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Contents of this issue on page 41^

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SOME NOTES ON THE OAKVILLE VIADUCT AND THE DYNAMITING OF THE CONDEMNED ARCH RIBS, AUGUST 12, 1912.

By C. H. CUNNINGHAM, B.A.Sc.

On Tuesday, August 13th, a rather interesting, and certainly unusual, event took place in Oakville when the big arch ribs forming the main span of the concrete viaduct under course of erection there, were dynamited. The arch span consisted of two ribs side by side, with vertical concrete posts carrying the slab and girders of the floor system.

These ribs had been completely concreted, but owing to several very serious faults in the construction, it was deemed advisable to destroy them and rebuild.

It was during the summer of 1911 that the county of Halton decided to call for tenders on a reinforced concrete viaduct over the 16-mile creek on the middle road between Oakville and the township of Trafalgar. Competitive designs in steel and reinforced concrete had already been prepared, calling for a clear roadway of eighteen feet. It was decided to adopt the concrete design and reduce the clear roadway to sixteen feet. Accordingly, these plans were prepared by Frank Barber, C.E., Toronto, as consulting engineer for Halton county, and on August 23rd the contract was awarded. Two schemes were submitted, one of which called for the floor to be 40 feet above ordinary water level, and the other at 50 feet. Owing to the better grades obtainable on the approaches the latter plan was the one adopted.

The main features of the design are a cantilevered slab floor supported on two main girders of various spans at 9 feet centres, which frame into square posts supported on heavy concrete piers. The stream itself to be spanned by a double rib arch of 135 feet 0 inches clear span on which the floor is carried by vertical posts and small girders. The arch ribs are if uniform width throughout, being 3 feet 3 inches square at the crown and increase in depth to 5 feet 6 inches at the skewbacks. The floor slab has an average thickness of 12 inches, and is reinforced entirely with ¾ inch round rods, cantilevering about four feet on each side.

Fig. 1.—Showing the Arch Just Before the Blasts.
The notches where the rods were cut are plainly visible.

Fig. 2.—The First Shot; Blowing the South Arch.
The charge in the east haunch did not explode, leaving a long end as seen in Fig. 3.

The girder spans, which form the viaduct approaches on each side of the arch are eight in number, six being on the west side; and range in lengths from 34 feet to 48 feet.

The parapets are also of concrete, and have practically no ornamentation. In fact, the whole structure is noticeably plain. Immediately that the contract was awarded work was begun, in order to get as much done as possible before frost set in. Concreting actually commenced on the footings on October 5th, and by the end of

November the arches were ready to concrete. It was at this point that the regrettable trouble ensued which culminated in the contractor going ahead contrary to the engineer's orders and concreting the arch ribs on centreing which was not sufficiently braced. An injunction and law suit followed, but meanwhile the arch ribs had been finished.

An investigation followed and showed up a considerable number of defects in the arches as erected. Also the weight of concrete was found to have been too great for the centreing, which had shifted and thrown the centre line of the ribs out of a vertical plane to the extent of about three inches at places. Probably no one of the faults in itself would have been sufficient to condemn the arches, but when all were summed up the engineers did not feel that they could stand behind the structure as it then was, and recommended rebuilding them.

An adjustment was finally arranged and the original contract cancelled. Work was not resumed till the spring, when another contractor undertook to complete the job for the county on a cost plus 10 per cent. basis. Work recommenced the end of June, since when good progress has been made.

The council finally decided to blow out the old arches, and accordingly all preparations were made. The concrete

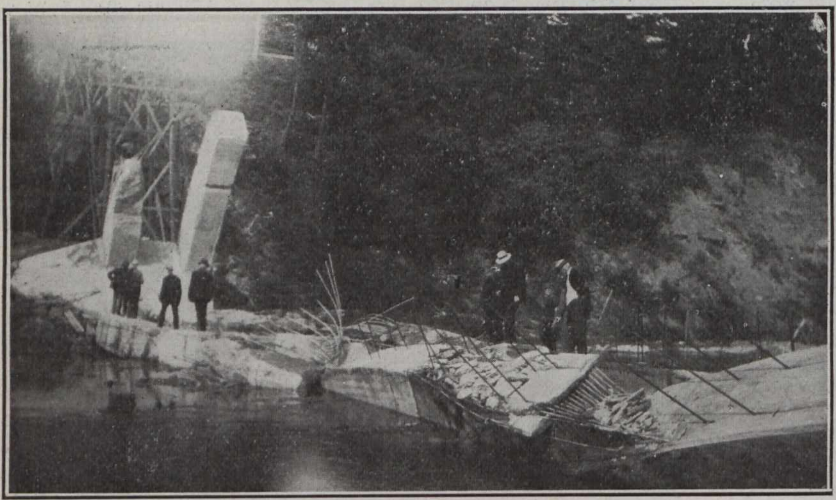


Fig. 3.—The Arches Blown Out and Lying in the Stream.
Note the grillage of rods shown at the break.

outside of the reinforcing, which consisted of 16 bars ¾ inch diameter along the intrados and extrados, was chipped away and the rods themselves cut at two places near each end haunch. There was but one connecting strut between the two ribs, situated at the crown. This was also severed and the ribs were blown out separately.

Charges were placed in the crowns and near each haunch. Dynamite was used and fired by the electric spark to ensure simultaneous explosions, although any one charge would have sufficed to destroy the arch.

The south rib was dynamited first, after which the charges were placed in the north rib. No mishap occurred whatever, and the skewbacks on the main piers were left unharmed. The photographs here reproduced will show the appearance of the arch before, during, and after the explosions. The reinforcing rods kept the concrete from breaking up to a considerable extent, and it will require a great deal of extra work to clear the stream bed in order to place the new centreing.

The steel rods, wherever they were exposed by the splitting of the concrete, were noticeably clean and entirely free from dust. Although these rods were simple rounds having no corrugations or other means of creating a mechanical bond, evidences of a very considerable bond were very plain.

From a military standpoint it might be interesting to note the ease with which such a structure as this could be destroyed by dynamite if so desired. One heavy charge, favorably placed, would be sufficient to preclude the passage of a stream that was not in itself readily fordable. However, it should be remembered that it took over a week for two men to cut the rods, in order that there should be as little damage done as possible to the skewbacks and piers.

ALUMINUM AND ELECTRO-METALLURGY IN FRANCE.

From a recent consular report we learn that the French manufacturers have formed themselves into a company called L'Aluminium francais, with a share and debenture capital amounting to 17,000,000 fr. ($3,400,000). The most interesting part of this combination lies in the fact that the new company has acquired the exclusive rights all over the world in the Serpeck process of aluminum manufacture, hitherto vested in the Nitride Company (Société des Nitrures), who had in 1910 bought up the rights and plant (at Mulhausen) of the Swiss holders of the patent, and had established experimental work in the valley of the Arc, near St. Jean de Maurienne. The Serpeck process, by which the production of nitrates forms part of the manufacture of aluminum, consists in the treatment of bauxite, the raw material of aluminum, in the electric furnace with air and coke, so as to fix the nitrogen, thus producing a nitride of aluminum. This product is then treated with a solution of caustic soda, which produces aluminate of soda and ammonia gas. From the aluminate of soda is extracted pure alumina, from which aluminum is obtained by the usual electrical process; while the ammonia gas is treated with sulphuric acid and produces sulphate of ammonia, largely used as artificial manure. The process is thus closely allied with that in use for the production of nitric acid and nitrates by the union of oxygen, nitrogen and steam in the electric furnace, dealt with under the heading of electro-chemical industries. Large works, utilizing 40,000 horse-power, are about to be established by the Aluminum Combine for the purpose of manufacturing ing under this process. The alumina thus obtained will be used by the various aluminum works grouped together in the new organization, and it is intended to carry on the production of the metal on a larger scale than ever, and to extend its use by all possible means. The company is also said to contemplate the erection of rolling and drawing works near Chambéry. It is calculated that, given sufficient water-power, the cost of the manufacture of alumina will be reduced, thanks to the valuable by-product of sulphate of ammonia, from 200 fr. to 50 fr. per ton, a net saving of 150 fr. per ton, or 300 fr. per ton of aluminum. The United States rights are stated to have been conceded to a subsidiary company with large financial resources, and licenses will probably be granted by the parent company for working the patent in other foreign countries.

The production of ferro-alloys and patent steels in the electric furnace grows apace in Savoy, there now being twelve factories engaged in this branch of the industry. The well-known works at Ugines (Savoie) for working the Paul Girod processes of producing electric steels of great resistance have lately turned their attention to armaments, and have supplied shells to the French and Russian navies.

EXTENSION OF AN OUTFALL SEWER.

A very interesting method for the extension seawards of an outfall sewer is described by Mr. John S. Brodie, M. Inst. C.E., borough engineer and surveyor of Blackpool, England, in a paper read recently at the conference of engineers and surveyors, held in connection with the annual congress of the Royal Sanitary Institute at York. The following abstracts are taken from the paper:

The old outfall at Gynn, Blackpool, was 1,304 feet in

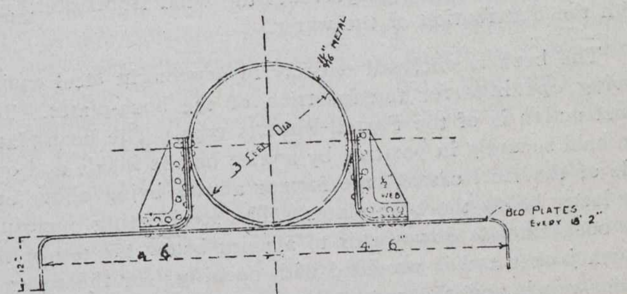


Fig. 1.—Cross Section Through Tube.

length, and consisted of cast-iron flanged pipes, 3 feet internal diameter, in 6-ft. lengths, bolted together and supported on timber piles and cradles. This outfall was laid in 1898, at the cost of £6,755, or at the rate of £15 10s. 9d. per linear yard. The work in 1898 was carried out by a contractor, and was never really completed to its intended length, which was 1,400 lin. ft., on the ground that the difficulties in connection with stormy seas and deepening water were so great that further extension was impracticable. Since then, sand banks have formed seaward of the old outlet, and it has been found necessary, in order to

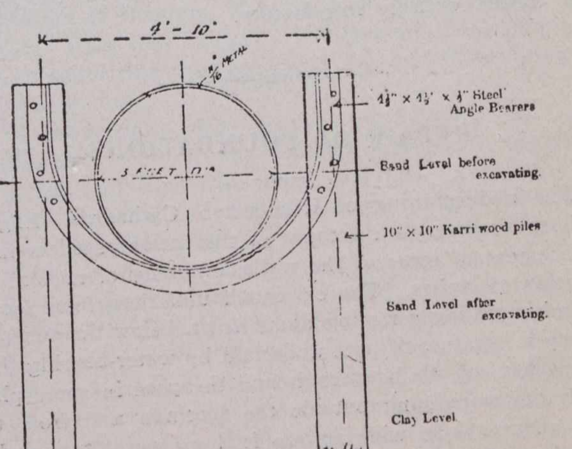


Fig. 2.—Cross Section Showing Piles and Cradling to Receive Connecting End of Tube.

prevent the sewage from lodging on the foreshore, to extend the outfall across the recently formed sand banks into deep water, seaward of the same.

The present extension has been made by means of a continuous steel tube, 3 ft. internal diameter, of solid welded pipes, in 18-ft. lengths, formed of open hearth steel, 11/16 in. thick, riveted together with cover straps 10 in. wide, 11/16 in. of thickness, with a double row of ⅞-in. rivets, spaced 3 in. centre to centre. The quality of the steel was such that the ultimate tensile breaking stress averaged 26 tons per square inch, with an ultimate elongation of 20 per cent. in 8 in. The whole of the tube, both inside and outside, has been heavily coated with an improved bituminous preservative. In order that the new tube should fit properly on to the flanged end of the old outfall, 10-in. square Karri wood piles were driven on each side of the trench at intervals of 6 ft. centre to centre, and connected by half-timber walings, to which close timbering, 3 in. thick, was secured, for a distance of 86 ft. seaward of the old outlet. The tube was built up for a total length of 600 ft., in the foreshore above highwater mark, at a distance of 3 miles along the coast line from its ultimate destination. In order that, when laid, the tube should not be subject to a rolling or rocking action on the sea bottom, caused by heavy on-shore gales, transverse steel bed-plates, 9 ft. long by 12 in. wide, and 11/16 in. in thickness, turned down at the ends for a length of 12 in., as shown in Fig. 1, were riveted to the tubes at 18 ft. centres, except for the 86 ft. length referred to

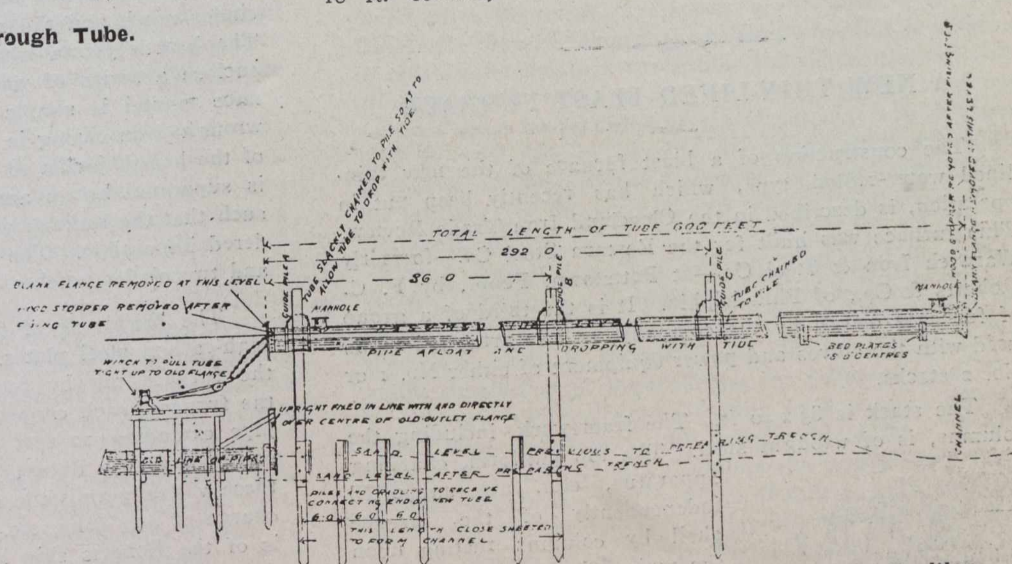


Fig. 3.—Longitudinal Section Showing Method of Dropping Tube in Position.

above where the tube rests on the Karri wood and steel cradles.

After being completed, the tube, which is provided with a 24-in. manhole and cover at each end, and also with blank flanges at the open ends, was filled with water and tested to a pressure of 50 lb. per square inch, at which pressure it was found to be perfectly tight. Timber watertight stoppers, easily removable, were then inserted at each end of the tube, close to the manholes above referred to, and caulked up watertight. The blank flanges were then securely fastened to the ends of the tube, and the manhole covers on the two manholes, one at each end, were also secured and made perfectly watertight. The tube was then launched from above high-water down the foreshore, to such a level between high and low water marks as would enable it to float with a 24-ft. spring tide. It was then floated into the sea, and towed by means of a steam tug for a distance of 3 miles, and was adjusted at high water over the trench, by means of guide piles, as shown in Fig. 3, where it was ultimately intended to lie. The blank flanges at both ends were then removed, the temporary stoppers maintaining the tube afloat. On the tide receding, the tube dropped down into its permanent position, the flow of sewage being held up temporarily by the shore penstock valves; the shoreward-end flange was then bolted up to the flange of the old cast-iron pipe, by means of 12 1⅛-in. steel bolts, and so secured in continuity of the old outfall. The manholes at both ends were then opened, the temporary timber stoppers were removed, the new outfall was then ready for the passage of the sewage.

The cost of the steel tube, which was constructed under contract by Messrs. Clayton, Son & Co., Limited, of Leeds, was £1,358, and the cost of launching, floating and laying was £592, a total cost of £1,950, or at the rate of £9 15s. per lineal yard.

Fig. 1 shows a plan and section of the new outfall tube sewer.

Fig. 2 shows the cross-section of the sewer as laid cn the cradles for a length of 86 ft. seaward of the end of the old outlet.

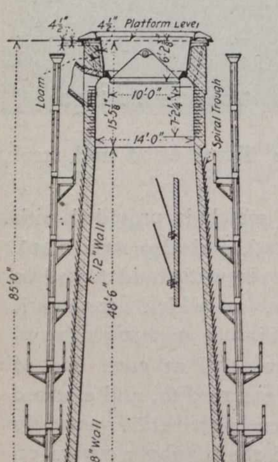
Fig. 3 shows the tube afloat, dropping down into its position on the receding tide.

The tube was manufactured and delivered on the fore· shore at Blackpool by Messrs. Clayton, Son & Co., Limited, of Leeds, and the launching, floating and laying has been carried out departmentally under the author's assistant, Mr. H. Banks.

A NEW THIN-LINED BLAST FURNACE.

The construction of a blast furnace of the new thin-lined water-cooled type, which has recently been put in operation, is described in the Cleveland Iron Trade Review. This furnace was built for the Eastern Steel Co.—formerly Warwich Iron & Steel Co.—at Pottstown, Penn., by F. C. Roberts & Co., of Philadelphia. It is the third of a group of furnaces owned by the company, and is arranged to be used with the stoves and power equipment of either No. 1 or No. 2 stacks.

The stack is 85 x 20 ft. The framework, including the columns, is of wrought steel. The top platform, charging apparatus, etc., are supported independently of the furnace shell by columns resting upon the main columns which support the furnace. Platforms are provided at various levels so that all parts of the furnace casing may be readily accessible. The lower portions of the furnace columns are enclosed in cast-iron casings filled with concrete. The in-wall is cooled by water carried and distributed by a spiral trough of the Roberts type. The waste water from the tuyeres and bosh-plates is delivered by different points in the spiral trough by an electrically driven pump. This trough is connected to the furnace shell by top bolts, which do not pass through the shell, thereby avoiding the possibility of water entering the furnace around the bolts. A washer is provided around each bolt and between the trough and the shell. As a result, there is an opening between the bottom of the spiral trough and the shell which is continuous, except for the interference of the bolts.



Section Through Thin-Lined Blast Furnace.

At the lower end of the spiral trough the water is discharged into a horizontal trough which in turn is connected to the drainage system. The construction and operation of the spiral trough is such that while some of the water circulates around the spiral a large quantity passes through the openings at the bottom to the courses of the spiral trough below and continues its flow to the horizontal trough at the lower end of the spiral. In passing from one course of the spiral to that underneath, the water is in immediate contact with the furnace shell, thereby forming a thin film over all of the plates. The effect of a well-distributed spray is thereby secured with the additional advantages that the side of the spiral trough prevents the wind from interfering with the distribution of the water.

The bosh is enclosed entirely in a wrought steel casing having openings for the insertion of the bosh-plates. The construction is of the Farrell-Roberts type. The bosh-plates are held securely in position by angles on the inside and outside of the steel casing, the former angles being above and the latter below the bosh-plates. The steel casing enclosing the bosh extends downwards to a point below the top of the hearth jacket and is provided with openings for the tuyeres, cinder notch and the run of bosh-plates below the tuyeres. The hearth jacket is made of wrought steel plates which enclose a series of water-cooled cast-iron plates. Tht furnace mantel is simple in construction and a continuous wrought iron casing is provided which extends from the top of the hearth jacket to the top of the furnace. The hopper is supported by an annular ring, the construction being such that the leakage of gas around the furnace top is rendered impossible. The furnace is equipped with 10 tuyeres and two cinder notches.

The brickwork of the stock line is protected by Cook high-carbon steel plates. The downcomer is connected to the furnace top by four branches equally spaced around the furnace, each connection being provided with a vertical pipe extending 22 feet above the furnace platform and is equipped with a Roberts relief valve. In the event of a slip these valves permit the escape of gas, but prevent the discharge of ore, coke, etc. The furnace charging apparatus is of the Roberts skip hoist design connecting below with the stock transfer system, which supplies all the furnaces.

This stack has now been in operation about two months, with results entirely satisfactory.

REPAIR OF FOUNDATIONS.

The underpinning of Winchester Cathedral, England, has been necessary on account of the serious settlement and displacement of some of the walls, cracking of masonry and distortion of arches. The original fcundations have footings on timber grillages resting about 10 ft. below the surface on a 3 to 7-ft. stratum of peat underlaid by water-bearing gravel with pockets of silt between it and the peat in some places. Small pits were sunk outside the footings and from them drifts about 4½ ft. wide and 20 ft. long were tunneled diagonally under the wide footings. They were kept dry by centrifugal pumps down to a depth of about 18 in. above the silt when they were allowed to fill and the remainder of the excavation down to the gravel was dug by divers in water about 10 ft. deep. Bags of cement were carefully laid on the bottom under water and cut open. When set the formed a solid floor sealing the bottom of the tunnel and enabling the latter to be pumped out and the work continued in the dry with mass concrete and cast concrete blocks built up to within 3 ft. of the overhead wall which was connected to the new footing with brick work.

THE TREATMENT OF WATER WITH CHLORINE.*

By Joseph Race, F.I.C. (Toronto's Filtration Plant.)

