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THE CANADIAN ENGINEER

An Engineering Weekly.

MECHANICAL ENGINEERING PROBLEMS IN ILLUMINATING GAS WORKS.*

By Mr. J. A. P. Crisfield, Engineer of Construction, the United Gas Improvement Company, Philadelphia.

[The problems which confront the mechanical engineer, who is connected with a gas plant, are brought to the notice of the reader. How these various questions may be solved to the best interests of all concerned is pointed out].

The business of the manufacture and distribution of gas for lighting, heating and power purposes constitutes one of the most familiar and important examples of that phase of modern civilization in which private capital, enjoying public privilege, undertakes to supply one of the conveniences or necessaries of living. With the gradual recognition of the mutuality of the relations between the Gas Company and the community which it serves has come a clearer conception of the obligations of both parties to the unwritten but none the less binding contract between them, and to-day it would be difficult to find a gas company whose officers do not feel in duty bound to render its customers the best service in its power at the lowest rate consistent with a fair return upon the capital invested. To accomplish this result it is essential that the management of the gas company, in its various departments, be expert, each in its particular duty; that the work in hand shall be performed by specially educated and carefully trained men. In no department of the business is this more apparent than in the gas works itself, where technical problems of the most intricate character are continually offering themselves for solution. It is here that the young mechanical engineer begins to realize for what his course at school was intended to fit him, and gradually, as he learns to recognize the principles of efficiency, economy and the conservation of energy through their numerous and most cunning disguises, he takes up his work of eliminating waste, extravagance and engineering fallacies.

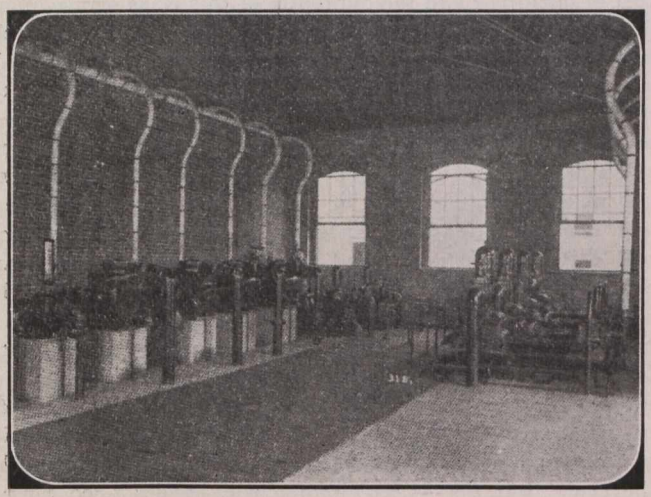

Fig. 1.

A pump room. The pumps shown in this illustration are for the purpose of handling hot and cold water, oil, tar, ammonia, etc. The services of a mechanical engineer are valuable in such work as this.

The modern illuminating gas works is a highly specialized plant, designed for the duty of gasifying coal, either by distillation in an enclosed retort, or else, by making from it, hydrogen and carbonic oxide by the action of steam, and adding thereto the light-giving vapors of liquid hydrocarbons. The former method is known as the coal gas process; the latter as the water gas process.

Before discussing the mechanical engineering problems which are met with in the design and operation of a gas works, it might be profitable to define that branch of engineering which is called mechanical. In the best known schools of mechanical engineering the course of instruction includes, among other things, the following subjects: Mathematics, to and including Thermodynamics; Modern Languages; Mechanical Drawing and Machine Design; Physics;

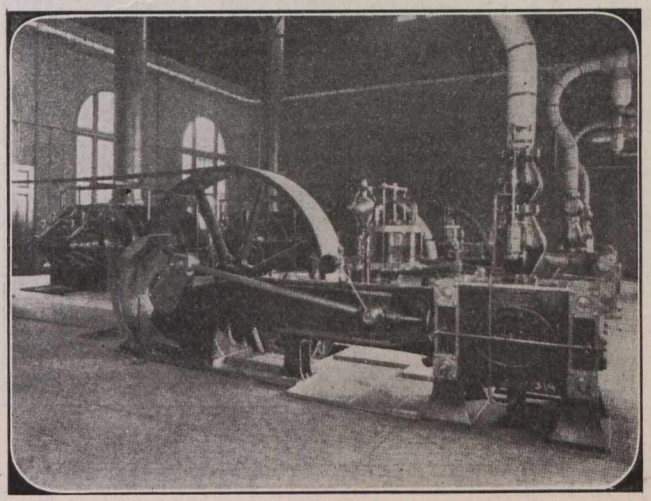

Fig. 2.

Positive blowers compressing air from atmospheric pressure to one pound, for use in a large carburetted water-gas plant. In this case the amount of work to be done is comparatively great and the utmost economy of operation is sought by the use of Corliss engines and efficient blowers, regardless of first cost.

General Chemistry, and Special Engineering Chemistry, including Combustion Engineering; Engineering Practice; Structural Engineering; Electrical Engineering. Hand in hand with instruction in the theory of the foregoing subjects, the scholar is given practical work in physical, chemical and mechanical laboratories. It will be seen that this course of instruction prepares the mechanical engineer for all branches of industrial undertakings in which success depends upon the efficiency of the means and methods employed and upon other economies of operation. He is trained to save; to do work with the least expenditure of energy; to consider no economy too small to be worthy of attention, knowing that in the aggregate many small economies may determine the success

*Presented at the meeting of the Mechanical and Engineering Section, held Thursday, October 13th, 1910.

or failure of the enterprise as a whole. The system of instruction which instils the theory of an operation and at the same time illustrates the theory in practice enables the mechanical engineer to forsee the direction in which success may be attained; and at the same time the practical instruction in the laboratories and shops saves him from the pitfalls in which the pure theorist is certain to flounder with fatal result.

In the treatment of the coal through the various stages of manufacture to the completed product, the gas manager is confronted with problems of efficiency and appropriate design; the phenomena of combustion; the handling of heavy and bulky materials; with chemical reactions of the most complicated nature. In order to insure good service, continuity of the supply of gas both as to quantity and quality, and a stable, profitable business, it is necessary so to design the plant that it possesses entire reliability, and so to operate it that the greatest net profit is obtained. With extravagance in first cost or wasteful operating methods,

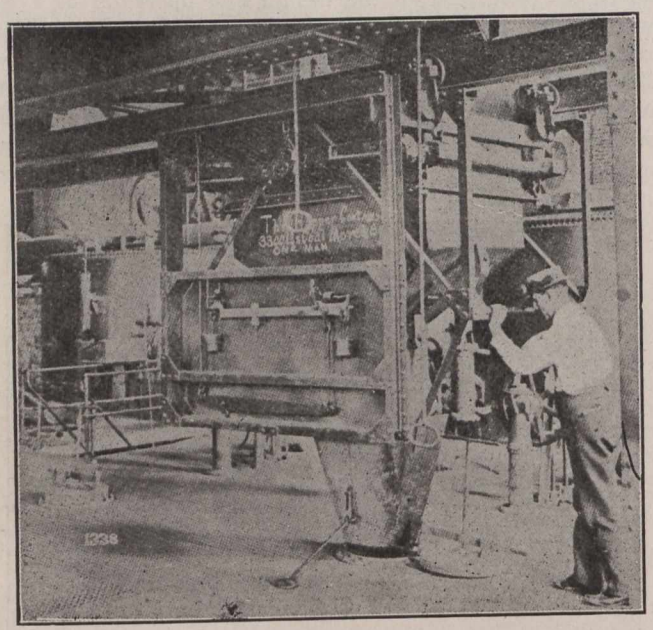

Fig. 3.

In addition to the fuel-weighing machine shown above, the mechanical engineer has applied methods of precision in the measurement of air required for blasting, the steam for producing water-gas and the oil for carburetting the water-gas. His effort has always been in the direction of replacing the old haphazard methods of gas-making with those of scientific accuracy.

whether due to design or bad management, what might have been a highly attractive undertaking in which capital would readily seek investment, soon degenerates into an over-capitalized and unprofitable operation with a reduction, or entire loss, of credit, meeting finally the expensive process of a reorganization. It is therefore at the very outset that mechanical problems are met and must be correctly solved before we may intelligently determine how to build the plant so that the high efficiencies and rigid economies necessary to success may be obtained. It is not alone sufficient to know that a given piece of apparatus will perform its function with the highest efficiency; the questions must be asked: What does this efficiency cost? Will it pay to make the investment? Will it pay, for example, to purchase machinery to unload the coal, and if so, what kind of machinery? What is the cost of operating this machinery, for steam, repairs, deprecation and attendance? Would it not be wiser to avoid locking up so much money in coal-handling machinery, which may be obsolete in a few years, and rather rely upon common labor, which, though costing a little more perhaps, all things considered, does not rust, carries with it no interest charge, and is so flexible that it may be employed in numerous other operations besides the unloading of coal? All the above are mechanical engineering problems.

While the construction of the foundations of the buildings in a gas works and the strength and other characteristics of the materials employed may be properly the business of the civil engineer, and while the chemical reactions involved in the generation and purification of the gas may strictly fall within the province of the chemist, still it will not be denied that the appropriateness of the design of the structures, both as to first cost and the facilities offered for economies in labor, the efficiency with which the chemical reactions are produced, and the thermal and mechanical efficiencies of the apparatus employed, are purely mechanical engineering problems.

One of the first problems of the mechanical engineer in the gas works is the receipt and storage of the coal for gas making and for boiler fuel. He must decide whether the amount of material to be handled will warrant the installation of mechanical unloading devices. Upon his knowledge of the cost of operating and the durability of this class of machinery depends the wisdom of the decision, and without special knowledge of this subject a mistake would probably be made which would materially affect the cost of a unit volume of the product. For example, it would not pay to invest $5,000 in machinery to handle from the car to the bin the 1,000 tons of anthracite coal that will be needed in a carburetted water gas plant supplying a city of 25,000 inhabitants. The steam and labor of attention necessary to operate the machinery will cost 5 cents a ton, and the interest (5 per cent.) and depreciation (10 per cent.) will add 75 cents more. Utilizing a simple hydraulic elevator costing $1,000, a laborer, at 25 cents for his wages, will put up one ton per hour, and the interest and depreciation at 10 per cent. on $1,000 will bring the cost up to 35 cents. If to this we add 5 cents a ton for operating the elevator pump, we find that by the adoption of the second method we have saved 40 cents a ton in handling the coal. But the $5,000-elevator will handle 5,000 tons at the same cost for interest and depreciation as it did the 1,000 tons. Its installation, therefore, in a plant of five times the size of the one first assumed will be justified, for then the comparison would be:—

For the $5,000 elevator:

	Cents.
Interest and depreciation	15
Operating expenses	5
Total cost of coal handling per ton	20

For the $1,000 elevator and common labor:

	Cents.
Interest and depreciation	2
Labor of operating	25
Steam for elevator pump	5
Total cost of coal handling per ton	32

The above example will serve to illustrate one phase of mechanical engineering in receiving and storing coal in a gas

works yard. The manager will make mistakes unless he always asks himself the question: Will it pay? Does the roposed investment bring the greatest return upon each dollar of capital? Is there not some other way of accomplishing the purpose, which during the assumed life of the apparatus employed, will show a greater net return?

Of less magnitude, but none the less necessary to the smooth running of the plant, are the mechanical engineering problems encountered in selecting the moving machinery required and in maintaining these machines in an efficient condition. For instance, the ratio of the water cylinders to the steam cylinders of the elevator pump should be the inverse of that for the oil unloading pump, if the work in each case is to be done with good efficiency. The engines which drive the blowers for furnishing blast to the generators should be chosen only after giving due consideration to reliability, thermal efficiency, first cost and durability. The volume of business done by some particular gas company may be so small that it cannot afford the best apparatus in the market; the interest item outweighs all others combined, and the mechanical engineer recognizes this and buys a cheap 10-horse power blowing outfit that will last long enough, or until the business has grown large enough to afford something better; but in large stations when the horse-power involved may and often does reach several hundred, the cost for interest and depreciation, even for the best that money can buy, is of less importance, compared with the cost of steam for operation; and the most efficient blowing unit obtainable should be installed, due consideration being given to the questions of durability, possible obsolescence or inadequacy in the near future. This suggests one of the most puzzling problems of the mechanical engineer in the gas works: namely, that of selecting the right sized unit, whether it be an installation of coal gas benches, a water gas set, or a combination of both; whether he should recommend an increase of storage holder capacity or install greater generating capacity, and whether, in case greater holder capacity is decided upon, it should be located near the generating plant or at a distance; in the latter case supplemented with a pumping plant and high pressure mains. It is true that the solution of these questions involves also business judgment, for instance, in making extensions of plant. This can be done in small successive instalments, each sufficing for a short time in the future, as growth of business shall demand; this while conservative and safe, may result in ultimate high total capitalization, due to greater cost of successive small extensions and changes. On the other hand, extensions may be made on a large scale sufficing for a long time at a much lower cost for a given capacity, but this subjects the business to the risk of heavy interest charges if its growth is not rapid, or to heavy replacement costs if improved apparatus be substituted for old. Sound judgment as to business prospects is here required, but after its exercise there is equally important use for the knowledge and judgment of the engineer, even if much that is ordinarily called business judgment is not itself the application of mathematical or of engineering principles.

Having designed and built a gas plant, with constant consideration of the result to be obtained, with an eye to thermal, mechanical and labor efficiencies, with the least expenditure of money compatible with the utmost reliability and fair durability, the mechanical engineering problems of operating must be met. One of the most important of these is the quality of the raw materials. Since it is the business of the mechanical engineer to secure the greatest possible quantity of heat units and light units in the finished product for each dollar expended for raw material, it is important that he does not handicap himself at the start by purchasing inferior raw materials. Although there is a growing tendency towards the purchase of coal on the basis of its heat value, still this practice is not by any means general, and it is customary for the engineer to purchase coal regardless of the percentage of fixed carbon, volatile combustible, ash, sulphur and water. How important a matter this is may be seen by reference to two analyses given below of samples of coke which, when good, is a most excellent gas-making fuel. Two analyses of bituminous steam coal are also given.

	Coke.		Steam Coal.	
	No. 1.	No. 2.	No. 3.	No. 4.
	%	%	%	%
Moisture	15.0	1.5	0.73	12.71
Volatile combustible	5.0	3.0	17.43	28.62
Ash	15.0	5.0	4.63	20.78
Sulphur	1.0	0.5	0.62	3.69
Fixed carbon	64.0	90.0	77.71	34.87
	100.0	100.0	101.12	100.67
B.T.U.	.....	.....	15,178	8,840

The sample No. 1 had been exposed to heavy rains, or it had been flooded when quenched, was badly burnt off in the first place and was the product from a seam of coal containing much ash and sulphur. From a mechanical engineering stand-point only the fixed carbon is of certain value for making carburetted water gas. Consequently the gas manager has actually paid 40 per cent. (0.9 ÷ 0.64 = 1.4) more for his fuel in purchasing sample No. 1 than in purchasing sample No. 2. Although he may not be able to control the dealers in the matter of the analysis of their coal, he is, to some extent, in command of the situation, owing to the fact that he may restrict his purchases to certain coal fields where the quality is good and uniform. He may also insist upon proper methods of quenching, and upon the shipment of the coke in covered cars or failing to be able to keep the coke dry en route, he may find that it will pay to build sufficient storage at the works to permit a partial drying out under cover.

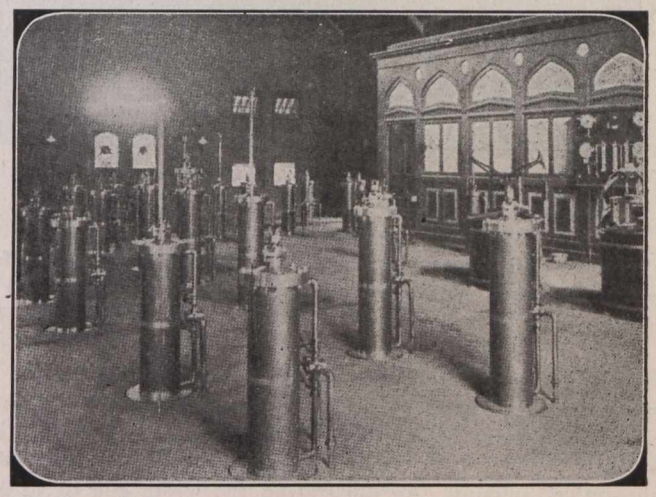

Fig 4.

A labor-saving device—the hydraulic cylinder. By simply turning a small cock, the cylinder shown above will open and close valve gates weighing many hundred pounds.

