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Of this issue of the Street Railway Journal 8300 copies are printed. Total circulation for 1907 to date 222,350 copies, an average of 8235 copies per week.

Our Recent Volume

We rarely refer to our own publication in these columns, but we do not feel that we should commence a new volume without at least a brief reference to the record of the past six months. Since 1900 the Street Railway Journal has been published in two volumes during the year instead of one, and now a single volume, or that including the issues for six months, is larger than any volume of this paper for twelve months before 1900. In other words, during the last seven years the reading pages of this paper have increased in number more than 100 per cent, in spite of the fact that the subscription price has been reduced 25 per cent. The record for the past six months has been in the same ratio as that since 1900; that is, the reading pages in Vol. XXIX., or for the first six months of 1907, have increased slightly more than 14 per cent over the reading pages issued during the corresponding period last year. To be exact, the number of columns of reading matter published from January to July, 1907, amounted to about 2620, corresponding to 1310 pages, which, reduced to a basis of $3 a year, means practically nine pages of the Street Railway Journal for one cent. We have not referred in this analysis to the quality of the reading matter or to the improvement in this respect which we believe has accompanied the paper in its increase in size, but believe that we have demonstrated that for the reader who wishes to keep informed as to all of the important events in electric railroading—engineering, operating, financial, legal and news—the Street Railway Journal is indispensable.

Standard T-Rail Specifications

Considerable progress is being made in standardizing the specifications and contour of rails for steam railroad service. At its meeting in Atlantic City, June 20-22, the American Society of Testing Materials voted to adopt, subject to a letter ballot, the standard specifications for steel rails which it has had under consideration for some time, though making no radical change in their wording. This action has been followed by the more or less definite rumor that the new Pennsylvania specifications include the cropping of the ingot 25 per cent, instead of the much smaller percentage now general, and to be otherwise so rigorous that they will increase the price of rails some $5 a ton. No rails, however, have been purchased under these specifications, and it is quite probable that when made public they will be found not to agree with the somewhat vague estimates which have been made of their terms.

During the debate on the subject of rails which has been so rife during the past year or so, many claims have been made that it would be better to substitute open hearth for Bessemer steel, as the former is considered better on account of its lower percentage of phosphorus. On the other hand, certain experts claim that immunity from breakage in rails is not so much a question of such slight differences in composition as would be secured by changing to the open-hearth process, or freedom from piping as would be gained by cropping the ingot, as it is of speed in rolling. According to this theory, it is claimed that with the present heavy A. S. C. E. sections, it is very difficult to roll these heavy sections without finishing them at too high a temperature.

In the meantime, the selection of a new standard section of T-rail is being discussed by the experts of the railroads and rail mills, but final decision on this subject is being withheld pending the report of the rail committee of the American Society of Civil Engineers. This committee was appointed in 1902, when it was found that the present A. S. C. E. standards needed modification. It is understood, however, that the Pennsylvania specifications referred to above take up the question of section of rail as well as its manufacture, so that there are really two independent bodies of engineers working upon this question.

Fortunately, the subject is not so pressing with street railway companies, and they can well wait until the matter reaches a more definite stage with the steam railroad companies.

The Interpole Motor

The interpole construction has already won a good reputation in stationary motors intended for a wide range of load and speed. The fundamental idea of counteracting the armature field by superimposing upon it an opposed magnetomotive force is an old one, and the recent interpole construction is novel more in detail than in principle. It is natural to expect benefits from an application of the same principle to railway motors, and the only wonder is that the announcement of interpole traction motors made last week at Niagara Falls and Lake Champlain was so long delayed. The papers by Messrs. Anderson, Hill and Renshaw, which we have already placed before our readers, put the principles involved very clearly and give good reason for some confidence in the excellence of the results. It must not be supposed, however, that the commutating pole is a panacea for all the ills that motors are heir to. As in the case of compound winding of generators, there are limits to be faced, and one can neither invoke compounding to remedy bad design nor to increase indefinitely the overload capacity. Intelligently applied, it is extremely useful and important. Just so with the commutating pole; it can do much but not everything, and it must be wisely applied and carefully designed in order to produce the best commercial results. It has some conspicuous virtues and a good many "talking points" to its credit.

Until the recent light broke upon us, we had, however, been under the impression that in recent railway motors sparking had been pretty thoroughly eliminated, so that heating was the thing which set a limit to good performance. We hardly know whether to confess our error and retract or not. Would we become the more beloved by taking the one horn of the dilemma or the other? With all seriousness, we are convinced that the interpole motor is theoretically excellent and practically very useful in certain cases. How thoroughly its range of applicability covers the field of electric traction remains to be shown by practice. It should seemingly make it rather easier to construct motors for high voltage, yet the maximum of 1700 volts for a 250-hp motor with an 18-in. commutator is not a very startling dénouement. M. Thury has already built a number of generators of similar output, six-pole machines at that, which are reported to give excellent commutation. It will doubtless prove somewhat easier to build a compact, high-voltage motor with commutating poles than without them, and for this gain there is good reason for congratulation. The coming of a practical and reliable large railway motor for 1500 to 2000 volts will certainly put a new face upon the heavier railway work. However well the single-phase commutating motor may turn out, we doubt whether even its most enthusiastic friend expects it to run with as perfect commutation as can be obtained in a d. c. motor of similar weight and output. The question is rather whether the a. c. motor will commutate satisfactorily considering its other advantages.

The future of the interpole motor—so far as heavy traction is concerned—must be determined by its own performance. A three-wire system worked on a four-motor equipment arranged in pairs, with 3000 to 4000 volts between the outside wires, would be an important addition to our means of heavy traction. It would give a thousand horse-power with hardly 300 amps. input, an amount of current that can be managed without great difficulty even from overhead conductors. For high-speed work it would be feasible, as Mr. Anderson indicates, to raise the voltage per motor even higher. With 5000 volts between the outside wires, the gain in distribution would be so great as to push a. c. operation hard, and especially if it be considered necessary to drop the frequency to about 15 cycles to get the best operating conditions.

This subject was also discussed at the Institute meeting, but until more operative data from large single-phase motors are available this question of frequency must be considered an open one. Certainly few engineers would wish to go to 15 cycles if good operation could be attained at 25. The commutating pole d. c. motor with its possibility of somewhat higher voltage most effectively strengthens the hands of engineers who, like Sprague, Parshall and Hobart, look with distrust on commutating single-phase motors. As we have many times intimated, high voltage on the working conductors is the desideratum in heavy electric traction; how it gets there and how it may be utilized are matters of minor importance. If the commutating pole construction can put 3000, 4000 or 5000 volts at our command with a simple and efficient motor equipment, a long step in advance will have been taken. It is now up to the builders of such motors to put them into active service and prove their virtues on a commercial scale.

The commutating pole motor is now also being built in considerable quantities for ordinary voltages. For this purpose it possesses many advantages over the older type, and while flashing over may occur, it is thought that by removing the incipient cause—sparking under the brush—together with copper and carbon dust, the chances of its occurrence would be greatly reduced. But although the gain in motors for ordinary voltage from this construction may be very material, it is insignificant compared with the possibilities in the larger sphere of electric traction.

Lightning and Lightning Protection

The papers on transmission line construction and lightning protection presented at the Niagara Falls convention of the A. I. E. E. give sufficient evidence that there are a great many things which are not yet fully understood with respect to the troubles inherent in high-voltage transmission. Lightning has been from the beginning one of the most serious difficulties with which electrical power transmission has had to contend. It has been one of the most frequent causes of failure of service, to say nothing of the more direct damage produced by the burning out of machinery and instruments.

Lightning, in popular parlance, has generally included all serious and destructive high-voltage phenomena. In a certain sense this very loose classification has justified the use of certain preventive machines, applied with equal efficiency, or lack of it, to all high-voltage discharges, however produced. Many genuine effects of lightning are merely induced discharges, and are comparable with the electrical forces properly belonging to the line. Direct thunderbolts falling upon the line are comparatively rare, but are so dangerous that they constitute a very serious peril to transmission systems. It is toward the averting of this particular risk that this discussion bears. Speaking broadly, attempts to diminish lightning risks have followed three lines of operation; first, the insulation of lightning protective devices; second, the erection of lightning arresters or their equivalent to keep the lightning off the transmission circuit; third, such general strengthening of the insulation as to minimize the destructive effects of lightning.

Until comparatively recently the first course mentioned was the chief reliance of the engineer. There was a strong tendency to install more and more so-called lightning arresters along the line, so that if a line was struck by lightning an easy path to earth would be available. As time has gone on experience has tended to show that too great multiplicity of lightning arresters is almost as dangerous to continuity of service as their absence would be. Lightning arresters installed within the station to protect a definite group of valuable machinery is one thing; lightning arresters installed upon a line where they cannot be kept under observation are quite another. Arresters installed far out upon the lines are so many possible sources of formidable grounds that are likely to put the circuits out of business. This fact, however, does not argue against the use of the lightning arrester to protect certain exposed points of the line when the arrester installed there can be properly taken care of. In very many transmission systems there are exposed spots where, for example, the line passes over bare hill tops in a district of frequent thunder storms. Such points may be very suitable for the installation of protective apparatus.