The use of chlorine as a disinfectant has developed entirely within the nineteenth century, and its general use followed directly in the wake of the commercial preparation of bleaching powder. This substance was often used in the early part of the century for the disinfection of sewage and water, and as early as 1854 its efficiency was so well recognized that an English Royal Commission recommended the use of this substance for deodorizing the sewage of London. In 1885 a special committee of the American Public Health Association stated that "taking cost into consideration, hypochlorites in general were the most efficient disinfectants available."

During the nineties many experiments with bleach and soda were made by Traube, Lode, Sickenberger, Kaufmann, and others, with the object of obtaining practically instantaneous sterilization of water for the use of travelers and troops in the field. Electrolytic processes were developed in 1889, when Webster in England and Woolf in America produced chlorine solutions from sea water, and used them for various purposes.

In 1897 bleach was used by Sims Woodhead for the sterilization of the water supply of Maidstone, England, subsequent to the outbreak of a typhoid epidemic. In 1904 and 1905, during the typhoid epidemic at Lincoln, a solution of sodium hypochlorite, commercially known as "Chloros," was used to the extent of approximately one part of available chlorine per million. This was carried out under the direction of Drs. Houston and McGowan, and was entirely satisfactory. A mawkish taste was, however, the subject of many complaints, and this was thought to be due to the action of the alkaline solution of chloros on the organic matter present.

Dr. Rideal has successfully used a form of electrolytic chlorine (oxychloride) at Guildford, England, for the treatment of water and sewage. Various combinations of chlorine were tried on the rivers Seine and Vanne in France, and at Meddlekerke and Ostend in Belgium. In North America Chlorine was first used on the commercial scale for water purification at Boonton, N.J., in 1908, and at Budby Creek, Chicago; since that date, the development of the process has been so rapid that over 200 cities are said to be using it at the present time.

In connection with sewage purification, the German experimental work at the Hamburg Hygienic Institute by Proskauer and Elsner in 1897, and later (1904-1905) the work of Dunbar and his associates, proved the practical possibilities of chlorine. In 1906 the Royal Testing Station at Berlin confirmed these results. In America, Phelps (1906), of the Massachusetts Institute of Technology, developed this branch of disinfection and carried out the first practical trial at Red Bank, N.J. Kellerman, Pratt, and Kimberley have also made experiments in this direction.

At the present time chlorine treatment of water or sewage is recognized in England and on this continent as a process capable of yielding excellent results at very low costs, but owing to certain disadvantages inherent to its use, it cannot be applied indiscriminately to all disinfection problems. It ought to be regarded mainly as an emergency measure, and secondarily as an adjunct to other forms of purification to provide an additional factor of safety. Each case in which the use of chlorine is suggested should be considered separately, as, except under strictly limited and peculiar local conditions, it cannot be regarded as a substitute for other purification processes. At the present time the problem is not how to use chlorine, although this phase cannot be considered finally solved, for the disinfection of water and sewage, but under what conditions it should be applied, how much it is desired to accomplish, and what amount of supervision is necessary. The views held by many German sanitarians are very different; they have not the high opinion of the process that prevails elsewhere, and generally regard it as inefficient. They severely criticize the bacteriological methods of the workers using gelatin plates for determining the efficiency, and give preference to enrichment methods. A study of their methods of applying chlorine to water shows that instead of using small quantities of disinfectant and allowing prolonged contact, they have employed as much as 40 parts per million of available chlorine with a ten minutes' contact, the excess being then removed by reducing agents, usually sulphites. Even with these large amounts, typhoid and cholera germs were not invariably destroyed, as in many cases the bacilli could be found after treatment, by means of enrichment in broth. Unless the view be taken that one single bacillus is sufficient to create infection in a susceptible individual, the criticisms of the German workers are not well founded, and their methods must be regarded as too stringent. The decreased typhoid death-rate in Toronto and other cities subsequent to the use of hypochlorite treatment is conclusive proof of the efficiency of the process, and refutes the theories of our German confrères.

The general principles regarding the action of hypochlorites are fairly well understood, but the details differ in every case and must be determined, as a full knowledge of them is essential to successful and efficient operation. The active constituent of hypochlorites for disinfecting purposes is chlorine, which liberates oxygen in a nascent condition when these substances are mixed with water. Nascent oxygen in small quantities inhibits the reproductive faculty of micro-organisms, and in large quantities kills them. It should be remembered that the results of chlorination are largely judged by the bacteriological results obtained, and, in these, the enumeration of the bacteria present plays an important part. The methods of counting the bacteria at present in use are dependent upon the ability of the organism to reproduce at such a rate as to form a visible colony within the period of incubation. Any substance which prevents the appearance of a colony during the period of incubation would be regarded as a disinfectant, but this does not imply that it kills bacteria. All substances known as disinfectant probably act at antiseptics in small quantities, and as germicides in larger ones, the line of division being imperfectly defined. The following tables show the action of chlorine on micro-organisms in water:—

City water is water drawn from the tap at the John Street pumping station and represents the main Toronto city supply approximately an hour after treatment by hypochlorite.

Control is water from the same original source as treated water, but not treated by hypochlorite. In order to make the bacterial counts in this water approximately comparable with the counts obtained in the treated water shortly after treatment, the original high count is reduced by dilution of the sample with water of the same kind sterilized by boiling.

Plating. In the column marked "Plating" are given the time intervals in days or hours between the time when the several Petri dishes were plated.

Count after—hours. In these columns are given the bacterial counts made on the several plates after the stated periods of incubation at 20 deg. C.

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* Paper delivered to the Society of Chemical Industry on May 16th, 1912, and published in the journal of the society.

Ratio. In these columns are given the ratios between the bacterial counts on the same plates at the different periods of incubation, as indicated. These ratios indicate the relative increases under the different conditions.

Original sample, untreated, shows the bacterial count in the control sample, before dilution with sterile water, and corresponds also to the count before treatment in the Toronto city water or in the water used in the laboratory experiment.

Experiment No. 1.
Toronto City Water.
Treatment with available chlorine equals 0·25 part per million. City plant.

Plated.		Count, after					Ratio.	
Time.	Day.	48 hours.	72 hours.	96 hours.	120 hours.	144 hours.	2:6 days.	2:5 days.
10	1	17,600	21,440	liquid	—	—	—	—
12	1	1,570	5,820	12,000	11,680	11,960	1:6·9	—
2	1	752	650	1,250	3,460	3,680	1:4·9	—
4	1	692	1,440	2,910	4,520	5,240	1:7·5	—
10	2	165	410	620	930	—	—	1:5·6

Control, lagoon.

Plated.		Count, after					Ratio.	
Time.	Day.	48 hours.	72 hours.	96 hours.	120 hours.	144 hours.	2:6 days.	2:5 days.
10	1	260	296	338	380	404	1:1·5	—
12	1	254	304	310	364	412	1:1·6	—
2	1	246	244	236	368	432	1:1·7	—
4	1	318	474	508	510	540	1:1·7	—
10	2	12,880	12,440	13,960	14,000	—	—	1:1·08
10	3	288,000	508,000	630,000	—	—	—	—

Original sample, untreated, 23,700.

Experiment No. 2.
Toronto City Water.
Treatment with available chlorine equals 0·25 part per million. City plant.

Plated.		Count, after					Ratio.	
Time.	Day.	48 hours.	72 hours.	96 hours.	120 hours.	144 hours.	2:6 days.	2:5 days.
10	1	14,000	16,800	28,000	22,800	26,000	1:7·6	—
12	1	3,400	5,700	16,200	5,000	7,100	1:13·6	—
2	1	520	2,100	3,440	3,920	5,200	1:7·0	—
4	1	740	1,900	2,860	3,720	—	—	1:7·4
10	2	500	2,300	2,480	—	—	—	—
4	2	1,120	1,910	2,380	—	—	—	—
10	3	2,400	4,150	9,300	—	—	—	—

Control, lagoon.

Plated.		Count, after					Ratio.	
Time.	Day.	48 hours.	72 hours.	96 hours.	120 hours.	144 hours.	2:6 days.	2:5 days.
10	1	180	180	268	liquid	—	—	—
12	1	124	138	226	230	238	1:1·9	—
2	1	136	116	140	176	188	1:1·4	—
4	1	210	158	240	316	340	1:1·6	—
10	2	6,600	7,900	10,800	12,300	—	—	1:1·8
4	2	25,200	26,400	28,400	—	—	—	—
10	3	640,000	896,000	960,000	—	—	—	—

Original sample, untreated, 22,800.

Experiment No. 3.
Control, laboratory tap water.

Plated.		Count, after					Ratio.		
Time.	Day.	48 hours.	72 hours.	96 hours.	120 hours.	144 hours.	2:6 days.	2:5 days.	2:4 days.
11	1	121	184	285	liquid	—	—	—	—
12	1	115	171	223	380	392	1:3·4	—	—
2	1	109	152	221	362	375	1:3·4	—	—
4	1	121	175	251	410	415	1:3·4	—	—
10	2	6,200	8,500	8,800	8,900	—	—	1:1·4	—
10	3	425,000	650,000	670,000	—	—	—	—	1:1·5

Available chlorine equals 0·1 part per illion. Treatment in laboratory.

Plated.		Count, after					Ratio.		
Time.	Day.	48 hours.	72 hours.	96 hours.	120 hours.	144 hours.	2:6 days.	2:5 days.	2:4 days.
11	1	520	940	1,350	2,360	2,780	1:5·3	—	—
12	1	390	770	1,080	2,040	2,320	1:5·8	—	—
2	1	187	260	690	1,840	2,080	1:16·4	—	—
4	1	91	130	280	760	840	1:9·2	1:22	—
10	2	42	120	670	920	—	—	—	1:10·9
10	3	320	1,210	3,500	—	—	—	—	1:2·9
10	4	8,700	14,200	26,000	—	—	—	—	—

Available chlorine equals 1.0 part per million.
Treatment in laboratory.

Plated		Count, after				
Time	Day	48 hours	72 hours	96 hours	120 hours	144 hours
11	1	2	5	7	8	10
12	1	1	1	2	2	4
2	1	0	0	0	2	2
4	1	1	2	2	6	6
10	2	0	0	0	1	—
10	3	0	0	0	—	—
10	4	5	13	16	—	—
10	5	79	166	—	—	—

It is evident that chlorine, in quantities smaller than 0.25 part per million, under the conditions of the experiments, mainly retards the growth of bacteria and kills very few. One part of available chlorine per million acts as a germicide, and there is no evidence of revivication. Since small quantities retard the growth when placed in such a suitable media as nutrient gelatin, it is probable that reproduction in water with a low organic content would be still further diminished. This is also indicated by the results.

From the results of these experiments and many others of a similar nature, it was decided to abandon the two-day incubation period recommended by the American Public Health Association and to count all plates on the third day. Three days is the period during which the formation of visible colonies proceeds most rapidly, and very little advantage can be gained by increasing it to four days. A three-day incubation period raises the standard of quality if numbers are given any consideration, and eliminates the anomalous results so often found when counts are made of chlorinated waters.

In this connection it is interesting to note the experience of Clark and De Gage, at Lawrence, Mass., during 1909. In the report of the Board of Health, page 319, 1910, they state: "It has frequently been observed that the numbers of bacteria determined at body temperature in the disinfected samples were much higher than the numbers determined at the usual room temperature. This phenomenon of reversed ratios between counts at the two temperatures has been occasionally observed with natural waters but a study of the records of many thousands of samples shows that the percentage of such samples is very small, not over 3 to 5 per cent. On the other hand 20 to 25 per cent. of samples treated with calcium hypochlorite show higher counts at body temperature than at room temperature. Similar counts have been noted elsewhere where waters are being treated with hypochlorites, but in many cases such results have been considered abnormal and have been omitted from the records. A phenomenon which has a frequency of 25 per cent., however, cannot under any circumstances be considered abnormal, and the omission of such counts from records is entirely unjustifiable. A careful study has been made of the conditions under which such reversed counts occur, and it appears that these counts are found in a considerable percentage of samples of water, sewage, etc., in which the room temperature counts have been reduced to less than 100 to 200 per c.c. by the use of hypochlorites, permanganates, and other oxidizing agents. A study of the types of bacteria remaining after disinfection shows that the proportion of spore-forming bacteria is practically the same after disinfection as it was in the untreated water, and the appearance of the reversed ratios apparently cannot be attributed entirely to the non-destruction of spores. The true significance of this phenomenon cannot be stated at the present time. It is evident, however, that, if the body temperature counts are omitted and reliance placed upon those at room temperature, a wrong and possibly a dangerous interpretation may be made as to the quality of the water which has been treated with hypochlorites."

Available chlorine equals 4·0 parts per million. Treatment in laboratory.

Plated.		Count, after					Ratio.	
Time.	Day.	48 hours.	72 hours.	96 hours.	120 hours.	144 hours.	2:6 days.	2:5 days.
11	1	1	1	1	4	5	—	—
12	1	0	0	1	3	3	—	—
2	1	0	1	1	liquid	—	—	—
4	1	0	0	0	0	0	—	—
10	2	0	1	1	2	4	—	—
10	2	0	0	0	2	—	—	—
10	2	0	0	1	—	—	—	—
10	1	1,620	Original 2,230	Sample, untreated. 2,860	3,620	3,840	1:2·3	—

This is possibly due to the cause previously mentioned, and the phenomenon would probably disappear by increasing the period of incubation.

Chlorine Treatment of the Supply of the City of Toronto.—The city supply is obtained from Lake Ontario at a point approximately 2700 feet south of the south shore of Toronto Island. The water is conveyed by means of a six-foot steel conduit to the north shore of the island where it descends a shaft (100 feet deep) and is then conveyed under the Bay in a tunnel 8 feet in diameter to the main pumping station where it is pumped directly into the distributing mains.

Under normal conditions the treatment of the water with chlorine does not present serious difficulties. The turbidity is low, coloring matter absent, and the organic content comparatively low. Successful treatment depends upon two factors, viz., perfect admixture and sufficient period of contact. The early experiences with the city supply seemed to indicate that the second factor was the more important, and this point is clearly shown in the following tables:—

Bacteria per c. c. gelatin 3 days at 20° C.

Date	Sampling point	Count
April 27th, 1911.	Main Pumping Station	34,000
	9,000 feet from Pumping Station	8,400
	13,000 " "	4,520
	19,000 " "	3 810
	*14,000 " "	2,340
May 11th, 1911.	Main Pumping Station	5,800
	2,000 feet from Main Pumping Station	5,680
	8,000 " " "	2 380
	14,000 " " "	2,140
	20,000 " " "	2,260
	24,000 " " "	1,980
	Average of series of samples.	
Oct., 1911.	5,000 feet from Pumping Station	300
	6,000 " "	203
	7,000 " "	103
	12,000 " "	86
	14,000 " "	87

* This sample represents water which has been partially stored in a high pressure service reservoir.

The treatment takes place at the north end of the island, the bleach solution being added to the water as it descends the shaft to the Bay tunnel. The capacity of the tunnel is such that with a normal consumption of 43 million gallons per day, the period of contact before reaching the main pumping station is approximately 50 minutes.

In the spring of 1911, when the Health Department decided upon the treatment of the island supply, it was thought that owing to the water going directly into consumption after treatment with chlorine, insufficient time would be given to reap the full advantage of the process. It was, however, decided that chlorine treatment should be used, and a mechanical appliance was devised by the chief engineer of the Island pumping station by which a constant amount of disinfectant could be added and perfect admixture ensured. This apparatus consisted of a small plunge pump, the piston of which was connected with the piston of the main supply pump and was fed with bleach from one of two storage vessels. Check valves were placed on the inlet and outlet of the small pump. As each stroke of the large pump corresponded to a stroke of the small one, by determining the relative quantities delivered by each it was possible to fix the amount of chlorine added by varying the concentration of the bleach solution. Perfect admixture was obtained by injecting the bleach solution into the water by means of a perforated injector. The process worked very satisfactorily, combining a very high efficiency with a low cost.

Samples of water were taken at a point only a few yards distant from the pump, and although the time elapsing between treatment and examination never exceeded 15 minutes and was usually much less, almost sterile water was obtained throughout the whole season. The results were as follows:—

Island Results.

1911.	Available chlorine parts per million.	Bacteria per c.c.		Percentage of samples of treated water showing typical *B. coli* in		
		Raw water.	Treated water.	50 c.c.	10 c.c.	1 c.c.
July	0-20	864	27	Nil.	Nil.	Nil.
August	0-20	1,018	12	"	"	"
September	0-34	725	28	8.0	"	"
October	0 50	1,256	15	Nil.	"	"
November	0-50	6,098	4	"	"	"

Samples taken at various points in the distribution mains showed greater numbers of bacteria than were found immediately after treatment, and an increase in the amount of chlorine used had no appreciable effect on these increases. Blowing out the mains effected a slight reduction, but only of a temporary nature, and several hours' treatment with a strong solution of chlorine (4 parts per million) also gave but little relief. As B. coli was almost invariably unmoved, even when 100 c.c. were tested, the phenomenon must be ascribed to the growths in the mains and not to a revival of the original flora. The period of time required for the water to reach the points where increases were found was almost invariably less than one hour, and as revival could not take place in such a short time additional evidence is furnished in favor of the theory of contamination with secondary growths. Despite these increased counts, the process must be considered an excellent one and efficient admixture the essential feature for obtaining successful operation.

On Toronto Island, one million gallons per diem were treated during the summer season, and since it was first installed in May, 1911, the process has been put into operation at West Toronto and Sarnia, Ont., with equal success.

Chlorine-treatment in Conjunction with Filtration.—It is well known that turbidity reduces the efficiency of the chlorine-treatment, and since in the case of the Toronto supply an increase of turbidity is usually accompanied by increased pollution, the chlorine treatment of the raw lake water can only be regarded as a temporary expedient. Its use as such has been entirely justified as there is no doubt that the adoption of the process for the city supply has resulted in a decreased typhoid mortality rate. In 1910 the rate was 43, and in 1911, during the whole of which chlorine was in use, the rate was decreased to 20.

Date. 1911.	Chlorine parts per million.	Bacteria per c.c. Gelatin 3 days at 20° C.			Samples showing typical *B. coli*. Raw water.				Filtered water.			Chlorined water.			Turbidity.	
		Raw water.	Filtered water.	Chlorined water.	50 c.c.	10 c.c.	1 c.c.	0·1	50 c.c.	10 c.c.	1 c.c.	50 c.c.	10 c.c.	1 c.c.	Raw water.	Filtered water.
April	0·25	10,910	—	6,421	3	2	0	—	4	—	—	3	1	0	65	—
May	0·25	4,813	—	1,545	—	8	5	—	—	—	—	0	0	0	4	—
June	0·26	16,821	—	2,437	17	3	0	—	—	—	—	0	0	0	6	—
July	0·28	864	—	310	22	14	0	—	—	—	—	3	1	0	5	—
August	0·31	1,018	—	74	19	12	2	—	—	—	—	0	0	0	4	—
September	0·32	725	—	104	11	10	0	—	—	—	—	0	0	0	12	—
October	0·42	1,256	—	81	18	17	2	—	—	—	—	0	0	0	8	—
November	0·38	7,150	—	132	22	9	1	—	—	—	—	0	0	0	8	—
December	0·33	11,999	—	84	34	16	9	—	—	—	—	10	4	0	13	—
1912.																
January	0·33	2,163	473	23	16	9	6	0	18	6	1	4	1	0	5	2
February	0·31	19,232	2,228	14	20	11	5	2	16	6	1	0	0	0	10	1
March	0·28	17,264	1,629	43	23	15	4	0	21	9	1	1	0	0	9	0·6
April	0·27	18,524	815	5·3	24	17	10	3	20	11	2	2	0	0	44	2·0

Until the system of slow sand filters recently put into operation had demonstrated its ability to sufficiently purify the water supply it was deemed advisable to continue the treatment with chlorine, and the effect of the reduction in turbidity and organic content is easily observable in the table given below. The filtration plant was first operated on January 4, 1912, so that the beds have not yet matured. It will be noticed that the efficiency is rapidly increasing despite the high rate of filtration (5.3 million gallons per acre per day).

As a result of prolonged incubation of city tap water after filtration and chlorine treatment, the following numbers of bacteria per c.c. at 20 deg. C. (average of 12 samples) were counted:—After 2 days, nil; after 3 days, 0.75; 4 days, 3.0; 5 days, 7.0; 6 days, 10.0.

Chlorine treatment of the city supply was commenced in May, 1910, but no results are given until April, 1911, as gelatin counts were not made until this latter date. From this date onwards there has been a steady progressive increase in efficiency, and the reason for this can only be attributed to a gradual removal of organic growths in the large distributing mains. No evidence of revival has been found within the period of time the water remains in the system, as the count decreases with increased period of contact, the best water being invariably found at the points farthest removed from the pumping station.

That is the reverse of the experience at Cincinnati with chlorine treatment of filter effluents. Elms (Eng. Record, Vol. 63, p. 472) finds that although the water at the reservoir appeared practically sterile, very much larger counts were obtained from city tap samples, and he attributes this to disturbances of the bacterial flora and secondary growths. The difference between the Toronto and Cincinnati results may be due to the presence of a larger amount of easily oxidized organic matter in the latter supply. Elms (loc. cit.) has shown that the efficiency of the process is inversely proportional to the amount of easily oxidizable matter present and that large increases of bacteria are common in such samples following a temporary reduction.