One of the most troublesome problems to be met with in a gas works is that of labor. It might be said that this is not particularly a mechanical engineering problem, since all

employers of labor must encounter it. Still, it is more the problem of the mechanical engineer than of any other, because he is, by education and experience, best fitted to reduce the amount of human labor required, and this is what he is continually attempting to do by the adoption of labor saving appliances, such as bucket elevators, belt conveyers, hydraulically operated valves and lifts compressed-air drip pumps, mechanical stokers for coal gas retorts, and for the boilers. In this field of endeavor he has no competitor. In common with many of his mates in other industrial enterprises, the mechanical engineer in the gas works has the problem of boiling water for making steam. No one will admit that this is, as a rule, intelligently and efficiently done to-day. And yet, knowing this, our practice and methods are not greatly different from what they were two thousand years ago. It is

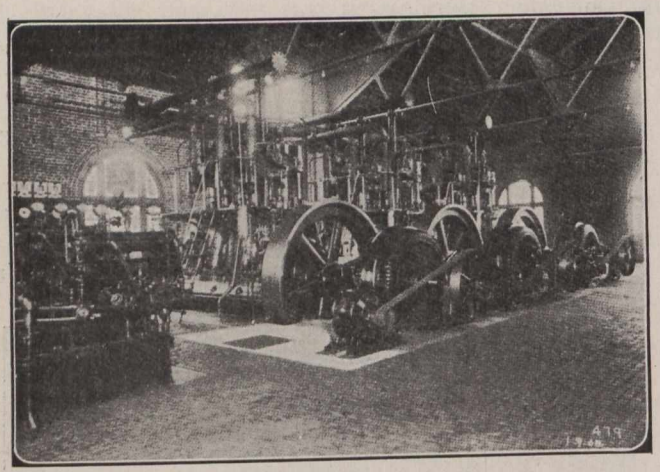

Fig. 5.

A Diesel engine power plant in which water-gas tar is the fuel, and where 25-cycle A.C. current is produced for power purposes, with a consumption of one-tenth of a gallon of tar per horse-power hour.

still believed that in boiler practice 50 per cent. excess air of combustion is necessary for best results, whereas, in almost every other form of combustion with which we are familiar, science has reduced the necessary quantity of air to the theoretical amount. As illustrating the waste due to 50 per cent. excess air in the ordinary boiler efficiencies, it may be calculated that such a percentage of excess means an increase of 10 per cent. in the total fuel consumed. In the year 1909 there were used in the United States under boiler furnaces for producing steam, approximately 340 million tons of coal. If this steam could have been produced by the combustion of coal with the **theoretical** amount of air, the saving would have been 34 million tons which, at an average price of $3.00 per ton, would amount to one hundred million dollars. Which of our young mechanical engineers, who are now earning their spurs at their chosen profession, will undertake to stop this waste and show us how to advance in the art of producing steam?

In a gas works a large percentage of the cost of the finished product is incurred in the generator of the water gas plant, or in the furnace of the coal gas bench. Here the problem is the apparently simple one of the combustion of carbon at temperatures above 2,000° F. However, owing to impurities in the fuel, such as ash of variable fusion temperatures, extra complications are introduced which make the operation extremely difficult. Clinkers—the bugbear of everyone who burns coal, sooner or later, as the operation continues—upset all nicely calculated adjustments, and, unless means and methods are adopted to vary the air and steam of combustion so as to bring about a readjustment, serious losses will result, both in efficiency of production and in the quality of the finished product. It is now that we find the mechanical engineer hard put to it, and it is only by combining his knowledge of the theory of combustion with his practical experience in doing things that he is able to supply the demand for gas and render the good service which the community expects of him. Lack of such knowledge and practical resourcefulness must be compensated for by increased investment for spare machinery, making it still more difficult to obtain the desired profit.

Many other interesting and important mechanical engineering problems might be mentioned, but enough has been said to indicate that the business of gas making is largely the work of the mechanical engineer. Even the abstruse reactions within the coal gas retort and the water gas carburetter are not entirely outside his field. Though they properly belong to the chemical engineer, still, the education of the mechanical engineer of to-day fits him for such work, should he care to specialize in it. Indeed, so satisfactory does the young mechanical engineer attack and master the work in a gas plant, that some gas companies have entirely restricted additions to their engineering forces to this class.

When we consider the immense amount of intelligent work which has been expended upon the engineering problems in a gas works, it is not to be expected that any very great economies in manufacture will be made. What reductions in the cost of the finished product will be made will be accomplished by close attention to the small savings possible in increasing thermal and mechanical efficiencies and in the substitution of mechanical appliances for human labor. These are problems which will be solved only by the trained mechanical engineer.

ENGINEERS' CLUB OF TORONTO.

At the meeting of the Club last Thursday evening, an illustrated address on "Municipal Bridges in Europe," was given by Mr. R. E. W. Hagarty, B.A., Sc. Mr. Hagarty said the contrasts to be noted between European bridges and those on this continent are: (1) In Europe the arch type predominates. (2) The art and architectural features of the bridge combine to eradicate the engineering features. (3) European bridges are the objects of more public attention and interest, as many have been built to commemorate historical events and designed accordingly.

It seems that traffic conditions have much to do with the number of bridges in a municipality. In London, where the traffic is well regulated, there are comparatively few bridges; but in Paris, where the traffic is not so efficiently regulated, there are numerous bridges. Paris has many beautiful and ornate bridges. The fact that one Parisian masonry bridge is three hundred years and another one hundred years old, seems to furnish a strong argument for using masonry bridges wherever possible. The long span is conspicuous; bridges there having spans of between 200 and 300 feet. A noticeable feature of the Parisian bridges is also that they give the same effect as the adjoining boulevard, and every bridge of any importance seems to lead to some great building, which is a prominent landmark.

The decorative effect of Parisian bridges is remarkable, statutes of historic characters or types are prominent as a

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OTTAWA: ITS WATER SUPPLY.

The city of Ottawa have resolved to give a trial to the now well-known method of water purification, viz., disinfection by the use of hypochlorite. This on the advice of the well-known water chemist, Allen Hazen, of New York.

It is interesting to note the extreme rapidity of conversion from skepticism to belief which this newest method of treating water has commanded.

It is only twelve months since The Canadian Engineer asked the question, Is water disinfection a dream? The question was inspired by a statement made at the time by Allen Hazen at a meeting of the Canadian Society of Civil Engineers. In the discussion following a lecture on slow sand filtration delivered by Hazen, he was asked a question relating to the efficiency of ozone and hypochlorite as disinfectants of water, and the fact of the latter having been used by the English Government in connection with an outbreak of typhoid at Lincoln ten years ago, where the water was dosed with hypochlorite for several weeks. Mr. Hazen's reply then was that he looked upon any method of disinfecting water as **a mere dream.** He then related a funny story, showing the cute manner by which he choked a man off who guaranteed to disinfect some water he was engaged in treating.

At the time we felt the necessity of stating in these columns that, granting disinfection of water to be a dream, many eminent scientific men were walking and talking in their sleep.

We find now that Mr. Hazen has either awakened from his sleep, or has joined the ranks of dreamers, for, on referring to that portion of his report dealing with his recommendation to disinfect the Ottawa water supply, he states: "The object is to destroy the bacteria resulting from the sewage pollution of the river." Truly, "we are such things as dreams are made of."

The problem of disinfecting water is still in its infancy. Exact data as to the proportionate amount of chlorine required relative to organic content and other possible contents in water is still wanting. Data, however, is piling up every day as to the wonderful efficiency of chlorine when properly and scientifically applied as a water germicide.

We note that Hazen as a basis recommends fifteen pounds of chloride of lime to each 1,000,000 gallons of Ottawa River water. At 33 per cent. available chlorine, this works out at .5 parts of available chlorine in 1,000,000 parts. This proportion is somewhat high as compared with the requirements of certain other waters. The organic content of the Ottawa water is, however, comparatively high, and the amount recommended will not prove excessive, judging from experiments made with the Ottawa River at Pembroke during this summer.

It is interesting to note that Pembroke, situated on the Ottawa River above Ottawa city, has been treating its water supply during the past year with hypochlorite, and, although the method of application has been of a crude and temporary character, it has proved so efficient that a by-law is being at present promoted to install a permanent hypochlorite installation, together with a new intake pipe into what has been found a purer water location in the main channel of the river than the present one in Pembroke Bay.

In connection with the city of Toronto water supply some interesting data has recently been published by Dr. Hastings, the Medical Health Officer. Here, .33 parts of chlorine per 1,000,000 are used. On November 12th last three samples were taken at the shore crib respectively at 9 a.m., 10 a.m. and 11 a.m. Samples were also taken at the pump station one hour later, viz., 10 a.m., 11 a.m. and 12 a.m., respectively. Each of the samples at the shore crib showed the presence of intestinal bacteria. Such were entirely absent in the samples taken after disinfection at the pump-house. The three samples respectively showed reductions of total bacteria as follows: 94 per cent., 98 per cent. and 97 per cent., the numbers of bacteria in the disinfected samples being 11, 4, and 10 per c.c. The disinfected samples were equal in purity to what is generally known as pure, unpolluted Ontario water, which normally contains from 8 to 10 bacteria per c.c. It may be assumed that with our present knowledge of what disinfection will do with the water, it is doubtful if ever the installation of the sand filtration plant now in progress would have been contemplated.

There appears to be no doubt whatever that we have in Canada many sources of water supply which are capable of being rendered absolutely wholesome and proof against disease transmission by the use of hypochlorite as a disinfectant, apart from any preliminary treatment by filtration.

Varying degrees of turbidity forms the main factor affecting the adoption of disinfection as a single method of water purification.

Turbidity is effectually removed from water by sedimentation when the water acquires conditions of quiescence or partial quiescence.

The Metropolitan Waters' Board of London look to sedimentation basins for as high efficiencies in water purification as they do to sand filtration areas.

Our lakes are simply huge sedimentation basins, and many of our rivers, such as the Ottawa, are simply strings of lakes forming sedimentation basins. It is for the latter reason that the Ottawa River is proverbially pure and free from turbidity at all periods of the year.

All existing data, up to the present, point to the conclusion that it is possible to render settled lake water, or water such as is presented by the Ottawa River, absolutely wholesome and free from the germs which accompany sewage pollution by the use of very small quantities of hypochlorite, the quantity being so small that it cannot possibly be traced in the water as supplied at the taps.

HYPOCHLORITE DISINFECTION PROPOSED FOR WATER SUPPLY OF CITY OF OTTAWA.

As a temporary method of treating the Ottawa water supply, pending certain investigations as to the merits of slow sand filtration, or obtaining a new supply from the Gatineau Lake, Mr. Allen Hazen reports as follows:

"Pending the installation of such a system a partial treatment of water might be adopted with advantage, such partial treatment consisting of the addition of hypochlorite of lime. The best amount to be added would be determined by experiment. Possibly a water with this degree of color would take a somewhat larger quantity than a water with

less organic matter. For the present base the estimate on 15 pounds per million gallons, or 50 tons per annum, at $25 per ton,. costing $1,250. The cost of applying would be represented by the salaries of four men and something extra for supervision, say $3,500 per annum. The total cost would probably be something like $5,000 per annum. In order to carry out this treatment all the water should be brought to the pumping station through one pipe. There is now one 40-inch pipe supplying water and a new 42-inch pipe is being built. It was the intention to give these two pipes separate connections with the pumping station. This arrangement would not lend itself conveniently to the hypochlorite treatment. In order to carry out that treatment advantageously both of these pipes should be connected to a new 60-inch pipe at a little distance from the pumping station, say at a distance of two or three hundred feet, where the two pipes could be brought together and the single large pipe carried to the pumping station. I would put a Venturi meter on this pipe, so that the amount of water being pumped could at all times be known with certainty. The hypochlorite of lime could be dissolved and controlled in a space in the attic over the present pumping station which is adapted to this use. The solution would be carried to the beginning of the 60-inch pipe and would become mixed with the water by the flow through it, and by the flow through the throat of the Venturi meter, so that the water taken to each pump would have its fair share of the substance. Passing through the pumps of course, would effect a very thorough mixing. The hypochlorite treatment on present evidence is equal in its effect to the ozone treatment in every respect, and is both surer and cheaper. It would not reduce the color of the Ottawa river water appreciably, nor would it remove any turbidity and sediment in it. Its object would be to remove as many as possible of the bacteria resulting from the sewage pollution of the river. A considerable bacterial purification could be secured in this way. The process is worth installing at once and continuing in use until permanent purification works or a new supply is installed, and I recommend that this be done."

IS A RATIONAL BASIS POSSIBLE FOR TELEPHONE RATES?

By Dugald C. Jackson, of the Mass. Institute of Technology.

The question of fair telephone rates is a very complex one. It is much more complex than the question of fair rates for gas or for tramway service. A gas company has a particular commodity to sell—associated with the disposal of some by-products, to be sure—but the main object is to sell one particular commodity. A telephone company, on the other hand, must sell service, which is more difficult to accomplish satisfactorily than the sale of commodities, perhaps for psychological reasons. On account of the wide range of service that telephone companies must supply, it seems necessary to group their customers and organize the groupings on the grounds of the use likely to be made of the service. This grouping of telephone subscribers as residence subscribers, business subscribers, private branch exchange subscribers, special line subscribers, party line subscribers, etc., etc., has become substantially universal. I will here give my own answer to the query that is found in the title of this paper. A rational basis of rates is possible, and it primarily consists in arranging the groups of subscribers so that no group fails to bring the revenue necessary to operate its service, and so that the subscribers are so fairly associated in the groups that in none are a considerable proportion of the subscribers not self-sustaining. Both of these acquisites are commonly neglected in the rates maintained by telephone companies.

The rates charged for telephone service in all the important American cities have grown up in accordance with expediency, and as the result of the judgment and experience of the telephone officials, and it is, therefore, not astonishing that the telephone companies have become accustomed to assert that rational methods of analysis cannot be applied to test the reasonableness of such rates. Ready means of inter-communication are now so essential a part of business and social life that it is equally natural for subscribers to view askance the efforts at telephone rate-making, which depend only on expediency or on the judgment of certain officials. Skepticism of the fairness of telephone rates fixed in that manner has led to investigations in a number of the more important American cities and states, and has produced reports like those made by the Merchants' Association of New York, in 1905, the Special Telephone Commission of Chicago, in 1907, the Board of Trade of New Orleans, in 1908, the Travellers' and Merchants' Association of Baltimore, in 1910, and the recent studies of the Commissions of the city of Los Angeles, and of the States of Massachusetts and Wisconsin.

The activity thus stirred up seems to give promise of the general adoption of a more rational basis of charges for service. It is undeniable that the judgment displayed by telephone officials has built up their business marvelously, and has made the telephone a necessary tool of commercial and social intercourse; but the very importance thereby given to the telephone service makes indefensible any opposition to legitimate efforts to get rates on a more rational basis. Guiding principles in so complex a subject can be evolved only as the result of thorough-going statistical study of the problem.

The startling complexity of the telephone rate problem is illustrated by the introductory statement of the Commission of Engineers, who in 1907, made a comprehensive report of the telephone situation in Chicago. I will quote three paragraphs from that report:

"A telephone company in a large city must face a problem in many respects more complex than that of any other public utility corporation. The water department is called upon to sell a single commodity, namely; water, and at prices which are fixed with comparative readiness. The gas company, also is called upon to sell a single commodity, metered for nearly every customer, and its conditions in dealing with customers are relatively simple. It may sell some additional by-products, as coke, tar and ammonia, but the quantities and market values of these are readily arrived at. The traction company has a more complex problem than some of the other purveyors of public utilities, but even here the price paid by the several patrons is uniform, and the substantial difference between patrons lies only in the lengths of the rides which they may choose to take.

"The telephone problem, on the contrary, involves many complexities, partially caused by the relatively large number of classes of service which the telephone company must offer to its patrons for the purpose of fully developing the telephone service of the city, and partially by the intangible character of the electric medium with which the telephone

*Paper presented before the National Municipal League at Buffalo, N.Y., Nov. 15, 1910.

business is carried on, the delicacy of the apparatus used, and the wide difference in the manner and extent of the use of the apparatus by the various subscribers.

"If a telephone company properly extends the telephone service in the city, it must be prepared to take care of the requirements of a range of patrons as wide as the interests of the city itself, including the largest business organizations, the hotels, the newspapers, the professional men, the small business houses, and residences of all classes. It must provide apparatus for the service of each class of patrons, which will enable it to furnish the service to each subscriber at an appropriate price within his means. It is desirable for the prices to be graded, so that the largest user shall not pay less than his fair share of the expense of maintaining the traffic and the remuneration to the company for its investment, and equally so that the smallest user may get his telephone service at a price which is within his means, and yet is reasonably remunerative to the company for its outlay."

