received, that such leakage as may occur in mains is located at certain isolated joints and is not general.

One phase of the investigation as conceived by the committee was that in reference to the practice of testing pipes when laid. Believing that in the majority of cases local conditions would not permit the trenches to be kept open until the pipes were tested, the question was asked as to the reasonable allowable leakage in testing after backfilling, as determined by the measured water necessarily introduced to maintain the test pressure. Such a method of testing is, of course, not to be compared with the visual examination of the joints under pressure, but it is necessary in many cases.

Of the 131 replies received in reference to testing pipe when laid, 76 state such tests are made, 36 that no tests are attempted, and 19 that sometimes the pipes are tested and sometimes not. The interesting and rather surprising feature in these replies is that all but six of those who state that the pipe is tested report that the test is made before backfilling the trench. Further, of the 75 who replied to the question as to the standard of tightness required before putting the pipe in service, 63 state this requirement to be "absolute tightness." Of those who report that it is customary to test the pipe when laid, 85 per cent. state that the test is made under the working pressure which the pipe is to carry in service. Only 18 report tests in excess of working pressure, the test pressures ranging from 30 lbs. excess to double the working pressure.

From the information received to date, it therefore appears that it is quite the general practice to test before backfilling and to require absolute tightness under the working pressure. If these replies can be accepted as

*Journal of the New England Water Works Association.

expressing the general practice of water departments, it is evident that the present standard is high, and the only question which might profitably be asked is as to what happens to the joints when the higher pressures due to water ram, and more or less incident to the operation of every system, are applied, and whether, therefore, pipes should not be tested at some pressure above that of working conditions. It is noticeable that but very few of the statements made in reference to leakage from mains and services are based on any actual tests after the pipes have been in use for any period of time, and the opinions expressed are generally formed from observation of such joints as have from time to time been exposed. Only four definite statements of tests for leakage of pipe after periods of use are reported, and these indicate only a small loss from the joints.

Naturally, only those systems where a high percentage of the services are metered can make any accurate estimate of the water not delivered to consumers. Where less than 75 per cent. of the services are metered, waste by carelessness inside the premises of consumers is undoubtedly the great factor in determining the amount of water supplied—a condition which clearly stands out in the replies received, by comparing the water furnished per capita with the per cent. of metered services. Thus, with due allowance for special industrial demands, the relation between meters and amount supplied is very approximately as follows:—

100 per cent. metered,	68 gallons per day per capita.
75 " "	75 " " "
50 " "	90 " " "
25 " "	110 " " "
0 " "	125 " " "

It is therefore evident, as would be expected, without the evidence of the present investigation, that, in the conservation of our water supplies, metering of the services is the great factor, and leakage from mains, except in particular instances, is of minor importance.

While this is true, however, there remains the fact that in completely metered systems the average unaccounted-for water amounts to about 20 per cent. of the total amount of water delivered to the distribution pipes.

Whether it is economically possible to reduce this loss by a better type of joint, better workmanship, testing at pressures above normal, cannot be determined by the evidence thus far made available to the committee. The information most needed to reach conclusions is that giving the results of leakage surveys of actual tests made after the pipes have been in service some years, of experimental work showing the relation between pressure on the joints and leakage, and, particularly, data from those departments where accurate tests have shown leakage in mains to exist. There is no doubt that in many cases there is a large loss from the pipe system, even though in the replies received to date to the circulars of the committee the great majority regard this loss as very small, or refuse to make any estimate.

The object of this brief preliminary consideration of the subject is to ask that members who have not replied to the circular do so at once, and particularly that any member who has at hand the results of definite leakage tests submit such information, which will, of course, be considered confidential.

An expression of the opinion of members on the general question as to whether further investigation of joint leakage is worth while would be of considerable interest.

CHARTS FOR ECCENTRIC LOADING ON RECTANGULAR AREAS.