The point of application of chlorine used in conjunction with filtration systems varies in different countries, English practice being to apply it to effluents only, and American usually to treat the raw water. In mechanical plants where coagulants are used it is convenient and economical to add the bleach prior to sedimentation, but the full advantage of the bleach is not developed in this method as the chlorine is acted upon by the full organic content of the water. Furthermore, the Lawrence, Mass., experiments have shown that when small quantities of chlorine are used (less than 3 parts per million) in conjunction with coagulants the action is soon complete and that subsequent storage increased the bacterial count from 100 per cent. to 670 per cent. There is an increase when chlorine is not used, but not nearly so marked as these figures indicate. These factors detract from the efficiency of the plant and better results can undoubtedly be obtained by treatment of the filtrates. This is proved by the Cincinnati results.

Any excess of chlorine added to water is considered by many to be removed by filtration, but of this there is no proof. Chlorine after addition to water exists in various forms—as free chlorine, hypochlorous acid, and in combination with organic matter. The two former can only be removed by special methods, such as the "Dechlor" and "Ferrochlor" processes, and although a portion of the latter is undoubtedly removed by sand filters, filtrates are obtained that give a chlorine reaction after acidification.

Experience with slow sand filters shows that chlorine interferes with the efficiency of the filter by reducing the formation of the "blanket" layer, and retarding the biological processes taking place in the lower layers. During the chlorine treatment of the prefiltered water at Lincoln, Houston found that although the removal of B. coli and other organisms growing at 37 deg. C. was satisfactory, there is almost invariably an increase in the bacteria growing on gelatin at 20 deg. C. This, he thought, was possibly due to the chlorine acting on the organic matter and changing it into forms more suitable for microbic life and that in the filter and underdrains reproduction was accelerated. The chemical results support this view, as the effect of treatment with chlorine was to increase the amount of organic matter found in the effluent. Rideal's experiments with sewage at Guildford indicate that similar action may take place in contact beds.

Some experiments on sand treatment, made in the filtration plant laboratories, indicate a similar action, and two typical examples are shown in the following tables:—

Experiment 1.

Available chlorine in liquid parts per million.	Bacteria per gram of sand after		
	3 hours.	24 hours.	48 hours.
Nil.	70,000	—	—
0·1	7,200	20,400	12,800
0·3	5,240	6,400	11,200
0·5	5,120	4,700	10,800
1·0	1,000	8,800	20,400

Experiment 2.

Available chlorine in liquid.	Bacteria per gram of sand after		Typical *B. coli* after 24 hours.				Free chlorine after 24 hours.	
	3 hours.	24 hours.	100 gr.	10 gr.	1 gr.	0·1 gr.	Without acidification.	After acidification
Nil.	12,100	71,000	+	+	+	—	—	+
3·0	80	114,000	—	—	—	—	—	+
5·0	55	150,000	—	—	—	—	—	+
7·0	25	214,000	—	—	—	—	—	+
10·0	26	500,000	—	—	—	—	—	+

The relative weights of water and sand were as 1 : 2.

It is observable that the effect of large doses of chlorine is first to reduce the bacterial count, but the reduction is not maintained and the subsequent increase is abnormally rapid. The conditions were evidently unsuitable for the reproduction of B. coli, and it remained inert.

From a consideration of all the available data there is no doubt that if chlorine is to be employed to full advantage, it must be added to the filter effluents. The turbidity, color, and organic impurities of a raw water are not apparently reduced by chlorine, but they are acted upon with consequent loss of available disinfectant.

The disadvantages of the addition of chlorine to prefiltered water may be summarized thus:

Mechanical filters: Reduced efficiency of chlorine.
Slow sand filters: Reduced efficiency of chlorine and reduced purification by filters per se.

Aesthetic Considerations.—Any compound of chlorine which liberates the free element on addition to water has a tendency to impart a distinct taste and odor to it, and when present in amounts exceeding 1 part per million of available chlorine it can generally be detected by the senses. This is the result of many experiments with Lake Ontario water, and although in some cases quantities smaller than 1.0 part per million could be occasionally detected, many blanks were also said to contain chlorine so that many of the positive results were due to auto-suggestion.

The taste of chlorine is sharp and acid, and the odor pungent, but these should not be confounded with the sensory characteristics of natural untreated waters. Many organisms such as Uroglena, Volvox, and Eudorina, impart a distinctly fishy taste and odor to the water in which they grow, and this is especially noticeable when the water is warmed. Uroglena probably effects this by the rupture of the oil sacs which it contains, and as the products of decomposition pass into solution they cannot be removed by the usual forms of purification. The majority of complaints regarding water supplies which are treated with small quantities of chlorine are due to these natural and uncontrollable causes, and although samples are often said to taste of chlorine it will generally be found that chemical tests give a negative result. As the reaction with potassium iodide and starch in acidified solutions is at least five times as delicate as the palate and nose, these complaints must generally be ascribed to auto-suggestion. In these cases the number of complaints will be found to bear no relation to the amount of disinfectant used: typical examples of this phase of the treatment were met with during the summer season on Toronto Island in 1911. Many complaints were received during the early part of the season when the rate was only 0.20 part per million of chlorine, and these entirely ceased during the latter half of the season when the rate was increased 150 per cent. The nature of the complaint has been the same as in other places where chlorine is in use, that it caused colic and other human ailments, that cattle and other animals refused to drink it, that it injured plants, fish, and birds, and extracted abnormal amounts of tannin from tea. No reliable evidence was ever produced in support of these statements, and they ought, therefore, to be treated as myths.

Corrosion.—There is no doubt that chlorine tends to increase the corrosive properties of water, but when the amount present is very small, the increased effect is so minute as to be inappreciable. Chlorine accelerates the action on iron by increasing the number of hydrogen ions, which are, according to the electrolytic theory of corrosion, mainly responsible for the deleterious effects produced. No injury has been noticed in the pumps at the main pumping station where chlorine-treated water has been pumped continuously for over two years, but it must be remembered that actual "free" chlorine is generally removed by absorption during the 50 minutes' contact in the tunnel under the Bay. If chlorine were added to a water in excess of the carbonates present, it is easy to conceive that an electrolytic action would ensue in a pump constructed of different metals or alloys of metals. The water becomes an electrolyte, and corrosion would take place. If a contact period sufficient for the assimilation of the free chlorine cannot be obtained previous to pumping, it is a good policy to inject the chlorine into the discharge pipe of the pump. In the case of plunge pumps this can be done as previously described, whilst with centrifugal pumps, the plunger of the small bleach pumps could be operated by a water-wheel connected in the discharge pipe. Dr. Houston in the 5th Report of the Royal Commission on Sewage Disposal gives some results of experiments on the action of chlorine-treated waters on lead piping. These show that chlorine (as "chloros"), in amounts varying from one to ten parts per million, does not appreciably increase the plumbo-solvent action of either unfiltered or filtered river water. Some experiments have been made within the last few days with the Toronto supply. Raw lake water, filtered water, and water treated with 0.25 and 0.50 part per million of chlorine all dissolved the same quantity of lead in 24 hours. The amount is, of course, so small that it cannot detract from the hygienic safety of the supply.

In conclusion, I wish to acknowledge the assistance I have received from the many valuable suggestions that have emanated from Mr. F. F. Longley, the resident engineer at the filtration plant.

WATER PURIFICATION AS ENDORSED BY THE ONTARIO BOARD OF HEALTH.

The following is an extract from a circular being distributed by the agents of the Ontario Board of Health at the Canadian National Exhibition at Toronto.

A level teaspoonful of chloride of lime should be rubbed into a teacup of water. This solution should be diluted with three cupfuls of water and a teaspoonful of the whole quantity should be added to each two gallon pail of drinking water. This will give .4 or .5 parts of free chlorine to a million parts of water and will in ten minutes destroy all typhoid and colon bacilli or other dysentery-producing organisms in the water. Moreover, all traces of the chlorine will rapidly disappear.

This method should be very valuable for miners, prospectors, campers, and those living in summer resorts where the condition of the waters might not be above suspicion.

CENTRAL STATION ELECTRIC POWER FOR RAILWAY OPERATION.*

By Frederick Darlington.

Every engineering operation seeks to accomplish some practical result, which is measured by its financial worth or capacity to earn money by saving labor in doing something useful. There are no exceptions to this, but for railroad work, which will be the subject to-night, we often have to look further and deeper for the full measure of worth, than is usual in any other matters with which I am familiar.

In the manufacture of cloth, for instance, the problem is simple, that is, make cloth of a desirable quality, at a minimum cost; likewise in making steel rails or bricks or paper, or any article of merchandise, there is a definite result to be obtained and the final test of different methods is the cost and value of the product, which in such instances is readily determined. There is no such simple way to judge the merits of transportation work for it is far more complex than manufacturing or other lines of production. This is seen in the great diversity of rates and classifications under which railroad accommodations are sold. In freight business, for example, there are different rates for long hauls and for short hauls, for car loads and for part car loads, and various classifications almost without limit. This diversity has not, as many people suppose, resulted primarily from a desire on the part of railroads to "charge what the traffic will bear," but rather from necessity caused by differences in transportation costs, combined with differences in the value of services rendered. It is not necessary to enlarge upon this for we all know it would be fatal to the interests of both buyers and sellers of transportation on a ton-mile basis, or on a uniform basis of distance hauled, or on any direct measure of transportation. An equitable rate for carrying a ton of wheat from Chicago to New York City has very little relation to an equitable rate for carrying a ton of wheat twenty miles from a farm to a grain elevator; likewise, there is very little relation between the cost per ton of transporting a car load of wheat and the cost on a single ton in a part car load lot, and short hauls and part car load lots may be quite as important in the aggregate as long hauls. What I want to bring out is not the value of the work done by the railroads, immense and necessary as it is, but rather to point out the need for still more and different railroad facilities, and to show that the use of electric power from central station plants will benefit railroads and at the same time benefit all other operations requiring power.

There is a wide field for improvement in railroad service that can be best accomplished with electric power, especially for local transportation. The statement has been made that the money expended in wagon hauling freight to and from freight depots of one of the largest railroad systems in New England, is greater than the gross receipts of the railroad from its freight business, and I am inclined to believe that this will apply to other American railroads. It is certain that the cost of wagon hauling freight to and from railroads, is a heavy part of freight transportation. Also in passenger service the collection and distribution of passengers to and from railroad depots, is a matter of large cost and has an important bearing on travel. This is evidenced by the work of electric interurban trolley roads, the favorite field of which is in the territory tributary to steam railroads, where they have in many places greatly facilitated the local collec-

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tion and distribution of traffic. I will not enlarge upon this for it is well understood.

In comparing steam and electric power for railroads, the comparison should not be based on the relative cost of operating certain trains by steam and by electric motive power, but the comparison should be made between the best use of steam power considering the cost and value of the service rendered, compared with the best use of electric power, considering the cost and value of electric service. It follows from the wide difference in the nature of the two kinds of power, that the train weights, schedules, etc., and even the locations that are best for railroads employing steam power, will not always be best for electric power.

As far as distribution of power is concerned, independent of whether it is for railroads or for other purposes, it is demonstrated that wherever a large number of small powers are to be supplied in a limited territory it is more economical to distribute it by electricity than by any other known method. An example is seen in the case of textile mills, where power from steam engines or water powers was formerly generated at each mill and conveyed to various rooms and machines by series of shafts and belts. This plan has been widely superseded with electric drive whereby electricity is generated in a central plant supplying numerous mills and is used to operate motors for driving small groups of machines in each mill, or even for driving a separate motor for each machine. Likewise, in railroad work, electric motive power enables a profitable service to be rendered, with greatly subdivided motive power suitable for light and frequent trains that if operated by steam power would be too costly to be profitable in such small units. So it has been in every field where electric power has been extensively applied. The most important result has not been a cheapening of work that was previously accomplished by other means, but more and better work has been accomplished, and so it will be with the use of electricity on railroads and this betterment will not be confined to railroading, because there is an interdependence in electric power operations, whereby any extension of electric lines and increased use of electric power for any purposes, leads to development of more and better electric power for all other purposes. How this must always result can be predicted by using a little justifiable imagination to clear the point of view of natural bias in favor of present conditions and methods that have gradually become unfavorable for present needs.

Custom and habit often leads to the continued use of apparatus and methods for work that could be better met by new means. To appreciate this, imagine that a wholly new country, that is destined by natural resources to become rich and prosperous, is to be opened up, settled and developed, and that some empire builder with a master hand and complete foresight could furnish the transportation and power facilities of the country. By means of electricity and the railroads, he could direct the development of the country. First of all by building railroads with electric motive power, he would at once provide the means of transportation that is always adopted where the population is sufficiently dense.

Following such lines of convenient transportation and power, population centres and settlements will naturally locate on the railroads with transmission lines along the roads, these various centres are tied together, forming the most efficient power system. If a country is to have a density of population and prosperity that would pay for transportation by electric roads, then the railroads should unquestionably be provided with transmission lines connecting the cities and these same transmission lines carrying electric power along the railroads, make the most economical means for distributing power for every purpose, and all the street cars, house lighting circuits, shops and factories along the railroad, would naturally derive their power from these lines, and towns and manufacturing centres are always attracted by convenient power, as well as by good transportation conveniences. Then again, a diversified and extended use of electric power within any area, increases the size of the power plants employed therein and accordingly reduces the cost of each unit of power generated.

A manager acting for a central power plant desiring to sell power to a city electric railroad system, recently put the matter as follows: To the banker president of the railroad, who has a reputation of being difficult to convince in any such matters as sacrificing or setting aside part of his property, the manager said, "Do you want to make a dollar?" To which, after the way of bankers, he answered, "Yes." Then the manager asked him if he "Would share the dollar with someone else who helped make it," to which he answered, "Yes, if he could not make it all himself." Then said the manager, "I will sell you power for your railroad at less than it costs you to make, and even so, I can make a profit on it, for you are making it in 2000-kw. units and I am making it in 6000-kw. units, and, therefore, at less cost than you are; but besides making it in larger quantities than you are, I am serving a great variety of companies and secure a more even and steady load than you do since you are making power for only one kind of service, namely, to operate an electric railroad; but in addition to these reasons, I want your business, because with your load added to my present load I can generate power in 8000-kw. units, and still further reduce my kilowatt-hour cost."

It is not a matter of opinion but of accomplishment that available central station power is a valuable asset to every prosperous settlement, just as are railroads and telegraph and telephone systems. As power machinery and methods of work that are not now adapted to the electric plant, are becoming obsolete or wearing out they are being supplanted by electric machinery and electricity is being installed in new works where foresight is exercised to realize the maximum benefit by centralization and unification of power.

Much that was sought by railroads long before electric motive power was available for their needs is now accomplished with electricity. Years ago Wellington in his standard book entitled "Railroad Location"—a book, by the way, that deserves a much more comprehensive title—pointed out that "In the sale of transportation the price that the consumer is able and willing to pay, is greatly affected by trifling differences of convenience." He emphasizes the importance of convenient local transportation facilities and says that "The loss to the railroad due to not supplying the best facilities might be borne if it meant simply a reduction of transportation tax upon the traveler or the shipper of freight." (In other words, less money paid to the railroad), but he asks, "How stands it with the traveler or shipper? They save indeed the two or three cents per mile, which the railway loses, but they have to pay the entire cost of cartage on their freight and pay for their own conveyance, besides suffering the annoyance and inconvenience, which they estimate at a good round sum." He says, "From poor transportation facilities, the loss is threefold: The cost to the public is greater. The receipts to the railroad are less. The traffic is decreased in volume." To quote still from Wellington, "This means from the point of view of political economy, and as a plain statement of fact, which would appear in census statistics, that the capital of the country and the world is less than it otherwise would be."

We can now add to Wellington's list of losses and state that poor transportation, when resulting from failure of railroads to employ electric power under conditions favorable to its use, will cause a fourfold loss, including the three losses enumerated and adding a fourth represented by the added cost of power, both for railroad working and for industrial uses, and in the fourth instance, as in the three enumerated by Wellington, this means, from the point of view of political economy, a loss to all—to the railroads and to the public alike.

While it has been one of the works of electric railroads to produce added values with better transportation facilities, it is not my intention to reiterate arguments for better local service with electric power as a means of increasing values. It is rather the purpose to accept the evidence of interurban railroads that electric power is disadvantageous for light and frequent train service, and from this premise to examine the conditions for its further application.

The general statements thus far made concerning central power supply and railroad operation, are all capable of verification by examining specific conditions, but, as I indicated at the commencement of this paper, a complete analysis to apply to all conditions is most complex. It will be possible

	Total cost per year	Cost per year per kw. of plant capacity	Per kw-hr.
Operating labor	$52,500	$2.10	0.100
Operating materials (exclusive of fuel)	15,000	0.60	0.025
Labor for maintenance of plant	15,000	0.60	0.025
Material for maintenance of plant	17,500	0.70	0.030
Total cost of power plant, operation and maintenance, exclusive of coal per yr.	$100,000	$4.00	0.180
Add the cost of coal at $1 per ton for coal of 13,500 B.t.u. per pound	82,500	3.30	0.15
Note:—The fuel cost will increase as the cost per ton increases or the quality falls off			
Other expenses pertaining to power plant operation, such as administration, legal and general expenses	10,500	0.42	0.02
	$193,000	$7.72	0.35
Add for fixed charges on the cost of power plant	225,000	9.00	0.41
Total cost of power per yr. with coal at $1 per ton and a load factor 25 per cent.	$418,000	$16.72	0.76

for me to give here only a few results based on actual operations which may be used by those interested as a basis to compute what economy centralization and unification of power supply will secure at other places.

The figures given below are for the cost of producing electric power in steam plants carrying railroad loads under conditions that are widely prevailing in the United States. These figures are not exact costs taken from any particular power plant, but are average costs worked out from actual results in several steam plants on heavy railroad and other work, so shown as to permit easy analysis for varying conditions of load and for different fuel costs, etc.

The figures given are the cost, including fixed charges, of producing power in a 25,000-kw. steam turbine plant, containing five main units of 5000-kw. nominal capacity each, but capable of carrying 50 per cent. overload or more in emergencies.

The yearly production of power is assumed at 55,000,000 kw.-hr. or a load factor of 25 per cent. on a maximum load of 25,000 kw., which is the total nominal capacity of the five generators. It is equivalent to an average operation of all of the generators for 2,200 hours per year at their rated capacity.

Such is the cost of electric power generation by steam for heavy railroad operation and general central station service.

There are two factors in the foregoing costs which are liable to maximum variations, viz., the cost of fuel and the average load on the plant, as it is called, the load factor. The assumed maximum load of 25,000 kw. could easily be carried on four ordinary 5000-kw. nominal capacity steam turbine generators, and leave one square unit in a five-unit station. A 25 per cent. load factor is assumed above (25,000 kw. maximum load and 55,000,000 kw.-hr. per year), the result in thermal efficiency would be about 8.4 per cent. It is difficult to determine from actual results just what the thermal efficiency would be at other load factors, but as it is sometimes necessary to know this as a basis for arriving at the fuel costs under varying load conditions, the following approximate figures are given for these variations. The coal is assumed to contain 13,500 B.t.u. per lb.

It would be difficult to demonstrate in detail the economies that can be derived from combination of mixed power service from the above plant compared with power for only one industry like railroads, and an attempt at it would lead back to the same generalities that I have already stated, but analysis of the schedules of costs and thermal efficiencies for a 25,000-kw. plant, working at 25 per cent. load factor, proves the broad assertion that in power generation large stations carrying mixed loads afford the maximum economies. Take, for example, the cost of general expenses and of fixed charges and of power station labor and material,

Yearly load factor (ratio of maximum load to average output)	Average operation per yr. hours	Thermal efficiency of plant	Cost of coal per kw-hr. at $1.00 per short ton
10 per cent.	876	6.5 per cent.	0.20 cent
20 " "	1752	7.8 " "	0.16 "
25 " "	2190	8.4 " "	0.15 "
30 " "	2628	9 " "	0 14 "
40 " "	3500	9.8 " "	0.13 "
45 " "	3940	10.1 " "	0.125 "

exclusive of coal. These things are little affected by the load factor, but even in so large a station as 25,000 kw. they amount to $13.42 per kilowatt per year, out of a total cost of power of $16.72 per kilowatt per year, with good coal at $1.00 per ton, or $20.02 with coal at $2 per ton, etc. Furthermore, even the fuel cost per unit of power generated will ordinarily be less in mixed service plants than on plants for railroad work only, since the former generally work at better load factors than the latter. The better load factor comes from serving a diversity of operations. Also with more operations the plant will be larger and for this reason as well it naturally has a better load factor and all unit costs are correspondingly less.

There are other important advantages from centralization of power in large power plants, which will have important bearing on the future of central station business, for industrial and for railroad power. One of these has to do with obsolescence and its importance in this connection does not always receive the attention that it deserves. Another is the utilization of off-peak or secondary power, which so far has been very little realized, but which will increase in importance.

Obsolescence has long been the bugbear of electric companies that are striving to earn dividends, and centralization of power seems to be their best means of salvation. We all know that electric companies that were started fifteen or more years ago, whether they were for lighting or for railroads, or for whatever purpose, have found a large part of the cost of conducting their business has been due to the failure of apparatus to meet growing demands not so much because it was worn out as because it became obsolete, when increasing business required larger powers and improved machinery.

Good serviceable power plants became obsolete because they could not do the increasing work of later years, and were discarded because the use of power increased. Centralized power plants meet changing conditions because they are built for larger service and constructed on a unit plan that can be economically extended to meet growing demands.

The utilization of off-peak power will be promoted by the concentration at central points of large amounts of off-peak power, which can be more readily utilized as second class power than the same amount of off-peak power if scattered through a number of small generating plants.

There are several very promising methods in prospect for utilizing off-peak or secondary power when it is concentrated in large blocks, but it is not within the scope of this paper to go into a discussion of them.