There are four general principles that cannot be safely departed from when considering rates of a public service company. These may be stated in the following words:

1. The company is granted certain privileges by the public for the purpose of enabling it to furnish readily some type of service to the people, and it should be expected to furnish service fitting the needs of the people; good of its kind, and at prices which are reasonable when judged by the conditions.

2. The company must not be unnecessarily harassed, but must be afforded reasonable opportunity for economically transacting the business related to giving the service for which the company was organized; and it must be allowed to make sufficient returns on its investment to enable it to attract the best and fairest minds to the management, and maintain a position of stable credit with the investing public.

3. A public service company in a new and developing country must see before it opportunity to earn returns on its invested capital which are large, compared with those adequate in stable and thickly-settled regions, in order that it may secure the capital needful for developing its plant and extending its service to meet the apparent needs of an expanding, but not yet stable population

4. A new company, even in a stable country, ought to earn more than current rates of interest for its investors, whose enterprise enables them to take the risks of establishing the business, but the rate of return on the investment may be expected to approach current rates of interest after the business has become profitable and is firmly established on fixed franchise rights covering a long period.

I will not here give the arguments to show the validity of these principles, or attempt to explain their significance. An acceptance of these general principles, leads as a consequence thereof, to recognizing that an equitable system of telephone rates should distribute the burden of expense which must be borne by the company for operating maintenance, depreciation and interest, between the users with reasonable consideration of the proportion of the expense which is caused by the service in each of the several classes; and the classes of service should be sub-divided in such a manner, that subscribers with relatively similar wants will naturally group themselves together.

The ideal method of charging for telephone service is to charge each customer in proportion to the service he receives from the company, measured in quantity received and of the quality corresponding to his needs; and to make the charge to all customers as low as is consistent with the operation and maintenance of the property, accompanied by the payment of a fair return on the money invested. When unlimited service rates are charged, two kinds of customers, namely, business customers and residence customers, are ordinarily differentiated from each other. Each of these kinds may be grouped in various classes by arranging individual subscribers on special lines, associating two or more subscribers on a party line, providing private branch exchanges, etc., according to the needs of the customers; and the rates charged for service in the several classes may be expected to differ, on account of differences in the cost of equipment required in different classes, and on account of differences in the average amounts of use of the telephone by customers in different classes.

Message rates for telephone service have decided advantages over flat rates in many particulars. Message rates manifestly make it possible to reduce the price of telephone service to the small users to the smallest fair annual charge for what they actually receive; and this is particularly true if effective and convenient means for curbing extravagant use of the service are introduced, as by the introduction of prepayment service, and convenient for collecting accounts are provided.

The smallest fair annual charge referred to is one that is sufficient to cover a reasonable interest and depreciation and maintenance for the portion of the plant that must be provided for the use of the average of the individual users in the subscriber's particular class, added to an amount which is proportional to the average number of messages transmitted from his telephone in a year.

All legitimate expenses of the operating company must obviously be provided out of the revenue obtained from the rates, and the rates should raise only enough revenue to meet these expenses, provided the word "expenses" is used comprehensively, so as to include returns on the investment. The expenses may be grouped as executive (general), operating, maintenance (repairs), taxes, renewals (depreciation), and the return on the investment. The last item is sometimes referred to as "interest" and sometimes as "interest and profit." In the latter phrasing, I presume that the interest referred to must be taken at current rates for secured investments, and that any additional return required to support the solvency of projects referred to in the third and fourth of the above mentioned general principles, may be called the "profit." A reasonable standing surplus is needed as a reservoir to maintain a parity of conditions from year to year, and if this has been drawn upon it must be replenished as earnings warrant.

If the rates by which the revenue is raised, are to be put on a rational basis, there must be some better reason for the differences between the charges for different classes of service than the best judgment of company officials, however able and experienced those officials may be. These differences now rest almost altogether on expediency, what the traffic will bear, as shown by the growth of the service, and a certain bulk judgment of the possibilities. To improve on this, it is necessary to obtain an intimate statistical knowledge of the traffic of each class of subscribers, the plant investment required to provide that traffic, the effect of the traffic on the wear of the plant, the expenses of operation associated with the traffic, and other like information that telephone companies have not been in the habit of gathering or recording. The plant, the money, and the traffic statistics must be brought into association. The telephone companies

have heretofore been satisfied to hold their accounting as a species of auditing, capable of showing what dividends the company can pay after leaving some surplus as the result of any year of operation, and they have failed to erect it into a statistical structure which will afford indications of the relative reasonableness of their different rates. The hesitancy of company management to enter upon full statistical records and study of its business, when not compelled to do so by the influence of keen competition, such as exists in some branches of manufacturing, is perhaps not unnatural, but it is a hesitancy that needs to be overcome for the joint good of the public and the serving companies.

As a basis of determining the reasonableness of rates, the following factors must be taken into account:

(1) The annual cost entailed by the investment which is needed to care for the subscribers' wants, which investment depends not only on the cost of the plant required to connect the subscribers to the exchanges, but also on the amount of traffic which is handled over the subscribers' lines; and (2) the cost per message entailed in caring for the subscribers' traffic.

The property required for each class of service must be maintained day by day, and also must be replaced as it depreciates from any cause below an efficient condition; interest must also be earned upon the investment. These should not be apportioned among the classes of service directly in proportion to the number of subscribers in the classes, but should be apportioned in proportions depending jointly on the numbers of subscribers, the character of the plant required, and the amounts of traffic in the several classes. The annual cost entailed by the investment which is needed to pay for the subscribers' wants, therefore, depends upon two things. One is the mere fact of his taking telephone service, and therefore requiring the company to furnish equipment, whereby it may be ready to serve him—the cost of which equipment is affected by the kind of line he subscribes for, as special line, two-party, private branch exchange, etc. The other is the extent of his traffic, since a large amount of service originated by a subscriber calls for a larger investment in certain portions of the plant, than would be requisite to care for the wants of a subscriber with a similar line but smaller traffic thereover.

The costs over and above the return on the investment are made up of (a) an operating cost; (b) the costs of general expenses (including taxes), superintendence, advertising, current repairs, instrument rentals, messenger expense, conduit, pole and roof rentals, sublicense expenses, and the like; and (c) the depreciation charge.

The investment required per subscriber in the various classes of service is a complex quantity. For instance, each subscriber requires one substation and one drop wire, regardless of the character of service; special line subscribers each require one subscribers' telephone circuit with switchboard connection; party-line subscribers are each chargeable with a part of the cost of one subscriber's line and switchboard connection, etc.

Interest and depreciation (renewals) carry a larger influence in the affairs of a public service company than in average business affairs, particularly because the total income of a public service company is a fraction of the actual money invested instead of being a multiple thereof. It is, therefore, manifest that a detailed knowledge of the cost of producing the property required for sustaining the public service is one of the features of prime importance in the problem of arriving at rational rates. This points to appraisals of the property of the telephone companies, as done in Massachusetts and Wisconsin, since the companies themselves seldom have adequate records of either property units or property costs. The apportionment of investment and annual expenses between classes of service for the purpose of testing the reasonableness of existing rates or fixing new ones, requires the assumption of factors and the utilization of averages, which the old type telephone man may criticize, but such criticism may be captious, rather than just. The whole fabric for instance, of charges for insurance depends upon careful actuarial computations founded on the use of averages, and it works out advantageously for both the insurer and the insured. A careful insurer would have a profound distrust of an insurance company which failed to gather, record, and use all pertinent statistics in connection with its rate making.

One of the difficulties of the situation is to devise a test of the equitableness of rates, which, as a test, will be satisfactorily applicable to all cases. It is being urged in some quarters that cost of specific performed service shall be determining. In other quarters, it is urged that the "value of the service" to the subscribers shall be determining. The latter seems but another way of proposing to make charges according to "what the traffic will bear," when that phrase is used in its objectionable sense of taking as much as the subscribers will give up. This phrase, "what the traffic will bear," however, has a meritorious significance which differs from its popularly accepted meaning of taking all that the customers will pay. According to its meritorious and correct meaning, it signifies that the charges made for service are adjusted as between the company and each of its customers, so that the company finds the dealings profitable with each, when the full situation is considered, and each customer receives services which, as nearly as practicable, meets his requirements and costs a price which makes the service advantageous to him, while no unjust discriminations between customers are allowed.

In passing, I will make a note that the last phrase does not involve equal prices to all customers, but does involve the treatment of all customers so that they obtain from the company relatively, a full return for their money.

It seems to me that the test of the reasonableness or equitableness of the rates maintained by a public service corporation is found in: (1) The effectiveness and simplicity with which the schedule classifies the customers, so that the total required income is collected in a manner which secures the same rate for all customers of a class obtaining approximately like service, though customers belonging in different classes may be subject to quite different rates, because they obtain service with differences of character which essentially affect the cost per unit; and (2) the certainty with which the rates secure from each class of customers the full annual operating cost of the service in that class and such a proportion of the reasonable return on the investment as the customers' traffic can afford. It then becomes a matter of public policy to determine whether a company receiving a public grant shall be privileged to take a larger proportion of profit from one class of customers than from another; the word profit being used to signify the aggregate return on the investment. This is a relatively new question in public policy, and the ultimate limitations of the policy must rest with experience and the future expressed judgment of our most judicial minds. It would be a manifest injury to the nation if the policy became so circumscribed

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THE ENGINEERS' LIBRARY

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

CONTENTS OF ENGINEERS' LIBRARY.

BOOK REVIEWS.

Hand-book for Millwright.—By C. J. Swingle, M.E. Published by F. J. Drake & Co., Chicago. Size, 5 x 8; pp. 400; price, $2.00.

Although this book is described as a hand-book, it is more than a hand-book, in that it deals with the theory and the why of considerable of the work that a millwright will have to do in design and construction.

It describes the practical planning and arrangement of mill buildings, and deals with the more practical questions involved in the strength of materials and evolving out of the modulus of elasticity and moments of inertia. Shafting, journal bearing, and coupling are referred to very fully. The question of what horse-power shafting will transmit is discussed, and several useful tables are given. The importance of proper alignment and levelling of shafting is dealt with, and location and size of pulleys, together with key fittings and set-screws are fully discussed. Belts and belt-drives are taken up, and Table "26" gives the horse-power that different leather belts will transmit per inch in widths at various speeds. A method of lacing and stretching is illustrated, and the chapter on belts is followed up by a discussion of transmission of power by rope drives.

The relative merits of gear wheels and electric installation as a method of drives is discussed, and the concluding chapter is divided up in a miscellaneous collection of information which will be of interest to all those having to do with the installation of mill machinery.

Practical Shaft-sinking.—By F. Donaldson, M.E. Published by the McGraw-Hill Co., 239 West 39th Street, New York city. Size, 7 x 9; pp. 140; price, $2.00.

This volume has been prepared by the chief engineer of the Dravo Contracting Co., and is a reprint of a series of articles that appeared in "Mines and Minerals" during 1909-10. The volume is well illustrated, and many of the diagrams have dimension figures clearly placed. In addition to a table of contents it contains a complete index to the various matters dealt with in the text.

Chapter I. contains brief descriptions of some of the deep shafts that have been sunk, and in addition contains specifications for sinking and lining shafts, together with forms of contract.

Chapter II. deals with the plant required for this class of work, and refers in some detail to the boilers, hoisting engines, head-frames and buckets required, and makes special mention of the use and conditions of air compressors and shaft-sinking.

Chapter III. deals with the difficulties encountered in the various kinds of soil, and pays special attention to the practical method used in sinking through soft ground, and the schemes devised for concrete lining of shafts. In this connection many interesting cost figures are given, examples being taken from work actually completed under the writer's notice. The pneumatic process of caisson sinking is dealt with, as also is the process of pushing forward by means of shields. In sinking through rock the author describes the method of drilling and blasting, as well as describes the tools necessary for this class of work. In this section, as in others, costs are given.

In Chapter VI. the method that is being used in soft ground, not only for sinking shafts, but for sewer work, is carefully described; that is, a scheme for freezing the quick-sand or mud.

Chapter VIII. deals with the various methods of pumping, discusses the relative merits of horizontal and vertical pumps, the handling of pumps and shafts, and concludes with special reference to the Cornish pumps.

The concluding chapter deals with shaft linings. The various methods of lining that may be adopted are described, together with the quantity of material required, and the probable cost of labor for this work. Methods of placing the material are also given. For the engineer with not too much experience in this class of work who expects to have to undertake it this book will prove of great practical assistance.

Telephonology.—By H. R. Van Debenter, B.S. Published by the McGraw-Hill Book Co., 239 West 39th Street, New York city. Size, 7 x 9; pp. 600; price, $3.00.

Although the field of telephony is very wide, and it is practically impossible for one author to prepare a general work covering the whole matter, yet in this volume the author has succeeded in arranging the most necessary information that is likely to be required in connection with telephone lines and operation. Much of the information is general, and may be found scattered through a number of publications, as well as the technical press, but considerable of the work is original matter, and, taken altogether, the book contains accurate, useful and up-to-date descriptions and data.

The author claims for the publication that it is a description of modern telephone appliances and of valuable articles on the erection, equipment and maintenance of telephone exchanges and lines, instruments and switchboards, together with apparatus for line and cable testing.

In the sixteen chapters the author deals with good talking equipment and the various mechanical parts that enter into the construction of a telephone line. Two chapters are devoted to batteries suitable for telephone work, and some sixty chapters are devoted to methods of line and cable construction. The automatic system is dealt with somewhat fully, and the concluding chapter takes up the latest invention—wireless telegraphy.

In addition to table of contents, the volume contains a complete index, which has been carefully prepared, also cross-indexed.

Encyclopædia of Municipal and Sanitary Engineering.—By W. H. Maxwell, A.M. Inst. C.E., and I. T, Brown, M.R. San. Inst. (editor of "The Sanitary Record). Published by Constable & Co., Limited, Leicester Square, London, W.C. Price, $10.50.

This in one volume forms an alphabetical list, comprising almost every detail in municipal and sanitary engineering. The subject matter is concise, and yet dealt with in a very efficient manner, considering the space possible to allocate in such a comprehensive work.

The list of contributors includes most of the well-known experts in the various departments of municipal enterprise. There is no question that an encyclopædia of this special

nature will prove invaluable in municipal and engineering bookshelves as a work of general reference. There are times when we require just some special information at some particular moment, and it may require no end of hunting up through files or catalogues to obtain it. It is here where the use of an encyclopædia comes in.

The municipal engineer is supposed to be a man who can answer any municipal engineering question at any moment. There are, no doubt, many who would desire to have a complete list of all municipal engineering problems right at their elbow, with the information terse, concise, and complete, ready to be served up at any moment.

We have carefully gone over this new encyclopædia with reference to subjects upon which we have some knowledge, and have concluded that it is well up to date in its information, and will form a valuable and ready reference in the municipal engineer's library.

Sewage Disposal.—By Messrs. L. P. Kennicutt (Director Department of Chemistry, Worcester Polytechnic Institute), C. E. A. Winslow (Professor of Biology, Massachusetts Institute of Technology), and R. Winthrop Pratt (Engineer of the Ohio State Board of Health). Published by John Wiley & Sons, of New York. Price, $3.00 net.

This valuable work to the engineer and student was commenced in collaboration by the above well-known experts before the publication of either H. P. Raikes' "Design, Construction and Maintenance of Sewage Disposal Works" or the English edition of Dunbar's "Principles of Sewage Treatment."

The chief value of the work consists in the fact that we have the views of the chemist, the biologist and the engineer combined in a unity. It forms also the most up-to-date and comprehensive treatise on American practice.

Many of the features, especially those dealing with the problems of sedimentation and the chemistry of sewage, are anticipated in Dunbar's valuable work and others of recent production. On the other hand, there is a quantity of original investigation and deduction which could only have been produced by the happy combination found in the joint authorship.

There is a distinct desire on the part of the engineer to know something of the inner science of sewage purification apart from the mere constructive features incident to installations. Many works on sewage disposal are simply a hash-up of catalogue illustrations, with references to particular installations when such are in vogue. The particular volume in question is calculated, on the other hand, to add an interest to the subject not usually found in most works.

Without doubt or hesitation, every student interested in sanitary engineering must at once make himself acquainted with this new classic on a subject which is becoming of more and more importance throughout Canada.

Sewage Disposal Works: Their Design and Construction.—By W. C. Easdale, M.S.E., M.R., San. I. Published by Spon & Chamberlain, New York. Price, $2.50.