By S. M. Cotten,
Bridge Engineering Department, Kansas City Terminal Railway, Kansas City, Mo.

The charts presented herewith give a graphical solution of the foundation-pressure formula $s = \frac{P}{L}\left(1 \pm \frac{6e}{L}\right)$. As usual, s is the pressure per square unit, P the vertical load on the foundation per unit of width, L the length of foundation, and e the eccentricity of P about the centre of the foundation. The same units should be employed for L and e, either inches or feet, so that, if P be expressed in pounds, s is given in pounds per square inch or per square foot respectively.

The charts will cover any probable requirements of practice, but their scope may be infinitely broadened by remembering that it is entirely immaterial what units are used to express e, L, s and P, provided only that these are expressed in corresponding terms. For instance, if, when using the inch as the unit, a value of L greater than 60 is required, transform the given quantities into feet and pounds per square foot, which will give a value of L covered by the charts.

Since the function k given by the charts is the value of the maximum pressure, s_1, when $P = 1$, Pk will give the value of s_1 for any other value of P.

Use of the Charts.—Given P, L and e, to determine the maximum and minimum pressures, s_1 and s_2. From the value of e, shown at the bottom of the chart, trace vertically up to an intersection with the line representing the given L; thence horizontally to the left, and read the value of k. Then, $s_1 = Pk$, $s_2 = 2\frac{P}{L} - Pk$. The value $2\frac{P}{L}$ can be read off at once, as it is $2\,Pk$ for $e = 0$.

Given P, e and desired value of s_1, to find the required length. Since $Pk = s_1$, $k = \frac{s_1}{P}$. Compute the value of k; enter the chart with this and trace horizontally to an intersection with the vertical representing the value of e; the required length lies on this intersection.

Given L, e, s_1, to find the maximum permissible load, P. Enter the chart with the value of e; trace vertically upward to an intersection with L; thence horizontally and read the value of k. Since $s_1 = Pk$, $P = \frac{s_1}{k}$.

The accuracy of the charts, to the extent indicated by the scales chosen, is assured by the fact that three values were computed and plotted for each value of L, the straight line representing this passing through all three points.

A few auxiliary facts that most texts appear to neglect may be worthy of mention.

To interpret properly the equation $s = \frac{P}{L}\left(1 \pm \frac{6e}{L}\right)$, it must be understood that this is merely a special form of the equation $s = \frac{P}{A} \pm \frac{Mc}{I}$, in which P is the normal load; A, the area to which P is applied; M the moment of P about the centre of gravity of A; c the distance from the centre of gravity to an edge of A; and I the moment of inertia of A about its centre of gravity. When A is a rectangle, the latter equation reduces to the former.

If the distance d of the load from one end of the foundation is fixed, an investigation of the charts will show that s_1 is a minimum (and hence P, the supporting power of the foundation, is a maximum) when $L = 2d$. The variations in s_1 and P for $d = 6$ and various values of L are shown in Table 1. It will be observed that the

Table 1.—Fixed Edge Distance of Load.

Showing variations in s_1 and P as L varies, the distance of the load from one end of the foundation being constant and equal to 6.

Values of L.	Values of s_1 when $P = 1$.	Values of P when $s_1 = 1$.
7	0.448	2.2
8	0.312	3.2
9	0.220	4.6
10	0.160	6.2
11	0.115	8.7
12	0.083	12.0
13	0.094	10.6
14	0.102	9.8
15	0.107	9.3
16	0.110	9.1
17	0.111	9.0
18	0.111	9.0
20	0.110	9.1
22	0.107	9.3
24	0.104	9.6
26	0.101	9.9
28	0.097	10.3
30	0.093	10.7

values of s_1 and P increase and decrease respectively as L increases from 12 ($= 2d$) to 18, at which point the order is reversed. For $L = 18$, $e = L/6$ and $s_2 = 0$; hence for values of L greater than 18, s_2 is negative, giving tension in the heel. The formula assumes that this tension is an actual force or stress, as the tension area of a section of a loaded beam. Consequently, in the case of foundations, unless an equivalent tensile force is provided, as by means of anchor bolts, the values given by the formula, or the charts, for values of e greater than $L/6$ are not true. If the conditions are such that tensile stresses are not provided for, the maximum length, L', over which P may be distributed, is $3d$. Hence, when d is less than $\frac{1}{3}L$ (e greater than $\frac{1}{6}L$), $s_1 = 2P/L'$, and