Next, turn to the power transmission side of the problem. In this the results in favor of large mixed operations are even more striking than in power generation. It is a difficult subject to generalize on, but briefly, suppose that a central plant is located at a favorable point at a coal mine or a water power, and it is desired to transmit power from the plant. It often pays to run 100 miles of transmission line to pick up a large load, whereas for a small load, the cost of 10 miles of transmission may easily be too great. It follows that if the aggregate amount of power surrounding the power centre is not large, it will not pay to go far for it, and the economical distribution area may be restricted to a radius of 10 miles or less. But, on the other hand, if the aggregate is large, long distance transmission will pay and the combination of large amounts of power per mile of transmission on long transmission lines, covering large areas, gives a big connected central station load. In this lies one of the great advantages in favor of including railroad roads on central plants, viz., where the amount of power and lighting scattered through a territory for manufacturing and similar purposes is not sufficient to make it economical to install electric transmission for this alone and where the railroad business is not sufficient to pay to transmit for railroad power alone, transmission for the combined loads will often be highly profitable.

There is a well-known power transmission company that affords an excellent example of the advantage of combining as much power as possible in a given territory. Its business aggregates something like 60,000 h.p., connected on several hundred miles of transmission lines, and the yearly cost of transmission including all fixed charges and operation and maintenance of the transmission system, amounts to about $12 per h.p. per year, based on its peak load of 50,000 h.p. Its load is industrial power and lighting with a few street railways. In the same territory there is a total consumption of power exclusive of steam railroads approximately 225,000 h.p. which if all served for a single central power plant would produce a maximum load of probably 150,000 to 175,000 h.p., but for various reasons, one of which is the use of exhaust steam for heating buildings, factories, etc., the maximum load that it would be profitable to serve from the central plant would probably give peaks of only about 100,000 to 120,000 h.p., exclusive of steam railroad operation. The yearly cost of power transmission including all fixed charges on transmission lines, for serving 100,000 h.p. in this territory instead of 50,000 h.p. maximum as now served, is estimated at $730,000 total or $7.30 per h.p. per year as compared with $12 per h.p., which is the cost of power transmission and distribution for 50,000 h.p. only.

An examination of the steam railroad traffic in the same territory indicates that if all of the railroads used electric motive power exclusively, the railroad load would require a generating capacity of between 200,000 and 300,000 h.p., and if only the railroad lines carrying heavy traffic and frequent train service were electrified in the territory, the maximum load, if served from a central station, would be somewhere between 150,000 and 200,000 h.p., and that the yearly load factor of this railroad load, including freight and switching and passenger service, would be between 40 and 50 per cent. It is clear that if this load were added to the industrial and lighting load, it would greatly facilitate and cheapen the unit cost of distributing power from the central station.

In conclusion, I want to review briefly what the substitution of electric motive power for steam on existing railroads should include. It is not enough to say that it would require the construction of central station generating plants, of transmission and distribution lines, generally following the railroads and of electric locomotives to replace steam. These would all have to be provided, of course, but that is not nearly all that should be done. Unless we look beyond such facts we cannot even appreciate the problem before us, much less solve it. When the railroads are paralleled by transmission lines over which central stations supply electric power for their operations, then the country traversed by the railroads will be in electric power zones, where power for any purpose may be taken from the lines along each railroad right of way and these lines will connect large central stations together, so that transmission lines will network the country as railroads now do and will connect important centres for power, as railroads do for transportation. Into this network of transmission circuits central electric plants will pump energy that can be drawn off in just the right amount to supply the needs of each point included in the network.

When this is carried out, the distribution of power, which is the greatest problem in the way of almost universal use of central station electric power, will be overcome with the resulting economy in generation as well as in distribution, since the most economical conditions for both generation and distribution are where large amounts of power are supplied at the best load factor attainable, which results when the largest number of operations are supplied from a single system. Thus there are many places where railroad electrification will be profitable as outlined, where it would not pay to build transmission lines for the railroad load alone or for the industrial power and lighting without the railroad load.

THE OVERHEAD PLANT OF A MODERN TELEPHONE SYSTEM.*

By Sergius P. Grace.

(Continued from last issue.)

On a breakdown test, the insulation stood 15,000 volts, alternating, for 15 seconds before breaking down. The voltage was gradually raised to the above figure.

For a ten-year-old wire this is very remarkable, and if we could be assured that all the rubber wire that we have purchased would give the same results the drop wire part of the plant would prove very economical to maintain.

During recent years, with the many manufacturers in the field to supply the large demand, and the introduction of many kinds of rubber substitutes to just meet the specifications, I am afraid that our drop wires are going to cost us more than they would if the old quality of wire had been maintained.

* Paper read before the Philadelphia Telephone Society and published in the Telephone News.

The invention of the paper telephone cable and the use of the lead press to form the cover has been described so often that I will not weary you by repeating the details. One point I wish to bring out clearly is that originally lead cable was designed for use underground, for which purpose it is splendidly adapted.

Lead is a metal which should be used only under quiescent conditions, because of the readiness with which it crystallizes and cracks under repeated bending. I do not know the name of the genius who first found that lead cables could be successfully used overhead. He is to be congratulated that so unsuitable a material as lead has proved so successful for the purpose.

Let us consider what an unmated couple we have when we hang a lead cable on a steel rope. Lead has a temperature coefficient of expansion of .0000160 and that of a hard steel rope is .0000064. In other words, for any given change in temperature, a lead bar or cable sheath will expand two and a half times as much as a steel bar or messenger rope. In a 110-foot span, with a rise in temperature of 100 degrees Fahrenheit, a lead cable would increase in length 2.13 inches, while the steel rope would increase only .84 inch, leaving a surplus of 1,29 inches of lead which obviously must be stowed away somewhere.

The lead cable, by reason of its excess expansion, is forced into taking care of itself by moving into the pole dips or other bends or kinks along the cable. If the cable were free to move throughout its entire length and were placed on frictionless rollers, it would expand in a straight line and not into the dips and bends along the length of the cable. These dips or bends may be called nodes of least resistance into which the cable moves back and forth with every temperature variation.

These daily excursions of the cable into the dips and bends will, in a few months or seasons, cause deterioration in the cable and finally result in crystallization and cracking.

In the older forms of cable construction it was generally the practice to band the cables closely to the steel strands and leave at each pole a dip of four to six inches.

Realizing that there is a difference in expansion rates between the lead cable and the steel supporting wire, the only rational method of suspension is one that will permit the cable to take care of its expansion and contraction in long, sinuous waves, so that at no point will the stress in the lead go beyond its elastic limit. This can be done by long hangers, large rings or big pole clips.

I wish now to refer to the prevalent evil of tight messenger wires. There is a difference of opinion as to whether this makes a better looking job than loose messengers with uniform, slightly sags, but, as I will point out later, tight messengers have a most destructive effect on pole line construction and increase the difficulties from expansion and contraction troubles, which are the main cause of repairs and excessive depreciation.

A wire of uniform weight per foot, when suspended between two supports, will describe a catenary curve, the fundamental equation of which is

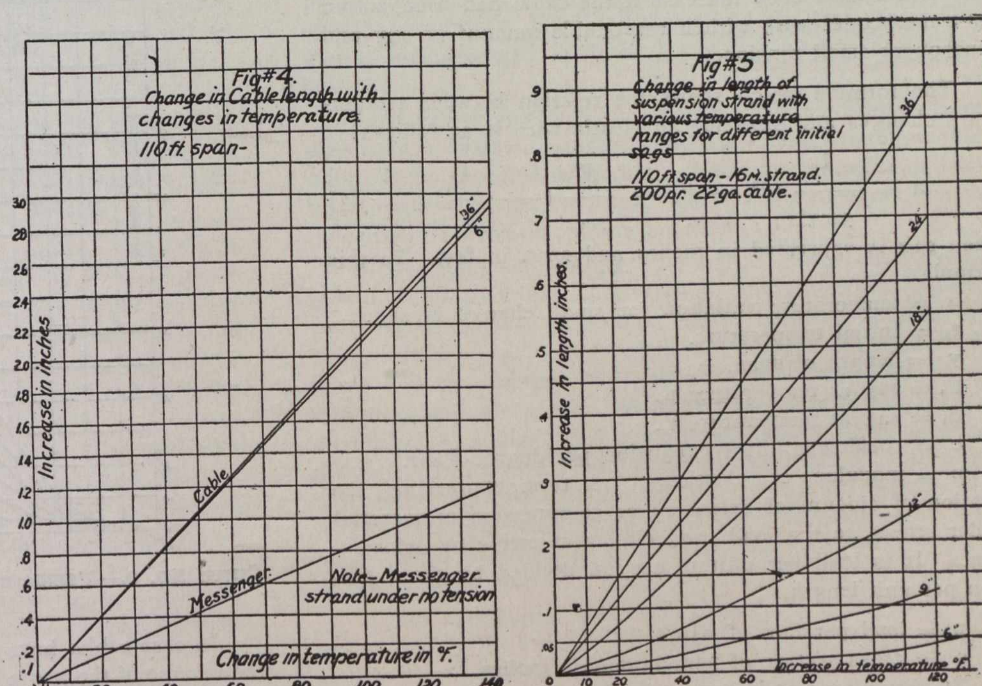
$$y = \tfrac{1}{2} a \left(E^{\frac{x}{a}} + E^{-\frac{x}{a}} \right) \qquad (1)$$

in which E is the base of the Naperian system of logarithms, x and y, coördinates, and a, the distance from the bottom of the curve to the horizontal axis. For catenaries of small deflection, the curve is practically that of a parabola, and we may write for the horizontal tension in the centre of the span the formula—

$$T = \frac{WX^2}{2d} + \frac{d}{6} \qquad (2)$$

in which W = weight per foot of wire and cable. X = ½ span in feet, d = sag at centre of span in feet. From this equation the curves in Fig. 3 were plotted

By referring to these curves, it will be noted how rapidly the stress in the messenger wire increases for a small decrease in the dip of sag of the span. For example, with a dip of 4.32 inches, the stress in the messenger wire supporting a 100-pair 19-gauge cable would be 27,500 pounds, and for a 50-pair cable 17,500 pounds. If, instead of a 4-inch dip, an 18-inch dip had been given these messenger wires and cables, the stresses would be 6,000 and 4,000 pounds, respectively.



Curves Nos. 4 and 5.—Showing Changes in Cable and Messenger Wire Lengths With Temperature Changes.

The standard sags which were worked out for our company are as follows:—

Span in feet.	Minimum sag in feet.
100	2
115	2½
130	3
150	4

These sags were determined with a view to producing the least strains in the overhead construction consistent with clearance and a reasonably good looking job.

Under these conditions, a 400-pair 22-gauge cable suspended with the standard sag will produce a stress in the messenger wire of only 4,203 pounds, or with a 16,000-pound messenger wire, a factor of safety of 4.

In addition to the great strain tight messenger wires place upon overhead construction, another peculiar effect is produced. A steel messenger wire is elastic, and, under a state of tension, will elongate to an extent dependent upon the modulus of elasticity of the material. When the stress is removed, the steel cable will come back to its original length, provided that we have not carried the stretching far enough to exceed the elastic limit of the material.

A tightly stretched messenger wire will be elongated nearly an inch in a 110-foot span, and its cross section will also be proportionately reduced. Now, under these conditions, if the temperature should increase, the sag will of course tend to increase an amount dependent upon the temperature coefficient of the material, but the increasing of the sag or length also has a tendency to reduce the tension in the wire and thus reduce the elongation which is dependent upon the modulus of elasticity.

Consequently, in a tightly stretched messenger wire, a condition of equilibrium will be reached in which it will be found that the length of the messenger wire will be increased but very little. Therefore, under these conditions, it is not a case of taking care of the difference in expansion between the lead and the steel, but, instead, almost the entire expansion of the lead will have to be taken care of and stowed away in some place. Obviously the movement which may be concentrated in a bend or pole dip, is very much greater than would have been the case if the cable had been placed on a messenger wire with a reasonable amount of sag and consequent small tension.

The formula which shows the relation between temperature changes and sags for an elastic wire is as follows:

$$a = \frac{1}{54cy^2}(d_1^2 - d_0^2) + \frac{3py}{2ecs}\left(\frac{1}{d_0} - \frac{1}{d_1}\right) \qquad (3)$$

when sag is expressed in inches and span in feet. In this formula.

a = temperature variation for small change in sag.
t_0 = initial temperature.
y = length of span.
d_0 = sag at temperature t_0.
d_1 = sag at temperature t_1.
c = coefficient linear expansion per degree Fahr.
e = modulus of elasticity. A term expressing the relation of amount of extension or compression of material under stress, to the load producing that stress or deformation. It is load per unit of section divided by the extension per unit length.

p = load per foot of wire.
s = cross section of wire in square inches.

By assuming small changes in the sag, successive values of "a" may be found from which curves showing variation of sag with temperature may be made.

Variations of sag may be reduced to variations in length from formula:

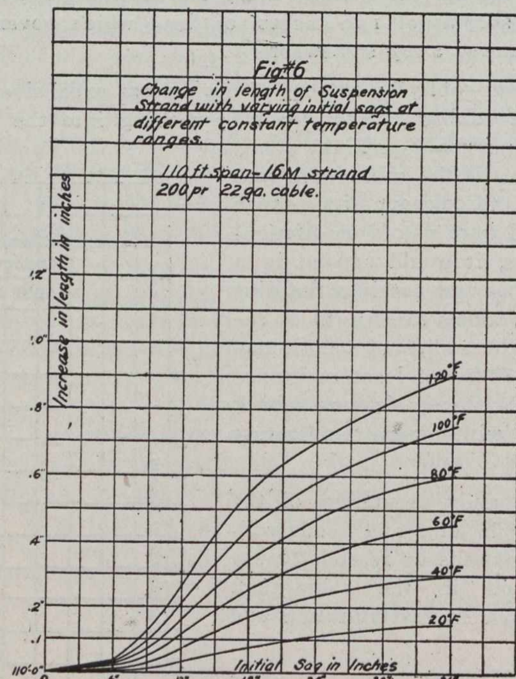
$$L = y\left(1 + \frac{8d^2}{3y^2}\right) \qquad (4)$$

In order to show these relations I have drawn several curves, using as a base formulas 3 and 4, except for curve No. 4, which shows straight-line expansion curves for lead and steel when under no tension.

Curve No. 5 shows the relation between increase in length of messenger wire and various initial sags of 6 to 36 inches with temperature variations of 0 to 100 degrees. This is for a 200-pair 22 gauge cable on a 16-M messenger, 110-foot span. For example, the increase in length for an initial sag of 6 inches for 100 degrees rise in temperature is only .025 inch, practically negligible, while under the same conditions with an initial sag of 30 inches, the increase in length would have been .7 inch, or 28 times as great. Curve No. 6 shows these relations in a different way, as the initial sags are plotted horizontally, and increases in length vertically for a series of varying temperatures.

It is clear from these curves how little variation is produced in the length of a tightly stretched messenger even with wide temperature variations.

In our standard practice, we specify a 30-inch sag for a 110-foot span. It may be assumed with safety that the daily variations in temperature will not exceed an average of 40 degrees, and a reference to curve No. 6 will show that above 30 inches initial sag, no material increase in length will be obtained for this temperature change. Consequently it appears that the standard 30-inch sag for this span is correct. In other words, with a 30-inch sag and average temperature changes, we realize 87 per cent. of the increase there would have been under a state of no tension in the messenger.



Curve No. 6.—Temperature Variation Effects on Messenger.

In case cables have been erected in the hot summer days, the reverse of the above expansion movements will take place. If dips have been left at the poles, cold winter weather will contract the lead cables and take most or all the slack out of the dips. On the other hand, if no dips have been left and the cable has itself been pulled up until no slack is left, the cold weather will have an extremely bad effect. This is because the cable will contract more than the messenger wire, and particularly so if it be a tightly stretched and elongated messenger, which will have the effect of taking the load off the messenger and throwing the major portion of the strain in the cable itself. Since a lead cable is easily stretched and deformed beyond its natural length by small stresses, under the above conditions the lead sheath will be permanently elongated and perhaps injured in many places. When the hot weather returns, this elongated lead sheathing will again expand at a higher rate than the messenger wire and show the familiar surplus of cable. The tighter the messenger is strung, the more aggravated will be these troubles.

Previous to the year of 1902, the practice in our company was to stretch the messenger wires very tightly and attach the cables closely to the messenger by means of marlin bands. This unfortunate method of cable erection marred what was, in most all other respects, an admirably designed and constructed aerial cable system of distribution. In the course of a few seasons, hundreds of breaks occurred, and when I came with the company, in 1902, it was one of the first problems passed to me for a solution.

It might interest you to know of some of the experiments we made at that time to determine the cause of the trouble. The general opinion was that the cracks were caused by the vibration of the poles and messenger wires, but both Mr. Snyder and myself felt sure that the principal trouble was due to expansion and contraction by temperature changes.

We placed a lead cable 67 feet long through rings on the roof of the telephone building. The cable has a 4-inch dip at one end, was fastened at both ends, but free to move along its length and expand into the dip. Around the cable we wrapped a resistance wire protected with a heat-insulating material. By passing current through the wire, we could raise the temperature of the cable to any desired degree. It was clearly shown that the cable was moved with temperature changes and that the coefficient of expansion was practically that of the lead sheath and not of the wires inside.

In order to determine the number of movements necessary to break the cable sheath in the average dip, a number of pieces of various size cables were bent with a dip of four inches and subjected mechanically to a movement of one inch along the cable. When the movements were made by a fast arm motion, it was found that 50 to 100 movements were required to break the sheath of the cable. When the movements were very slowly executed by the arm, it took from 200 to 300 movements to crack the sheath.

The cables with large diameters broke first, which was to be expected, since the angular opening at the surface of the sheath for a given movement would be larger because of the increased value of the radii. To make sure that the same results were occurring in practice, metal gauges were placed on existing cables to measure the increase in the dip and the movement of the cable along the span.

On many cables we were able to observe a daily longitudinal movement of the cable of one-half to three-quarters of an inch. All these experiments and tests prove very conclusively that our lead cables are constantly moving on the messenger wires because of temperature changes. We may, without exaggeration, imagine them to be alive and writhing and twisting about the supporting wires with the unceasing variations of heat and cold.

Unquestionably, because of these movements, aerial lead cables start to deteriorate from the day of their erection, and microphotographs of the molecular arrangement taken yearly would plainly show the changes in the molecular structure of the lead.

Another interesting phenomenon in overhead cables, is the effect produced by the difference in expansion rates of the entrained air in the cable and the lead sheath. Air has a greater coefficient of expansion than lead, and, therefore, when a cable is heated on a warm summer day, the air inside is compressed. If there be an opening anywhere in the lead sheath, the air will escape because of its compression; then, if a summer shower takes place, the cable is very suddenly cooled and the air inside will be rarified into a partial vacuum. This causes air to rush into the cable from the outside, and, as under these conditions there is usually water present on the surface of the cable, the water will be driven into the interior of the cable very rapidly and cause a serious case of trouble, which will take some time to locate and remedy.

In some of the older construction work, it was the practice to fill each joint with paraffin. In a few seasons it was noticed that nearly all these paraffin joints had a collapsed appearance. I believe this can be ascribed to the melting of the paraffin in very hot weather and its being driven each way into the cable by expansion. Then, if the cable was suddenly cooled by a shower, the paraffin would solidify and leave voids or vacuum pockets inside the lead sleeves. The outside air pressure would then force in and crumple up the lead sleeving.

A crystallization and cracking effect similar to expansion cracks is sometimes caused by the repeated blows of tree limbs.

Electric light and trolley crosses also play havoc with lead cables, and when a heavy arc is drawn, the lead will run in streams like so much water.

Lightning, as a rule, entering a cable does not burn large holes in the lead sheath, but the puncture is more like the hole made with a brad-awl or punch.

From time to time we have heard curious stories of various kinds of bugs and beetles devouring the lead sheath of telephone cables in California, Australia, and other parts of the world. There seems to be no doubt that there are several species of beetles which, for some strange reason, have aspirations to build a home inside the sheath of telephone cables. I understand that in California they have actually caught the bug in the act, and the state entomologist is now engaged in looking up his pedigree and ancestors.

Lead cables placed in boxes over vibrating bridges have also been a frequent source of trouble. This trouble would naturally be expected on account of the susceptibility of lead to crystallization and cracking, due to repeated blows, which they would receive in such a position.

Many times, in looking over aerial cable construction, it will be noticed, particularly if the messenger wires have been tightly pulled, that some of the cables will have expanded so much as to force themselves above the messenger wires. It is puzzling to account for this large amount of excess cable unless we remember the elongation of the messenger wire that takes place under tightly stretched conditions. It has been shown previously that a messenger wire stretched very tightly did not materially increase in length for large temperature changes. The same effect will be produced in a tightly stretched messenger wire if some of the corners give way or the anchors loosen up slightly.

If the messenger wire had not been elongated, this giving way of the corner or anchor would produce no change in its length, but since the messenger wire is tightly stretched, when the corner gives way, the tension will be decreased and the messenger wire will increase in cross section. Its length will actually be decreased.

Since the cable was not elongated, it is apparent that, with the shortened messenger wire, we will have a surplus of cable which can only take care of itself by pushing around and above the stand. This phenomenon will also be observed when a splice is made in the middle of a section and the splicer's carriage and guy rope has stretched the messenger wire beyond its normal elongation. When the weight of the splicer and carriage is removed, the messenger wire will shorten and produce an apparent increase in the length of the cable.