This volume consists almost exclusively of descriptions, illustrated with drawings and photographs, of the various tanks, chambers, filters, beds and other details of sewage works, including the numerous types of appliances required in connection therewith.

The author has had many years' special experience in the use and application of all manner of sewage disposal apparatus, and is well qualified to edit a descriptive work of this character. The work is purely practical in nature, and is designed with the view of supplying in a small compass a ready reference to practically all the constructive parts in modern sewage disposal work.

The volume is entirely up to date, and contains some valuable notes with reference to special appliances designed for the introduction of disinfectants to both potable waters and sewage effluents.

In Canada, where sewage disposal is practically a new feature in engineering, such a work as above described will prove of great value to municipal engineers and others who are called upon to prepare plans and specifications for the installation of modern effective works of sewage purification.

Sewerage: The Designing, Construction and Maintenance of Sewerage Systems.—By A. Prescott Folwell. Sixth edition, revised and enlarged. Published by John Wiley & Sons, New York. Price, $3.00.

This well-known practical treatise on sewer construction has now reached a new edition, enlarged to take in also construction features in sewage disposal plants and notes on methods of treatment.

The contents and illustrations of the book are invaluable to the sanitary constructing engineer. Such chapters as those which deal with Designing, The System, Amount of Sewage, Flushing and Ventilation, Collecting the Data, Detail Plans, Specifications, Methods of Assessment, etc., are all of such practical importance that they should form ready reference in the drawing office.

During the past this work has been recognized as a standard text book in engineering schools, and its enlarged and revised edition will form a welcome addition to technical educational literature, as well as to the engineer's library.

General Specifications for Structural Work of Buildings; C. C. Schneider, M. Am. Soc. C.E., paper, 68 pp., 6″ x 9″. The Engineering News Publishing Company, 75c. net.

This edition is a revision of that published in the Transactions of the American Society of Civil Engineers in 1905, with much additional matter, chiefly as regards concrete. The arrangement of the subjects, etc., calls for no comment since practice is now fairly standard in this regard, so much so, in fact, that a general index is apparently regarded as unnecessary. Individual opinions would make of a work of this nature an endless source of debate. We have agreed with one clause and condemned another and doubt not that the comments on this work could be expanded into a volume many times the size of the original.

The live loads on floors are specified in three ways: (a) Uniform load per sq. ft., (b) Concentrated load at any point, (c) Uniform load per lin. ft. of girders. The maximum result is to be used. A table of the three values to be used in different classes of buildings is given. This is a radical departure from the usual practice but would appear logical and, on acquaintance, involves but slightly more calculation.

The strength of connections shall be sufficient to develop the full strength of the member. This clause is sometimes amplified to accentuate a fundamental absurdity. If the minimum sizes of sections available compel a designer to use an amount of metal in a member in excess of that required by the maximum combination of stresses, it would appear a palpable waste to still further load down the structure with details in the same proportion. In pointing out the fallacy at the root of this clause we are not in any way minimizing the necessity for **adequate** detailing.

European, and chiefly German, practice has been followed in the specifications for reinforced concrete which are prefaced by some words of comment which are interesting chiefly as indicating that, in the opinion of an eminent engineer, the condition of the concrete industry still warrants warnings concerning the applicability of concrete; and the fact that he calls them tentative affords an interesting point in comparison with the standard practice in steel design.

There are some interesting and valuable tables, details, hand and travelling crane loadings and an exceptionally good abstract of the building laws of fourteen American cities.

W. S.

PUBLICATIONS RECEIVED.

Technical Drawing Series.—By Gardner C. Anthony, A.M., Sc.D. Published by D. Heath & Co., Boston, Mass. Size, 6 x 8; pp. 105; price, $1.00.

The Condition of the Steel of the Gillender Building.—Published by Toch Bros., 320 Fifth Avenue, New York.

Standard Specifications for Structural Steel, Timber, Concrete, and Reinforced Concrete.—By John C. Ostrup, C.E. Published by the McGraw-Hill Book Co., 239 West 39th Street, New York. Size, 6 x 9; price, $1.00.

Pure Water and the Pollution of Waterways.—By Chas. A. Hodgetts. Published by the Canadian Conservation Commission. (Pub. doc.) Size, 6 x 9.

General Specifications for Structural Work of Buildings.—By C. C. Schneider. Published by The Engineering News Publishing Co., 220 Broadway, New York. Size, 6 x 9; pp. 70; price, 75 cents.

Construction of Electric Furnaces for the Production of Pig Iron, Steel, and Zinc.—By Eugene Haanel. Issued by the Department of Mines, Ottawa, Ont. Size, 6 x 9; pp. 80. (Pub. doc.)

Ores, Non-Metallic Minerals, Fuels, etc.—Report of analyses from 1906 to 1908 by F. G. Wait, M.A. Issued by the Department of Mines, Ottawa, Ont. Size, 6 x 9; pp. 130. (Pub. doc.)

Sewage Disposal Works: Their Design and Construction.—By W. C. Easdale. Published by Spon & Chamberlain, 123 Liberty Street, New York. Size, 6 x 9; pp. 260; price, $2.50.

Sewerage: The Designing, Construction, and Maintenance of Sewerage Systems.—By A. Prescott Folwell. Published by the D. Van Nostrand Co., New York, 23 6 x 9; pp. 500; price, $3.00.

Dynamo Electric Machinery: Its Construction, Design, and Operation.—By Samuel Sheldon. Published by the D. Van Nostrand Co., 23 Murray Street, New York city. Size, 5 x 8; pp. 330; price, $2.50.

The Tesla High Frequency Coil: Its Construction and Uses.—By George F. Haller and Elmer Tiling Cunningham. Published by the D. Van Nostrand Co., New York, 23 Murray Street. Size, 5 x 8; pp. 125; price, $1.25.

Geology of the Haliburton and Bancroft Areas.—By Frank D. Adams and Alfred E. Barlow. Issued by the Department of Mines, Ottawa, Canada. (Pub. doc.) Size, 6 x 9; pp. 410.

Practical Shaft Sinking.—By Francis Donaldson. Published by the McGraw-Hill Book Co., 239 West 39th Street, New York City. Size, 6 x 9; pp. 140; price, $2.00.

Electricity: Experimentally and Practically Applied.—By Sydney Whitmore Ashe. Published by the D. Van Nostrand Co., 23 Murray Street, New York city. Size, 5 x 8; pp. 350; price, $2.00.

Reinforced Concrete in Sub and Superstructure.—Vol. VIII., Deinhardt-Schlomann Series, technical dictionary in six languages. Published by the Copp, Clark Co., Limited, Toronto. Size, 4 x 7; pp. 415; price, $1.80.

Board of Estimate and Apportionment.—Report of the City Engineer of the city of New York, 1909. Size, 7 x 10; pp. 390. (Pub. doc.).

The Effect of Keyways on the Strength of Shafts, by Herbert F. Moore, has just been issued as Bulletin No. 42 of the Engineering Experiment Station of the University of Illinois. This bulletin records the results of tests made to determine the relative strength of solid shafts and shafts with keyways. Various sizes of shafts were tested, and for each size of shaft the weakening effect of keyways of several proportions was determined. Tests were made on shafts subjected to twisting only and on shafts subjected to twisting and bending at the same time. The results show that the weakening effect of keyways of the usual proportions upon the strength of shafts is considerable, a square keyway of the usual size causing a reduction of about one-sixth in the strength of the shaft. Formulas and a diagram are given for determining the effect of keyways of various proportions. The effect of keyways for the Woodruff system of keying is discussed. The results of the tests are summarized in a table showing the power which can be transmitted by various sizes of shafts with keyways of usual proportions. Copies of Bulletin No. 42 may be obtained gratis upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

Rock Drills.—By Eustace M. Weston. Published by the McGraw-Hill Book Co., 239 West 39th Street, New York. Size, 6½ x 9; pp. 370; price, $4.00.

CATALOGUES RECEIVED.

Filters.—The Roberts Manufacturing Co., of Chestnut Street, Philadelphia, Pa., describe their filters and attachments. These filters have several unusual features.

Electric Specialties.—The Verities, Limited, of Aston, Birmingham, England, forward a catalogue describing the large number of special attachments that may be used in connection with electricity. Not only household, but factory specialties are described.

Incinerators.—The United States Incinerator Co., 524 White Building, Buffalo, N.Y., describe a sanitary, odorless and economical destructor of garbage. This incinerator is adaptable and portable, and will be of great use in villages, mining and contractors' camps, doing away with the filthy and unhealthy cesspool.

Automatic Sewage Pumps.—Merritt & Co., of Philadelphia, Pa., are distributing a special package containing information of their various appliances for the raising of sewage and the control of sewage disposal plants. They will be pleased to forward the same to engineers interested.

Chimneys.—H. R. Heinickle, 147 Fourth Avenue, New York, N.Y., forward a catalogue describing and illustrating their design of hollow radial brick type of factory chimneys.

Sewage Ejectors.—The Ansonia Manufacturing Co., of 30 Church Street, New York, N.Y., describe their ejectors for sewage disposal plants. In addition to descriptive matter the booklet contains considerable tabular information.

Sewage Filters.—F. W. Stoddart, of Bristol, England, describe their continuous filter system in a brief pamphlet.

Ditchers.—The St. Paul Ditcher and Carrier Co, of St. Paul, Minn., are distributing an illustrated leaflet describing the Hovland tile ditcher.

Belting.—"The Difference between Albeco Laminated and Multi-Lap Leather Belting" is the title of a booklet being distributed by the American Laminated Belting Co., 113 Hudson Street, New York. This booklet is especially interesting in that it gives close comparisons of the operating principles, power transmitting qualities and ultimate economy of both types of belting.

Sewer Pipe.—The American Sewer Pipe Co., Akron, Ohio, are distributing an interesting booklet, fully illustrated, and containing detailed information as to their sewer and fittings, their size, dimensions and prices

Hoists.—The Whitton-Kramer Electric Tool and Hoist Co., of Birmingham, England, in their catalogue "K" 18 describe a series of electric hoisting specialties. Hoists suitable for all kinds of work or power as required.

Pavements.—The Rudolph S. Blome Co., of the Bank Floor Utility Building, Chicago, would be pleased to send you a booklet describing their granitoid concrete pavements. This booklet has a score of illustrations showing what has been done in the matter of the laying of this permanent pavement.

Sanitary Specialties.—The Adamsez, Limited, sanitary engineers, of London, England, are issuing a catalogue, 6 x 9, containing some 300 pages, which describes every class of sanitary appliances of the most approved type. Not only illustrations, but dimensions and prices are given.

Iron Works.—The Cargo Fleet Iron Co., of Middlesborough, England, issued a 50-page booklet describing their works and a list of their products which they market, which include rails, angles, channels, flanges, blooms and billets.

Reciprocating Meters.—The Mechanical Instrument Co., of 120 Liberty Street, New York city, have issued an interesting booklet describing their mico reciprocating meter for counting piston travel. This device measures accurately the actual total distance travelled in both directions of all reciprocating motion.

Incinerators.—The great interest taken in sanitary matters and the disposal of garbage by incinerators will cause engineers to gather information on the various kinds of destructors now on the market. The Decarie Incinerator Co., of Hopkins, Minn., are distributing a catalogue which describes their incinerator, its method of operation, and contains interesting data gathered in a number of American cities.

Hauling Machinery.—The Buffalo, Pitts Co., of Buffalo, N.Y., recognizing the place steam hauling machinery will occupy in this country, have prepared to meet the new conditions by designing and building steam-hauled trains on highways. Their new catalogue "F" describes very fully this class of machinery, and this firm will be very pleased to forward their catalogue to those interested in transportation.

Water Turbine Plants.—By Jens Orten-Boving. Published by Raithby, Lawrence & Co., 231 Strand, London, Eng. Size, 9 x 12; pp. 200.

This book has been prepared partly as a text-book, dealing with modern theory, design and application of water turbines and accessories, and partly as a catalogue. It is especially intended to be of practical use to those responsible for the design of complete water power installations, and is confined to the more purely mechanical portions of such plants. The question of dams, conduits, flow of stream, etc., is not dealt with. The work is divided into three parts, each section fully illustrated.

Part I. deals with the theory of turbines, reaction and impulse, output, velocity of water, efficiency, speeds, governors and pressure regulators. The question of tests is taken up, and examples are given.

Part II. has to do with the dimension and weights of the various sizes and types of governors, valves, sluice-gates and strainers. Pipe lines and the method of making joints and anchorages is taken up in this chapter and several illustrations given.

The concluding chapter is taken up with descriptions of various power stations. Engineers cannot usually spare time to visit the various plants, but their knowledge of power plants will make it easy for them to, from this book, grasp the more interesting features of the largest installations throughout the world.

IS A RATIONAL BASIS POSSIBLE FOR TELEPHONE RATES?*

(Continued from Page 652.)

that the railroads would feel that equal proportions of profit must be earned on all parts of their systems and from all kinds of traffic. What the effect of so circumscribed an answer would be in the case of corporations giving service within the limits of a single city or a single state like most of the telephone companies, is not so clear.

The cost of performing the service seems to me the most important factor in determining rates, but its application to telephone service must be made with a cautious consideration of all the facts. Reasons for this are obvious when the problem of telephone service is carefully scrutinized. In city service, the large business users demand a celerity and accuracy for the service which adds much to its cost. Physical conditions prevent providing this fast service for one class of subscribers and not for others in intimate intercommunication therewith. But some of the latter classes, as for instance, the residence users of moderate means, may have no interest in or care for the remarkable speed and accuracy which characterizes the telephone service of many American cities. Service of a lower grade of speed and accuracy, which is less costly to produce, would equally well satisfy the desires and needs of such subscribers. A distinction should, therefore, probably be made in class rates, so that the cost of extraordinary speed and accuracy may be placed on the classes of subscribers who demand it.

A similar condition exists in the relations of city and rural telephone service. The business subscribers of the city demand the speediest and most accurate service obtainable at any cost, but rural subscribers are usually well satisfied by a more leisurely grade of service. However, the city conditions are forced, by the demands of the city, to be spread over both the city and the closely related rural communities; and, here again, the extra cost of the speedy service ought to be borne by the classes of subscribers imposing it. As the provision of the speedier service requires greater investment in rural plant, than might otherwise be necessary, it is obvious that the cost of performing specific service in the suburban communities may not always be a fair basis of rates in case the cost is to be put where it belongs.

The foregoing indicates that city business rates may be reasonably expected to be higher than residence or rural rates. A differentiation between business and residence users under flat rates has heretofore been common, and this is additionally justified by the lower average calling rate which is usually characteristic of residence subscribers where flat rates are in vogue. The relations pointed out above apparently justify an adjustment in favor of residence users of moderate requirements even when measured rates are adopted. The policy of some telephone companies apparently is in this direction, although those companies have endeavored to support their policy on the untenable theory of charging in proportion to what the traffic will bear.

Progress is plainly being made in the direction of rationalizing telephone rates. One of its indications is found in the syllabus of an opinion delivered in a telephone rate case by the Wisconsin Railroad Commission, which says:

"No reasonable objection can be taken to a schedule of rates based upon the actual quantity of the service rendered."

It would be difficult to quarrel with this, provided "quantity" is construed to comprehend both the number of

(Continued on Page 664.)

ROADS AND PAVEMENTS

HIGHWAY DUST REDUCTION IN THE URBAN DISTRICT OF ALTON.*

By C. Bertram Hartfree, Surveyor to the Council.

In the pre-motor-car period surface watering was generally found all-sufficient to allay the dust upon the highways; as traffic increased in numbers and speed the old-fashioned box-spreader watering van was superseded by the rotary sprinkler and other forms of sprinklers, which in the larger towns were motor propelled and where electric tramlines existed travelling along them.

It was soon found that watering was not the solution of the dust difficulty, and its excessive use tended to injure the road surfaces, in addition to being the cause in several instances of successful actions for damages against local authorities arising through accidents to cyclists. On the coast towns lesser quantities of water were required owing to the use of sea water; possibly from this, experiments were made in inland towns with solutions of common salt and soda, but the use of deliquescent salts did not come to the fore until the introduction of the proprietary palliatives, Westrumite, Akonia, and calcium chloride. The tarring of road surfaces was also successfully tried by several pioneers, including Mr. Cass, of Farnham, and the present perfection in the use of a tarred matrix due to the efforts of Mr. Gladwell. The use of tar in road construction dates back to the year 1837. It does not appear to have been generally adopted; possibly the tar was not of the quality of that now obtainable, and the introduction of railways with continual decrease of use of highways led to its being required until the present age of increased road traffic.