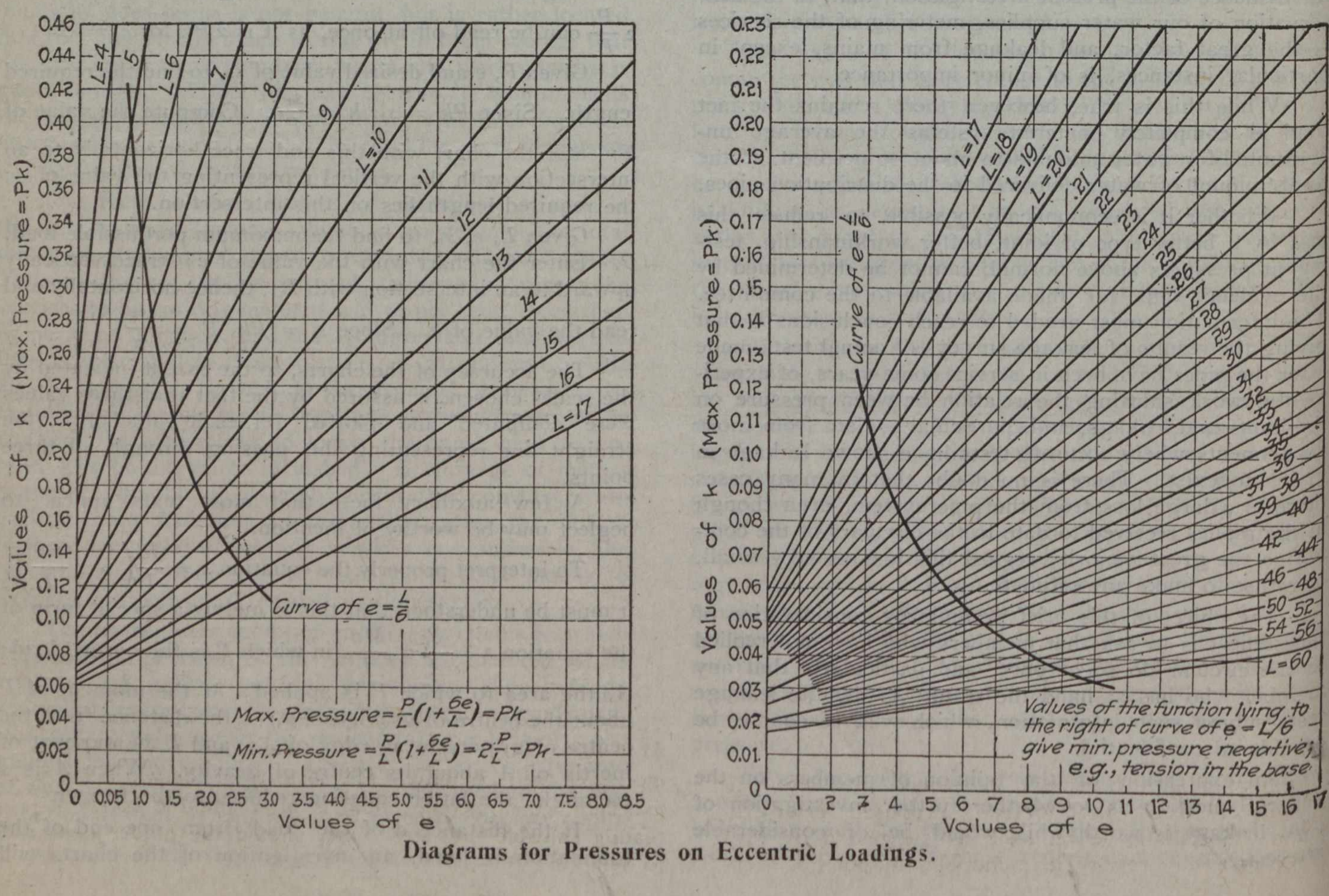
Table 2.—Variation of Proportions of the Footing.