In conclusion, when we stop to consider that the lead telephone cable was originally designed for use underground, where the lead could be quiescent, it is a marvel that our engineers, construction and maintenance men have been so successful in keeping operative the many thousands of miles of aerial plumbing throughout the Bell system.

I venture to say, however, that our present form of lead aerial cable is not the final answer to the solution of aerial distribution, but that in the years to come, we will have a much more flexible cable with a sheath capable of withstanding the mechanical shocks and temperature changes of overhead construction.

Finally, at the risk of tiresome repetition, I am again going to say that one of our most important duties is so to design and construct the overhead plant that while it serves its proper purpose in the giving of efficient and economical service it will in appearance give the least offense to the public taste that every day is demanding more and more on the æsthetic side of the city beautiful.

NEW APPLIANCES FOR TESTING STONE PAVING BLOCKS.

Tests of paving materials as regards crushing strength and resistance to frictional wear have been conducted for the city of Paris, France, by its municipal laboratory for about 40 years. The equipment of this laboratory has been supplemented recently by the reconstruction and improvement of old appliances and the installation of new ones. This new equipment is described by Mr. Pierre Labordere, engineer of the Roads and Bridges Department, and Mr. Frederick Austett, Chief of the Paris Municipal Laboratory for Testing Materials, in a paper prepared for presentation at the 6th Congress of the International Association for Testing Materials at New York City, Sept. 3-7. An abstract of this paper follows:

Preparation of Test Pieces.—The preparation of the test pieces comprises two operations: Cutting to shape and finishing. The first operation is accomplished by means of a helicoidal wire, composed of three steel wires 2 mm. in diameter, each forming an endless band 30 metres long, running in vertical plane with a velocity of 7 metres per second. It is maintained in uniform tension by a counterweight and rests on the specimen to be cut. This latter is firmly secured on a plate, situated in the centre of a frame carrying the the pulleys which serve to guide the wire. The wire carries with it an abrasive material consisting of powdered sandstone and granulated steel, continuously moistened by a jet of water. The rate of cutting is 5 centimetres per hour in granite of medium hardness.

The operation of sawing with wire leaves irregularities on the surface of the specimens, which irregularities must be eliminated; and, moreover, the specimens to be tested must have perfectly flat and strictly parallel faces. In order to bring about this result a polishing machine consisting of a crown of carborundum composition, running at a speed of 1,400 revolutions, is used. A front plate, serving as a guide, is mounted on the frame, facing the crown.

Testing the Specimens.—The test comprises the following determinations: Resistance to crushing; resistance to impact; resistance to attrition.

The crushing strength is determined by means of a 250-ton hydraulic press, on cubes of 5 mm. side. This test does not present any special features.

For impact tests, the laboratory possesses a tup, arranged to drop vertically and enabling tests to be performed with any height of fall between 5 cm. and 3 metres. Several interchangeable tups are available, so that, if necessary, tests can be repeated under different loads. For testing paving setts, a tup weighing 6 kilos and falling 1 metre is employed.

The head of the tup is provided with a brake, which is set in operation by the effect of the impact and stops the mass instantly after the rebound, thus preventing the secondary impact due to successive rebounds.

The test specimen (a cube of 5 mm. side) is fixed in a box which, in turn, is bolted to the anvil base. This box is provided on all four sides with spring pushes exerting a uniform pressure of 6 kilos on the specimen it contains, through interposed steel plates. The cube projects from the box for a distance of 1 centimetre.

To prevent the tup from striking the cube slantwise in the event of the contact surfaces of the two being not exactly parallel, or of the upper face of the cube not being perfectly true, the cube is covered with a kind of cap of tempered steel, the perfectly flat inner face of which is applied to the upper face of the cube by means of lateral springs, so as to insure complete contact. The upper portion of the cap is spherical; and by this means each blow of the tup is transmitted integrally to the entire surface of the test cube. A note is taken of the number of blows required to produce the first crack; and then of the total disintegration.

The authors have been impressed by the imperfections of the machines for the test for resistance to attrition (wear under friction) typified by the Dorry machine used in France and consisting of a cast iron disc mounted horizontally and rotating in its own plane, the specimens of stone to be tested being placed in contact with the disc.

The test pieces being of rectangular section, whereas the different points of the disc in contact with same have a trajectory of concentric circumferences, the wear set up by is irregular, both as regards the disc itself and the test pieces. It is therefore somewhat difficult to measure the attrition produced; and the tests made with discs that exhibit irregular wear are difficult of comparison with one another.

A new machine which has proved thoroughly satisfactory has been designed and constructed for the resistance to attrition test.

It consists of a cast iron drum rotating about a horizontal axis. The blocks to be tested are placed in pivoted boxes sliding vertically in recesses, and are brought into contact with a generating line at the top of the drum. Powdered sandstone and a jet of water are delivered from a couple of calibrated funnels onto a point a little in front of the plane of contact with each test piece.

The drum has a diameter of 60 cm., in order that the arc on which the specimens rest may have a very slight curvature. A few turns of the apparatus are then sufficient to impart to the lower face of the specimens a curvature corresponding exactly to that of the drum surface. When this is achieved, the height of the test piece is measured, the measurement being repeated at the conclusion of the test.

To prevent the formation of grooves on the surface of the drum the following plan has been adopted: Each test piece, 6.5 cm. wide, is separated from the adjacent test piece by a distance of exactly the same width as the pieces themselves, namely 6.5 cm.

After every 1,000 revolutions, the cylinder is displaced on its shaft by a distance of 6.5 cm., the shaft being provided, for this purpose, with two stops situated at each end and limiting the displacement of the drum in either direction.

In this way a very considerable number of tests can be performed with the apparatus without any sensible abrasion of the drums, and above all without the formation of grooves thereon. The apparatus is constructed to take 6 test pieces at once, the drum being 80 cm. long.

The Canadian Engineer

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CONTENTS OF THIS ISSUE.

THE COMMISSION FORM OF GOVERNMENT.

The problem of city government has been a difficult one to solve. Many forms of municipal government have been tried in the past thirty years in the United States, and, while some of these have shown distinct advance over preceding methods, still not one could be called an unqualified success. Mr. Oswald Ryan, of Harvard University, in a recent analysis of the real problem of Commission government, makes some interesting commentaries on this form of city government which has proved unusually efficient in the Western United States and in some of the Western cities of Canada.

The municipal needs of the present day are stronger than ever in their demand for a system which will ensure administration by experts. The increasing social and economic complexity of modern urban life has entailed burdens and obligations hitherto unknown to local government, and if the work of meeting these needs is not carried on with the assistance of permanent experts the cities must fail in their obligations. At the same time it is plain that government by experts alone is undesirable and out of harmony with American political ideas. A staff of permanent officials which is out of touch with the electorate tends to develop into a professional bureaucracy, tied up with red tape and unresponsive to the popular will and needs. It is, therefore, necessary that the expert should be under the constant supervision of the layman, who will thus form a connecting link between the professional staff and the people. In this way the permanent official will be brought into contact with the needs of the people, and the people, through their elected supervisors, will possess the means of controlling the permanent official.

It is precisely this adjustment between the professional and lay elements in the government which has been responsible for the marked success of the English borough governments. As in the commission plan, the l gislative and administrative powers of the English borough are vested in the council, which is the sole governing authority. The actual work of administration is carried on by a permanent staff of experts acting under the supervision and control of standing committees of the council.

The principle underlying the organization of the commission system of city government is clearly in harmony with what American and English experience has shown to be the most effective working principle that may be applied to the government of cities in a democracy. The commissioner, being an elective official, can not be expected to be an expert official. Indeed, experts will never accept an office of such uncertain tenure as that subject to the fluctuating influence of politics. The commissioner may be an efficient unprofessional, supervisory official, however, acting in the same capacity as the English council committee: and in such a capacity he will reach his maximum efficiency. Under this clearly defined distribution of functions between the elective and the permanent official each official will exercise that kind of function for which he is best fitted. This proposition, clearly understood, settles the crucial point in the problem of commission government.

If the commissioner's function is defined as supervisory with respect to his relation to the administrative service, the question may arise: Will it not now become necessary to have a permanent expert department head working under the supervising commissioner? This question must be decided with reference to the character of the commissioner's duties. In the small city, where the affairs of the different divisions of the department are left to the charge of the subordinate officials, these duties would be comparatively light, and only the general direction of the activities should rest with the commissioner. Under such circumstances the commissioner would be able to direct the work without the aid of a permanent head. It is probable, on the other hand, that the work of directing one of the great departments of the very large city would be too onerous and too complex for the layman to discharge without the aid of a permanent administrative head, in which case it would be found necessary to institute the permanent official.

With the development of the commission plan into a more distinctly supervisory character, the people will have worked out a system of city government which does not differ in essential principles from that with which they started out, the council plan. The machinery of the commission government is more centralized and more responsive, but the relation between the elective official and the permanent administrative staff is common to both systems. It is upon these principles that the permanent efficiency of the commission government must rest, just as it was contempt for these principles that caused the failure of the reform municipal systems of the past thirty years. If the commission plan conforms strictly to these principles, there is reason to believe that it will not become the subject of a tale "full of sound and fury, signifying nothing."

THE TORONTO CITY ARCHITECT'S DEPARTMENT.

The inquest at the time of the Neilson building collapse brought to light considerable evidence which showed the necessity for reorganization of the Toronto City Architect's department. While there have been many rumblings since in the City Council as yet no action has been taken. We hope that the City Council and the Board of Control will seize the opportunity to get a strong man to take charge of this department of the city's work. The City Architect's department is in some respects the most important section of municipal activity. It is perfectly clear to all that some drastic action must be taken with regard to the present organization of the department. The protection of the public demands the appointment of a man at the head who is not only capable of handling the executive end of the work, but also a man who is well versed in the technical details. The ideal head for this department is a man well versed in the strength of materials, one who has made a special study of it, in fact. The various equations in the different handbooks it should be possible for him to deduce, and he should know where they are to be relied upon and where not. In fact, if any improvement is to be made in the department, such a man as outlined must be chosen. The difficulties of the department at the present time are due as much to the lack of technical knowledge as to the lack of executive ability.

The Assistant City Architect Price has been mentioned in the Board of Control as a possible appointment as City Architect. A man who showed himself to be so ignorant of the fundamentals of building materials as the Assistant City Architect did in the Neilson investigation ought not to be entrusted with this important work. Under a competent City Architect, however, he might make a very capable inspector. The Toronto building by-laws are in wretched shape still, even after the past year's revision, and it requires a man well versed in modern building materials and their strengths to put them in proper shape. All of the above facts demand that the Board of Control and the City Council appoint a man who possesses qualifications which fit him for the position. The history of civic appointments in Toronto has not been above criticism. The necessities of public safety, however, demand that all question of political expediency and personal pull be eliminated. *The Canadian Engineer* is interested, because it is not the artistic, but the scientific or engineering side of architecture which is at stake.

EDITORIAL COMMENT.

In recent comments on the new Canadian Pacific Railway building in Toronto, one of the Toronto daily papers speaks very favorably on the style of architecture and the general pleasing appearance of the building. While it is true that it is "a design peculiar to our age and country," we believe that the corner of King and Yonge Streets is no place for a sixteen-story building. It may be "satisfactory" and "satisfying" to certain members of the daily press, but it certainly will not be spoken of in such terms by the man living in its shadow. It is time that the City Council passed the ten-story limit amendment to the building by-law.

* * * *

Attention has been called to the fact that the British School of Architecture at Rome is inaugurating a scholarship in architecture open to all British students under thirty years of age. The scholarship is worth $1,000 per year, and is tenable for three years. The expectation is that a number of Canadian students of architecture will try for the scholarship, full details of which can be secured from the Department of State.

CHANGES DUE TO THE NEW WELLAND CANAL.

The construction of the new Welland Canal will necessitate a number of changes along the course of the first section of the old canal. It is understood that the government has under consideration the changing of the aqueduct under the Welland Canal necessitated by the crossing of the Welland River. Enlargement of this aqueduct would be extremely difficult. As an alternative it is suggested that the aqueduct be abolished and that lock gates be installed in the river at Port Robinson, raising the level of the water in the river to that of the canal. This would mean a raised elevation of about nine feet. Levees would then be built along the shores of the river to prevent flooding. A harbor and turning basin would be built at the intersection of the river and the canal. It is also reported that the government will construct a large pipe line from Lake Erie to provide a water supply for the towns and cities who are now being supplied from the canal.

LARGEST FLOATING DOCK.

The biggest floating dock in the world was launched recently from the Cammell & Laird's yard at Birkenhead. It has been constructed for the British Admiralty. The dock is capable of lifting battle ships having a displacement of 32,000 tons. It covers an area of two and a quarter acres and has three large workshops on board besides accommodation for the dock master, petty officers and crew.

MUNICIPAL TELEPHONE OWNERSHIP.

Some figures on the cost of telephone systems in Ontario are given in a recent report of the Ontario Provincial Government by Francis Dagger. This report gives the operation of the systems now operating under the Local Municipal Telephone Act of 1908.

The Act provides means whereby a municipality can furnish the necessary capital to construct a telephone system upon a petition from any number of ratepayers. This capital is repaid by the subscribers in ten annual instalments of principal and interest, the cost of operation and maintenance being also a charge upon the ratepayers who are telephone users. In this way the ratepayers who take a telephone obtain service at actual cost, while those who do not, are exempt from all liability in connection with the cost of constructing, extending, operating or maintaining the system.

The following table includes the most important farmers' telephone systems at present being operated under this Act, with the latest available figures, showing the number of subscribers to each system:

	Subscribers.
Brussels	700
Tuckersmith	505
Chinguacousy	412
Maidstone	247
Rochester	240
Sandwich South	219
Gosfield North	206
Blyth	203
North Easthope	200
Colchester, North	173
McKillop	167
St. Vincent	144
Colborne	125
Goderich	105
Laird	101
Tay	100
Oliver	53
Paipoonge	44
Total	3,894

In order to convey an adequate idea of the benefits resulting to the communities in which these systems are in operation, it may be stated that in answer to the question, "How many farm telephones were there in your district before you started?" the townships of Colborne, Maidstone and Sandwich South replied "None." These three municipalities are now furnishing telephone service to 591 subscribers. In reply to the same question, the township of Colchester North replied, "One"; Gosfield, North, "Four"; Tuckersmith, "Five," and Chinguacousy, "Thirty." In these four townships there are at this date 1,296 farmers who have telephones in their homes as a result of municipal ownership under the Act referred to. It would be safe to say that similar conditions obtained in the other municipalities, although definite figures are not available.

As these figures will doubtless encourage the ratepayers in other rural municipalities to devote some thought to the important question of obtaining telephone service at cost, the writer has obtained authentic data in regard to the cost of construction and operation of these systems, of which the following is a summary:

Original Cost of System, Per Subscriber.

Brussels	$88
Tuckersmith	66
Chinguacousy	73
Maidstone	44
Rochester	41
Sandwich, South	65
Gosfield, North	43
Blyth	93
North Easthope	65
Colchester, North	40
McKillop	66
St. Vincent	57
Colborne	44
Goderich	48
Laird	38
Tay	59

It will be noticed that there is a considerable difference between the cost of constructing the various systems named. In explanation it may be stated that this is due to several causes. The Blyth system, which shows the highest cost, provided central office equipment and built pole lines to serve many more subscribers than are at present connected. The cost of connecting additional subscribers using the same switchboard and poles will be much less per telephone than $93, and in this way as the system is filled in the average cost per subscriber over the whole system will be reduced. Again, the cost of the Brussels system includes a central office building and an expensive modern central switchboard equipment; while the Tuckersmith municipality does not own any central equipment, its lines terminating upon the "Bell" switchboard at Seaforth. Chinguacousy, also, only provides a central office equipment for half its subscribers, the lines of the remainder terminating in the "Bell" exchange at Brampton. The lower cost given are mostly accounted for either by the fact that smaller poles are used, or that there are more subscribers connected on each mile of pole line. For example, in Maidstone there are five subscribers to each mile of pole line, while in Sandwich, South, there are only seven telephones for each two miles. Some systems also economize by buying lower-priced equipment, and by the farmers providing much of the labor at cost, while other municipalities purchase more expensive, because of a higher grade equipment, and had the plant constructed by qualified contractors who, of course, require a profit over and above the actual cost of labor.

Annual assessment to subscribers for ten years in repayment of cost of system, with interest at five per cent:

Brussels	$*11.36
Tuckersmith	8.37
Chinguacousy	9.00
Maidstone	5.85
Rochester	5.44
Sandwich, South	8.42
Gosfield, North	5.83
Blyth	*12.00
North Easthope	*10.50
Colchester, North	5.72
McKillop	9.72
St. Vincent	7.95
Colborne	†8.00
Goderich	†7.95
Laird	4.22
Tay	9.00

* Includes cost of operation.
† For five years, plus cash payment of $15.00.

Reconstruction and Renewals.—It may be pointed out that the above payments cease at the end of ten years, the original debt being wiped out. It must not, however, be understood that at the termination of this period subscribers will obtain service at the figures given in this article under the heading of "Annual Payment by Subscribers for Cost of Operation," as provision will then have to be made for such reconstruction and renewals of plant as may from time to time be rendered necessary by depreciation and obsolescence. The cost of this provision will have to be assessed against the subscribers, in addition to the amounts now paid for operation and ordinary maintenance. What the actual amount of such an assessment would be depends very much upon the quality of the equipment and the manner of its construction when the system was first built. For this reason it is important that municipal systems be well constructed and only the best equipment adopted in the first place, as a badly-constructed system, with inferior, because cheap, equipment, may require almost total replacement at the end of ten years, which would necessitate the continuance of an assessment nearly approaching the figures named above.

With a properly engineered and well built system, using high-grade equipment, a yearly amount not exceeding half the original assessment should be ample to take care of all necessary repairs and reconstruction. Assuming this to be so, in a system such as Chinguacousy, the subscribers of which now pay $9 in payment of principal and interest, plus $3 cost of operation, would at the end of ten years pay $4.50 plus $3, or $7.50 per annum, instead of $12 as at present. In considering this matter there is, however, another element to be considered, which is that the Act provides for additional subscribers paying the same assessment as the original subscribers who shared the cost of building the main pole leads and of equipping a central office to accommodate many more telephones than were installed at the start. It will be apparent that the cost of connecting additional subscribers using the same central office equipment and pole leads which have already been paid for by the original subscribers, is very much less than the amount paid by these original subscribers. This difference is set aside by the municipality as a reserve fund to be expended on maintenance, reconstruction and extensions, and it is within the range of possibility that by the end of ten years this fund may have reached a proportion which would considerably reduce the amount to be assessed against subscribers on account of depreciation or obsolescence.

Annual Payment by Subscribers for Cost of Operation.

*Tuckersmith	$3.50
†Chinguacousy	3.00
Maidstone	1.00
Rochester	1.00
Gosfield, North	2.00
Sandwich, South	2.00
*Colchester, North	3.00
*McKillop	3.50
*St. Vincent	7.00

* Do not own central switchboard and pay Bell Company for switching.

† Pay Bell Company for switching half their system. Own switchboard for other half.

Reasons for Low Maintenance Charges.—The above figures, with the exception of St. Vincent and Chinguacousy, do not include anything for maintenance, being the cost of switching only. Most of the systems report that so far the maintenance has consisted of very little more than the renewal of batteries, and that one dollar per year per phone would cover this item. The majority of these systems are, however, comparatively new and under ordinary conditions the necessity for repairs would be slight. Moreover, these repairs are in many cases effected by the subscribers themselves without becoming a charge upon the system.

It will be noticed that a few of the systems enumerated above do not own any central switchboard. This would appear to be a serious mistake, as it places the property of the municipality absolutely subject to the control of another organization. It is parallel to buying a house and giving the key to another party, with the right to control your entrance and exit according to his pleasure or goodwill towards you. It has already been argued in the law courts that a telephone system which does not own and control its central switchboard is not a system at all, but a mere collection of lines having no terminals and powerless to furnish even its own subscribers with service without the consent of another party, which it cannot control.

PLACING CONCRETE WITH A MOVABLE STEEL TOWER.

An interesting method of placing concrete for a locomotive roundhouse is being used by the Lake Shore and Southern Railway in Chicago.

The chief difficulty in this particular job is the fact that concrete has to be distributed over such large area, the roundhouse being 405 feet in diameter. Also the pit walls are so high above grade that distributing by wheelbarrows is impossible and the cost of a series of wooden towers is found to be prohibitive, three towers costing nearly $2,200.

W. B. Louer, Chicago representative of Chain Belt Co., was consulted and he suggested a steel tower and from this developed the portable steel tower which has been found to be most satisfactory and economical, as the total cost set in place was less than $1,000. The material for this article has been furnished by the Chain Belt Company, of Milwaukee, Wis., while the contractor's costs have been taken from an article published recently in Engineering and Contracting.