Finding that ordinary watering did not cope with the evil, the author first tried the only other means at that time at his disposal, and had the main thoroughfares under his charge thoroughly swept by a rotary broom, and this gave better results in subsequent surface watering, but left much to be desired. In the year 1907 trials were made with Akonia and calcium chloride; with both these palliatives the road was well swept before use, the solution being laid by two applications with one day's interval between. Both showed to great advantage over ordinary watering, and in the following year the principal streets were treated with calcium chloride to the great satisfaction of the frontagers. The season was not good for economic results, as intermittent heavy rains reduced the effectiveness of the salts. Given orthodox summer weather it was found that the road being fairly well swept and the solution sprayed from an ordinary watercart, using 3 cwt. of calcium chloride dissolved in 300 gallons of water (this covered about 800 yds. super.) letting a day lapse, and giving a similar treatment on the third day, no further solution or watering was required for ten or twelve days, when, should there have been no showers, it was found necessary to damp the surface by a slight sprinkling of water in the ordinary manner, and four days later a weak solution, using 2 cwt. of calcium chloride to 300 gallons of water, and subsequently best results were obtained by spraying a weak solution every seventh day, and damping it four days after. The road surface after this treatment was in better condition than one heavily watered, but had a greasy appearance in winter, especially during foggy weather, which gave rise to several complaints. Unlike tar, it does not save any wear upon the road, merely maintaining a damp surface.

The cost of this particular season exceeded ordinary watering by 25 per cent., the calcium chloride costing £2 9s. 3d. per ton at station, while a hired horse and man for street watering were paid 7s. 6d. per day, water supply being under the council's control, and charged 6d. per 1,000 gallons. Taking into consideration the extra benefits derived and the less wear upon the roads, the author has no hesitation in recommending either Akonia or calcium chloride as being more effective and economical than ordinary watering. He believes that both these palliatives are now sold in granular form for use, spread upon the surface from a shovel, or mixed with road metalling previous to rolling, but of the results he has no information. In concluding this part of the paper the author begs to point out that for good results it is imperative to sweep all dust off the road-surface before laying deliquescent salts, as otherwise these are washed away with the dust in the first rain that follows, while spread upon a clean macadam surface there is less possibility of this happening. It is interesting to note no complaint was received in respect to injury to fishing waters.

In the year 1909 the Hampshire County Council voted the sum of £1,000 for the purpose of making one-half contribution towards tar painting granite-coated main roads and this was distributed among the various district councils. In the rural districts difficulty was found upon the point whether surface-tarring was a question of maintenance, in which case their rate could not legally be used towards contributing the remaining half of cost; expert legal opinion, however, has now decided that the parish rate can be used for the purpose, and this procedure is now followed instead of obtaining the money by public subscription. The author's district being urban, the original difficulty did not occur, and a contract was made with the Taroads Syndicate to spray 20,000 yds. super. with distilled tar at ⅞d. per yard, the preliminary sweeping and subsequent dusting or sanding being done by the council's men. The machine sent was too large for the purpose, an independent engine weighing quite 14 tons hauled the machine, which was capable of spraying three-quarters of a mile half width of road. This undoubtedly would be excellent for long stretches of country road, but the roads treated had no alternative routes, and although in some cases the width exceeded 30 ft., in other parts it was 17 ft., and in addition to local stopping carts a large amount of through traffic passed over. In consequence, the wet tar could not be fenced off, carts and cycles repeatedly passed over, causing side slips to at least two venturesome cyclists, with the usual results.

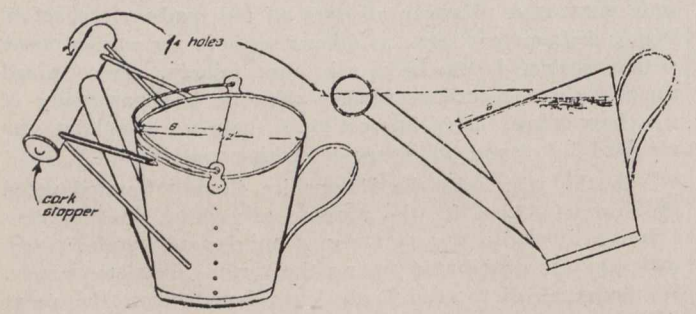
The cost of this was 1⅛d. per yard, including the ⅞d paid the syndicate; the remainder covered the cost of sweeping by horse-broom and hand, also dusting over with clean road dust and sand. In this experiment the tar was not brushed in, and, as far as possible, clean road dust was used upon the surface with successful results. Sand was used only when rain threatened, and, heated over rough sheets of galvanized iron, proved very beneficial in absorbing wet tar, and to a great extent causing it to set quickly and preventing its washing down street drains. The trouble caused by tar sprayed upon a moderately fine day which melted again upon a subsequent hot day, sticking to carriage wheels, was overcome by sprinkling damp sand over wet patches from previous day's spraying. The amount of tar used was five gallons per yard.

The depressions in roads were filled with small material previous to tarring; but the results were not good, possibly owing to the water used in binding not thoroughly drying out.

*Paper read at the recent Guildford meeting of the Institution of Municipal and County Engineers.

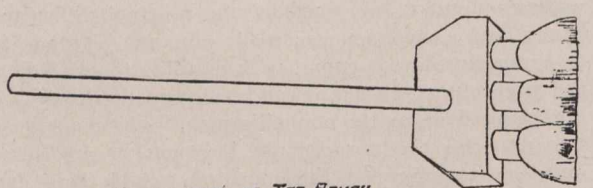
In many patches the tar did not penetrate the new material, and in a number of instances the heavy engine wheels tore out the patches during tarring operations. In justice to the contractors, the author must say that he has seen their small combined tractor and sprayers give perfect results. Patching with small-gauge angular flint coated with tar and pitch was tried after surface-painting. The flint was dried upon old sheets of galvanized iron and mixed with hot tar and pitch.

The holes were filled without picking the surface, a neat patch resulted, but the material did not wear well; a further experiment was made with iron slag obtained from a local foundry. This absorbed the tar and pitch freely, gave better results than the flint, but left too much to be desired, and in consequence, Clee Hill and Rowley Rag 1-in. clean material were tried. These wore better, but the patch was not neat in appearance, and the final experiment of the season was made with Clee Hill stone two parts, ½-in. flint one part, the whole dried, mixed and tarred, using about 9 gallons of crude tar at 2d. per gallon and 8 lb. of pitch, costing 2d. per pound, to ton of metalling; a neat and strong patch resulted. But the experiments clearly showed that best effects could only be obtained by picking around and in the holes to be filled, and this was tried at commencement of the present season, but is now superseded by the use of Tarvia matrix mentioned hereafter.

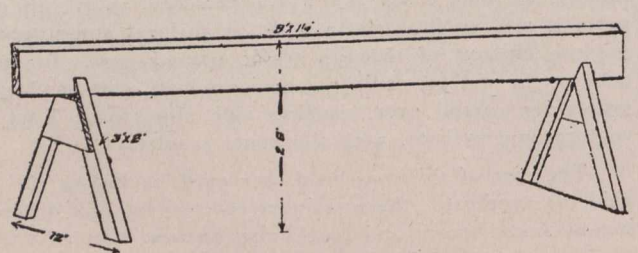


CONVENIENT FORM OF CAN FOR TAR PAINTING

SECTION SHEWING ADVANTAGE OF WIDE HALF COVER



USEFUL TYPE OF TAR BRUSH



CONVENIENT FORM OF TRESTLE

Diagram accompanying Mr. Hartfree's Paper.
(Plate No. 1.)

Surface tarring showed great dust reduction, and has lengthened the life of the roads. The total abolition of dust has not been obtained, although constant scavenging of the streets prevented the trouble from horse droppings felt in many places; but there still was annoyance from dust blown off by-roads, gardens, pavements, and swept out of premises. In consequence the tarred surfaces were watered weekly and swept clean with the horse broom, and this nuisance was reduced. At the commencement of the present season it was decided, in addition to main roads, to tar portions of the district roads; the main roads estimates also included laying 100 tons of granite upon a tarred matrix and a similar quantity with Rocmac solution.

The area to be tar-painted was intended to be one-third by hand treatment and the remainder to be by contract, subject to a small machine being used. The following prices were received for contract work: Hand treatment, crude tar, including labor in sweeping and dusting, 1½d. per yard; machine treatment, including labor as before, 1¼d. per yard, using distilled tar 1⅞d. per yard. Machine tarring, the council to provide for sweeping and gritting, with distilled tar; prices ranged from 9/10d. to 1 3/16d. per yard, and crude tar from ⅞d. to 1d. In every case about 6 yds. per gal. was quoted. The offer of a firm to supply a horse-drawn machine using distilled tar was accepted, they agreeing to commence work within seven days from signing the contract. This was cancelled owing to their delay in commencing, and the whole of the work was carried out by direct labor.

At first there was only a 40-gallon boiler available, and the tar was dipped out and spread from watering cans provided with horizontal spreaders. This type is preferable to the rose spreader as a more uniform covering is obtained; the tar was well brushed in with special tar brushes and left to dry in by the sun; towards evening dust was sprinkled on by hand, and not direct from the shovel, sufficient to cover only being used.

The best results were obtained on scorching hot days, commencing tarring about 11 a.m. and finishing at 3 p.m.; this allowed a perfectly dry and hot surface before treatment, and good sun drying after. When the tar had reached a rusty brown color it was taken as sufficiently dried. With the small boiler about 1,000 yds. per day could be covered, working from six to six, but tarring during suitable hours only half this quantity could be covered. To further advance the work a "Weeks" 80-gallon boiler and sprayer was purchased at a cost of £29 10s. This gave satisfactory results and 2,000 yds. were treated, working a full day; but, as before, the best effects were obtained by treating about 1,000 yds. during the hottest part of the day. At first, trouble was found with the spray, arising through insufficient knowledge on the part of the men using it, the tar from previous spraying having caked the nozzle. Afterwards, by cleaning it immediately after use and warming the end before the next operation, no further choking occurred. The Phoenix Engineering Company, of Chard, have an excellent arrangement upon their latest machines providing for easy cleaning of valves and nozzles. With the advent of the "Weeks" machine it was possible to make comparisons between crude and distilled tar and Tarvia by hand treatment and machine-sprayed; the crude tar was obtained from local gasworks, and was subjected to no other treatment than well boiling to expel water and free ammonia, and the admission of a little lime to neutralize the fixed ammonia. This gave rise to a noticeable smell, but, the work being carried on in an isolated part of the district, no serious complaint was received.

The cost of various treatments were:—

Hand Painting.	d.	
Crude tar, 1 gallon to 7 yds.	¾	per yard.
Distilled tar, 1 gallon to 5 yds.	1⅜	"
Tarvia, 1 gallon to 6 yds.	1⅜	"

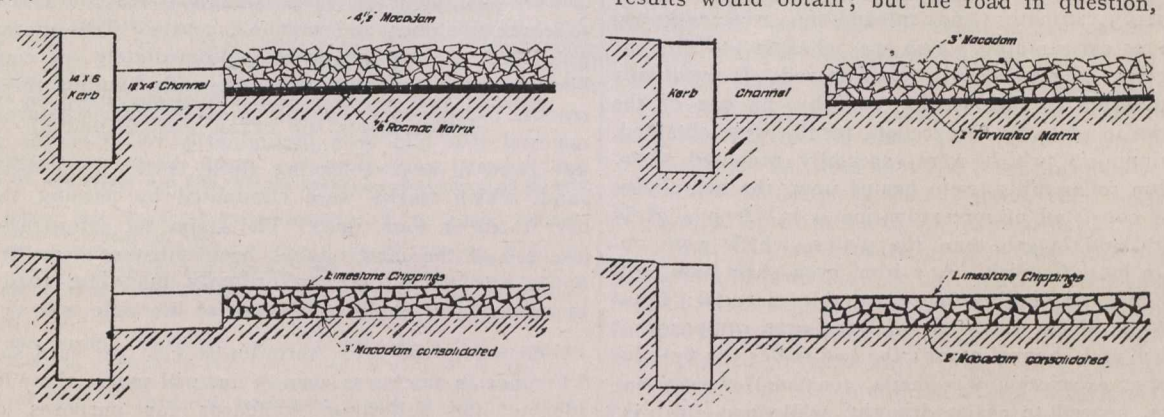
Spraying.

Crude tar, 1 gallon to 7 yds.	½	"
" " " and covering with limestone dust	⅝	"
Distilled tar, 1 gallon to 6½ yds.	1	"
" " on flint surface 1 gallon to 5 yds. and coating with sand	1⅜	"
Tarvia, 1 gallon to 5½ yds.	1¼	"
" " " and covering with limestone chippings	1⅝	"

Crude tar costs 1½d. per gallon, distilled tar 3¾d., and Tarvia 4⅜d.

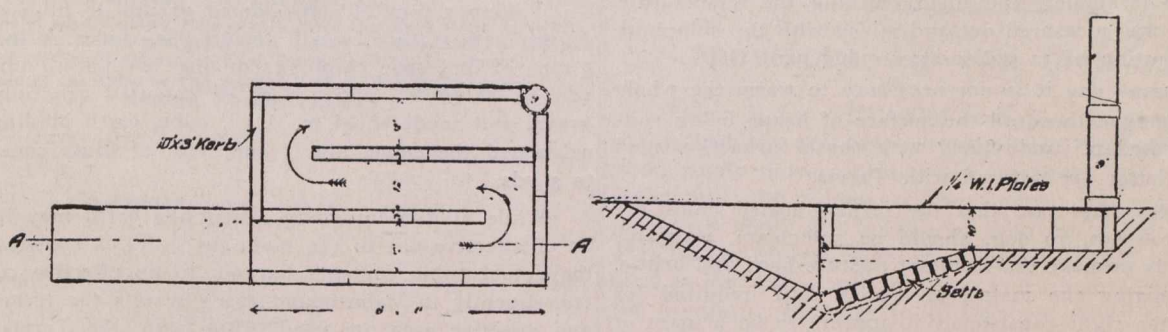
Rocmac.

The construction of a Rosmac road is on somewhat similar lines to the various tar sub-binders, the tar being replaced by the Rocmac solution, which contains caustic soda, sugar, molasses, and several other ingredients, the names of which the makers do not divulge. The mineral portion of the matrix is carboniferous limestone; magnesium limestones are unsuitable. A sound foundation to road is imperative.



ROCMAC ROAD

TARVIATED MATRIX ROAD



PLAN

SECTION A.A.

HOT PLATES FOR DRYING CHIPPINGS

Diagrams accompanying Mr. Hartfree's Paper. (Plate No. 2.)

The road surface was first lightly scarified to within 12 in. of channel stones, raked over and rolled to the required camber, the surplus material being carted away. Upon this foundation a layer of matrix ⅞ in. thick was spread, the matrix consisting of Shepton Mallet limestone dust two parts to one of ⅜-in. chippings from the same locality. To every cubic yard of the limestone 15 gallons of solution were added, and the whole well mixed and turned over seven times. Thorough mixing and turning over are essential for good results, and half-yard mixings should be the maximum. The mixture was immediately spread and raked over to the required thickness and covered with 2-in. Clee Hill basalt to a depth of 4 in.; as soon as sufficient granite was spread to render rolling possible it was rolled by a 10-ton roller. At the end of an hour the matrix commenced showing through the interstices of the macadam, first the ooze containing the smaller particles and eventually the chippings until the whole of the voids were filled and a slurry that could be swept appeared on the surface. No water whatever was required on wet days, but during sunshine it was necessary to water the roller and wheels to prevent the matrix sticking to them. This being of a nature somewhat similar to a quick-setting cement, spreading must immediately be followed by rolling, and the whole of the material spread during any day must be rolled before the expiration of that day's work.

The makers advise, wherever possible, one-half of the road be repaired at a time, although, where this is not possible, the full width may be treated with traffic passing over during the progress of work, but the author doubts that good results would be attained under this condition, especially as they further advise that all traffic be fenced off for forty-eight hours. In the event of an alternate route existing so as to divert vehicular traffic, greater convenience and better results would obtain; but the road in question, in addition to being the principal thoroughfare of a country town, is also a main road between London, Winchester and Southampton.

At first difficulty was met in joining up the two halves of the road, but after the men gained experience imperceptible joints were made. Owing to the binding material being in the first instance at the bottom there were opportunities of preventing the formation of holes in surface, which, with water-bound roads, get filled with small material and do not show until the road has set, while on the Rocmac road these are easily detected and filled with large stones, which the roller can squeeze (not crush) into position. The surfaces around adjusted manhole and hydrant covers were also easily brought into conformity with the remainder, the

cover being raised to required level. The surrounding metalling was picked out to a depth of 3 in., and new material laid upon a bed of matrix, well ramming with a hand rammer, sufficed to finish the surface, and this treatment also obtained a neat finish to edge of channel stones.