Showing proportional carrying power of an area of 24, Eccentricity of load of 3, as L and the width b vary.

Values of L	Values of k	Values of P when $s_1 = 1$	Values of b	Values of Pb
24	0.073	13.70	1.0	13.7
20	0.095	10.54	1.2	12.6
16	0.134	7.47	1.5	11.2
12	0.208	4.81	2.0	9.6
8	0.406	2.46	3.0	7.4

$s_2 = 0$. Of course, this consideration does not ordinarily enter into foundation design, it being an established principle that the resultant shall not cut the base outside the outer edge of the middle third.

A case that sometimes arises is: Given the vertical load and its eccentricity, to determine the most economical dimensions of the footing. The charts will show that the area required decreases as L increases. Table 2 shows a special case of the relative bearing power of the same area, for a fixed value of e, as L varies. Though a specific case, the conclusions therefrom are general; namely, that the minimum area to carry a given eccentric load will be given by making the length of footing as large as possible. —"Engineering News," New York.



Diagrams for Pressures on Eccentric Loadings.

Editorial

MUNICIPAL CONSULTING ENGINEERS.

O. J. Godfrey, F.C.A., past president of the Dominion Association of Chartered Accountants, has contributed an article to a western municipal journal, in which he makes a direct and unjustified attack upon the engineering profession. To sum up his charges, he alleges:—

(1) That municipal consulting engineers purposely underestimate the cost of improvements so as to obtain the voters' consent to the projects;

(2) That the over-expenditures would not occur if the engineers did not get a percentage on the over-expenditures;

(3) That he knows of no case where the actual cost of waterworks or electric light came within the original estimate made by the consulting engineers.

Of course, Mr. Godfrey's charges were not quite so bluntly worded, but when stripped of their excess verbiage, they are in fact exactly as above stated. As a remedy he suggests that a board of engineers be organized by the province (his argument deals principally with conditions in his home province of Saskatchewan), the board's services to be placed at the disposal of all towns and cities in the province. The provincial officials are subsequently to fix the amounts to be paid by the municipalities to the province for any services rendered by the board.

Mr. Godfrey's three charges are hardly likely to be taken seriously by any municipal official who has the slightest knowledge of the ethics and standards of the engineering or any other profession. To engineers themselves the charges are mildly amusing. They are on a par with some other ideas prevalent among some very narrow-minded laymen, such as that surgeons operate unnecessarily for the fees derived; that lawyers drag cases through pre-arranged red tape in order to increase the legal costs; and that dental surgeons drill holes in perfectly good teeth in order to create something to fill.

Any number of cases can be cited where the costs of finished engineering work have been within preliminary estimates. And frequently it is not the engineer's fault when estimates are exceeded. Additions to the original work contemplated, failure of councils to provide the necessary funds when needed, depreciation due to mismanaged sales of debentures, change in sites, increase in prices of materials while council is "getting together" on the proposition, and many other factors beyond the engineer's control often result in excess expenditures.

Any engineer who would indulge in sharp practice such as alleged by Mr. Godfrey, would be disciplined unmercifully by his fellow-engineers. It is not likely that Mr. Godfrey can quote chapter and verse in substantiating his sweeping but vague charges, but if he can, the Canadian Society of Civil Engineers would no doubt be glad to take prompt action upon any real facts that he is able to produce.