Of late the introduction of steel tower transmission lines has greatly improved conditions with respect to protection against lightning. Such towers are peculiarly exposed to lightning, being pointed metallic structures of considerable height. In addition, for some reason which we never have been able fully to comprehend, constructors of tower lines have insisted, as a rule, upon making even the cross-arms of steel, thus throwing the whole responsibility of line insulation directly upon the insulators themselves. In a good many instances the result has been disastrous to continuity of service, since any failure of the insulator, however small, is likely to produce a dangerous ground. Given such structures, it was almost instinctive to try to convert them into lightning rods by pointed extensions carried well above the topmost wire. This construction has been at times heralded as a panacea against troubles from lightning. It unquestionably averts a certain proportion of strokes which might otherwise prove disastrous, but indications are that the protection is very far from being complete. The next natural step was to install a grounded wire well above the other wires, thereby in a measure bringing the earth potential up above the level of the transmission wires. A certain measure of protection is undoubtedly afforded by this procedure. Unfortunately, however, in a steel pole line the earth potential already comes fairly within the interiors of the insulators, only a few inches at most from the high-voltage wires, and lightning is quite apt to take this convenient path instead of the adjacent one cleverly provided.

Lightning rods and grounded wires seem rather to be palliatives than effective remedies, and in the last resort the burden of protecting the line is again thrown back upon the insulators. It is in improving the insulator itself that the best chance for added protection may be found. The greater the insulation strength of these the less likelihood that minor lightning discharges will break down the line and the better chance that a direct lightning stroke will take to the grounded wire rather than to the grounded cross-arms over or through the insulator.

A 50,000-volt line equipped with insulators having a factor of safety of three has 100,000 volts' worth of insulation to spare against an attack of lightning. The same line with a factor of safety of two has only 50,000-volt surplus to the good, while a 5000-volt line with the same factor of safety has but 5000 volts to spare. One ought, therefore, to find a very considerable protection against lightning in a high factor of safety in the insulator and in the use of such working voltages that this factor of safety shall have a large absolute value. We should expect upon the whole, therefore, to find high-voltage lines standing up against lightning better than those of lower voltage, owing merely to greater absolute spare insulation strength. The report of the committee on this subject before the National Electric Light Association bears out quite strongly this view of the case. The statistics of the last year indicate, as in the case of previous reports, that circuits of, say, 5000 to 10,000 volts and below, show in proportion to their numbers much more frequent damage by lightning than really high voltage systems and a considerably smaller percentage of complete immunity from damage. To be perfectly fair, one should perhaps eliminate from this reckoning the distribution plants operating at about 2300 volts, on account of their relatively very great mileage of exposed wire; but even after this is done inspection shows that the high-voltage plants, with their great absolute insulation strength, seems still to have considerable advantage.

It would probably be impracticable actually to insulate a line against heavy lightning discharges. It is comparatively easy, however, so to insulate it as greatly to increase the chances of effective operation of auxiliary protection such as is afforded by grounded wires, lightning rods, and other protective devices. The question of safety in the last resort is, therefore, put squarely up to the insulator, and the greatest need of electrical power transmission resolves itself to-day into better insulators with increased factors of safety.

A. C. ELECTRIFICATION ON THE ILLINOIS TRACTION SYSTEM

BY JOHN R. HEWITT

The Illinois Traction System is, without doubt, one of the largest electric traction interests in the country. It embraces every phase of interurban railroading and is at the present time extending in all directions in an astonishingly rapid manner. We believe that we are correct in stating that all the lines constituting this system were constructed by the Central Illinois Construction Company, and that they are operated by various operating companies which, in their turn, comprise the McKinley Syndicate.

The object of the present article is to deal with the extensive a. c. single-phase lines recently put into commission, together with those under construction which are to be put into operation in the near future, and to describe the apparatus employed in their operation; but owing to the many features of peculiar interest in this system as a whole, it seems advisable to preface this description with a few general remarks covering the most salient points.

The map published herewith in Fig. 1 will give a general idea of the territory served and the accompanying table will show the names of the different operating companies, the mileage of each line and method of operation, whether a. c. or d. c. At present the total mileage in operation amounts to 381.5 miles, and the proposed lines aggregate approximately 90 miles, making a total of 471.5 miles of road that will be in operation in the near future. Of these, 95 miles are at present operated on, or being equipped for, the a. c. single-phase system.

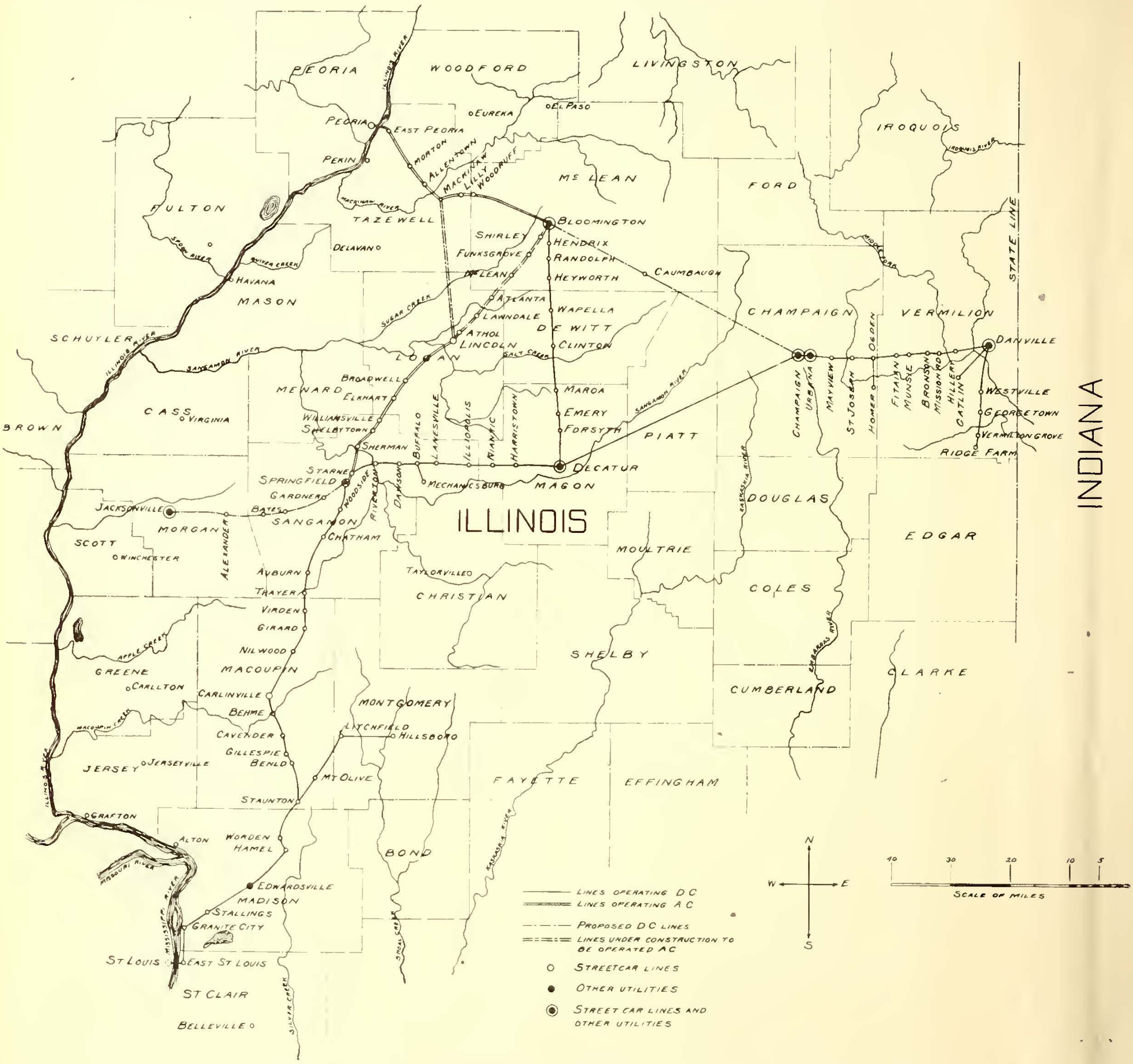


FIG. 1.—THE PRESENT AND PROPOSED LINES OF THE ILLINOIS TRACTION SYSTEM

Besides the roads already mentioned, it has been announced in the daily papers that a road, in connection with the Illinois Traction System, is to be constructed between Bloomington and Chicago, but it is too early to make any definite statements concerning this at the present time.

Over and above the operation of these electric roads as outlined above, the Illinois Traction System controls the city street railway lines in numerous cities in the Middle

West and provides for other public utilities, such as power and light, in these districts. Some of the towns served in this manner are indicated on the accompanying map, but in this respect the map is incomplete.

To operate this vast system there are at present nine power houses, located, respectively, at Danville, Champaign, Decatur, Bloomington, Peoria, Riverton, Edwardsville, Venice and Jacksonville. Most of these have already been described in the columns of the Street Railway Journal.

The sub-stations, which are widely distributed over the system, are too numerous to describe in an article of this length, but at the same time it is interesting to note that considerable use is made of portable sub-stations, which can be used with such good advantage on a system of this size to reinforce the power on any portion of the road that is overloaded temporarily from any cause, or to provide power when construction work is being done which would otherwise cripple operation.

As is evident, the equipments are very numerous and comprise cars of many different types and a large variety of electrical apparatus. The cars range from the smaller type of street car to some of the finest specimens of interurban cars to be seen on the continent of America; prominent among these are the handsome sleeping cars running between St. Louis and Decatur, which have already been fully described.

The freight business, in all probability, has reached larger proportions on this system than on any other system of electric roads in the country; two 50-ton. d. c. electric locomotives are in daily operation, and a 40-ton a. c. locomotive will shortly be put into service on the newer sections of the road. Practically all the coal used in the various power houses is hauled over the syndicate's own roads electrically, and a very extensive business is being carried on in handling coal for domestic purposes as well.