Upon the question of dustlessness this type of road is superior to a water-bound macadam road, but during summer is not equal to the ordinary macadam with a tarred surface; but the author does not consider that sufficient length of time has elapsed to give a definite opinion on this subject. The author is told that the claim for dustlessness has been fulfilled in the North, but the average rainfall being about double that of the South, a much higher standard naturally is required here.

Tarviated Matrix.

Through Mr. Gladwell's generosity in giving his specification to the profession, road construction—using a tar sub-binder—is so well known that the author must apologize for dwelling upon the subject.

When arranging for laying a length of road upon a Tarvia matrix, estimates and information were obtained with a view to ascertaining which was cheaper—to mix the material locally, or purchase it ready mixed. It eventually appeared advisable to mix locally, and by the use of the furnace shown in plate No. 2 excellent results were obtained.

The chippings, which were specially prepared ⅜-in. Clee Hill from roller mills, were heated upon the hot plates. The furnace consisted of an excavation 9 in. deep slightly less in width and length than the plates, which were obtained from a local foundry. Any iron, even sheet iron, will do for this purpose, failing more suitable material; those used were ¼-in. thick, the walls of flues were composed of discarded kerb and channel stone; the bed under the fire, for which a deeper excavation was made, consisted of worn-out granite setts, spaced to assist draught, while two old 9-in. drain pipes formed the chimney. The Tarvia was heated in an ordinary tar boiler, and upon reaching the temperature of 125 deg. was measured out and mixed with the chippings in the proportion of 12 gallons per cubic yard.

On a sunny day it is not necessary to warm the whole of the chippings; those on the surface of heaps being sun-dried are raked off and mixed with those furnace-warmed before the latter are covered with Tarvia.

It is very important that the furnace-heated chips are not made too hot, 70 deg. should be sufficient; excessive heating tends to make the resultant mixture hard and brittle.

After mixing the matrix is heated until required for use; if of the right consistency it appears to be a mass of shiny, black particles, similar in appearance to anthracite coal, and for weeks after, if kept so long, it should be possible to push a stick into any part of the mass without effort. The cost of the matrix was:;—

	£	s.	d.
30 tons roller chippings, Clee Hill, at 13s. 10d...	20	15	0
280 gallons of Tarvia at 4⅜d.	5	2	1
Manual labor (including construction of furnace)	4	3	9
Team labor (hauling fuel)	0	2	0
Cost of fuel	0	5	0
	£30	7	10

Equal to 20s. 3.13d. per ton; the price quoted for mixed matrix was 20s. 3d. per ton at railway station. In consequence no charge has been made in the above for haulage of granite and Tarvia from station No charge either has been made for use of boiler and plates, as these were in hand and were required for other purposes, but the cost of construction of furnace—about 4s.—is included.

In using the material, the surface of road being scarified, raked and rolled to the required contour, using plenty of water during rolling of formation, the matrix was spread to a depth of ½ in. and covered with a coating of 2-in. basalt; the roller was very slowly moved on to the granite. It appears to be very important with tarred matrices that the roller moves uniformly and slowly; quick movement was found to give the wavy appearance to surface so common with water-bound roads. After the roller had passed over some three or four times the matrix appeared through the crevices of stone, and the macadam was next sprayed with liquid Tarvia, and covered with top binder, using the same material as for sub-binder, and the whole sprinkled with Shepton Mallet chippings and rolled in.

After some dozen turns up and down, rolling ceased for the day, and on the following day a few more turns completely finished the material.

Before commencing the second day's rolling the few interstices that appeared were filled with top binder and consolidated, and the same material used for a neat finish to channel stones and manhole covers. This material was subjected to very heavy tests immediately on completion. Twenty army transport engines, each hauling three heavy trucks, passed over, leaving no depression whatever in the material that had been preliminarily rolled on the previous day; but, of course, leaving slight tracks upon the work in hand, which tracks were eliminated by passing the roller over three or four times. The claim for comparative dustlessness of the material has been substantiated. It also is much less noisy than an ordinary macadam road with a tarred surface. As to its length of life time will show.

Owing to the great variation in cost per yard super. the difference in thickness even ¼ in. will make, the author has adopted the following standards for purposes of comparison:—

Taking 2 tons of consolidated granite to fill 1 cub. yd. of the new surface equal to 12 yds. super. 3 in. thick; 5 tons of limestone chippings or dust accounting for 3 cub. yds. or 18 super., and a yard of imported grouting (small gravel and sand) equal to ½ yd. cube, earth binding being calculated the same, and 5 cub. yds. of flints consolidated to 3 yds.

While all the foregoing except the earth may be taken as of effective use in the road, the latter is contributing to the actual cubic contents but not to its effective contents; consequently in water-bound roads results the terms actual and effective area are used, while with the Tarviated and Rocmac roads the actual area is taken as the effective area. No credit is given for scarified material carted away.

Comparative costs on estimated thickness of 3 in:—

(A). Flint Road.

	£	s.	d.
273 yds. of flints, including breaking.....	75	12	1
Hauling flints	11	11	5
Spreading	3	6	0
Rolling	6	5	0
Sweeping	1	3	4
Hauling water	2	1	6
Hauling binding	1	17	6
	£101	16	10

2,208 actual yards 3 in. thick = 11.07d. per yard.
1,968 effective " " = 1s. 0.4d. "

(Continued on Page 663.)

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CONTENTS OF THIS ISSUE.

CONVICT LABOR ON PUBLIC ROADS.

The use of convict labor on public highways in the United States is becoming more general.

In Canada two provinces have tried the experiment, and in continuing the experiment one or two things will be absolutely necessary to insure its success. The first will be that the control of such work shall be vested in the hands of a highway engineer and not at the direction of the provincial criminal authorities. As a road builder the prison laborer will not be of use to the State unless his work is under the direction of competent men.

The convict camps should be under the inspection and supervision of the Board of Health. The people of the Province, although they have every confidence in the prison authorities as officers of the department of justice, will be more satisfied that the food and sanitary arrangements for the convicts are suitable if the Provincial Board of Health have the right of inspection.

Badly as we require good roads, we must consider the humanitarian side of this matter, and must not disregard rules regarding the physical and moral health of the convicts, nor must we forget that unfortunate citizens are assigned to the country jails with a view of reforming and improving the manhood of the convicts rather than for the purpose of building highways.

PROVINCIAL AID FOR HIGHWAYS.

There is no division of sentiment in Canada as to the desirability and necessity for better highways. Every good roads movement has the universal indorsement of legislators and taxpayers, but when the reports commence to show the burden of taxation a halt is called. The longer stretches of rural highways on which front land at low value and with low assessments cannot stand the taxation necessary to so improve these highways as to make them comparable with the roads and pavements of the cities, where land values and assessments are high.

Although the rural districts will receive benefit from the improved highways in the matter of increased land values and greater ease at reaching markets, yet those dwelling in cities have considerable to gain from the improvement of rural highways. Good roads mean a lower price for farm and garden produce to the consumer and higher price to the producer, because waste is eliminated.

TELEPHONE RATE REGULATION.

The question of fair telephone rates is one which has for some time been a question for the consideration of both the telephone companies and the railway boards. During the past few weeks several hundred telephone companies operating in Ontario have submitted to the Ontario Railway and Municipal Board their toll charges,

and the Dominion Railway Board have before them several applications as to the justness of the Bell Telephone schedule.

The question of fair telephone rates is a complex one, and in this issue of The Canadian Engineer, in a paper entitled "Is a Rational Basis Possible for Telephone Rates?" Mr. D. C. Jackson, of the Massachusetts Institute of Technology, discusses the question very fully and fairly.

The telephone franchise is so exclusive that in discussing rates and conditions it is impossible to compare it with an electric lighting or railway franchise. The value to the subscriber in a telephone system consists in the uninterrupted large connections that may be made. Under these conditions it has been possible, and in many cases it has been the policy of the telephone companies to charge the very highest rate that the customer is able to bear. In Canada we expect that in the future the decisions of the railway board will be fixed, first, on service rendered; secondly, on fair return for investment, and combined with these consideration will be given to the cost of construction and maintenance.

The postal system of Canada as a government operated institution gives universal satisfaction, and a postal system, combined with a government controlled and operated telephone system, appears to be the goal to which we are now working, and if there is one field of activity more than another which naturally falls rightfully into the domain of government control it is the telephone and telegraph systems of our country.

CLASSIFICATION OF EXCAVATED MATERIAL.

The classification of material to be excavated or excavated is frequently a matter of much contention. Many specifications have been framed to cover the different classes of material. The Contractor quotes recently a set of specifications copied from a railroad contract. In these specifications a new classification is attempted. For earth, loose rock and solid rock they are as follows:—

"All excavated materials shall be classed under three heads, namely: Earth shall include all clays, indurated or otherwise, disintegrated shale, said stone and other rock that partakes of an earthly nature, and all other materials which can be loosened by a pick or plough, one picker keeping two shovellers busy, and a railroad plough drawn by four draft animals, weighing on an average 1,000 pounds.

"Loose rock shall consist of all boulders and masses of rock, disintegrated or otherwise, whether stratified or not, that can be removed economically by the use of a pick or bar, although blasting may be resorted to in order to lessen the cost to the contractor, or hasten the progress of the work.

"Solid rock shall consist of all boulders and masses of rock, whether stratified or not, which can only be removed by blasting, and must after blasting be blockholed."

This method of classification and these specifications are a great improvement on those ordinarily used on railroad work. With these "physical tests" the contractor is much more likely to receive fair treatment than where the question of size of the particles govern the classification.

SIZE OF THE GALLON.

American manufacturers doing trade with Canada or Canadians purchasing in the United States commodities that are sold by the gallon or tanks and sprinklers, whose capacity is rated by the gallon, should bear in mind that the Canadian and American gallon are of different sizes.

The gallon in use in the United States is the old Queen Anne gallon, and is equivalent to 8.3389 pounds avoirdupois, or about 231 cubic inches. In Canada we use the English imperial gallon. This was made the standard in 1828, and contains 10.0172 pounds avoirdupois, or a little more than 277 cubic inches. It will be seen that the Canadian purchasing in the States on the American gallon will not get the capacity he expects, and the American tendering on Canadian work must be careful to estimate on the larger size.

EDITORIAL NOTE.

A very commendable movement has been initiated in Montreal, which has for its purpose the construction of the model highway from Montreal to Sherbrooke, to serve as an object lesson in the good roads campaign which the Provincial Government of Quebec is encouraging. Quebec is recognizing the importance of highway transportation, and no better method of educating the people in this can be thought of than the building of a good highway.

ENGINEERS' CLUB OF TORONTO.

(Continued from Page 648.)

means of ornamentation. A good example of Parisian extravagance in ornamental decoration of bridges is Pont Alexander III., built in 1900 for the Paris exposition. The span is 352 feet and the width of the bridge is 132 feet. The steel work is painted white, and at each approach to the bridge, columns are placed on each side 75 feet in height. Figures on the bridge are gilded and the bridge is made to appear most striking in ornamental effect.

With regard to the Swiss bridges, they may be said to be of a more rugged type, as necessitated by the nature of the country. Switzerland has some striking railway bridges in the Alps. The viaduct is used very extensively in Switzerland. The steel arch Behn bridge is a famous bridge in Switzerland. The German bridges are massive and are peculiar for their church-like architecture, a notable example being that at Cologne. The Germans favor the short arch in bridge construction.

The Dutch bridges also have the short arch, but have a break in the center, often times comprising a draw bridge. The elliptical instead of the parabolic arch is also noticeable in some cases. A fine example of massive architectural effect is shown in bridges at Amsterdam, where it is carried even to the use of enormous lamp posts on the bridges. The lift weight bridge is used in Holland and the twin draw bridge is quite extensively used.

The famous London bridge, built in 1769, cost £720,000, and it was widened in 1902 at a cost of £100,000. It is 928 feet long, 65 feet wide. The lower arches are granite. The center span is 152 feet. It is estimated that 110,000 pedes-

trians and 22,000 vehicles cross this bridge every 24 hours. The building of the Tower Bridge was started in 1886 and completed in 1894; was designed by Sir Horace Jones and Sir Wolf Barry. The permanent foot passage is 142 feet above low tide and the twin lift is 22½ feet above low tide. The central span is 200 feet, and it requires 1½ minutes to open. The Tower Bridge cost £1,600,000, and it is estimated that 50,000 pedestrians and 12,000 vehicles cross it every 24 hours.

In general, it may be said that the arch is common to the bridges all over Europe; the various individual characteristics of the French being artistic effect and long span; of the Swiss, the viaduct type; of the German, the short arch and church-like architecture; of the Dutch, the short arch with straight break in the center; of the English, the arch and general harmonizing effect with surroundings. Many fine views of the different bridges of each country were shown during the evening.

HIGHWAY DUST REDUCTION IN THE URBAN DISTRICT OF ALTON.*

(Continued from Page 660.)

(B) Road Laid with Rowley Regis Granite.

	£	s.	d.
212 tons 2¼-in. Rowley Rag at 13s. 3d.	140	9	0
84½ " 2-in. " " 13s. 6d.	57	0	9
42 " 1-in. " " 11s.	23	2	0
Hauling granite	18	7	6
Spreading, &c.	6	17	11
Rolling	10	0	0
Scarifying	4	15	8
Sweeping	3	10	8
Hauling water and cost of water	3	0	0
Hauling binding	4	1	4
Grouting 40 yds.	4	15	0
Earth binding	0	0	0
	£275	19	10

2,508 actual yards at 2s. 2.4d.
2,268 effective " 2s. 5.2d.

Note.—Some of the above were spread on a flint surface which did not require scarifying.

(C) Clee Hill Granite Spread in 1908.

	£	s.	d.
227 tons 18 cwt. 2¼-in. Clee Hill Stone at 14s. 6d.	165	4	7
219 " 14 " 2-in. " " at 14s. 8d.	161	2	3
18 " — " 1-in. clean stone at 12s. 7d.	11	6	6
16 " 3 " 1-in. to dust at 11s. 7d.	9	7	1
40 yds. grouting at 3s. 2d.	6	6	8
Haulage	20	17	5
Spreading, &c.	7	10	0
Rolling	16	1	5
Scarifying	6	5	0
Water and binding	9	11	9
Sweeping	4	7	1
	£417	19	9

Actual area 3,370 yds. at 2s. 5¾d.
Effective " 3,130 " 2s. 8d.

(D) Clee Hill Granite Spread on Flint Surface Partly Scarified.

	£	s.	d.
153 tons 2 cwt. at 13s. 9d. and 13s. 11d. per ton.	105	15	4½
10 yds. grouting	1	11	8
16 yds. earth binding	0	0	0
8,000 gallons water	0	4	0
Rolling	4	6	3
Scarifying	0	17	8
Hauling granite	7	13	0
Spreading	3	5	0
Sweeping	1	4	0
Hauling water and binding	5	1	0
	£129	17	11½

1,074 actual yards at 2s. 5d.
978 effective " 2s. 7.9d.

(E) Rocmac Road.

	£	s.	d.
93 tons 10 cwt. 2-in. Clee Hill stone at 13s. 11d.	65	1	2½
15 " 18 " ⅜-in. limestone chippings at 10s.	7	19	0
30 " 5 " limestone dust at 10d.	15	2	6
568 gallons Rocmac fluid at 10d.	23	13	4
Team labor	8	11	4½
Manual labor (including night watchman)	9	15	2
Steam rolling, 44 hours	5	10	3
Scarifying	3	2	6
	£138	15	4

The area covered was 1,266 yds. with an average thickness of nearly 2½ in., at a cost of 2s. 2.3d., but on the 3-in. basis costing 3s. 1½d.

Note.—A portion of granite was hauled from station to depot and from thence to road, otherwise cost would have been 3s. 1d. on 3-in. basis.

(F) Tarviated Road.

	£	s.	d.
69¼ tons 2-in. Clee Hill basalt at 13s. 11d.	48	3	9
32¾ " ¼-in. " chippings at 13s. 10d.	22	13	0½
7½ " ⅜-in. limestone at 10s.	3	15	0
Rolling, 21 hours at 2s. 6d.	2	12	6
Scarifying, 1,208 yds. at 5⅛d.	3	2	11
Hauling chippings and limestone to depot	1	0	4
Other team labor	2	18	3
524 gallons Tarvia at 4⅜d.	9	11	0½
Haulage and return carriage on Tarvia barrels.	0	12	6
Fuel for tar boiler	0	5	10
Manual labor	9	17	4
	£104	12	6

1,208 yds. at 1s. 8.8d. per yard.
666 yds. by 3-in. at 3s. 1.7d. per yard.