Failing the ill, no remedy is needed. But even if such evils did exist, Mr. Godfrey's proposed remedy is unsound. Socialistic action such as suggested by Mr. Godfrey generally results in monopoly, despotism, inefficiency and loss of personal enterprise. This sort of community municipal engineering service has been tried before, not a thousand miles from where these lines are penned, with results that apparently do not outshine individual effort, taking the whole facts of the cases into consideration, and carefully weighing them in the balance.

THE WAR LOAN.

Aside from the patriotic phase, the Canadian war bond is an excellent investment. Dominion government bonds, in point of merit, rank ahead of all other Canadian issues. Our credit in the United States is better even than that of Great Britain. No one in Canada or, for that matter, anywhere else, doubts the stability of the borrower. Canada will be able to meet the interest on its war loans, past, present and future, without any difficulty. Our shores are free from the invader and, thanks to the British navy, are likely to be. While the Dominion is prosecuting its share of the war vigorously, those who are staying at home are seeing that greater production is achieved from the soil and from natural resources.

However pessimistic the passing phases of the Great War may be inclined occasionally to make us, no one who analyzes the available facts, can doubt ultimate victory or fail to have well-seasoned optimism in the future of this Dominion, of the British Empire and of their securities.

Small subscriptions are an important factor in the success of our war financing. The outstanding feature of the recent British "victory" war loan was the great number of small subscriptions, which helped to swell the loan to record proportions. Our banks have much to do in financing war orders placed here and in carrying the increasing volume of agricultural and industrial production. Financial and other corporations will subscribe liberally to the coming war loan, but it is absolutely necessary that many thousands of subscriptions, ranging from $100 to $25,000, should be received in order to make the loan a real success. Dominion war loan bonds are one of the world's best investments and have a patriotic flavor. A subscription to our war loans is not a sacrifice. It is a duty, and incidentally it remunerates the subscriber handsomely.

A large number of small subscriptions to the war loan will be more appreciated by the government than a small number of large subscriptions. The allotment of the loan to large subscribers will be cut down by the government so that all the small subscribers may have their full share of bonds.

There are many thousands of people who have from $100 to $5,000 for investment. Their duty is to lend this money to their country. The security of the war bond is excellent, the income yield is high and the bonds are readily saleable at any time, should the holder desire to sell.

INVESTIGATION OF THE HYDRO RADIAL PROJECT AT HAMILTON.

In last week's issue reference was made to the investigation being made into the Hydro Radial project at Hamilton and to the appointment of a board of five engineers who had been asked to submit a report thereon. In the same item reference was made to the Canadian Northern-Hydro-Electric controversy.

In order to remove any misunderstanding which may have been caused by the publication of this item it is only proper to state that this board of five engineers, consisting of Messrs. Leonard, Kennedy, Tye, Herdt and Francis, was appointed specifically to report as to the need of a proposed Hydro-Electric line from Port Credit to St. Catharines, Ont.

It will be remembered that when the by-law in connection with this road was submitted to the ratepayers of Hamilton on January 1st last, the said ratepayers refused to authorize their council to enter into the proposed agreement with the Hydro-Electric Power Commission for the construction and operation of such a line. It having been intimated that the rejected by-law would again be submitted at an early date, a citizens' committee, of which C. W. Cartwright is chairman, wrote to the Toronto Branch of the Canadian Society of Civil Engineers asking that it name five engineers who could investigate the radial proposition and submit a report which would enable the citizens of Hamilton to determine whether the project was in the public interest or not.

As a result of this communication to the Toronto Branch of the Canadian Society of Civil Engineers, the board of engineers already referred to was appointed.

Its investigation is to be confined to the proposed Hydro-Electric line from Port Credit to St. Catharines with special reference to the interests of Hamilton in connection with it.

PERSONAL.