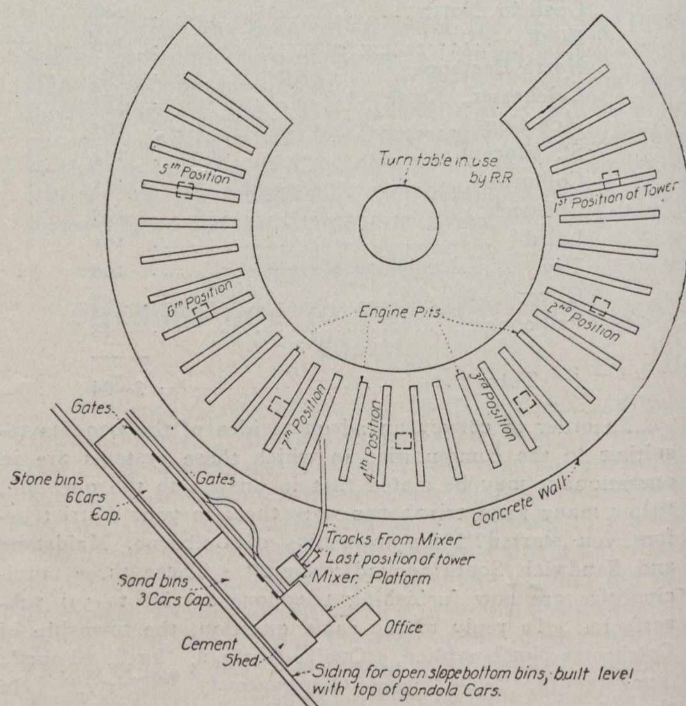

Fig. 1—Plan of Concrete Roundhouse and Construction Plant.

Considerable ingenuity had to be exercised in the design of this tower to make it portable and flexible so that concrete could be placed in any part of the range of its spout which is 60 feet long, with an additional loose vertical spout 30 feet long. This enables placing concrete 95 feet away from base of tower.

Fig. 1 shows a plan of the concrete roundhouse and the layout of the construction plant.

Fig. 2 shows the construction of the tower which is 72 feet high. The steel work is carried on wooden skids which lie across two railway rails forming a truck. On the bottoms of the skids where they rest on the rails are steel plate shoes which are fitted with clamp buts for anchoring the tower to the rails. The tower is also guyed, the guys running through blocks at the deadmen.

The horizontal spouting is made of heavy galvanized iron 10 in. by 10 in., open at the top, and is set on a light frame steel truss. The steel truss and spouts are all supported by a 40-foot boom which is rigged from top of tower and held in place by steel blocks and cable running to a winch. The winch is secured to side of tower so that the boom spout and loose leg may be raised or lowered or swung in a semi-circle, giving a wide range of work and placing concrete anywhere within a radius of 95 feet.

The steel tower is made up of 6-foot sections, sections being composed of steel angles and channels. The tower

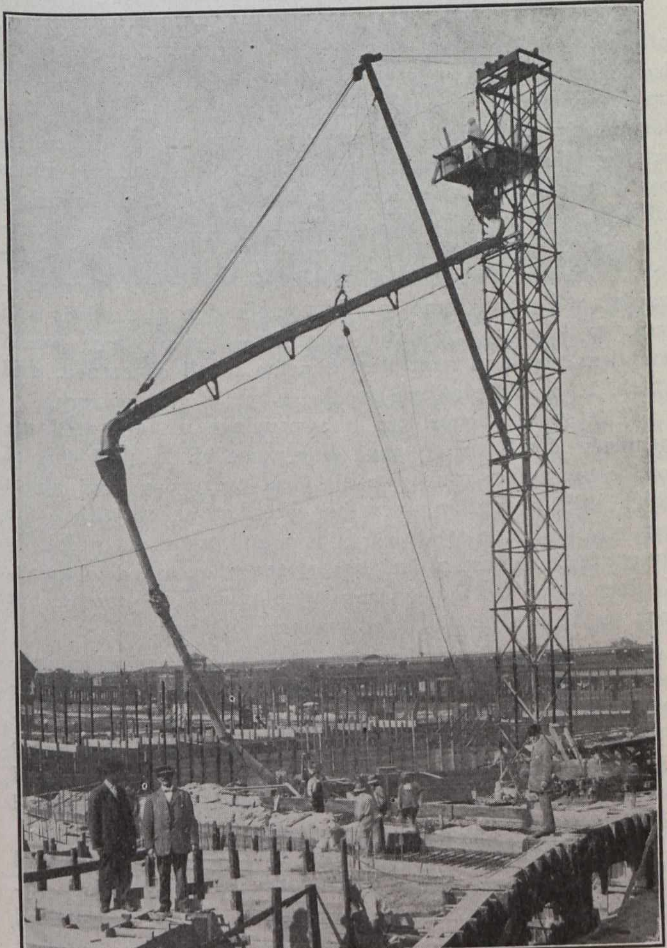

Fig. 2.—View of Steel Tower, Showing Concrete Chute in Position.

rests on heavy wooden skids that have steel liners, which rest on railroad rails, making the whole rigging easy to move.

After the concrete has been placed in one section the tower is drawn back along the rails by means of the hoisting engine of the tower. This operation is accomplished by loosening the guy wires and a change of 60 feet can be made in about four hours time. Then they are ready to distribute again.

The concrete is mixed by a concrete mixer which is situated about 600 feet away from the tower on account of having the mixer near the storage bins which are on a railroad siding. The mixer discharges into cars which are conveyed to the tower, and the concrete is dumped in the bucket of the elevator and hoisted to the top of the tower where it is automatically dumped into the receiving hopper. This receiving hopper has a gate which is operated by a man standing on a platform at the top, and he regulates the flow of the concrete through the spouts.

The roundhouse is being built on a piece of ground which was formerly swampy, and the new floor will be some 5 or 6 feet above the former level of the ground. The footings for the foundations of the walls and engine pits were carried 22 feet below track grade. This work was done by hand in trenches. The work was in sand and close sheeting was necessary as was also the use of several small pumps. After the concrete was carried to ground level forms for the walls of the engine pits and for the outside walls were built. These forms carried the work several feet above the general level and the distance over which the work was spread, made the use of wheelbarrows or carts impracticable, so the chuting system was adopted. The roundhouse is about 800 feet long, measuring along the circumference. The steel tower was erected on a track running through the centre of the house and at a point within 95 feet of one end. After all the concrete up to the floor level had been placed the tower was moved back 95 feet and another set of forms was poured so that after three moves had been made, half of the concrete was poured. The tower was then "snaked" down to within 95 feet of the other end of the roundhouse and proceeded to pour the concrete there, being "snaked" backward toward the centre as the work progressed. Before the tower was moved to the last half of the work it was necessary to turn it around so that the spout would run in the opposite direction. Turning the tower about, was accomplished as follows: A pit was dug in the sand just ahead of the tower and cribbing was placed in it, with a platform and track on top so that the tower could be pulled onto it. A 40-ton hydraulic jack was arranged on the cribbing underneath so that it would operate against the platform and raise the tower about half an inch. Supported on the hydraulic jack the tower was turned around by means of a crowbar, short distances at a time, while three men at each guy line shifted them to new positions until the tower was reversed. Three men were required to a guy line as the cable and tackle block were quite heavy, and as the weight of the tower with its boom and spout is considerably unbalanced caution was exercised in shifting the guys.

The number of men required to run the plant consists of 1 foreman, 17 laborers and 2 engineers. The number may vary but this is an average crew. They are divided as follows:—

1 foreman at $4.00	$ 4.00
5 men unloading cars	16.00
3 men hauling sand and stone	9.60
1 man on cement	3.20
1 mixer engineer	6.00
1 man charging and dumping mixer	3.20
2 men on concrete car	6.40
1 man at top of tower	3.20
1 tower engineer	6.00
3 men handling spout	9.60
Total per day	$67.20

A portion of this daily cost will be eliminated for the last portion of the work when the tower will be located at the mixer. The average day's run of concrete may be taken at about 120 cu. yds. The maximum has been 147 cu. yds., but the minimum full day's run has been about 100 cu. yds. The work has been arranged so that 400 cu. yds. is run for every move of the tower. The moving of the tower requires about 4 hours, but the necessary track relaying, and the building of a new incline for carrying the concrete car high enough to dump into the hoist, requires about a day.

It may be said, then, that 400 cu. yds. is run about every 4½ days. The labor cost for this is, therefore, 4½ × $67.20 = $302.40, or 76 cents per cubic yard.

The use of the movable tower is the main feature of the concrete work, and this has no doubt saved considerable money to the contractor over the cost of handling the work by any other method.

METHODS OF ROAD CONSTRUCTION AND THE PROBLEM OF DUST SUPPRESSION.*

By Frank B. Earl.†

To the average citizen the condition of the streets seems to have been of little interest, but with the advent of motor-driven vehicles and the increased importance of highway traffic, we have come to realize that our highways are our arteries of travel and that when congestion exists the whole body of politic is made to suffer. From the moral standpoint, we have begun to recognize that, in providing a smoother path for the feet of men and by improving their method and means of communication with each other, we are making this world a better place to live in.

In conversation with the mayor of a certain city, the speaker outlined to him the general conditions of the streets of the town, suggested certain improvements, told him how the same would increase the value of the abutting property emphasized the fact that there was no improvement possible by which the community would reap such large and quick returns, that home-seekers would be attracted, rentals increased, etc. In reply this official expressed a desire that the foregoing be told to the community at large, with the result that a public meeting was held and a general outline of the above suggested benefits given to the public. This is a long step in the right direction, as it is the taxpayer who is most vitally interested in these questions, because he is the one who foots the bill.

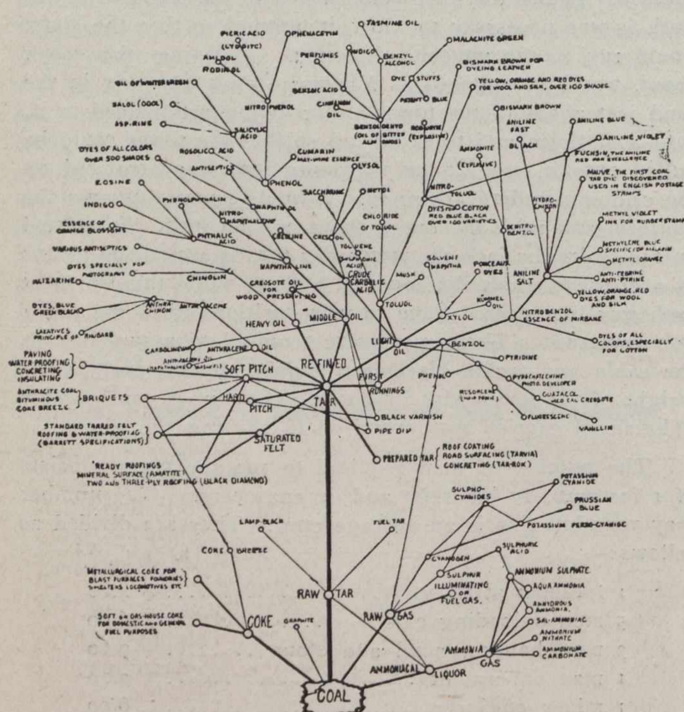

Fig. 1.—Products of Coal Tar, with Special Reference to American Conditions.

("The Coal Tar Tree" graphically illustrates the almost innumerable products and by-products that are derived from ordinary coal, such as is found in practically inexhaustible deposits throughout a great portion of this and other countries.)

There was spent on the roads in the United States last year $142,000,000 and I presume that nearly twice that amount will be spent during this coming year. New York State is bonding for $50,000,000; Ohio is likewise bonding for $50,000,000, and Pennsylvania for the same amount; New Jersey $10,000,000, and thus it is being done all over the country.

In Montclair, N.J., they are considering the advisability of issuing bonds to the amount of $400,000 to make it "The Town Beautiful." Essex County, N.J., has increased its appropriation for repairs $30,000. The city of Newark, N.J., is spending nearly $1,000,000 more this year than it has ever expended before.

This gives some idea of the amount of money appropriated, and shows why the attention of legitimate business has been attracted, and it also provides a reason for the large number of questionable enterprises which come and, fortunately, go with the season. Some of the difficulties arising from these conditions are startling, and at times contracts seem to have been let, because of the low prices offered, to irresponsible bidders who, of necessity, were compelled to resort to dishonest practice or lose money on the job. The speaker believes the time has come when contractors will form some sort of combination themselves and seek to classify business interests—a step which would doubtless result in multiplied benefits to all concerned, and which is, he believes, within the scope of this society.

The speaker considers it a privilege to talk with the members of this society regarding come of the problems of road construction which we all meet every day, and about which little or nothing new has been advanced within the last year. For that reason it is a subject about which he always feels a sense of embarrassment when asked to speak. He does not know that he has anything new to present, but such as he has he will gladly share with you.

The ordinary water-bound macadam roadway when subjected to automobile traffic rapidly goes to ruin and for some years past many experiments have been made to replace this type of construction by substituting some more effective binder, both on new work and the resurfacing of old roads; the two chief binding materials experimented with being asphaltic and tar compounds.

Both asphalt and tar are used in new construction and in dust prevention—there being many grades of each, varying in density and viscosity, the lighter grades being used for dust prevention and the heavier in resurfacing and new construction.

Naturally, the speaker is best acquainted with Tarvia, because he deals in this material exclusively in the construction of roads and for the prevention of dust. In his experiences with various municipalities over a part of two States and in driving constantly over the roads, he comes in contact with every form of material that is on the market and has opportunity to note the method, results and machines, and to draw definite and intelligent conclusions, which he will endeavor to state briefly to you without any disposition to criticize one way or the other.

In order to present the pedigree, so to speak, of the tar binder, he is going to start at the real beginning of affairs—for you all know that tar is a derivative of the distillation of coal and that coal itself was formed in the Carboniferous Age by the accumulation of masses of vegetation and trees.

Very little is in reality known about coal. Some writer has aptly called it "buried sunshine." Not a misnomer, as it suggests the source of light and heat which is driven off

* Abstract of paper presented at meeting of the American Society of Engineering Contractors, May 9th, 1912.

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from the coal and also the diversified colors which we get from the coal tar products. During this formative period of coal these forests were the habitation and feeding place of the Brontosaurus and other Saurians that have been extinct for ages, but the skeletons of which have been found in the rocks of that period by modern scientists, carefully chipped out, and assembled into the complete skeleton. The larger museums contain specimens of these animals—the American Museum of Natural History in New York City being especially favored in that respect.

Fig. 2.—Distributing Tarvia "B" by Means of an Ordinary Watering Cart Fitted with a Distributing Device.

The family relation existing between coal and tar and the derivatives is graphically shown in the coal tar tree. (Fig. 1). The main stem of this represents the raw tar. Off to the left coke is designated, which is a residue from the fractional distillation of coal. The drawing also shows the production of gas and ammoniacal liquors, refined tars which are used in the saturation of felt for roofing and waterproofing purposes, and those which are manufactured into Tarvia for use in road construction. You will also notice that the various branches of this tree represent the drugs, chemicals, disinfectants, germicides, insecticides, and almost innumerable by-products. Finally, it is of interest to note that by synthetic chemistry we have a class of coloring dyes, etc., which are important in the commercial world.

The making of coke and the separation of the distillates was formerly accomplished by the Bee-hive oven, patented in England in the year 1620. The coal is fed into the oven through the opening at the top and leveled off with a hand rake. The face of the oven is then bricked up to within a few inches of the top, and the heat, which has been retained in the brick from a previous operation or from a preliminary heating, is reflected from the dome of the oven, thereby causing the coal to disintegrate. The gases pass out through the opening at the top, leaving a residue which hardens upon cooling. This is of a light silvery color, and is known as "Coke." In this type of oven all of the by-products are lost, and because of the smoke and disagreeable odors of escaping gas it was impossible to operate it in the near vicinity of dwellings. For these reasons the Bee-hive oven is rapidly becoming replaced by the more modern coal gas retort. In this the operation is substantially the same, except that the distillation of the bituminous coal is done under the exclusion of air. By this method the gases are carried off in pipes, recondensed and scrubbed, thus relieving them of their deposit of tar and ammonia.

The modern gas retort is a more efficient type of oven, which, being built in series, is capable of handling a much larger quantity of coal, and as it is mechanically operated, is much more economical. In the treatment of the gases for the recovery of the tar and ammoniacal liquors, the gas is forced through a series of baffling plates which are perforated with tiny holes. The plates are placed one back of the other, but in such a way that the unperforated surface of one plate is opposite the perforation in the other plate. The gas is then drawn through these plates and the tar, which exists in minute globules, adheres to the unperforated surface of the plate and is thus recovered. For the recovery of ammonia the gas is passed through a cylinder containing revolving wooden paddles which are constantly kept wet, and the gas coming in contact with the wetted wood is relieved of its ammoniacal deposit.

As it has been shown, in a general way, how tar is produced, it might be interesting to explain the manner of its distribution to consumers. It is sent in tank cars, which are fitted with steam coils to heat the material before transferring it to the distributing wagon. It is also shipped in barrels by rail or boat and by tank steamers, the hold of which is partitioned off fore and aft for the transportation of tar in bulk.

There are three grades of Tarvia on the market—"A," "X," and "B"—the "A" and "X" grades being used in new construction and resurfacing, while the "B" grade in light resurfacing, and as a dust preventative. For example, Tarvia "B" was successfully applied to the surface of a water-bound macadam street in Phillipsburg, N.J.

In this instance an ordinary watering cart was used, fitted with a distributing device, as seen in Fig. 2, at a cost of about $10. The surface of the street was first carefully swept, then from one-third to one-half gallon of Tarvia "B" was evenly distributed over the surface and broomed out with hand brooms where necessary. After an exposure of several hours this surface was lightly covered with a drifting of sharp, clean sand and the street thrown open to traffic. The initial cost of this treatment was 3 7/10 cents per square yard. The traffic there is more than ordinarily heavy, the street being the outlet for several foundries. Notwithstanding this, the street has been maintained for two years without other maintenance than the annual application of Tarvia "B."

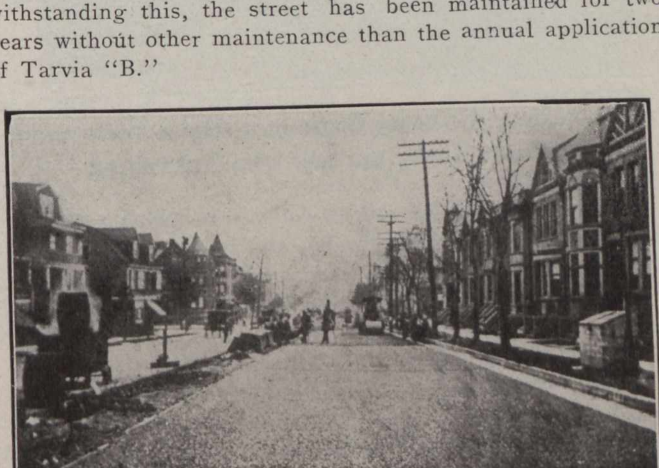

Fig. 3.—Rolling a Tarviated Macadam Road Constructed by the Mixing Method.

In new construction there are two distinct methods of application—the penetration method and the mixing method. In the former the tar binder is applied by hand or machine to the stone in place on the road, while in the latter the stone and binder are mixed together, like concrete, and then the mass deposited and the road rolled. (See Fig. 3).

Early Street, Morristown, N.J., is an example of the penetration method of construction of a 6-inch tarviated macadam in which Tarvia "X" was used as a binder. The method employed in the construction of this street was as follows: First, the road bed was carefully prepared, and, after being brought to grade, thoroughly rolled. Four inches of crushed stone of the 1½-inch size was then placed upon the road and likewise rolled until there was no perceptible movement beneath the roller. Over this was placed two inches more of the same size stone, and these again rolled. Tarvia "X" to the amount of one and one-half gallon to the square yard, heated to a temperature of 250 degrees Fahr., was then poured by hand from suitable sprinkling cans upon this prepared surface, after which clean screenings were drifted over the surface of the road in sufficient quantity to fill the voids without leaving any excess material. The road was then again thoroughly rolled and the second coat of Tarvia "X," from one-half to three-quarters of a gallon per square yard, poured over the surface. Over this finally was placed another coating of screenings and the road thoroughly rolled to a finish.

The entire cost of laying this pavement, including all the gradings, was 78 cents per square yard. Early Street was paved two years ago and is at present in good condition.

In passing it may be of interest to note that the cost of removing Tarvia from the package and heating it to the required temperature is about one and three-fourth cents per gallon less than the cost of the same operation with asphalt binders.

Fig. 4.—Tarvia "X" Being Distributed from a Tank Wagon Fitted with a Fire Box and Hose Attachment.

Tarvia "X" can be quite readily transferred from the barrel when one head is removed, and if reasonable care is exercised it is not necessary to destroy the barrel.

The distribution of Tarvia "X" from a tank wagon fitted with a fire box by means of a hose attachment is shown in Fig. 4. In this operation the Tarvia is heated in the tank car, drawn off into the tank wagon, which has a capacity of six hundred gallons, attached to the steam roller and drawn to the point of operation. Steam connection is made between the roller and the tank wagon and the Tarvia forced from the tank through the hose under a pressure of about 15 pounds. This method is recommended as being more efficient and economical than the use of hand distributors.

The mixing method of application is favored by many engineers as giving better and more uniform results than the penetration method. The materials are either mixed together by hand or by machine. In the case of hand-mixing, Tarvia "X" heated to 250 degrees Fahr., using from 18 to 20 gallons to the cubic yard of stone, is thoroughly mixed by hand upon a mixing board and placed upon the prepared road bed in the desired thickness. The mixture is then leveled off with hand rakes, the voids filled with screenings, and the whole thoroughly rolled. Over this again is poured, as in the previous operation, the required amount of Tarvia. The second coat of screenings is then applied and the road rolled to a finish.