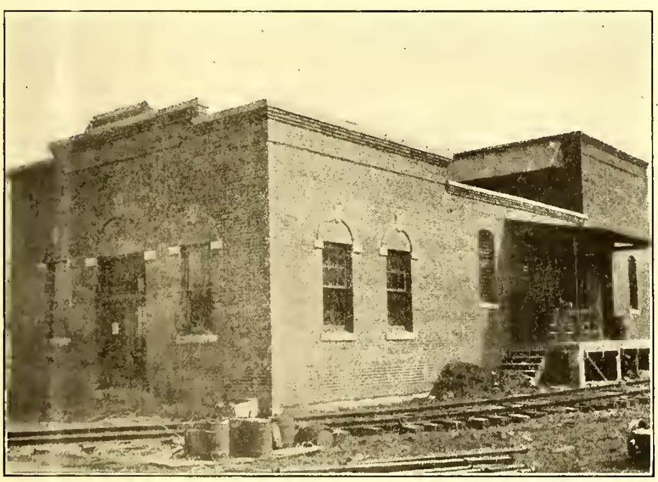


FIG. 3.—EXTERIOR OF DANVERS SUB-STATION, FREIGHT HOUSE AND WAITING ROOM

Carload lots of cattle and grain are also hauled by the electric locomotives, and a great deal is done in the direction of the express business. The usual load for the electric locomotive varies from ten to twelve loaded cars. To facilitate the handling of such large quantities of freight, belt lines are being built around many of the larger cities, notably at Springfield and Decatur. There are freight depots in all the towns and cities connected by the various lines.

Confining our attention now to the a. c. system recently put into operation and to those roads about to be converted from d. c. to a. c., the line from Peoria to Bloomington, which is 38 miles in length, is already in daily operation with single-phase current. This section was first operated from terminal to terminal on the new system on Sunday, April 1.

The line from Springfield to Lincoln, 30 miles in length, is at the present time in daily operation with direct current, but the catenary line is erected for high-tension a. c. operating and the sub-station buildings are completed, while the apparatus is at present being installed. This section will change from d. c. to a. c. operation in the course of a week or two.

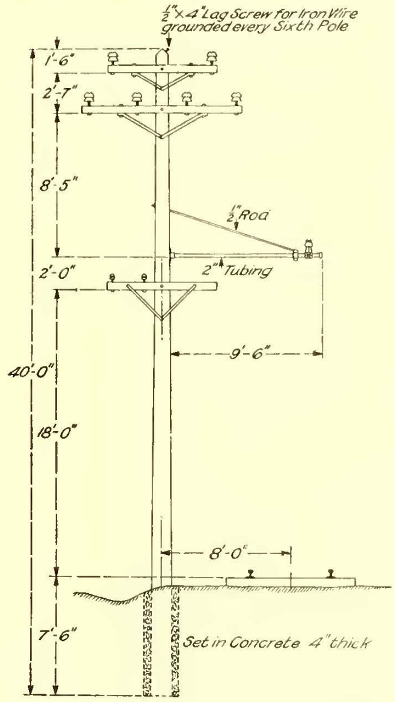


FIG. 2.—DETAILS OF HIGH-TENSION TRANSMISSION LINE

The road from Lincoln to Mackinaw, which will be operated a. c., will be approximately 27 miles long and is at present under construction.

GENERAL SCHEME OF ELECTRIFICATION

The general scheme of electrification of these roads now operating a. c. and those about to be put in operation during the next few months is as follows:

The power is generated at the new Peoria power house at a pressure of 2300 volts. It is stepped-up to 33,000 volts in the power house and is fed to the transmission line at this pressure. At the sub-stations this potential is reduced to 3300 volts for feeding the trolley. There are power houses situated at Bloomington and Decatur, from which it is also proposed to feed the transmission line if occasion demands.

To render this description more concise and avoid confusion, the Peoria to Bloomington section will be described in detail as being typical of the a. c. construction and equipment throughout. Special mention will be made where details of other sections differ to any marked degree.

POWER HOUSE

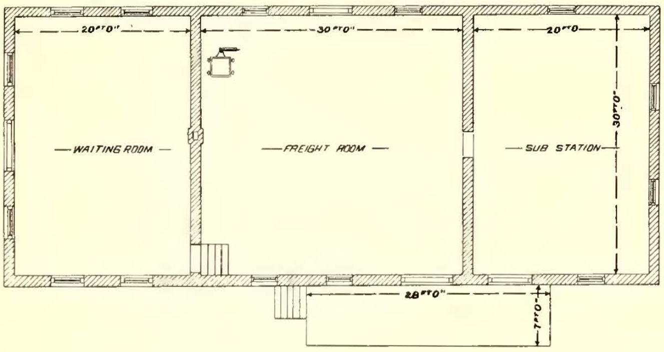
The steam equipment of the new power house, recently erected at East Peoria for supplying energy to the Peoria-Bloomington line, is a red brick structure with a roof of reinforced concrete and concrete floors.

The electrical equipment includes two Curtis turbines, each of a capacity of 2000 kw; these are four-stage condensing units operating with an average vacuum of 29 in. and at a normal speed of 750 r. p. m. The generators themselves are three-phase, 25-cycle General Electric machines; each has four poles and delivers current at a pressure of 2300 volts.

Two General Electric rotary converters have been installed to supply power for the city service; these are 750-kw, 10-pole, 25-cycle units running at a speed of 300 r. p. m., and supply 1250 amps. at 600 volts.

There are thirteen transformers in all—six 700-kw Westinghouse units wound for 33,000-2300 volts and six 250-kw Westinghouse transformers wound for 33,000-430 volts. The thirteenth is a General Electric transformer of 75-kw capacity, and is wound for 33,000-2300-1150 volts. All of these transformers are oil-insulated and water-cooled.

Two exciter sets are provided for supplying current to the



GROUND PLAN.

FIG. 4.—PLAN OF DANVERS AND MORTON SUB-STATIONS

fields of the main generators; one of these is a turbo exciter set and the other a motor-driven set. The former is a 75-kw, four-pole, horizontal Curtis turbine set, running at 2400 r. p. m., and supplies 600 amps. at 125 volts, while the latter consists of a 100-hp, 25-cycle induction motor direct coupled to a 70-kw generator which has a speed of 500 r. p. m. and supplies 560 amps. at 125 volts.

The other principal items among the auxiliary apparatus are as follows: Two Wheeler condensers of the surface type, two horizontal air pumps by the Wheeler Condenser Company, one circulating pump and two feed-pumps by Dean Brothers; there are also two step bearing and two step bearing return pumps. The feed-water heaters are of the Cochrane type, manufactured by the Harrison Safety Boiler Works.

The boiler room is equipped with eight Stirling water-tube boilers, each having a capacity of 500 hp and providing steam at a working pressure of 190 lbs. per square inch. These boilers are stoked mechanically by motor-driven chain grates.

This description of the power house is far from complete, as a long and more detailed article will be published in the near future which will deal with the Peoria power house alone, and, therefore, will give fuller particulars.

HIGH-TENSION TRANSMISSION LINE

The illustration, Fig. 2, will show the details of the high-tension transmission line, and it will be seen that it does duty for supporting the trolley wire. Ultimately the transmission line will be in duplicate, but at present only three wires are strung.

The high-tension voltage is 33,000, three-phase, at 25 cycles per second. The wires are of No. 2 B. & S. hard-drawn copper supported on Locke No. 312 porcelain insulators tested to a pressure of 60,000 volts. The insulators are fixed to truss pins of malleable iron.

The pole line will certainly rank as one of the prettiest pole lines in the country; every pole is wonderfully straight and has the appearance of being turned in a lathe. They are of Spokane cedar, 40 ft. in length, with a diameter of 7 ins. at the top and range from 12 ins. to 14 ins. in diameter at the base. The poles are buried to a depth of 7 ft. in the ground, each being planted in cement, and, where the poles were planted on fills before the grading was completed, they are buried in barrels of cement.

The upper cross-arm, which is not at present in place, will carry two insulators, will be 4 ft. in length, and have a section of 3¼ ins. x 4½ ins. The lower arm carries four insulators, is 10 ft. long, and has a section of 3¾ ins. x 5¾ ins. The cross-arm for supporting the telephone insulators is 4 ft. in length. All the cross-arms are stiffened by means of galvanized iron angle braces. The distance from the center of track to the center of poles is 8 ft. The relative height of these cross-arms, the spacing of insulators and other dimensions will readily be seen by reference to the cut, Fig. 2. The poles are spaced 140 ft. apart on straight, level tangent, and at curves and street crossings the spacing is usually reduced to 100 ft., but this distance is varied to suit any special conditions.

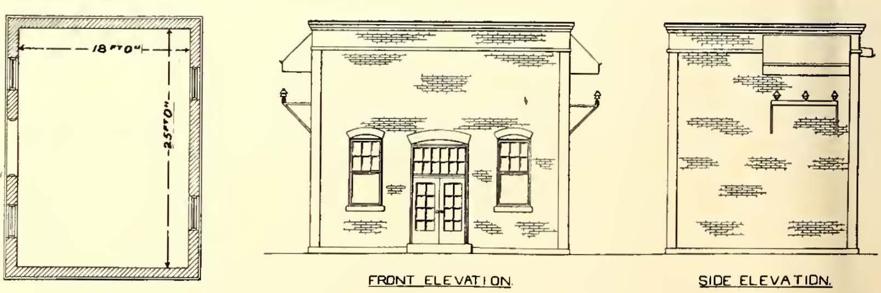
An efficient means of protecting the transmission line from damage by lightning is afforded by a No. 6 B. & S. galvanized iron wire strung for the entire length. This wire is grounded at every sixth pole and the ground wire is stapled to the poles at intervals of 3 ft. The wire is attached to each pole by means of a lag screw and two washers, the wire lying between the washers and being tied on either side of the lag screw by means of a length of iron wire which has its ends turned up for a distance of 6 ins. in a horn fashion. This device will add materially to the efficiency of the lightning protection.