G. M. CAREY has been appointed a member of the Hydro Commission of Petrolia, Ont.

W. VALLANCE, assistant municipal engineer of Point Grey, B.C., has resigned.

E. J. ZAVITZ, formerly on the staff of the O.A.C., Guelph, has been appointed provincial forester for Ontario.

JOHN R. McDONALD, who has for several years been in charge of the mines of the Franco-Canadian collieries, at Frank, B.C., has resigned.

F. A. DALLYN, A.M.Can.Soc.C.E., provincial sanitary engineer, Toronto, has returned from England, where he has been investigating sewerage and sewage disposal plants.

SAMUEL D. WILLIAMS, for the past three years chief division civil engineer of the M.C.R. at St. Thomas, Ont., will leave shortly to take up new duties in the Detroit office of the company.

D. WALTER MUNN, of the Montreal Rolling Mills branch of the Steel Company of Canada, has joined the engineering department of the Algoma Steel Corporation, Sault Ste. Marie, Ont.

E. W. DuVAL, formerly superintendent of the C.P.R. at Saskatoon and Moose Jaw, has qualified for the rank of lieutenant and has been appointed O.C. of the University draft for the 196th Western Universities Battalion.

SAM R. HENDERSON, for seven years president of the Manitoba Good Roads Association, was presented with a heavily jewelled and suitably engraved gold watch at the recent annual banquet of the association in recognition of his record of valuable service.

WILLIAM HENDERSON, who has been resident architect of the department of public works, British Columbia, for the last fifty years, was presented with an illuminated address and a gold-mounted ebony cane at a banquet recently held in his honor at the Dominion Hotel, Victoria, B.C.

Lieut. G. ROY COCKBURN, formerly a professor in the University of Toronto, who went overseas with a draft of officers from the 170th Mississauga Battalion and was attached to the 58th Battalion in France, has now been transferred to No. 2 Field Survey Co. of the Royal Engineers. This unit is officered by scientists drawn from universities of the Empire.

H. B. HAWKINS, of Brantford, Ont., who has for the last six months been assistant to E. E. Curtis, manager of the Brantford Gas Company, has been advanced to the managership in place of Mr. Curtis, who has left for Bartleville, Oklahoma, where he takes the position of inside manager for the H. L. Doherty Company, which controls the Brantford office.

M. A. GRAINGER, who has been acting chief forester for the province of British Columbia since H. R. MacMillan's appointment as lumber commissioner to study foreign markets, has now been appointed chief forester. Mr. Grainger, who is a graduate of King's College, Cambridge, England, came to Canada in 1897. He joined the Forestry Branch upon its inauguration and has occupied an important position in it ever since.

OBITUARY.

DENIS MURPHY, former M.P.P., and a member of the Timiskaming & Northern Ontario Railway Commission, passed away at his home in Ottawa on March 10th. The deceased had been in failing health for the past six months, and his death was not unexpected. He was in his 75th year, having been born in the county of Cork, Ireland, on April 2nd, 1842. In 1849 he came to Canada with his father and settled in Chatham, P.Q. For a long time he was engaged in the forwarding business on the Ottawa River, in partnership with the late J. W. McRae, and in 1892 he was elected president of the Ottawa Transportation Company, which office he held until his death. Since 1905 he had held the position of government commissioner for the Timiskaming & Northern Ontario Railway.

THOMAS BROOKE TOWNSEND, of Aldershot, Ont., passed away recently. Deceased was born in Yorkshire, England, in 1834, and came to Canada in 1857. He was a civil engineer by profession, and was associated for many years with the old Great Western Railway. He had charge of the rebuilding of the bridge over the Desjardins Canal that replaced the structure destroyed in the great Desjardins Canal accident. In 1860 he designed and supervised the building of the private car used by the late King Edward on his tour of Canada. In 1872 he entered the service of the Department of Railways and Canals, and he designed the Welland Canal locks, gates and bridges. In 1881 he retired from the Department of Railways and Canals, and a few years later retired from active work and took up farming at Aldershot.