The method employed in machine-mixing was used recently in the construction of Park Avenue, Newark, N.J., which was built by the Essex County Park Commission. Crushed stone is loaded into the hopper, which is then lifted to an elevated position and its contents delivered into the drum of the mixer, where it is heated. After the stone is thoroughly dried and heated to the desired temperature, Tarvia "X," which has been previously heated in an ordinary heating tank, is also mechanically lifted and deposited upon the stone in the mixer. The stone is then thoroughly coated with the Tarvia, after which it is dumped into wheel-barrows and carried to its destination. The evidences are that this is destined to become a very popular method for the construction of bituminous macadam roads, and the experiences of those who are familiar with this machine would lead us to believe that it is well adapted to this work.

The asphalt bound macadam is built by using these same methods of construction (with the exception that heavy asphalt is used instead of tar as a binder). Many types of new roads have been experimented with during the last few years—with the view of solving the problem of an automobile-proof road without going to the heavy expense of a permanent pavement. One of the latest additions to the list is known as "Dolarway Pavement." This consists of a carefully laid concrete base, usually six inches thick, of not less than 1:3:5 mix, with expansion joints approximately every 25 feet. Upon this prepared concrete base there is placed a thin coat of Dolarway bitumen which is broomed out with a horse sweeper. This method of construction has been thoroughly tried for several years, and the evidences are that in the near future it will become very popular. This pavement is low in the first cost, dustless, resilient, economical to maintain, and, in fact, has all of the virtues of the best types of permanent pavements in use to-day without any of their disadvantages.

TESTS OF CROSS-ARMS.

The Department of Agriculture, Forest Service, has recently been conducting some strength tests of cross-arms and results are embodied in Circular 204, just issued by the department. The material tested includes practically twelve cross-arms of each of the following seven groups: Douglas fir, shortleaf pine, longleaf pine, graded by the manufacturers as 50 per cent. heart; longleaf pine, 75 per cent. heart; longleaf pine, 100 per cent. heart; Southern white cedar, and shortleaf pine, creosoted. Each of these cross-arms was tested in a 200,000-lb. Riehle universal testing machine. The comparative strength was as follows:

	Average Maximum Load.
Longleaf pine, "75 per cent. heart"	10,180
Longleaf pine, "100 per cent. heart"	9,780
Shortleaf pine	9,260
Longleaf pine, "50 per cent. heart"	8,980
Shortleaf pine, creosoted	7,650
Douglas fir	7,590
White cedar	5,200

A summary in the report concludes with the statement that, all things considered, cross-arms of the species and dimensions tested are strong enough for ordinary use; with longer arms the strength is relatively of much more importance. With the standard 6-ft. cross-arm, however, the question of strength need not enter into calculations of line construction, except in the rare case of abrupt change in grade. The ability of the timber to resist decay and methods of preventing decay are considerations of greater importance.

CONCERNING WEB STIFFENERS.

It is easy to say that the function of a stiffener is to prevent buckling of a plate girder web, and that it must be designed to accomplish this purpose. But when one attempts to summarize one's ideas as to how this shall be done one finds that the fund of accurate information concerning stiffeners is meagre. The actual design is accompanied by so many assumptions as to make one who inclines to theory rather than experiment somewhat sceptical of the results obtained. Notwithstanding the indeterminate character of the action of stiffeners of loaded plate girders, it is satisfying to know that failures of web stiffeners are very rare, and that those that have been known to occur are of such a nature as to cause no other serious consequence than slight inconvenience and expense of repairs. But many tons of steel are used annually in stiffeners, and the subject is therefore one that merits more study than has been given it, says the "Engineering Record."

Web stiffeners are used at concentrated loads for the double purpose of transferring these loads from the flanges into the web and to prevent the web from buckling under the compression, and they are also used at intermediate points between concentrated loads solely to prevent buckling of the web. The sizes of these intermediate stiffeners are nearly always assumed, but their spacing—that is, the horizontal distance from one set to the next—is now quite generally determined by a formula based upon compression in the web resulting from the shearing forces acting upon it. Some important specifications still use the arbitrary method of spacing intermediate stiffeners at horizontal distances not exceeding the depth of the girder, even though this rule has practically no reason for its existence. Since the tendency of a web to buckle must be due to the compression acting within it, and since this compression is a direct function of the shearing force on the web, it seems perfectly clear that the method used for spacing intermediate stiffeners should bear some relation to that shear; that, other things remaining the same, the greater the shear the closer together should be the stiffeners.

There seems to be a deep-seated conviction that intermediate stiffeners must be fitted accurately at both top and bottom flanges, for by being so arranged they add strength to the girder in some mysterious way. It is readily seen that if fitted to a compression flange, stiffeners might act to a limited extent as braces to this flange, and hence the expense of fitting them might be justifiable; but when one looks for a reason for fitting them to a tension flange it is not forthcoming, except it be in the desire to secure a tight fit for the sake of appearance, or to eliminate small openings wherein painting is difficult. Of course, it is perfectly right to insist on close fitting at flanges for either of these two reasons, but let us not deceive ourselves into thinking that intermediate stiffeners must be fitted to both flanges to add strength in some unknown manner.

Stiffeners at such concentrated loads as bearings and columns should be, and usually are, designed as columns, and sufficient rivets should be placed in them to transmit the proper forces between stiffeners and webs. Determining the cross-sectional area of a set of stiffeners under a column load or over an end bearing by applying the ordinary column formula is on the side of safety, for this process assumes the stiffeners to have their maximum compression throughout their entire length, whereas the stress diminishes from the maximum at one end to zero at the other. In this respect, therefore, the ordinary stiffener at a concentrated load differs from a column, because in the latter the loads are applied at the ends, and column formulæ as generally used apply to this case only.

Consider the stiffeners under a column which rests upon the top flange of a plate girder. The entire column load is transmitted first to the top flange, then to the outstanding legs of the stiffeners under the column. The outstanding legs must be carefully fitted, and must be of sufficient area to give proper bearing against the horizontal legs of the top flange angles. The stiffener legs lying against the web transmit very little or no stress from the top flange, because they are sheared or ground to fit the curved fillet of the flange angles, and should be neglected in determining the required area for bearing at the top flange, and it is for this reason that only the outstanding legs of stiffeners should be relied upon to transmit the column load from the inside of the top flange angles. When the stress has thus entered the outstanding legs, these legs are thrown into compression, and until a portion of this stress is transferred to the legs lying against the web, the comparatively thin projecting legs must be able to sustain this comparative stress without buckling.

It is just here that a link in the chain is usually overlooked, for this buckling tendency is ordinarily not considered, even though the bearing against the flange may be carefully provided for. As the stress becomes distributed over both legs of the angle stiffener, column action is approached, and for this reason a column formula is applied to determine the gross cross-sectional area of the two legs of the stiffener. In the case here supposed—that is, the case of a stiffener under a column,—the maximum stress exists only for a short distance down from the top, for the uppermost rivet in the stiffener transmits its quota of stress from the stiffener into the web, and each succeeding rivet further diminishes the stress until at the bottom the stiffener has no stress at all. Consequently, when stiffeners are designed as columns having the full stress through a length equal to the girder depth, they are on the side of safety.

It is apparent, then, that if the bearing of the outstanding legs be sufficient to transfer the column load from the top flange, that if the cross-sectional area of the stiffener angles be large enough to satisfy the column formula, and that if the rivets be the correct number, there still may be a weak link in the design if the buckling of the outstanding leg at the top be overlooked. An interesting case of this buckling occurred a few years ago at the Union Street drawbridge in Salem, Mass., U.S.A., This was a deck plate girder highway swing bridge, with a centre bearing having the entire revolving weight suspended from the centre casting by means of a series of round rods which were attached at their ends to the top of the centre casting. The rods passed through holes in the distributing girder flanges, and their lower ends engaged in nuts bearing against the bottom flanges of the distributing girders. This arrangement resulted in a series of large concentrated upward forces on these flanges, and a set of angle stiffeners were used for reinforcement at each rod. The outstanding legs of these stiffeners were too thin and they buckled, the buckling being confined to the lower 8in. of each stiffener. As a consequence of the failure of these stiffeners, the drawbridge settled vertically to such an extent that its operation was almost impossible because of frictional resistances at the abutments. The Salem case made an everlasting impression on the engineers who had anything to do with it, for local column action of the outstanding legs had been manifestly overlooked in the design.

The brief analysis here given indicates that the designers should investigate four things in connection with stiffeners at a concentrated load:—

First, the bearing area of the outstanding legs should be sufficient to transmit the column load from the flange.

Second, the thickness of the outstanding leg should be sufficient to prevent buckling of this leg.

Third, the entire cross-sectional area of the angle or angles should be sufficient to carry the load as a column having a length equal to the depth of girder.

Fourth, enough rivets must be placed in these stiffeners to transmit their stress into the web.

The action of stiffeners over an end bearing of a girder is similar to the case here considered, unless there be on top of the girder a column load. In the latter case the stiffeners must not only transmit the shear from the web into the end bearing, but they must also carry the column load from the top flange of the girder to the bearing. While the principles involved in the two examples are the same, their application is slightly different.

A NEW AUSTRALIAN DAM.

The cabled announcement of the formal opening of the Burrinjuck Dam in New South Wales, and the irrigation scheme for which it is to supply the water, is a more than ordinarily interesting event in Australia's domestic history. Burrinjuck is not as large as Assuan Dam, but it is the second largest dam in the world, and it certainly rivals the great Egyptian work in picturesqueness. It is set in between two steep granite hills that rise from oposite sides of the Murrumbidgee River. These mountains are about 2,500 feet high and form the gateway to the long and winding gorge, rugged and rocky, through which the upper Murrumbidgee flows for about 200 miles.

The dam, set in the neck of the gorge, will ultimately rise to a height of 240 feet from the foundation level—ultimately, for the engineers have decided that the irrigation scheme can be started with the dam at only about half the height it will have reached when the entire area is ready to be watered. The areas immediately adjacent to the Yanco diversion channel can easily be served with the dam at a height of only 120 feet, and this land is the portion now formally opened. The dam is expected to reach its full height some time next year. The retaining wall will then be 240 feet high, 784 feet long (curved in plan to a radius of 1,200 feet), with a breadth of 170 feet at the base and 18 feet at the crest. It will back up the waters of the Murrumbidgee for 45 miles in the long gorge, and create an inland sea among the mountains of 20 square miles in area and over 33,000 million cubic feet in content—nearly half as big again, say the mathematicians, as Sydney Harbor. It is calculated that on the average flow the Murrumbidgee will take a year to fill the Burrinjuck reservoir.

From Burrinjuck the water is, under regulation, allowed to flow on for 200 miles down the bed of the river to Berembed Weir, near the town of Narrandera. From Berembed the diversion canals reach out. The Berembed Weir and lock have already been completed. Under the northern irrigation scheme a main diversion canal, now nearly completed to its full length, runs out straight in a north-westerly direction for 132 miles to a point near the town of Gunbar, not far from the Lachlan River (a long but uncertain lower tributary of the Murrumbidgee). The triangular area hemmed in between these two rivers and the canal is to receive particular attention from the irrigationists, but subsidiary channels stretch out to the east of the main canal as well. The area to be served at once is about 125,000 acres, shortly to be increased to about 350,000, and, finally, when the northern irrigation scheme is in full working order, to 1,300,000 acres.

THE ATTITUDE OF THE RAILWAYS TOWARD FOREST FIRES.*

E. A. Sterling, F.E., Forester, Pennsylvania Railroad Company.

"Railroads" and "unknown origin" are the two headings under which the causes of a large majority of our forest fires are listed. Even after allowing for inaccuracies in the records, the number of fires resulting from railroad locomotives is unquestionably large. The attitude of the railroads towards the forest fire evil, and the possibilities of reducing this particular source of danger, are therefore questions of interest and importance.

While the railroads for many years have, perhaps, shown too little interest in forest protection, it must be remembered that indifference has characterized most of the other interests, from the Government down to the smallest woodlot owner. The railroads could hardly be expected to worry about forest fires when the States through which they ran had neither laws nor organization to prevent or fight fires. So many of the developments tending toward the solution of forest problems have not taken place until recently, that criticism of any particular interest reflects discredit on all. Practically all of the definite accomplishments in forestry, both in Canada and the United States, have taken place in the last ten years, and the greatest achievements are less than five years old.

Under the latter, the beginning of effective fire protection stands out prominently. Our forests are still far from safe, but Federal, State, and private activity has paved the way, and another decade should remove the fire menace from our remaining forests. In this work, which must be co-operative to succeed, the railroads are doing their full share.

Certain basic causes must underlie any given set of conditions. If the railroads have been the too frequent cause of forest fires, there are various reasons why this has been true. First of all, no spark arresters have been designed which will eliminate flying sparks under all conditions, and at the same time give the locomotive free draft. While the various devices in general use greatly reduce the danger from this source, the fact must be accepted that there are certain mechanical difficulties which have not been entirely overcome.

If it is recognized that sparks capable of starting fire reach the ground, the next logical step would be the removal of inflammable material from the right-of-way. It is easy to advise this, or even to legislate to this end; but to the comparatively new roads which have pushed into the forest regions, the expense of a fireproof right-of-way is a very serious consideration. Most of the main trunk lines now clear their right-of-way twice a year, but this is by no means a guarantee against fires from locomotive sparks. The strip of property owned by the railroads is too narrow for a safe fire belt. Adjoining property offers quite as great a menace, so that, even if the railroads kept a right-of-way of fresh mineral soil, live sparks might easily start fires in the slashings and accumulated litter on adjoining property over which they have no control.

As one other consideration, it may be mentioned that for years the railroads shared in common with the public the attitude of calm indifference as to what happened to our forests. Co-porations occasionally lead in developing public sentiment; more frequently they are guided by it. The man on the street even now it is hardly awake to the importance of forest protection; yet, the railroads are taking the matter in hand with an energy in advance of public sentiment.

* Paper read before Canadian Forestry Association, February 7th and 8th, 1912.

The fair analysis of the situation reveals several reasons why the railroads have been either the primary or the indirect cause of many forest fires. No reasons can be found, however, for the railroads deliberately,permitting or desiring to start fires, although such is often the popular conception of the matter. From many standpoints the railroads are the heaviest losers when a forest area burns. It takes away tonnage, both present and future; reduces summer tourist travel; and, unless the region is developed for agriculture, merely furnishes ground on which to run tracks between more productive points. Damage claims follow every fire, and alone are enough to bring about any protective measures within reason.

The past gives us little of which to be proud, so it is best to forget, save as a lesson, the semi-annual pall of smoke which has marked our forest fire losses. If we date our history some two or three years back, we can find basis for a future of greater promise. In the United States, no one factor in forest fire prevention can be mentioned without including others. The Forest Service set the pace in the systematized fire work on the national forests; while the States, the timberland owners, through their forest protective associations, and the railroads followed. To-day all are working together in closer co-operation than was ever believed possible, and the results from only two years of combined efforts are most encouraging.

To tell specifically what the railroads are doing would occupy too much time. Briefly, the measures which are proving most effective are the removal of combustible material from the right-of-way, systematic reporting of all fires which start, and prompt action in extinguishing them, regular patrol during dry seasons, use of oil-burning engines in forest regions, wherever practicable, and the keeping of spark arresters and ashpans in good condition. The clearing of land adjacent to the right-of-way is a very important development, which is permitted in Massachusetts and required by New Jersey, the latter providing for a 200-foot strip between the outer rail and a 10-foot fire-break. About 235 miles of such fire-breaks have been constructed during the past two years, with the result that the number of fires has been very greatly decreased. Where the Northern Pacific and Great Northern Railroads traverse National Forest land, 200-foot strips are cleared and maintained under a co-operative agreement between the railroads and the Forest Service.

The systematic patrol of the railroads, particularly under the direction of the State forest officials, is proving a valuable fire preventive measure. Minnesota provides for this in the new forest law; New York has required the patrol of railroads in the Adirondack region; while the Maine Central has provided a voluntary patrol. In the West, the Forest Service co-operated with the railroads in patrol work, most of the patrolmen being on the Government rolls, because of the protection afforded adjacent forest land.

The use of oil-burning engines is required by law in New York State from April to November on all roads traversing the Adirondack forests. This, however, puts a heavy burden on the railroads, and is hardly a fair or practical measure in regions remote from sources of crude oil supply. Two transcontinental roads, after extensive experiments, have voluntarily installed oil-burning engines on divisions traversing the National Forests.

The Pennsylvania Railroad and other roads operating in the more thickly populated Eastern States have to contend mainly with small fires started in woodlots, stubble fields and second-growth woodlands. These fires rarely assume serious proportions, and are guarded against by the trackmen and other employees, all of whom are under definite instructions to report fires and promptly extinguish those which start. Only one fire was reported by the State fire wardens as having been caused by the Pennsylvania Railroad during 1911, and this, upon investigation, was found to have occurred beyond the possible range of live sparks.

A striking summary of the railroad forest fire problem and most excellent recommendations for fire control were passed as resolutions at the Forest Fire Conference in Portland, Oregon, in December, 1911. It would be impossible to do better than close by quoting these resolutions:—

Whereas, The protection of the timber resources means: The stumpage value to the timber owner of approximately $2 per M. feet B.M., employment and remuneration to the wage earner of approximately $8, tonnage to the railroads both in supplies, equipment, and forest products approximately $6 to $8 per thousand, benefits to the farmer and merchant through the use of supplies, an insurance of community prosperity and the general public welfare; and,

Whereas, It is recognized that the railroads operating in forested regions are a source of fire danger menacing the preservation of this resource for use; and,

Whereas, The danger from forest fires is common to all and co-operation is necessary to meet this danger; now, therefore,

Be it resolved, That in order to secure the best results this co-operation be systematized along the following lines:—

1. Clearing up rights-of-way of railroads of all combustible material on ground; not necessary to take down trees or take out stumps unless punky, rotten or hollow.

2. Establishing efficient patrol of tracks during dry seasons, both night and day.

3. Increase efficiency of spark arresters and transforming of all engines being operated through timbered districts to oil-burners as far as practicable.

4. More strict enforcements of orders that steam be turned on all ashes dumped from engines. Stringent enforcement of orders that no ash-pans be dumped while train is in motion.

5. That orders be given expediting the furnishing of men from road gangs and section crews.

6. Reports of all fires by all train crews at first telegraph or telephone station.

7. Sharing expense of patrol by railroads.

8. That association, Federal and State organizations furnish their regular employees within their respective territories to assist in fire patrol.

9. That authentic information of the condition of railroad rights-of-way, the methods used under different conditions, and of all fires originating on or adjacent to the right-of-way be obtained by Federal, State, and private organizations in order to present definite data to effect improvement in methods.

10. That this situation be kept before the railroads, the organizations interested in fire protection, and the general public, in order to ensure a practical working out of these recommendations.

I have been asked to say a word in addition as to what the Pennsylvania Railroad is doing in relation to forestry The main line of the Pennsylvania Railroad runs through a hardwood country, mostly second-growth hardwood, where the lumbermen, in the early days, took off most of the valuable timber. The railroad has some thirty thousand acres on which a start has been made in exploiting the timber on a commercial basis. Work has been done on some fifteen properties, and after our logging operations these properties are in a much more productive state than before. The work has been done on a much more economical basis than by lumber companies in Pennsylvania, and the net profits have been approximately $19 per acre. This has been done by finding a market for the products that the lumbermen are unable to sell.

On the technical end we were very careful to cut with reference to a future crop. We found a market for everything produced, and I think the forest has been left in as good shape as is possible in view of the timber being taken off. Utilization has been carried to the finest point, practically everything, even down to the charcoal wood, being cleaned up. We have revived the charcoal industry, and are burning charcoal on old hearths that were abandoned so long ago that six to eight-inch trees are growing up through the centre of them. The question of forest utilization is closely allied with the water supply problem. Therefore, we have had to modify some of the cutting in reference to the water-supply end of the question.

In planting and nursery work, the policy is to plant about a million trees a year. We do not always reach that, and I am not sure that it is advisable. It is a question as to how extensively a corporation should engage in forest planting. This is not what I would be expected to say, perhaps, but I believe that for most Eastern railroads the purchase and long-time management of timber lands is more profitable than planting. Forest planting, from a general standpoint, is very important. The road is trying to teach the farmers to plant waste lands, and also how to handle their wood lots. This coming spring seedlings are to be offered from the company's nursery at practically cost price. How great the demand will be I do not know, for there has not been very much enthusiasm about forest planting because there has been so much second-growth forest land.

Another point is that of fire protection. On the properties which are being logged and planted we have done the usual things in the way of fire protection, with which you are familiar. General instructions have been issued to all trainmen with regard to fire. Recently these instructions were summarized and distributed in booklet and placard form to employees, and also to the farmers along the line. I think the people are pretty well aware that fires are something we do not want.

As to preservative treatment of timber against decay, I think that is more important than planting; I do not know that it is more important than lumbering. It means a good deal in a hardwood country like Pennsylvania, because we have non-durable woods, such as beech, birch and maple, which are now being converted into ties. When these woods are treated with creosote they give better life than the durable and more expensive species, such as white oak, which are used untreated. The railroad treats the equivalent of a million and a half ties a year. By treatment these million and a half ties will last three times as long as they otherwise would, and practically cut down the drain on our local forests to that extent. The railroads, however, are not in the treating business for the purpose of saving the forests, but to save money. Still, wood preservation, in my opinion, is an important factor in the line of forest conservation.