SUB-STATIONS

The sub-stations on the Peoria to Bloomington section are located at Danvers and Morton, while the Springfield to Lincoln section is provided with sub-stations at Selbytown and Lincoln, and when this line is finished through to Mackinaw additional sub-stations will be built.

The Danvers and Morton sub-stations are identical in all respects. The external view shown in Fig. 3 and the plan in Fig. 4 will give a good idea of their general features.

It will be seen that a waiting room, freight house and sub-station are combined in one building, which, it may be interesting to note, is also a feature of a large number of the sub-stations on the different d. c. lines of the Illinois Traction System. The great advantage in this instance is that the man in charge of the freight house and waiting



PLAN.

FIG. 5.—PLAN AND ELEVATIONS OF DANVERS AND MORTON SUB-STATIONS

room can perform all the necessary work in the a. c. sub-station, which requires no attention excepting when the oil switch is thrown by an excessive overload. This arrangement entirely avoids, on the one hand, unnecessary delays when the switch is thrown, or, on the other hand, the expense of keeping at the sub-station an employee who would necessarily be idle for practically the whole time.

The buildings are of red brick with reinforced concrete ceilings and concrete floors. The dimensions of the sub-stations proper at Danvers and Morton are: Length, 30 ft.; breadth, 20 ft., and height, 21.5 ft.; while those at Selbytown and Lincoln, which have no freight house or waiting room attached, are slightly smaller, being 25 ft. in length, 18 ft. in breadth and 21.5 ft. in height. Fig. 5 shows the plan and two elevations of the Selbytown and Lincoln sub-stations.

The equipment of those sub-stations already built as regards their main features and the capacity of electrical apparatus installed is identical. Each has a capacity of 400 kw, there being two 200-kw, 25-cycle transformers installed. These units are wound for 33,000 volts on the primary side and 3300 volts on the secondary; they are standard G. E. transformers and are controlled on the high-tension side by two K-6 oil switches, interlocked to form a double-pole unit. The low-tension side is controlled by a single pole form K-2 oil switch, which is mounted on the back of the low-tension panel. In addition to these switches there are three K-6 oil switches, for sectionalizing the high-tension transmission line, which are interlocked in such a manner as to form a triple pole unit. Two single-pole, 33,-000-volt air brake disconnecting switches are provided for connecting the oil switches controlling the high-tension side of the transformers to either side of the line sectionalizing switch, and in this manner to enable the sub-station being fed from either end of the line as desired.

Between the oil switch controlling the high-tension side of the transformer and the transformers themselves, there are four 33,000-volt disconnecting switches, two for each

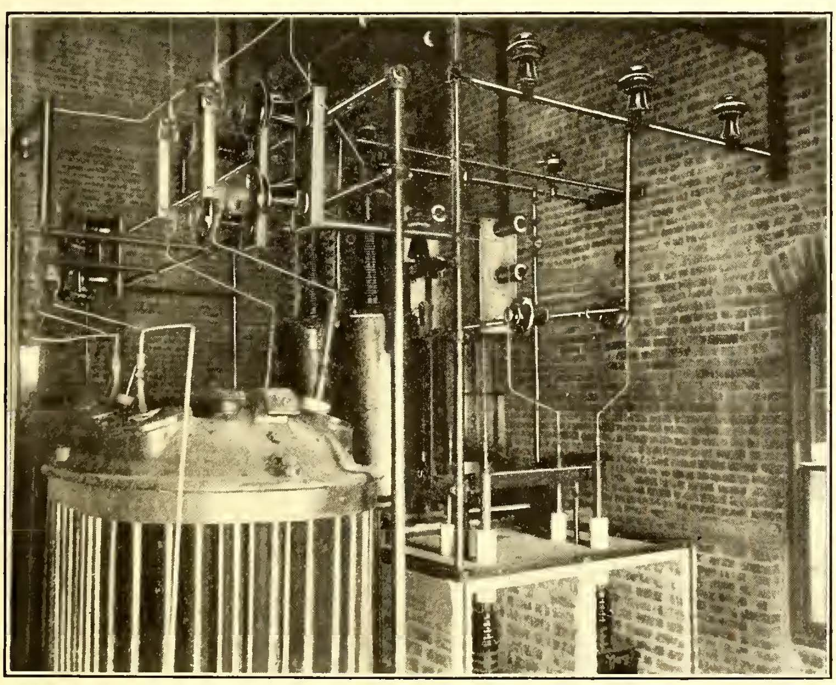


FIG. 7.—TRANSFORMER SWITCH COMPARTMENTS, ETC., IN THE MORTON SUB-STATION

transformer, which enables either unit being cut out of service at will, and in a similar manner two 3300-volt disconnecting switches are provided in the secondary circuit between the low-tension oil switches and the transformers. One lead from the low-tension side of each transformer is connected to a bus situated beneath the floor that leads to the track outside of the building.

The wiring diagram given in Fig. 6 will clearly demonstrate the relative positions of the various switches and also of the other electrical apparatus, while the views reproduced in Figs. 7 and 8 will show the actual position of the high-tension wiring, etc. A plan showing the arrangement of the electrical apparatus is given in Fig. 9, which

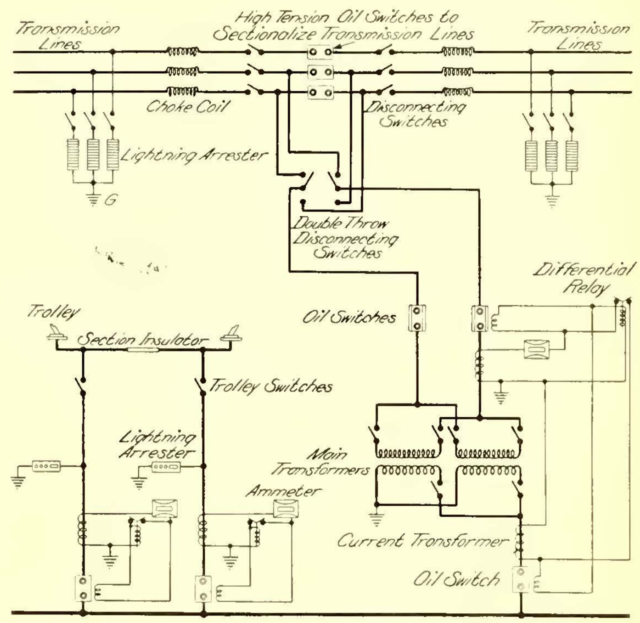


FIG. 6.—WIRING DIAGRAM FOR SINGLE-PHASE SUB-STATION AT MORTON AND DANVERS

arrangement is identical in all four sub-stations. In the Danvers and Morton sub-stations three transmission wires pass through the building, while at Selbytown and Lincoln only two wires are used; their appearances will be noted in Figs. 6 and 9, respectively.

The switchboard in each sub-station consists of four panels:

(1) A line section panel on which is mounted the operating mechanism for the line section switch.

(2) A high-tension transformer panel which controls either or both of the transformers, according to how many of the disconnecting switches are in circuit; on this panel there are mounted an ammeter, the operating mechanism for the double-pole, high-tension transformer oil switch and a differential relay.

(3) A low-tension transformer panel provided with an ammeter, the operating mechanism of the low-tension oil switch and an inverse time limit overload relay of the bellows type.

(4) A double-pole feeder panel equipped with two ammeters, two oil-switch operating mechanisms, and two inverse time limit relays of the bellows type. The feeder panels are illustrated in Fig. 10, which also shows the feeders passing through the sub-station wall to the trolley.

The relays on the low-tension transformers and feeder panels are made "time limit" in order to prevent their tripping when a large current is taken during the acceleration of the cars; they are set for about five seconds.

The differential relays on the high-tension transformer panels are not used at either Morton or Danvers, as the baggage man in these stations is called by an alarm bell whenever an oil switch is thrown. The differential relay will be used as an overload relay without any time limit feature, but it will be set to trip only on the most severe overload conditions.

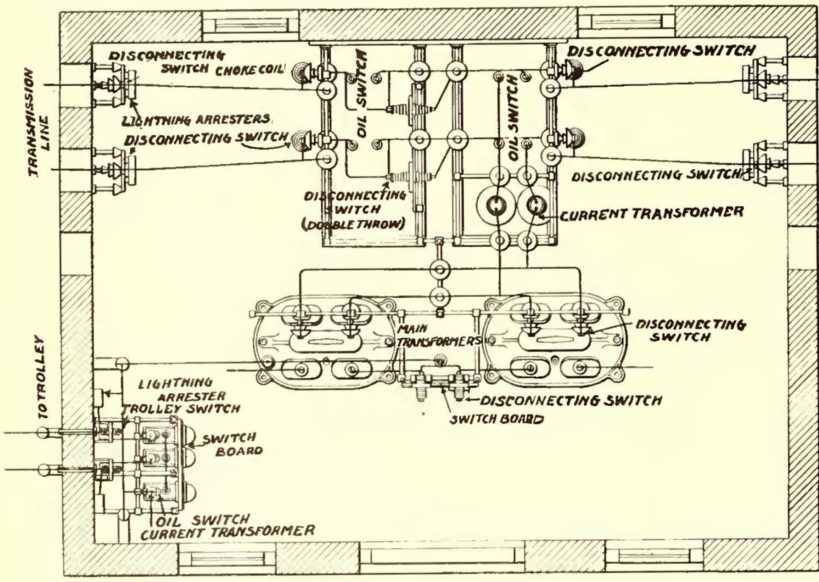


FIG. 9.—ARRANGEMENT OF APPARATUS IN SUB-STATION

As the sub-stations at Morton and Danvers stand back some distance from the transmission line, it was decided to bring the lines over the front of the building, and hence the lines both enter and leave the sub-station at the front. Fig. 11 will show the details of construction where the lines enter and leave the building and the method of protecting the leads from weather; this picture was taken on the roof of the Danvers sub-station.