Other Comparisons.

(1) Tonnage of granite and limestone used—total cost—

	s.	d.	
(a) Waterbound roads without imported grouting	16	4	per ton.
(b) Waterbound roads with imported grouting	17	1½	"
(c) Rocmac road	19	11½	"
(d) Tarviated road	19	2½	"

(2) Amount rolled per day of 9 hours—

(a) Waterbound	36 tons.
(b) Rocmac	28 "
(c) Tarviated	46 "

(3) Percentage of cost allocated—

	Water-bound.	Rocmac.	Tarviated.
Granite and limestone.	84 1/8	65 3/8	71 1/4
Water and binding	1 1/8	—	—
Rocmac fluid	—	17 1/4	—
Tarvia	—	—	10 1/8
(1) Materials	85 1/2	82 5/8	81 3/8
(2) Scarifying	1 1/2	2 1/2	3
(3) Rolling	3 5/8	4	2 5/8
(4) Team	6 7/8	3 1/2	3 1/2
(5) Manual	2 1/2	7 3/8	9 1/2
	100	100	100

IS A RATIONAL BASIS POSSIBLE FOR TELEPHONE RATES?*

(Continued from Page XVI.)

messages and the distance of the message transmission; it being understood, however, that any comparison must rest between users needing service of equal quality. If the latter condition is not tacitly understood, the statement ought to be amended so as to read that "no reasonable objection can be taken to a schedule of rates based upon the actual quality of the service required and the quantity rendered."

As also showing the tendency toward rationalizing rates, I will quote from a recent finding of the Massachusetts Highway Commission in respect to telephone rates in the large city of Boston and its surrounding important suburban district:

Knowing that a certain revenue must be raised, the Massachusetts Commission has pointed out:

"That the district to be covered by a given telephone rate, should be the territory generally used by the great majority of the subscribers therein, rather than a much larger territory, the greater portion of which is seldom used by the majority of subscribers.

"That the company should collect its revenue for calls between more distant portions of the territory from those who make use of such service, rather than from those who use only local service involving the use of a much smaller portion of the plant.

"That the suburban exchanges have of necessity so much occasion for calling into Boston and vice versa, that the five-cent toll rate between Boston and suburban exchanges should be extended to cover the longest distance consistent with a well-balanced schedule and with fairness to the company.

"That business service, at least, except for essentially local service, should be placed on a measured basis; and

"That so far as it is possible to do so, the rate schedule should be so made as to furnish telephone service to the small user at the lowest yearly charge that is fair and equitable, and, on that as a basis, adjusted to meet the requirements of the medium and larger user."

Telephone companies still assert that no rational basis for telephone rates can be found. A few of the companies have adopted their rate schedules as the result of certain actuarial operations, but most of them have arrived at their schedules by the path of expediency and gradual modification. Few can support the reasonableness of their schedules on a foundation of facts produced from their accounting records, but I believe that this condition not only ought to be overcome, but it is likely to be overcome. The willingness of the telephone companies to co-operate with supervisory commissions, in gathering, and, to some degree, in studying, cost and traffic statistics, is an encouraging indication. With accumulating statistics which give a clearer understanding of costs of giving service and the relation of speed and accuracy of service to its costs, each modification of rate schedules under the supervision of wisely constituted commissions ought to approach closer to a rational basis. A more effective organization of cost keeping than has yet come into vogue should be insisted on. It must also be constantly remembered that traffic is a factor of the utmost importance, and traffic statistics must be made of record and carefully studied.

The telephone rate problem seems as complex as any facing the Public Service Commissions, not excepting the problem of railroad freight rates; but telephone rates are usually made for the territory of an individual city, or, at most, an individual state, which gives ground for expecting more rapid progress in improving the basis of fixing telephone rates than can probably be reasonably expected for freight rates.

THE CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.

The Canadian Independent Telephone Association held its fifth annual convention in Toronto, November 17th and 18th. They resolved to ask the Ontario Government to repeal the present law, which gives municipalities the power to grant exclusive telephone franchises. An effort will be made to obtain an amendment of the local municipal telephone Act, by making provision for the appointment by the ratepayers of a board of commissioners to undertake the management of any system constructed under that Act. They will also ask the Dominion Government to amend the Railway Act by empowering the Board of Railway Commissioners to order connection between rural telephone systems and the local systems of all companies within the jurisdiction of the Parliament of Canada.

New Fees Fixed.

The membership fee in the association was changed to five cents per telephone connected with each system, and $1 for each company. The present fee is two cents per telephone and $2 per company.

Eligible as Members.

The association also adopted a resolution making eligible for membership all proprietors, stockholders and officers of telephone systems in the Dominion, other than those owned by the Bell Telephone Company of Canada, or in which that company has a controlling stock interest.

Officers Elected.

The following were elected to the official positions for the ensuing year:—President, W. Doan, M.D., Harrietsville, (re-elected); vice-president, C. Skinner, Sherbrooke; secretary-treasurer, Francis Dagger, Toronto, (re-elected); executive committee—P. R. Craven, New Liskeard; T. R. Mayberry, M.P.P., Ingersoll; A. Hoover, Green River; Levi Moyer, Beamsville; M. House, Bridgeburg; T. R. Ralph, North Augusta; G. W. Jones, Clarke, Ont.; T. G. Ramshaw, Lowville; George Taylor, Blenheim; auditors—C. B. Adams, Harrietsville, and A. Denholm, Blenheim.

The feature of the morning session was the address of President Doan, which was a comprehensive review of the telephone situation. He said in part:—

Taking all things into consideration the independent telephone men of Canada are to be congratulated upon the success that they have won.

This success has come on so quietly and so quickly that I am in grave doubt as to whether or not the scattered and poorly-organized independent telephone forces of Canada really appreciate the advanced position which they enjoy.

Of one thing I am certain—neither the financial circles of Canada nor the residents of the large cities have the faintest idea of the progress made by the movement or the money invested in the business. Some of them are just beginning to show signs of an awakening, and, as it were, are rubbing their eyes as if trying to gain a clear vision. But the Bell Telephone Company comprehend—and while in one way they are keeping very quiet and trying to make it appear that they are not disturbed, still, in another way, they are indicating the greatest possible anxiety.

Growth in Five Years.

Continuing, Dr. Doan said:—"Five years ago there were scarcely any independent telephones in Canada. The Bell Telephone Co. was then the whole thing. It not only owned and operated the only telephone system of any importance in the Dominion, but it owned what was at that time the only telephone manufactory in Canada, namely, that of the Northern-Electric & Manufacturing Company, Limited, of Montreal, which was then, and is now, the manufacturing and supply department of the Bell Telephone Company of Canada. People who can remember that far back say that the policy of both the Bell Telephone Company of Canada and the Northern-Electric & Manufacturing Company, Limited, is different now. Some go so far as to say that the Northern-Electric & Manufacturing Company, Limited, was not then advertising "the beauties of locally-owned and locally-operated telephone systems," and that they were not then out with agents trying to sell telephones to the rural communities of Canada.

Struggle at Ingersoll.

I have been told of the struggle at Ingersoll, Ont., where the citizens finally organized an independent telephone company, and are to-day giving up-to-date central energy telephone service to over nine hundred subscribers as compared to 200 subscribers served by the once arrogant Bell telephone monopoly.

You have all heard more or less of the successful Norfolk County independent telephone movement, which had its inception in Waterford, Ont., and has developed to a point which has forced the Bell Telephone Company to abandon that field.

If we have taken the trouble to inform ourselves, we know in a general way how the southern portion of Ontario is fast becoming a net-work of independent telephone lines outside of the more important cities.

Lately the movement has taken hold in the northland, and crossing from Fort William and Port Arthur, which own and operate municipal telephone plants, to Cobalt and Haileybury, we find the Temiskaming Telephone Company in sole possession of the field, and looking southward we find the movement rapidly taking hold in the entire southland.

The development in Prince Edward County has spread to the north and east, and a careful study of the territory now covered by independent telephone lines reveals the fact that by the building of a comparatively few independent connecting links these various local telephone systems could be joined together into one vast system of independent telephone lines covering the territory west from the Detroit River and Lake Huron nearly to Montreal, and from Lakes Erie and Ontario north to Lake Nipissing.

Starting again in the Province of Quebec at St. Lambert, which is just across the river south from Montreal, we find the National Independent Telephone Company with lines running to Levis, Quebec, Riviere du Loup, and on down into New Brunswick, and connecting with the independent telephone lines of Maine and the New England States.

The facts are, and sooner or later the Canadian public will come to realize, that the independent telephone systems of Canada (not including the Government-owned telephone systems of Manitoba, Saskatchewan and Alberta), cover the Dominion of Canada much more completely and are to-day giving telephone service outside of the cities to more people in Canada than are served by the one-time telephone monopoly of this country.

Hold in the Cities.

Already the independent telephone movement has taken hold in the cities. We have seen how the citizens of Ingersoll have outdistanced the once arrogant Bell Company. Now let us consider the development at Brantford, Ont., where the Canadian Machine Telephone Company is now operating the Lorimer system of automatic service. When that city of 20,000 inhabitants granted a franchise to the Independent Company, the Bell Telephone Company of Canada served less than 500 telephone subscribers in Brantford. The Brantford service then (as it is now in many Canadian cities) consisted of an overloaded, antiquated manual switchboard of the local battery type, while the principal streets of the city were obstructed by unsightly poles and a network of wires, which the city council and mayor were unable to control. When competition came the Bell Company got busy. Down came the poles. Up went a new Bell central office building. An underground cable system took the place of the unsightly network of wires, and to-day the Bell Telephone Company boasts of and advertises Brantford and Brant County, Ont., as showing the banner telephone development in the Dominion of Canada.

But let us see what became of the Independent Telephone Company, whose franchise forced all of this activity on the part of the Bell Company. An investigation reveals the fact that this competing company is to-day furnishing good independent telephone service to over 1,200 subscribers in Brantford and vicinity, and by interchange of traffic with neighboring independent telephone systems, it enables the subscribers of the Canadian Machine Telephone Company at Brantford to talk to more people in the territory surrounding Brantford and for less money than can the subscribers of the Bell Company.

What has been accomplished at Brantford is now taking place at Peterboro' and Lindsay, where the Bell Company has been forced by competition to tear out its local battery systems and install up-to-date telephone plants.

Telephone an Economy.

Five years ago the great mass of the Canadian public looked upon the telephone as a luxury. To-day the telephone is recognized as an economy and a necessity, and the three great Western Provinces of Manitoba, Saskatchewan and Alberta, recognizing this, have purchased the Bell telephone lines in said Provinces, and are now engaged in building telephone lines and furnishing Government telephone service to the respective residents. The wisdom of this movement has been clearly established. As an aid to emigration alone, the fact that the settler can obtain telephone connec-

tion with his oft-time distant neighbor and trading point has induced and enabled many a family to settle and remain upon the frontier. As an investment the telephone has proven to be one of the most economical and largest dividend-paying expenditures that a farmer can make.

Since that time, the Ontario Government, recognizing the great benefit of telephone service to the Province as well as to the locality, has enacted legislation by which the residents of any locality can by petition to its municipal council secure the provision of the necessary funds to install a local telephone system, and, recognizing the injustice of the exclusive Bell Telephone contracts above referred to, the said Ontario Government at the last session of the Legislature passed what is known as the Charters bill, and thereby provided a way by which any and all local telephone systems in the Province shall provide operating connections with adjoining telephone companies.

The effect of this legislation of the Ontario Government will prove to be far-reaching and very beneficial to all locally owned and operated telephone systems regardless of whether these local systems are municipally owned or privately owned. Under the operation of this law the Bell Telephone Company of Canada can no longer enforce contracts designed to retard the Independent telephone development in Ontario, and this fact was keenly recognized by the officers and attorneys of the said Bell Telephone Company when they labored so strenuously before the committee to have the authority of the Railway Board changed from "shall issue an order" to "may issue an order," which would have enabled the Bell Company to have fought every application in an effort to prevent the Board from granting the desired connection, thus making the proceedings so tedious and expensive that the smaller companies would be debarred from taking advantage of the Act. Independent telephone men and the public owe a debt of gratitude to the Hon. I. B. Lucas and the members of his committee for the firm stand they took in this matter.

Ontario Telephone Act.

During the past year we have tasted the first real fruit of the Canadian Independent Telephone Association in the enactment of the Ontario Telephone Act, which was introduced in the last session of the Ontario Legislature by Mr. Charters, who has publicly stated that the credit for initiating this legislation is due to Mr. Francis Dagger, secretary of the association, and who deserves a place in the telephone history of Canada, dating from his services as Dominion Government expert of the Mulock investigation down through his services as Government expert for the Provinces of Manitoba and Saskatchewan, and now as secretary of this association, and by his assistance to Mr. Charters and the Legislative Committee in the preparation and enactment of the law above referred to.

In my opinion the benefits of the Charters bill to the many Ontario operating telephone companies is dimly understood. You may not know it, but I am of the opinion that in addition to the many benefits the public will gain from this Act, it will prove to be the means of saving to the various Ontario companies, in the aggregate, over hundreds of thousands of dollars. This law, if I rightly understand its purport, will, when fully understood and complied with, nullify the efforts of the many pernicious private contracts by which the Bell Company hoped to strangle the Independent telephone movement in Canada.

Had it not been for the financial support, (feeble as it was), given to Mr. Dagger by the association during the past year, he could not have given the necessary time to assist in the good work, and now with the law enacted there is coming up much detail regarding its application, and this will require the constant attention of some person capable of understanding the necessities of the situation.

Time for United Effort.

Now is the time for the association to jump in and be strong, now is the time for the members of the association and for all those interested in the extension of the telephone movement in Canada to contribute liberally to the support of the organization which is prepared to reap the benefits of the victory you have won. Mark you, and mark it well, the Bell Telephone Company will try, and try hard, to nullify the effect of this Charters bill. Without the watchful care of some person capable of comprehending the full situation you may expect at least effort upon the part of the Bell Company, through some unsuspected agent, to introduce adverse legislation. Now is the time when every independent operating telephone company and association in Canada, no matter whether under contract with the Bell Telephone Company or not, should contribute to the support of this Canadian Independent Telephone Association, and a contribution equal in amount to five cents for every telephone owned and operated by said owners is a good safe investment for you to make as a donation in support of the movement. If this is done, and done cheerfully and soon, this association can build up a strong compact working force from which practical timely aid can be expected by every Government, municipal and privately-owned telephone system in the Dominion of Canada.

During this session one of the delegates prepared a table showing a comparison of Independent and Bell telephones in a few districts. The table showed 4,512 Independent 'phones and 629 Bells, as follows:—

	Independents.		Bell.	
	Local.	Rural.	Local.	Rural.
Ingersoll	400	500	200	25
Welland	280	300	140	40
Caledon	100	162	5	3
Brussels	90	500	10	5
Harrietsville	..	320	2	2
Blenheim	87	343	61	4
Markham	88	280	45	21
Port Hope	10	360	..	..
Forest	72	233	15	..
Sombra	22	64	14	..
Wheatley	65	235	47	..
	1,214	3,298	539	100

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

12184—November 5—Amending Order No. 12119, dated October 27th, 1910, by striking out the words, "without their first being brought to a stop," in the third line of the operative part of the Order.

12185—November 7—Directing that Order No. 11767, dated 23rd September, 1910, which authorizes the C.P.R. Co. to open for the carriage of traffic portion of its line known as the Kipp-Aldersyde Branch, from mileage 0 to mileage 28.2, be rescinded, and that the trains of the C.P.R. Company over said portion of railway be limited to speed of thirty miles an hour.

12186—November 7—Authorizing the C.P.R. Co. to construct bridge No. 7.4 on the London Sub-Division, Ontario Division of its railway.

12187-8-9—November 7—Authorizing the C.N.O.R. Co. to construct its railway across the side road between Lots 9 and 10, Broken Front Concession, Township of Thurlow, County Hastings; and across the public road in Lot 2, Concession 1, city of Belleville, County Hastings, station 2340.88; and across MacDonald Street, between Lots 7 and 8, Broken Front Concession, city of Belleville, County Hastings, station 2269.47.

12190—November 7—Authorizing the C.N.R. Co. to construct its railway across twenty highways west of the second Meridian.