All these specific things the Pennsylvania Railroad and other railroads are doing; but, with the exception of the Lackawana Railroad, so far as I know, they are not tackling the main problem, which is that of timber supply. The railroads are increasing their consumption of timber every year, but they are not doing a thing to provide for their demands ten or fifteen years hence. The Lackawana Railroad is the one exception, and it has bought land in the South with a view to providing a supply for both the present and the future.

Why have not the railroads and other large wood-consuming corporations taken this matter up? It certainly seems that the only logical solution of their coming wood problems is to have their own source of supply. The planting of trees will not of itself meet the problems for each corporation. We could plant ten million trees a year, but that would not save the day, because the trees would not mature in time. And, what is more important, it will cost more to buy open or cut-over lands locally and plant them than to go into the South and buy mature timber. That can be proven by figures.

It seems to me that the logical thing, the step that will make forestry permanent, is for the consumer to get into the timber-producing business. But this has not been done. It seems to me that one reason for the present do-nothing policy is that the higher officials, the men who really run the railroads and control the finances, are enthusiasts along other lines than that of wood-production. They do not see why they cannot buy ties just as they buy rubber bands. They have been told that difficulties would come, but an idea like that does not sink deep into minds which have developed with other ideas. Other interests, other problems, other policies command attention, and it is a hard job to make these people see that they are going to find they will be in difficulties for wood. Yellow pine ties have increased in price at the rate of three cents per tie per annum, but that does not necessarily mean anything to a purchasing agent, general manager, or president. The fact that tie renewals will cost a few hundred thousand dollars more a year is not overshadowing in importance; it will simply be made upon something else. But this problem may come with a rush. I hope it does, because I believe it will be the greatest thing for forestry that ever happened. The steel tie may come, but that is really not part of the problem.

I merely wish to call your attention to the big wood supply problem that the railroads are facing. They are doing their share along the ordinary lines of fire protection, planting, wood preservation, etc., but the other things, the big problems of wood supply for the consumers of the future, remain unsolved.

THE CASTING OF A LARGE BED-PLATE.

The Mesta Machine Company, Pittsburg (U.S.A.), recently cast an engine bed, the net weight of which was 120 tons. The casting is one of the bed-plates for an engine that is being built by the Mesta Machine Company, and which will be installed by the Youngstown Sheet and Tube Company, Youngstown, for operating its blooming mill. As 130 tons of metal were required to pour the mould, the iron was tapped simultaneously from five air furnaces, each furnace having been charged with iron of the same average analysis. The melting of the metal was so regulated that all of the furnaces were ready to tap at approximately the same time. The metal was tapped into six ladles, four of which were poured at one time, and, after these were emptied, the contents of the remaining two ladles were poured into the mould. Binders were placed across the mould throughout its entire length, and these were held in position by rods extending through the bottom plate. Bottom-pouring ladles were used, such as are generally employed for casting steel. This large mould was poured in an exceedingly short period, as only 17 minutes elapsed from the time when the metal was tapped into the ladles until the mould was filled. The casting was allowed to cool slowly in the sand for a period of 16 days. The removal of this casting from the pit presented an interesting problem, owing to its great weight, which, including the cores, must have approximated more than 200 tons. The sand was first removed from around the sides of the casting, and each end was gradually raised until the entire casting was clear of the pit. This permitted the removal of the cores and facilitated the subsequent handling of the bed-plate.

THE STRENGTH OF CONCRETE POLES.

Tests on reinforced concrete poles were recently conducted by the Carnegie Steel Company at its plant in South Sharon, Pa., with the view of determining the relative cost and strength of that material as compared with wood for such construction. The poles tested were 32 ft. long, 10 in. square at the butt and 6 in. square at the top. All corners were bevelled and iron steps bent up ¾ in. were inserted in the forms before placing the concrete. The mixture used was 1 part of Universal Portland cement, 2 parts bank sand, passing ¼-in. screen, and 4 parts crushed limestone, passing a ¾-in., but retained on a ¼-in. screen. About one barrell of cement, ¼ yd. of sand and ½ yd. stone were used in the construction of each pole.

The reinforcement consisted of four groups of twisted rods at the corners placed not less than ¾ in. from the surface. Each group was made up of one ½-in. rod 32 ft. long, two ½-in. rods 24 ft. long and 3/16-in. rods 16 ft. long. The reinforcement was thus proportioned to the decreasing stress toward the top of the pole. Sheet steel separators held the reinforcement in place and were cut away to avoid breaking the continuity of the concrete above and below the separator.

The forms used consisted of an upper and lower section held together by bolts, the lower being a single pieces while the upper was made up of a series of units beneath which the concrete was forced. The poles thus made weighed about 2,500 lb., or five times the weight of a wooden pole of the same length.

The tests were conducted with two concrete poles and a 32-ft chestnut pole under the same conditions. It was found that poles of wood showed practically the same deflection as those of concrete up to 2,000 lb., the load being applied at right angles to the pole and at the top. The deformation at 2,000 lb. amounted to 25⅝ in., this loading being far greater than could ever be experienced in actual use. For deflections of less than 15 in. the concrete pole showed no permanent set. The test on one of the poles was carried to destruction and failure resulted at the point where the 24-ft. reinforced rods ended, the concrete being crushed for about 3 ft. above and below the break.

The results obtained showed that the cost of manufacture of such poles should be from $7.50 to $10, as against $4 to $5 for a wooden pole. The cost of wood poles is thus from one-half to two-thirds that of the concrete poles and their life of usefulness is from ten years to a maximum of twenty, whereas the life of a concrete pole is practically unlimited.

METHODS AND COSTS OF APPLYING STUCCO WITH THE CEMENT GUN.

The cement gun is being used a good deal on construction work of different kinds. The methods and costs of its use on certain work will, therefore, be of interest. Mr. R. C. Hardman, superintendent of construction in the U.S. War Department, in a recent issue of Engineering News, describes the use of the gun for placing stucco on the exterior of a small frame building, containing 631 square yards of surface and having 56 door and window openings. The methods and cost of doing the work, as outlined by him, are given as follows:—

The building, which is two stories high, consisted of a main front with two rear wings, in the space between which the gun was stationed, with the sand and cement storages immediately behind. The typical force in the operation of the gun was one man running the engine and gun, two men mixing and sacking dry material and charging hopper, one nozzleman, one laborer to help nozzleman, and two laborers cleaning grounds and screeding.

The entire building was first covered with cheese-cloth, then with a cheap grade of building paper secured by laths running vertically on the studs. This was then covered with mesh reinforcement secured by 1½-in. staples. Grounds were placed on alternate studs to give a stucco thickness of 1¼ in. The panels thus formed were filled alternately to within about ¼ in. of the face of the grounds. The grounds were then cleaned off with a small trowel and about thirty minutes later the stucco was brought flush with their face and screeded off. The screeding was done by unskilled Mexican labor with a straight-edge shod with steel. When these panels were set, the grounds were removed and the panels between were filled in the same way. The work was done in four sections vertically. The top section was done first so that falling material might find a lodging place below. When a section was completed it was lightly sprayed to secure uniform color and cover up joints. The mixture used throughout was one part of Portland cement to three parts of sand.

In shooting the mixture onto the wall the nozzleman stood so that the nozzle was from three to four feet from the wall, and kept the nozzle in continual motion so as not to pile up too much mortar in one place. In accordance with the principle of the device, the dry mixture was mixed with water at the nozzle. The amount of water used was just enough to keep the mortar below the running point. Water was delivered at about 40 lb. pressure. The air pressure used was 26 lb. A higher pressure than this caused too much waste of material (mostly sand) by rebounding and a lower pressure tended to clog the hose with dry material.

The apparatus consisted essentially of an engine, an air compressor and the "cement gun," which is a hopper, having a caisson lock, for receiving the dry material and from which it is forced through a hose to the surface to be covered. As used, the outfit comprised a 4-cycle, 4-cylinder gasoline engine, connected to a 2-cylinder single-acting air compressor by means of belt and pulley operated by a belt tightener. On the front end of the engine and operated by its flywheel was a small water pump for the engine water-cooling system. A second water pump attached to the compressor and operated by its flywheel was available for pumping water to the hose nozzle. Neither of these pumps was used, as the water pressure from the mains was sufficient.

Connected to the air compressor was the hopper or "cement gun" proper. This consisted of two connected air chambers—upper and lower—each closed at its top by a flap valve hinged to swing downward by gravity and closed by outside levers. The feeding mechanism, which consisted of a revolving slotted wheel, was at the bottom of the lower chamber and allowed the dry mixture to fall through and be forced through a hose, at the nozzle of which it was mixed with the proper amount of water.

In operation the lower chamber was first closed by its valve and filled with air. The dry mixture, which previously had been sacked for convenience, was put into the upper chamber, the upper valve closed and the air turned in. As soon as the pressure in the upper chamber equaled that in the lower the valve connecting the two chambers opened by gravity, allowing the dry mixture to fall into the lower chamber where the revolving slotted wheel allowed it to feed through into the hose connected to the bottom of the lower chamber under the feed wheel. When sufficient material had been forced from the lower chamber to allow its valve to be closed, the exhaust from the upper chamber was opened and the pressure reduced until the lower valve was held closed by the pressure in the lower chamber. The upper chamber was then again filled with the dry mixture, so that the feeding and discharge through the hose was continuous and uniform.

The feeding mechanism was operated by a paper wheel and friction disk controlled by a lever. The dry mixture passed through the feed wheel into the hose and was then picked up by air directly from the compressor and forced through the hose. The hose used was a 2-in. steam hose.

In the accompanying table is given an itemized statement of costs:

Table Showing Cost of Stuccoing 631 Square Yards of Surface With Cement Gun.

		Cost.	Cost per sq. yd.
Material for lathing:			
Cheese cloth, 631 sq. yd. at	$0.035	$22.09	
Building paper, 56.8 squares at	0.30	17.04	
Wire, 631 sq. yd. at	0.1278	80.64	
Lath, 500 sq. yd. at	5.25M	2.63	
Nails, 10 lb. at	0.04	0.40	
Staples, 200 lb. at	0.0425	8.50	
		$131.30	$0.2081
Labor for lathing:			
Carpenters......... 16 hrs. at	$0.5625	$ 9.00	
Carpenters......... 59 " "	0.50	29.50	
Carpenter helpers...144 " "	0.375	54.00	
Laborers........... 33 " "	0.218	7.22	
Laborers, Mexican.. 41.5 " "	0.156	6.49	
		$106.21	$0.1683
Total for lathing		$237.51	$0.3764
Material for plastering:			
Portland cement, 65 bbl. at	$3.43	$222.95	
Sand (at site)			
		$222.95	$0.3533
Labor for plastering:			
Nozzleman .... 96 hrs. at	$0.5625	$54.00	
Engineer ....100 " "	0.375	37.50	
Laborers, mixing..212 " "	0.156	33.13	
Laborers on wall..156 " "	0.166	26.00	
Laborer (hose) .. 59 " "	0.218	12.94	
		$163.57	$0.2592
Fuel:			
Gasoline, 97.5 gal. at	$0.22	$21.45	
Lubricants		4.90	
		$ 26.35	$0.0418
Total for plastering		$412.87	$0.6543
Total		$650.38	$1.0307

Time: 12 days.
AVERAGE: 52.51 sq. yd. per day.

The resulting cost per square yard appears rather high, but it must be remembered that the stucco is 1¼ in. thick (the average thickness is somewhat more owing to the stretching of the cloth between studding), the cement is high in cost, and efficient labor difficult to secure. The nozzleman was an experienced man, but all other labor was unfamiliar with the work.

As the building covered was relatively small and badly cut up by openings, the results given above are perhaps not quite fair to the "cement gun" as too much time was lost in moving the hose lines and the consequent starting and stopping, which has a tendency toward clogging the feed hose. Time was also lost by the wearing out of the feed hose about a foot from the hopper, due, apparently, to a whirling motion of the sand as it came from the hopper.

As has been stated, the gun was placed in a recess in the rear of the building so that the entire job was done without moving the plant. Fifty feet of hose was used and all parts were reached by running through window and door openings.

On the whole the apparatus is considered a success, certainly so if used on comparatively large surfaces where little changing of position is required. The quality of stucco secured is the principal argument in its favor.

OUR RAIL MILLS CAN HANDLE THE BUSINESS.

A despatch from Ottawa stated that importations of rails from the United States have been heavy and that Canadian mills could not cope with the demand. Mr. J. H. Plummer, president of the Dominion Steel and Coal Corporation, thinks otherwise. Interviewed at Sydney, he admitted an increased demand, but stated that if it had come to stay, the mills are well on the way to take care of it. It is not clear that the demand is permanent, he thinks. "There is a factor in the case naturally not known to the public. Rail contracts are made each fall for the whole of next season's requirements. The steel companies then proceed to make contracts for the balance of their output of steel. The present shortage represents demands which the railways did not foresee last fall, and it is useless to blame the rail mills. They could not afford to enter on the season's business with any considerable amount of steel unsold, and would be unable to take large extra orders for rails whatever their rail mill capacity might be.

"It is true that we are passing through a period of active railway building but that has been our condition for some years. The present output of 4,000,000 tons would lay over 3,000 miles of railway, and even in these days that represents great growth. In any case, so far from the steel companies being held up as having failed to keep pace with the requirements of the country, they are entitled to credit for having in the face of enormous and sudden growth in the demand for rails, been able to supply 90 per cent. of the consumption."

DIESEL OIL LOCOMOTIVE.

Much attention has lately been paid to the possibilities of the Diesel oil engine. So far it has not been used for locomotive purposes on road or rail, but, as was announced a few weeks ago. Dr. Diesel is at work with Messrs. Sulzer Brothers, at Winterthur, and Herr Adolph Klose, of Berlin, on a 1,000 to 1,200 h.p. Diesel locomotive. Steam locomotives have, of course, been made of much larger sizes, and the above engine will not, therefore, improve on its immediate predecessors in this respect, but it may be expected to show very large economies in fuel consumption. The Diesel engine proposed for this work is of the two-stroke cycle, four-cylinder type, having its cylinders arranged in pairs at an angle of 90 deg. The engine is directly geared to the driving wheels, and does not transform its power electrically. An auxiliary engine drives air pumps for giving increased torque when starting or when climbing a grade. The whole is expected to weigh about 85 tons. It will be seen that this locomotive gives the most direct form of challenge to the steam locomotive.

BRITISH COLUMBIA ELECTRIC RAILWAY.

New rules promulgated by the government of British Columbia will mean that the British Columbia Electric Railway Company will have to invest considerable money in new cars before the first of 1911. The principal regulation is in regard to overcrowding. In Vancouver, particularly, all cars are filled not only in rush hours but also in the early morning. With the new law in force, not only will the company be liable if this continues, but also those who crowd the car after it has its maximum number of passengers according to law. To carry the passengers offering, the number of cars will have to be almost double what it is now. If passengers are not taken care of, there is a provision in the agreement with the city to be invoked.

After a fight of several months' duration, it looks as if Point Grey will come to the British Columbia Electric. The by-law passed by the ratepayers last January was quashed, and since then no cars have been running in Point Grey. There has been complaint from many ratepayers. Now it is proposed to re-submit the by-law to the ratepayers with the necessary alterations, and on September 7th, the voting will take place. With no cars running, building has not been so active in Point Grey as was anticipated early in the year, though the sections reached by the city cars have gone rapidly ahead.

CANADIAN NORTHERN RAILWAY AND VANCOUVER.

The Canadian Northern and the city of Vancouver are still negotiating about a location on False Creek, and it is probable that an agreement will be reached, for the railway wants to get a site for terminals and the city wants the railway. The railway is willing to recoup the city for the $600,000 necessary to extinguish certain riparian rights, the borrowing of which money was approved by the ratepayers two weeks ago. In addition, it proposes certain improvements. On the other hand, some of the aldermen favor a rental basis, suggesting $120,000 per annum, this being reached by a valuation of $20,000 an acre.

After a long rest, the canal project between the head of Burrard Inlet and Pitt River has been revived. This would give the world-famed Coquitlam a sort of direct water connection with the sea.

RAILROAD EARNINGS.

The following are the railroad earnings for the week ended August 21st:—

	1911.	1912.	Increase or decrease.
C. P. R.	$2,267,000	$2,694,000	+ $427,000
G. T. R.	993,677	1,097,394	+ 103,717
C. N. R.	307,500	372,900	+ 65,400
T. & N. O.	37,499	31,899	— 5,600
Halifax Electric	5,706	6,308	+ 602

The gross earnings of the Canadian Pacific Railway for July, 1912, amounted to $12,052,399, the working expenses were $7,6(?)4,222, leaving as net profits $4,448,177. In July, 1911, the net profits were $3,703,028. The increase in net profits over the same period last year is therefore $745,149.

The statement of earnings and operating expenses of the Canadian Northern Railway Company for July shows an increase in net earnings over July, 1911, of $133,000:—

	July, 1912.	July, 1911.	Inc.
Gross earnings	$1,829,700	$1,475,900	$353,800
Expenses	1,335,100	1,114,300	220,800
Net earnings	494,600	361,600	133,000
Mileage in operation ..	4,297	3,711	586

CHEAKMUS RIVER POWER.

Messrs. Bloedel, Stewart and Welch, Limited, are applying for permission to develop a valuable water-power on the Cheakmus River, which empties into Howe Sound. The enterprise will be one of the largest of its kind in the province and if carried out will mean the expenditure of several million dollars. Messrs. Stewart and Welch are well known in Canada, being railway contractors, and the proposed power is located close to the route of the Pacific Great Eastern Railway, which will extend from Howe Sound to the north. Sufficient electrical energy may be generated to operate a large section of the railway and also for lighting and power purposes all through the district at the head of Howe Sound.

PERSONAL.

MR. R. F. PACK, general manager of the Toronto Electric Light Company, has tendered his resignation to the directors of that company.

MR. C. R. REDFERN has been appointed roadways engineer of the Department of Works, city of Toronto, in succession to Mr. A. A. Kinghorn, B.A.Sc., who has been appointed in charge of the day labor construction throughout the city.

C. H. C. WRIGHT, B.A.Sc., professor of architecture in the Faculty of Applied Science and Engineering, University of Toronto, has been elected recently a Licentiate of the Royal Institute of British Architects. It is not often this comes to a Canadian, and we congratulate Professor Wright most heartily on the honor.

MR. W. FRANK EVANS has been appointed manager of the new Concrete Reinforcement Department of Alfred Rogers, Limited. Mr. Evans will be remembered as the former chief engineer of the Expanded Metal and Fireproofing Company. He will attend to the sales of "Steelcrete" concrete reinforcement, for which Mr. Rogers has obtained

W. FRANKLYN EVANS.

the agency from the Consolidated Expanded Metal Companies of Pittsburg. Alfred Rogers, Limited, have already had extensive experience in concrete construction through the work of the cement sales department, which Mr. J. Lavelle has managed most capably ever since its organization some years ago.

OBITUARY.

GEORGE HALSTEAD, professor of engineering in the Manitoba University, died at his South Lancashire home on August 28th. He became ill while crossing to England and died from typhoid fever.

COMING MEETINGS.

CANADIAN GAS ASSOCIATION.—Fifth annual convention will be held in Toronto, August 24th to Sept 9th, 1912, during the Exhibition. Sec'y-Treasurer. John Keillor, Hamilton, Ont.

CANADIAN FORESTRY ASSOCIATION.—Convention will be held in Victoria, B.C., Sept. 4th-6th. Secy., James Lawler, Canadian Building, Ottawa.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Second Annual Meeting to be held in Toronto, Sept. 16, 17 and 18.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Annual Assembly will be held at Ottawa, in the Public Library, on 7th October, 1912. Hon. Sec'y, Alcide Chaussé, 5 Beaver Hall Square, Montreal, Que.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

EIGHTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.—Opening Meeting, Washington, D.C., September 4th, 1912. Other meetings, Business and Scientific, in New York, beginning Friday, September 6th, 1912 and ending September 13th, 1912. Secretary, Bernhard G. Hesse, Ph. D., 25 Broad Street, New York City.

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.—Sixth Congress will be held in the Engineering Societies Building, 29 West Thirty-ninth Street, New York, Sept. 2-7, 1912. Secretary, H. F. J. Porter, 29 West Thirty-ninth Street, New York.

ILLUMINATING ENGINEERING SOCIETY.—Sixth Annual Convention to be held at Hotel Clifton, Niagra Falls, Ont., Sept. 16-19, 1912. Secretary, Preston S. Millar, 29 West Thirty-ninth Street, New York.

AMERICAN ROAD BUILDERS' ASSOCIATION.—Ninth Annual Convention will be held in Cincinnati, December 3, 4, 5 and 6, 1912. The Secretary, 150 Nassau St., New York.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary. Professor C. H. McLeod.

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

OTTAWA BRANCH—
177 Sparks St. Ottawa. Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, W. D. Baillairge; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, Mr. Hugh B. Fergusson, 409 Carter Cotton Bldg., Vancouver, B.C. Headquarters: McGill University College, Vancouver.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-jack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

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

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm. Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

THE UNION OF NEW BRUNSWICK MUNICIPALITIES.—President, Councillor Siddall, Port Elgin; Hon. Secretary-Treasurer J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALTIES.—President, Reeve Forke Pipestone, Man.: Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

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

ASTRONOMICAL SOCIETY OF SASKATCHEWAN.—President, N. Mc-Murchy; Secretary, Mr. McClung, Regina.

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

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

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

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, 57 Adelaide Street, Toronto, Ont.

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

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, John Hendry, Vancouver. Secretary, James Lawler Canadian Building, Ottawa.

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

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

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary. H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

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