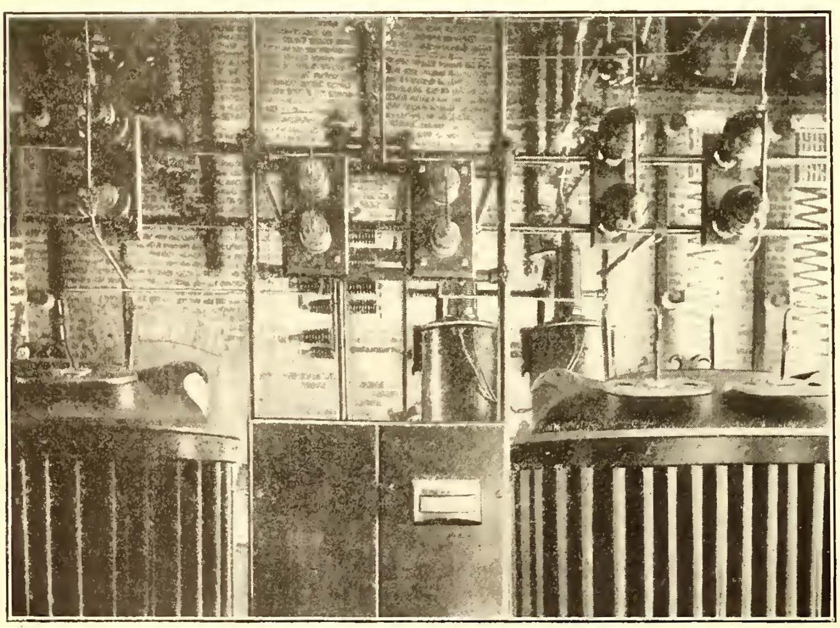


FIG. 8.—ELECTRICAL APPARATUS AND HIGH-TENSION WIRING IN MORTON SUB-STATION

OVERHEAD CONSTRUCTION

The remarks already made concerning the high-tension transmission line apply in a large measure to the trolley construction, isasmuch as the transmission line poles serve for supporting the brackets; the whole of the overhead construction has a strikingly neat appearance. As is usual with single-phase railways, the trolley is of the catenary suspended type, consisting essentially of a 000 grooved copper wire suspended from a steel messenger cable; the latter is composed of seven strands of No. 11 B. & S. galvanized steel wire. The diameter of the messenger cable is 7/16 in. The potential of the trolley is 3300 volts at 25 cycles, and the messenger is supported on Locke No. 1032 insulators.

The main portion of the road is provided with the bracket type of construction, but through towns and cities of any size the span construction has been adopted. Figs. 12 and 13 are typical pictures of the line;

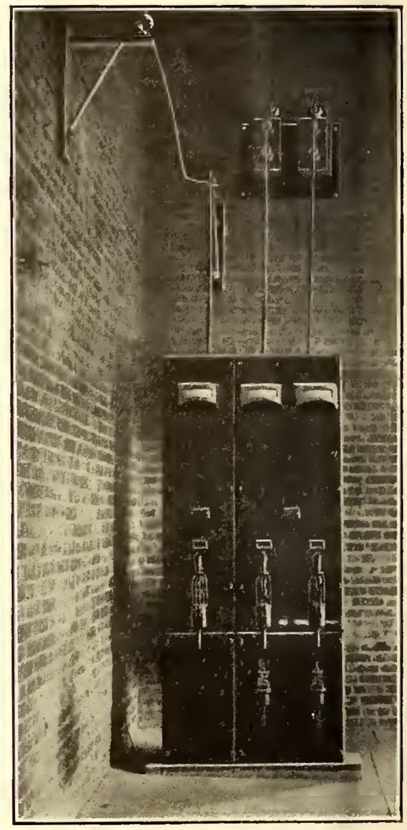


FIG. 10.—FEEDER PANELS IN THE MORTON SUB-STATION

Fig. 14 shows some special span work at the outskirts of Morton, while Fig. 15 illustrates the span construction through Danvers and further shows the point at which the high-tension transmission line enters the sub-station. This latter picture was taken before all the hangers were in position.

The details of the bracket construction will be seen by referring back to Fig. 2. The bracket proper consists of an iron pipe 2 ins. in diameter and 9 ft. 6 ins. in length spiked to the pole in the usual way. The bracket is 20 ft. above the track, making the distance from trolley to track 18 ft. and the height of the messenger cable above the track at insulators 20 ft. 6 ins.

As has been previously mentioned, the poles are spaced 140 ft. apart on straight, level tangent track. The three-point suspension has been adopted, which gives a support to the trolley from the messenger every 46 ft. 8 ins. The suspension on curves and crossings are correspondingly closer together when the spacing of the poles are reduced. The illustrations, Figs. 16, 17 and 18, on the next page, will give a good idea of the form of hangers used, the views being confined to apparatus which has not previously been described in this paper. All of the line material was made by the General Electric Company. Fig. 16 shows the intermediate hangers; they consist of malleable iron "grips" or "sister hooks" and malleable iron clamps riveted to a stem of machine steel 1/8 in. x 5/8 in. The center point hanger, which is also made of malleable iron, is similar to that illustrated in an article by the author, published on page 556 of the Street Railway Journal for Oct. 13, 1906. The grips of these clamps, as is the case with the intermediate hangers, are closed when in place so as to grasp the messenger cable. Fig. 17 shows the form of hangers used with bridle pull-offs; in this instance the stem is a steel rod. The bridle arrangement consists of pulling the hanger off at both top and bottom, which keeps the trolley and messenger in the same alignment and prevents tripping. All the pull-off wires, guy wires, etc., are insulated by means of hickory strain insulators. Fig. 18 shows the type of catenary anchored hangers used. The trolley is anchored every 1000 ft., in addition to the anchors at the approach and end of each curve.

On straight tangent track the trolley is staggered 10 ins. every 2800 ft., to prevent excessive wear of the pantograph current collector. Besides the pull-offs and push-offs at every curve, there will be steady braces at each staggering point; these steady braces are essentially the same as the push-offs; the insulating material is hickory wood.

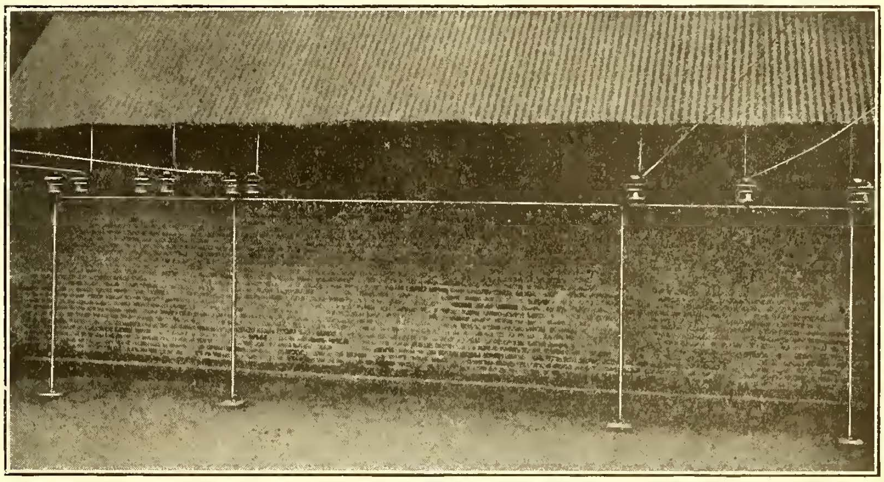


FIG. 11. VIEW TAKEN ON THE ROOF OF THE DANVERS SUB-STATION, SHOWING PROTECTION OF HIGH AND LOW-TENSION LEADS

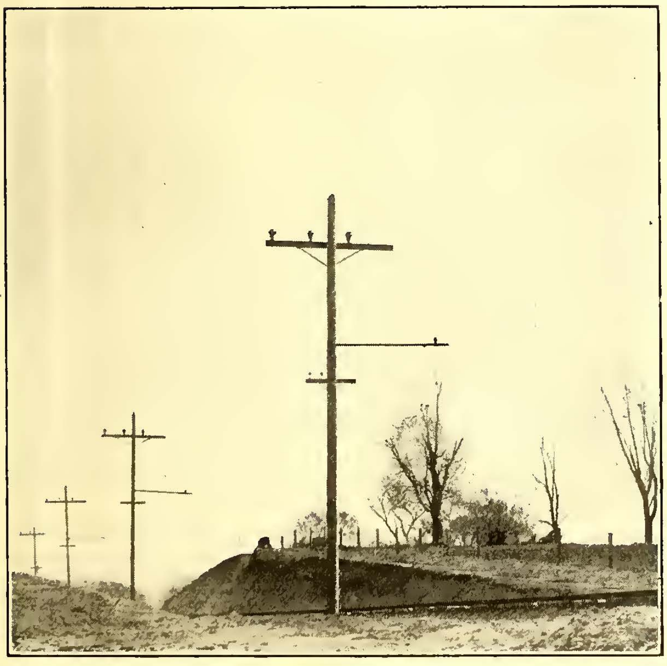


FIG. 13. TRANSMISSION LINE AND BRACKET CATENARY CONSTRUCTION NEAR BLOOMINGTON

The type of section insulator used is shown in Fig. 19; there is a section insulator at each sub-station and one between sub-stations. The dead section, where the a. c. trolley ends and the d. c. trolley begins, is composed of two such section insulators with a 40-ft. length of dead trolley between. Dead sections are situated at about a mile from the terminal at each end of the line.