12191-2—November 7—Authorizing the C.O.R. to construct its railway across the public road between Lots 291 and 295, Parish of St. Benoit, Co. of Two Mountains, station 1266.15; and across the public road between Lots 223 and 218, Parish of St. Benoit, Co. of Two Mountains, station 1407.11.

12193—November 7—Authorizing the corporation of the village of Port Colborne to lay a water main under the track of the G.T.R. Co. where the same crosses St. Arnaud Street, Port Colborne, Ontario.

12194——November 7—Authorizing the corporation of the town of Pembroke, Ont., to lay a water pipe under the C.P.R. where the same crosses MacKay Street, Pembroke, Ontario.

12195—November 7—Authorizing the corporation of the village of Port Colborne to lay a water main under the G.T.R. where the same crosses Welland Street, Port Colborne.

12196—November 7—Application of the Interurban Electric Company, Limited, to erect power wires across the track of the switch extension of the C.P.R. Company on Symes Road, in city of Toronto, Ont.

12197-8—November 7—Authorizing the Seymour Power and Electric Co., Ltd., to erect wires across the wires of the Bell Telephone Co. at Lot 25, Concession 9, Township of Sydney, County of Hastings; and at Lot 21, Concession 9, Township of Sidney, County Hastings.

12199 to 12205 Inc.—November 7—Authorizing the Hydro-Electric Power Commission of Ontario to erect transmission wires across the wires of the G.N.W. Telegraph Company at Lot 4, Concession 3, Township of South Easthope, County Perth, Ont.; across the wires of the Toronto Power Company, and the Toronto & Niagara Power Co., at Lot 158, Township of Stamford, County Welland, Ont.; across the wires of the Toronto, Niagara and Western Railway Company, and the Toronto & Niagara Power Company at Lot 20, Concession 4, Township of Pelham, County Welland, Ont.; across the wires of the Toronto Power Company, and the Toronto & Niagara Power Company at Lot 12, Concession 4, Township of Etobicoke, County York, Ont.; across the wires of the Toronto Power Company, and the Toronto & Niagara Power Company at Lot 20, Concession "A," Township of Pelham, County Welland, Ont.; across the wires of the Bell Telephone Company at Lot 14, Concession 3, Township of North Oxford, County Oxford; and across the track of the Toronto, Niagara and Western Railway Company at Lot 12, Concession 4, Township of Etobicoke, County York, Ontario.

12206—November 3—Directing that every steam railway company, subject to the legislative authority of the Parliament of Canada, shall equip its sleeping, dining, baggage, mail, express, and passenger coaches with emergency tools, consisting of a sledge, axe and saw, said tools to be kept in a conspicuous place in every such car, and said cars to be so equipped on or before April 1st, 1911.

12207—November 19—Directing the C.P.R. Company to construct and operate the extension of the Clover Bar Coal Co.'s spur across its lands to the lands of the Humberstone Coal Company, in the north-west quarter of Section 7, Township 53, Range 23, west of 4th Meridian.

12208—November 7—Authorizing the G.T.P. Branch Lines Company to construct a spur from its Melville-Regina Branch to Colmer Gravel Pit, District of Yorkton, Sask.

12209—November 7—Authorizing the C.P.R. Company to construct an industrial spur and branch thereof for the Gros Falls Co., at mileage 2.22 from Piles Junction on said railway.

12210——November 8—Authorizing the Welland Tel. Co., Ltd., to erect telephone wires across the track and wires of the M.C.R. Co., at private crossing to Jacob Ruch's farm, Lot 13, Concession 12, Township of Bertie, County Welland, between 2nd and 3rd public road crossings west of Stevensville Station.

12211—November 8—Directing the Atlantic and Lake Superior Railway Co. to construct, within 60 days from date of this Order, and maintain at St. Jean l'Evangeliste, Quebec, suitable shelter for accommodation of freight and passengers.

12212—November 8—Authorizing the C.N.O.R. Co. to construct its railway across the side road between Lot 38, Concession 1, Township of Sidney, and Lot 1, Broken Front Concession, Township of Thurlow, County Hastings.

12213—November 8—Dismissing application of the C.N.R. Co. for approval of location of its railway through Townships 38-30, Ranges 23-24, west of 4th Meridian, mile 21.38 to 36.49, reckoned from junction with Vegreville-Calgary Branch.

12214—November 8—Authorizing the G.T.R. to construct a branch line of railway commencing at a point on the Applicant Company's railway east of its Chesley station, to premises of the Chesley Chair Company, Ltd.

12215—November 8—Approving plan of standard iron fire protection for decks of timber bridges; and authorizing the G. N. Railway Company to substitute the same for the style of protection required under Clause 10 of Order 11446.

12216—November 3—Dismissing application of the Township of Sandwich East for an Order authorizing the G.T.R. Co. to allow the applicant to construct a drain on its right-of-way, from the Parent Outlet between Lots 143 and 144, Concession 1, parallel to its railway, westerly to the Little River.

12262—November 11—Authorizing the C.P.R. Company to construct an industrial spur for the Canadian Nursery Co., Ltd., on the north side of the tracks of its railway, in Lot 40, Parish of Pointe Claire, County Jacques Cartier, P.Q.

12263—November 11—Approving and sanctioning the location of the C.P.R. Company's Georgian Bay and Seaboard line of railway from mileage 74.25 to mileage 87.65.

12264—November 11—Temporarily approving the agreement entered into by the Bell Telephone Company with the municipality of the Township of Maidstone.

12265—November 11—Relieving from providing further protection, the G.T.R. Company, at the crossing of the highway known as Three-Quarter Township Line at Lot 19, mileage 95¾.

12266—November 11—Authorizing the corporation of the town of Maisonneuve, Quebec, to lay a gas pipe under the track of the C.N.Q.R. Co. at First Avenue, Maisonneuve.

11267—November 12—Approving the temporary crossing of the tracks of the Toronto Street Railway Company of the tracks of the C.P.R., C.N.R., and G.T.R. Companies, at Queen Street, Toronto, Ont.

12268—November 12—Authorizing the G.T.R. Co. to construct a branch line of railway, or siding, to the premises of the Milnes Coal Co., North Toronto, Ontario.

12269—November 12—Amending Order No. 12211, dated November 8th, 1910, made upon application of the residents of St. Jean de l'Evangeliste, and directing the A. & L. S. Railway Company to construct a suitable shelter for the accommodation of freight and traffic at St. Jean de l'Evangeliste, by substituting the words "Quebec Oriental" for the words "Atlantic & Lake Superior," where they occur in the fifth line of the recital to the said Order.

12270—November 7—Authorizing the Trenton Electric & Water Co., Ltd., to erect electric wires across the wires of the Bell Telephone Company at Lot 36, Concession 2, Township of Sidney, County Hastings, Ont.

12271—November 14—Authorizing the C.P.R. Company to open for traffic that portion of its line of railway known as the Teulon Branch, between mileages 47.7 and 74.5.

12272—November 14—Authorizing the C.P.R. Company to construct an industrial spur for the Bawlf Collieries Co., Ltd., at Bawlf, Alta.

12273—November 14—Authorizing the Alberta Central Railway Company to construct a branch line of railway at Rocky Mountain House, in Township 39, Range 7, west 5th Meridian.

12274—November 14—Authorizing the Seymour Power & Electric Co., Ltd., to erect electric wires across the track of the Central Ontario Railway Company near Anson Junction, Lot 16, Concession 1, Township of Rawdon, Countyof Hastings.

12275-76—November 10—Directing that the G.T.R. Co. cease from interfering with any facilities now enjoyed by Daniel McManamy, of the city of Sherbrooke, Quebec, for the handling of traffic over the company's siding adjacent to the applicant's property.

RAILWAY EARNINGS; STOCK QUOTATIONS.

The following table gives the latest traffic earnings it is possible to obtain at the time of going to press:

Road	Wk ended	1910	Previous week	1909
C. P. R.	Nov. 14	$2,108,000	$2,267,000	$2,130,000
G. T. R.	Nov. 14	899,760	902,420	924,271
C. N. R.	Nov. 14	379,900	357,200	369,800
T. & N. O.	Nov. 14	23,483	20,837	35,377
Hal. Elec.	Nov. 14	3,642	3,816	3,155

Figures showing the earnings of Canadian roads since July 1st, this year and last, are appended:

Road.	Mileage.	July 1st to	1910.	1909.
C. P. R.	10,326	Nov. 14	$41,132,000	$29,133,000
G. T. R.	3,536	Nov. 14	17,135,672	16,160,525
C. N. R.	3,180	Nov. 14	5,962,900	4,821,700
T. & N. O.	264	Nov. 14	866,658	667,628
Hal. Elec.	13.3	Nov. 14	86,445	81,390

Stock quotations on Toronto, Montreal and London exchanges, and other information relative to the companies listed in the above tables, are appended. The par value of all shares is $100.

Co.	Capital. 000's Omitted.	Price Nov. 18 1909.	Price Nov. 10 1910.	Price Nov. 17 1910.	Sales last week.
C. P. R.	$150,000	-177	-196	-196½	669
Mtrl. St.	18,000	206½-206	224-223½	223¾-223	267
Hal. Elec.	1,400	.....	130-	130-129	37
Toronto St.	8,000	-123	-120	123½-123¼	405
G. T. R.	226,000	1st pfd. 107;	2nd pfd.	52¼; com.	24½.

TORONTO STREET RAILWAY RECORDS REMARKABLE GAINS IN EARNINGS FOR THE PAST TEN MONTHS.

The following figures will show the steady progress and increase in earnings for the past ten months: —

	Earnings.	Increase.
January	$326,780	$38,727
February	307,774	32,929
March	342,000	44,258
April	329,941	30,007
May	361,150	31,047
June	362,371	31,764
July	369,431	39,612
August	386,066	43,258
September	428,924	47,688
October	382,673	46,386
Totals	$3,597,882	$385,065

CONSTRUCTION NEWS SECTION

Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.

TENDERS PENDING.

In addition to those in this issue.

Further information may be had from the issues of The Canadian Engineer referred to.

Place of Work.	Tenders Close.	Issue of.	Page.
Chapel Cove, N.S., breakwater	Dec. 5.	Nov. 10.	622
Maccan, N.S., timber supply	Dec. 5.	Nov. 10.	622
Nanaimo, B.C., public buildings	Nov. 28.	Nov. 10.	622
Nelson, B.C., public buildings	Nov. 28.	Nov. 10.	622
Stratford, P.Q., landing pier	Dec. 5.	Nov. 10.	622
St. Louis du Mile End., Que., post-office	Nov. 24.	Oct. 20.	537
Walhachin, B.C., steel bridge	Nov. 28.	Oct. 27.	569
Winnipeg, Man., pole and line supplies	Dec. 1.	Nov. 3.	56
Walhachin, B.C., bridge	Nov. 28.	Nov. 3.	600
Point Grey, B.C., reservoir	Nov. 26.	Nov. 17.	54
Winnipeg, Man., motor generators	Dec. 15.	Nov. 17.	54
Port Arthur, Ont., church	Dec. 12	Nov 17.	644
Ottawa, Ont., coal	Dec. 12.	Nov. 17.	644
St. Joseph de Lettelier, Que., wharf	Dec. 6.	Nov. 17.	644
Rigaud, Que., public building	Dec. 5.	Nov. 17.	644
Grand Falls, N.B., public building	Nov. 30.	Nov. 17.	644
Wolfville, N.S., church	Dec. 1.	Nov. 17.	644

TENDERS.

St. Henri, P.Q.—Tenders will be received until Dec. 6th for alterations and additions to post office. R. C. Desrochers, Secretary, Dept. of Public Works, Ottawa.

Ottawa, Ont.—Tenders will be received until November 25th for the construction of an armoury at Pincher Creek, Alta. Eug. Fiset, Colonel, Deputy Minister of Militia and Defence, Department of Militia and Defence.

Ottawa, Ont.—Tenders will probably be invited in January for the construction of the Hudson Bay Railway from the Pas Mission to Split Lake.

Toronto, Ont.—Tenders will be received until December 12th for fittings for Central postoffice. R. C. Desrochers, secretary, Board of Control.

Toronto, Ont.—Tenders will be received until November 29th for sewer construction. G. R. Geary (Mayor), Chairman Board of Control.

Toronto, Ont.—Tenders will be received until Nov. 29th for the purchase and removal of the old low duty Worthington pumping engines, Nos. 1 and 2, one of which has been scrapped. The other is still in the engine room, in which the electrical pumping equipment has to be installed.

Souris, Man.—Tenders will be received until February 1st for the following material for delivery during spring and summer of 1911: Approximately 40 tons of 12-inch standard C. I. waterpipes. Approximately 85 tons of 8-inch standard C. I. waterpipes. Approximately 200 tons of 6-inch standard C. I. waterpipes. Approximately 150 tons of 4-inch standard C. I. waterpipes. And special castings. Seventy fire hydrants. Six 8 gate valves. Fifteen 6 gate valves. Twenty-four 4 gate valves. 45 C. I. valves boxes. 20,000 lbs. pig lead. 2,000 lbs. oakum. 2,000 feet of 20-inch standard vitrified sewer pipe. 000 feet of 18-inch standard vitrified sewer pipe. 3,250 feet of 15-inch standard vitrified sewer pipe. 4,750 feet of 12-inch standard vitrified sewer pipe. 7,050 feet of 10-inch standard vitrified sewer pipe. 13,350 feet of 8-inch standard vitrified sewer pipe. And specials. Interested parties desiring to tender on any of the above, can obtain further information by writing, stating what material they intend tendering for, to the town secretary-treasurer or engineer. C. R. Heath, engineer.

Weston, Ont.—Tenders will be received until November 26th for the construction of a combined transformer substation and fire hall. J. H. Taylor, Esq., clerk.

Winnipeg, Man.—Tenders will be received until December 15th for an electric travelling crane, also for 500 K.W. motor generator sets. M Peterson, secretary, Board of Control. (See official advertisement elsewhere in this issue.)

Winnipeg, Man.—Tenders will be received until Nov. 28th for the construction of the following sewers: In Carter Avenue, from Wolfe to Cameron Street; in Wolfe Street, from Nairn to Carter Avenue. M. Peterson, Secretary, Board of Control.

Prince Rupert, B.C.—Tenders will be received until Jan. 3rd for the construction of a buoy depot, including the erection of a reinforced concrete wharf, timber approach trestle, power house with chimney, buoy shed, stores, offices and dwellings; also the installation of drainage and water systems. Alexander Johnston, Deputy Minister Marine and Fisheries, Ottawa, Ont.

Vancouver, B.C.—Tenders are invited for ditching on the property of the Western Canada Power Company, Limited, and adjoining lands near Ardly station, Burnaby. Cleveland & Cameron, engineers, Winch Building.

Vancouver, B.C.—Tenders will be asked for the construction of a cement sidewalk along the west side of Main Street from Wellington Street to Princess Avenue.

CONTRACTS AWARDED.

St. Johns, Nfld.—The contract for the erection of a new factory building was awarded to M. & E. Kennedy, at approximately $60,000.

Montreal, Que.—The Montreal city council at its last meeting awarded to the John McDougall Caledonian Iron Works Company, Limited, of Montreal, the contract for a motor driven centrifugal pump of 5,000,000 gallons capacity, for $7,716.00. The unit consists of a 16-inch two-stage turbine pump driven by an Allis-Chalmers Bullock 500 h.p. wound rotor motor. There were fifteen tenders for this unit including the John Inglis Company, of Toronto; Canada Foundry Company, of Toronto; Chapman & Walker, of Toronto; Canadian Boving Company, of Toronto; Canadian Buffalo Forge Company, of Montreal; Nather and Platt, of Montreal, and Peacock Bros., of Montreal.

Toronto, Ont.—The Board of Control awarded contracts for pillars and lanterns for the city's new lighting system as follows. The pillars will be purchased as follows: 56 from Reid & Brown, at $36 each; 140 from the Canada Foundry, at $42; and 300 from the Flour City Company, of Minneapolis, at $35.28 each. The lanterns will be obtained as follows: 700 from Reid & Brown, at $1.61 each; 1,050 from the Canada Foundry, at $2.30; and 5,000 from the Flour City Co., at $1.37.

Ottawa, Ont.—The tender of the C. C. Ray Company was accepted for the supply of coal for charity purposes. The price for Scranton coal is $7.20 in ton lots; $3.80 for half tons and $1.90 for quarter tons. Another brand of coal called the Lopez was offered at $6.20 per ton, but the board decided for the better quality.

Coderich, Ont.—The contract for an addition to the post office has been awarded to Messrs. Nagle and Mills, contractors, of Ingersoll. The price is $7,023.