THE TRACK

The track from Bloomington to Peoria is laid with 70-lb. rails of the standard A. S. C. E. section spiked to the ties in the ordinary manner. The gage of the track is standard, and is bonded throughout with G. E. 10-in. ribbon bonds with solid copper terminals 7/8 in. in diameter. Each bond has a capacity equal to that of a 0000 trolley wire. The cross bonds are made of 000 trolley wire provided with

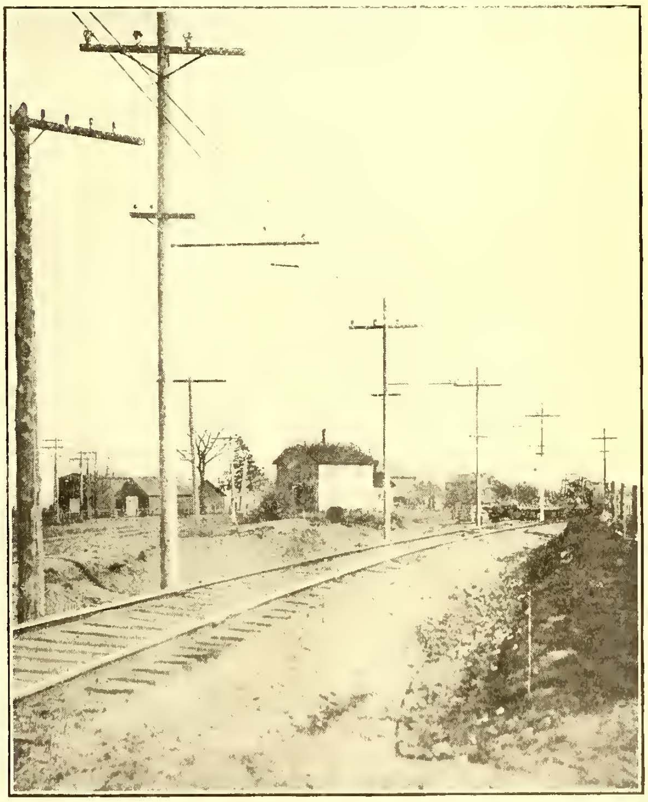


FIG. 12.—TRANSMISSION LINE AND BRACKET CATENARY CONSTRUCTION NEAR MORTON

standard G. E. terminals. Continuous rail joints are used throughout, which cover the bond and avoid any chance of theft. The ties are of white oak of standard dimensions, namely, 8 ft. long, with a section of 8 ins. x 6 ins. They are spaced with 2-ft. centers. There are no very severe

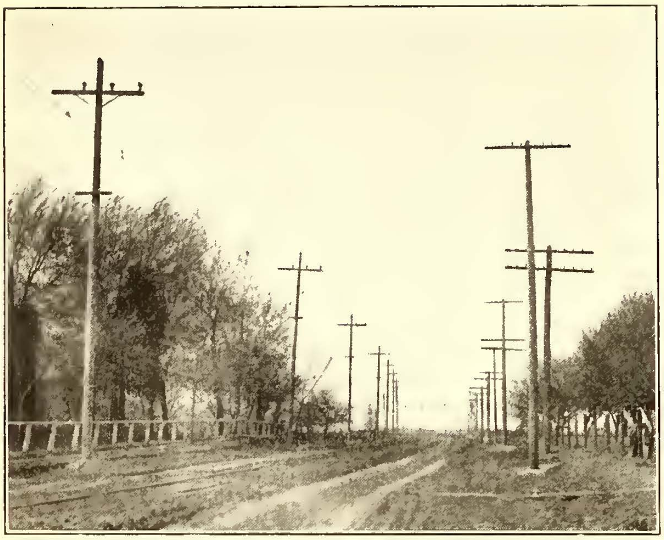


FIG. 14.—VIEW SHOWING SPECIAL CATENARY CONSTRUCTION THROUGH MORTON

curves on the road, but some of the grades amount to 2½ per cent.

Fig. 26 illustrates the handsome steel bridge erected across the Illinois River to East Peoria. It is 800 ft. in length, with five spans, one of which is a bascule draw span operated electrically from the Peoria power house.

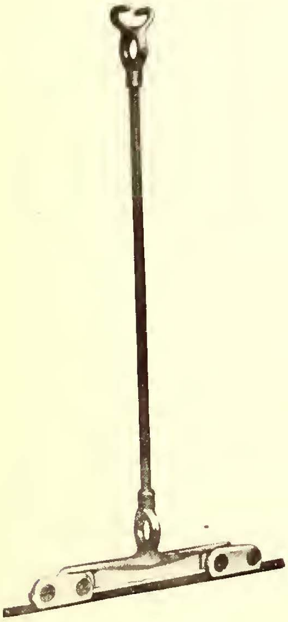


FIG. 16.—INTERMEDIATE SUSPENSION

FIG. 15.—CATENARY CONSTRUCTION THROUGH DANVERS

The piers are of concrete. A truss bridge with a span of 120 ft. has been erected across the Mackinaw River at Mackinaw.

THE ELECTRICAL EQUIPMENT OF CARS

At the present time there are ten cars, and in the near future ten additional cars will be placed in service. Each car is equipped with four GEA-605 motors, which are 75-hp units capable of operating both a. c. and d. c. The motors are wound for a maximum of 250 volts; they have bar wound armatures of the iron-clad type wound with three coils per slot, which are connected to form a series drum winding. As these motors are of the same standard pattern as those which have been in operation on the Blooming-

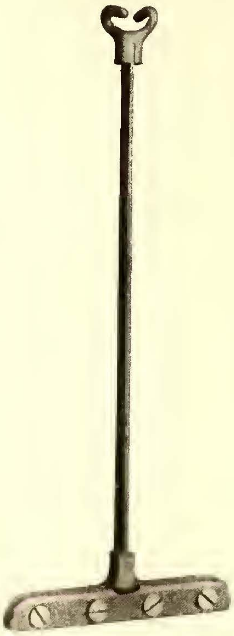


FIG. 17.—CATENARY CURVE PULL-OFF SUSPENSION

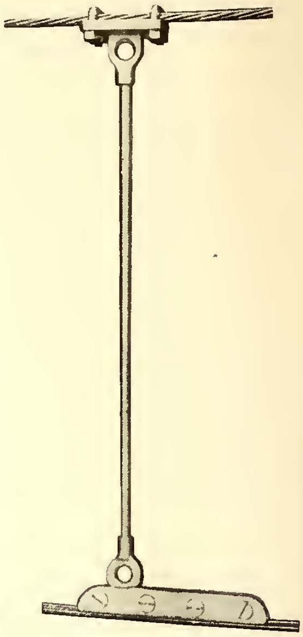


FIG. 18.—CATENARY ANCHOR SUSPENSION

ton, Pontiac & Joliet Railway for the past two years and on the Toledo, Chicago & Interurban Railway since its first being in operation, it is needless to enter into a detailed description here.

THE CONTROL

The control is of special interest, being of the Sprague-General Electric multiple-unit type adapted to the a. c.-d. c. operation of cars as single units or in trains of several cars. In adapting the multiple-unit system to both alternating and direct-current operation, the apparatus has been de-

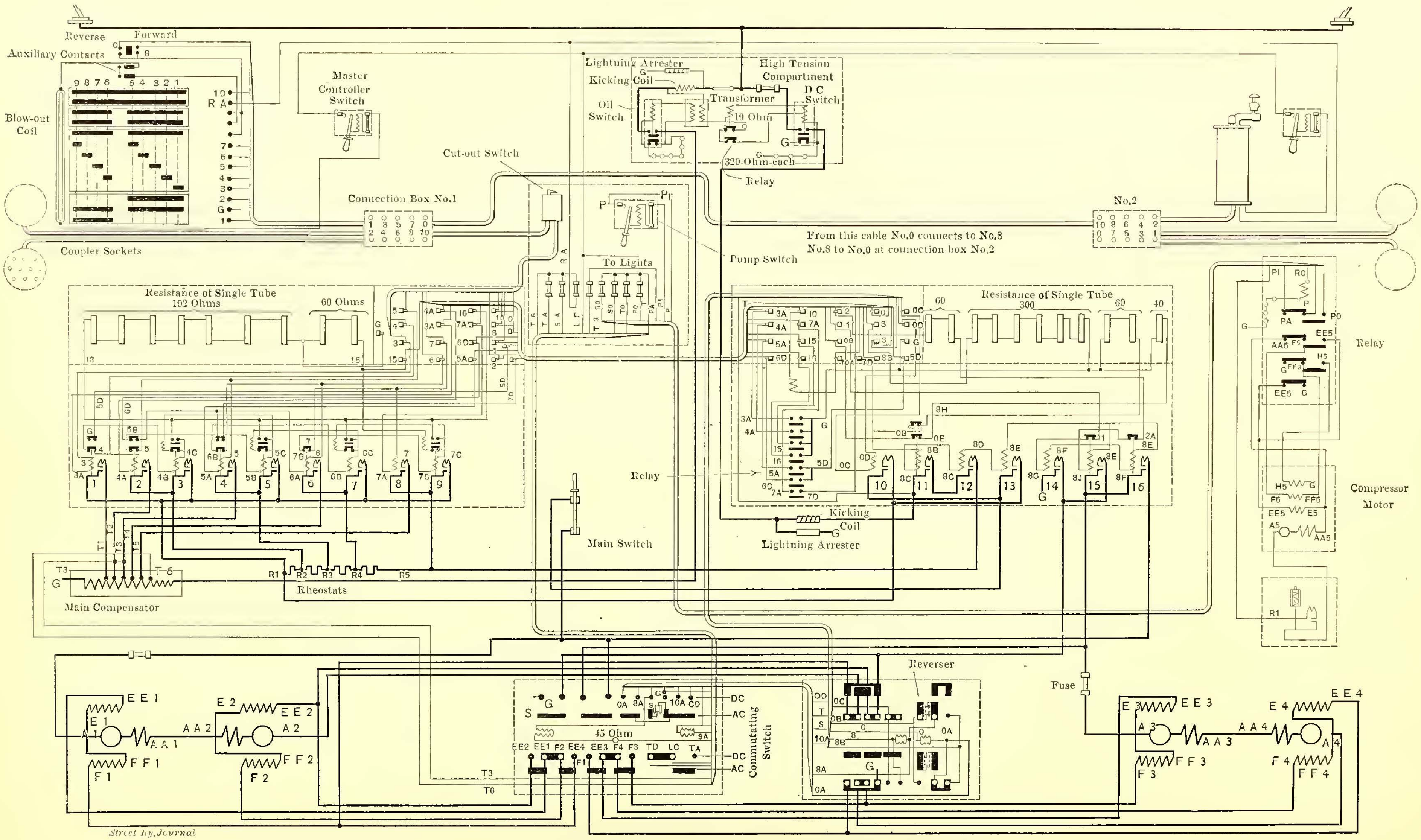


FIG 21.—CONNECTIONS OF TYPE M MULTIPLE-UNIT CONTROL SYSTEM, WITH FOUR COMPENSATED MOTORS FOR A. C.-D. C. OPERATION, ON THE ILLINOIS TRACTION SYSTEM

signed in such a manner as to render all changes in the connections, when the car passes from one source of power to the other, entirely automatic and independent of the motorman; or, in other words, the system has been made automatically selective.

The master controller is of the standard type, and its

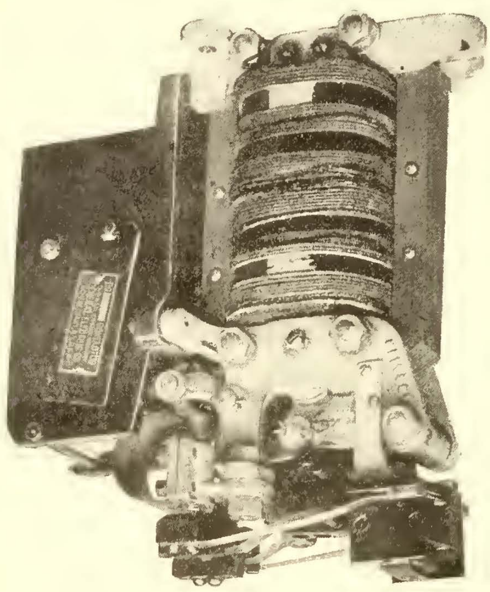


FIG. 22.—DIRECT-CURRENT CONTACTOR—MAGNET SIDE

function for a. c.-d. c. operation is precisely similar to when employed on straight d. c. service. The contactors are also virtually the same as those used in straight d. c. working, differing only in the fact that the former have a laminated magnetic circuit, while in the latter case the magnetic circuit is of solid metal. A standard type of reverser modified for the reception of an a. c.-d. c. operating coil is used to

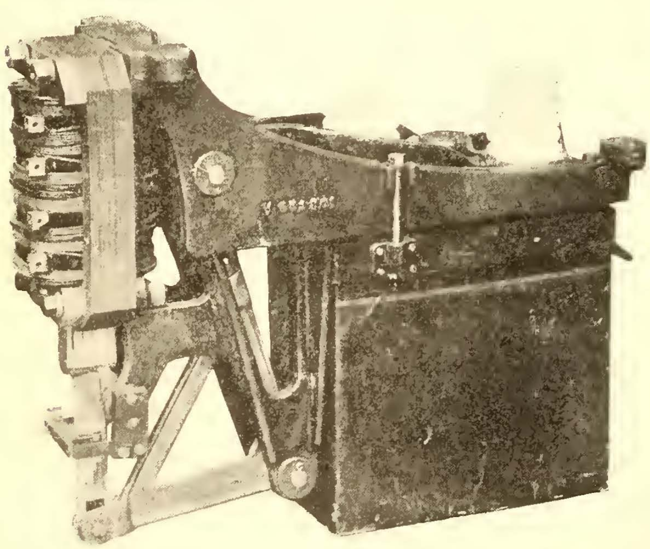


FIG. 20.—OIL BREAK CONTACTOR

change the direction of rotation of the motors. The commutating switch resembles the reverser in both size and operation; its function is to commute the motor fields and to control the trolley supply to the auxiliary circuits.

The connections which render the operation of the main a. c. and d. c. switches automatically selective are shown in the wiring diagram, Fig. 21. The operating coil of the a. c. switch is energized from the secondary of a transformer, and, therefore, is not affected by the direct current. The coil of the d. c. switch is in series with the primary of the same transformer, and, on account of the high inductance, is not affected by the alternating current.

The main a. c. oil switch or contactor is shown in Fig.

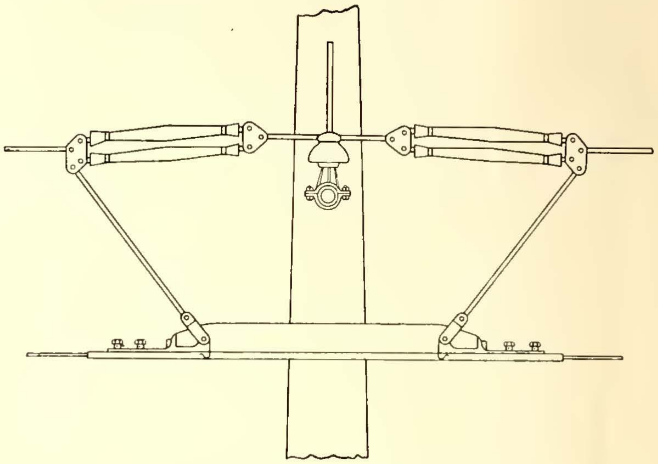


FIG. 19.—SECTION INSULATOR

20, while the two views of the direct-current switch are given in Figs. 22 and 23.

The circuits for the coils of the contactors are controlled

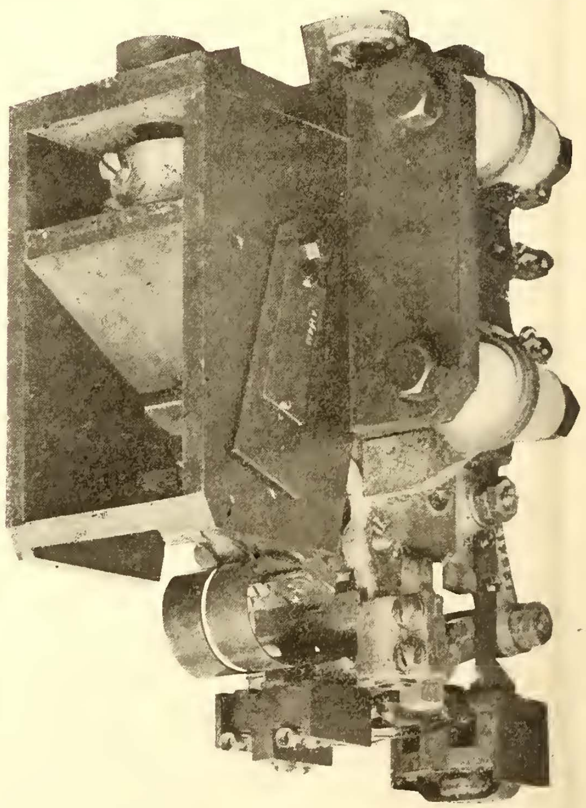


FIG. 23.—DIRECT-CURRENT CONTACTOR—CIRCUIT-BREAKER SIDE

by an independent relay governed by the master controller, which relay has a gravity position for d. c. operation, and on a. c. power its coils are energized by alternating current. At the instant the leading car of a train passes from one source of power to another, all the main switches throughout the entire train and the relays controlling the circuits of the contactor coils are thrown, while the auxiliary circuits of the rear cars, such as heating, lighting, etc., remain unchanged until the dead section is passed. Each car is provided with two-wheel trolleys and a pantograph, which can be used interchangeable if desired, although the pantograph is primarily intended for a. c. operation. Potential control is employed with a. c. operation. On the first point of the master controller the motors are connected to a compensator tap giving approximately half voltage; after this point acceleration is obtained by cutting in more sections of the compensator. During a. c. running the motors are permanently connected two pairs in series, while during d. c. operation the motors are brought partly up to speed while connected four in series and then thrown into two pairs in parallel. The wiring diagrams given in Fig. 21 will show all the details of connections, together with the relative position of the different pieces of apparatus one to another electrically.

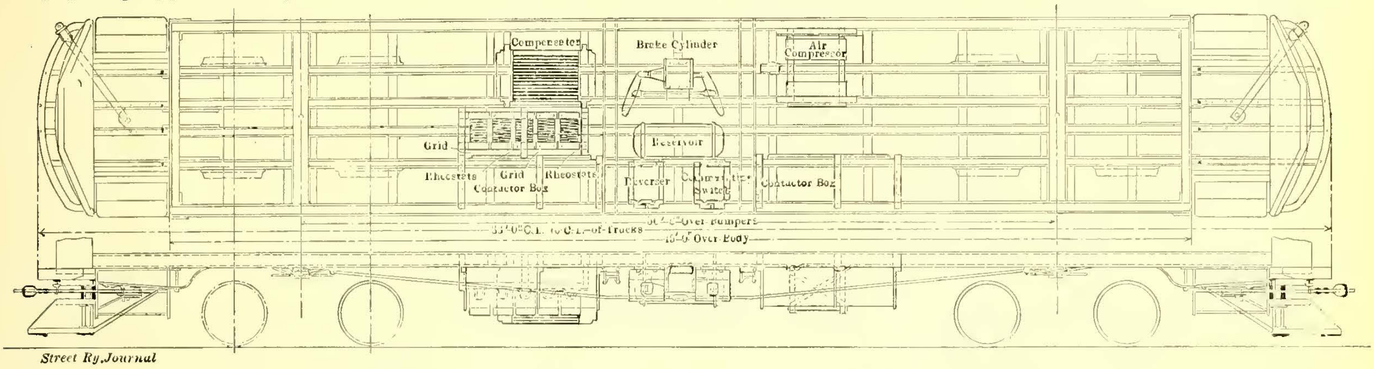


FIG. 24.—PLAN OF CAR, SHOWING GENERAL ARRANGEMENT OF APPARATUS

All the heavier pieces of apparatus are situated under the car, and their location can be seen by referring to Figs. 24 and 25.

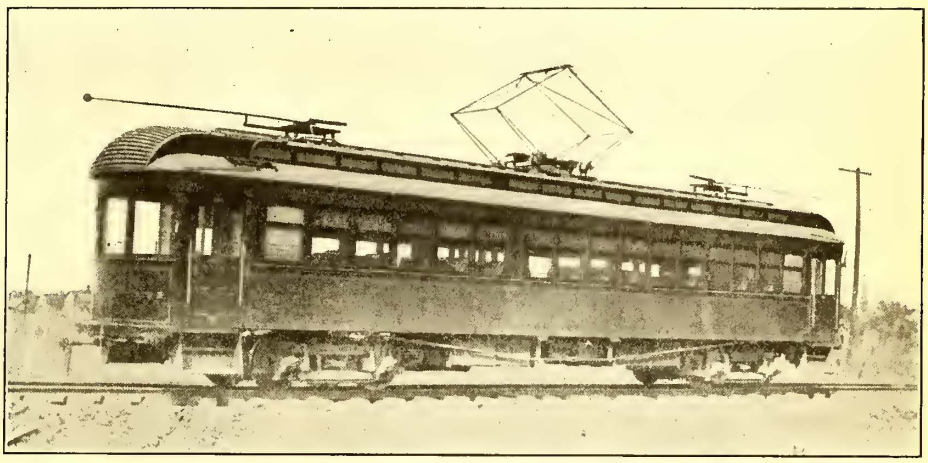


FIG. 26.—INTERURBAN CAR ON THE ILLINOIS TRACTION SYSTEM EQUIPPED FOR A. C.-D. C. OPERATION

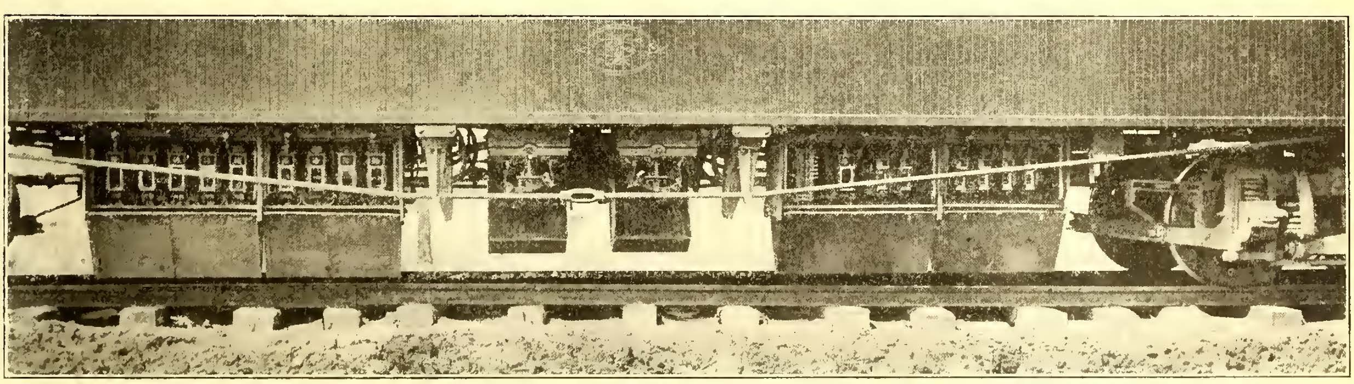


FIG. 25.—ARRANGEMENT OF APPARATUS UNDER CAR

The protective devices, including the main a. c. and d. c. switches, together with their protecting fuses, the a. c. lightning arrester, the 1.5-kw transformer (already referred to while describing the selective system), a tube rheostat (used in series with the coils of the main a. c. and d. c. switches), and a relay are placed in the high-tension cabinet, which is insulated with a lining of asbestos to prevent all fire risks. This cabinet is situated in the car and the general arrangement of the apparatus inside will be seen in Fig. 24. There is a small cabinet attached to the above which contains all the fuses for the auxiliary circuits.

CAR BODIES

The car bodies were built by the American Car Company, of St. Louis, Mo. They are of the interurban, double-ended type provided with a vestibule at each end. Their overall length is 56 ft., and each has a seating capacity of fifty-eight persons, the ordinary passenger compartments accommodating thirty-six and the smoker accommodating twenty-two people. Each car is provided with a toilet. Fig. 26 will show the general appearance of the cars.

The cars are of a handsome appearance, neatly finished in the interior with weathered oak. An electric heater by the Consolidated Car Heater Company, of Albany, N. Y., is situated under each seat, and, in addition, a Peter Smith hot air heater is provided in each car. The interior lighting is by incandescent lamps, while the headlights are General Electric enclosed arcs. Both trucks are motor trucks of the Brill 27-E type furnished with wheels 33 ins. in diameter. Each car is provided with a standard General Electric straight air brake equipment.

Road From— To—	Length in	Name of Operating Company.	Proposed, in Operation or Under Construction.	Operating at Present A. C. or D. C.	Operating A. C. or D. C. in Future.
Peoria—Bloomington	38 miles	Peoria & Bloomington Railway Co.	In operation	A. C.	A. C.
Champaign—Danville Including Homer, Catlin and Ridge Farm Divisions.	64 miles	Danville, Urbana & Champaign Railway Co	In operation	D. C.	D. C.
Jacksonville—Springfield	33 miles	Illinois & Western Railway Co	Under construction	....	D. C.
Springfield—Decatur	40 miles	Illinois & Central Traction Co	In operation	D. C.	D. C.
Springfield—Lincoln	30 miles	Springfield & Northeastern Railway	In operation	D. C. Until June 1, 1907.	A. C. After June 1, 1907.
Lincoln—Mackinaw	27 miles	Springfield Lincoln & Peoria Railway Co.	Under construction	....	A. C.
Bloomington—Decatur	44 miles	Chicago, Bloomington & Decatur	In operation	D. C.	D. C.
Lincoln—Bloomington	30 miles	....	Proposed	....	....
Springfield—Staunton	60 miles	St. Louis & Springfield Railway Co	In operation	D. C.	D. C.
St. Louis—Staunton—Hillsboro	57 miles	St. Louis & North Eastern Railway	In operation	D. C.	D. C.
Champaign—Decatur	48.5 miles	St. Louis, Decatur & Champaign Railway Co.	Operates June 1, 1907.	D. C.	D. C.

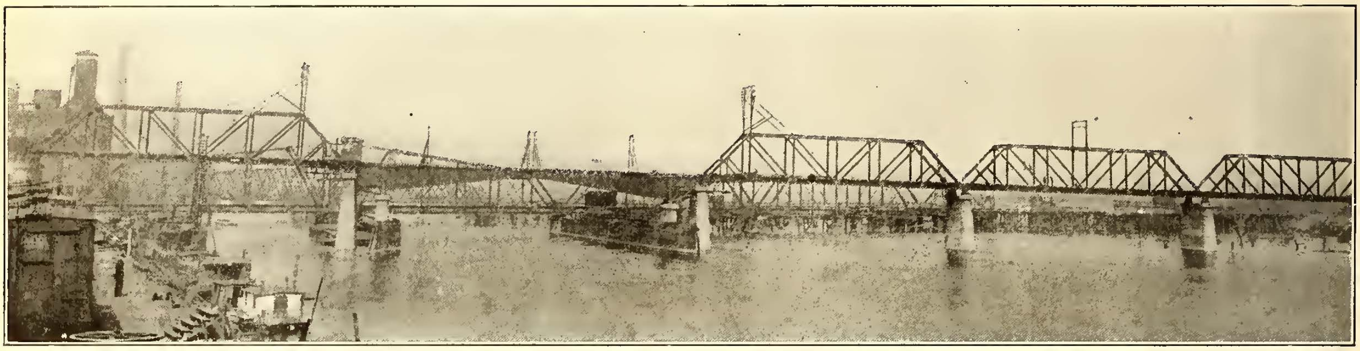


FIG. 26.—FIVE-SPAN BRIDGE CROSSING ILLINOIS RIVER AT PEORIA

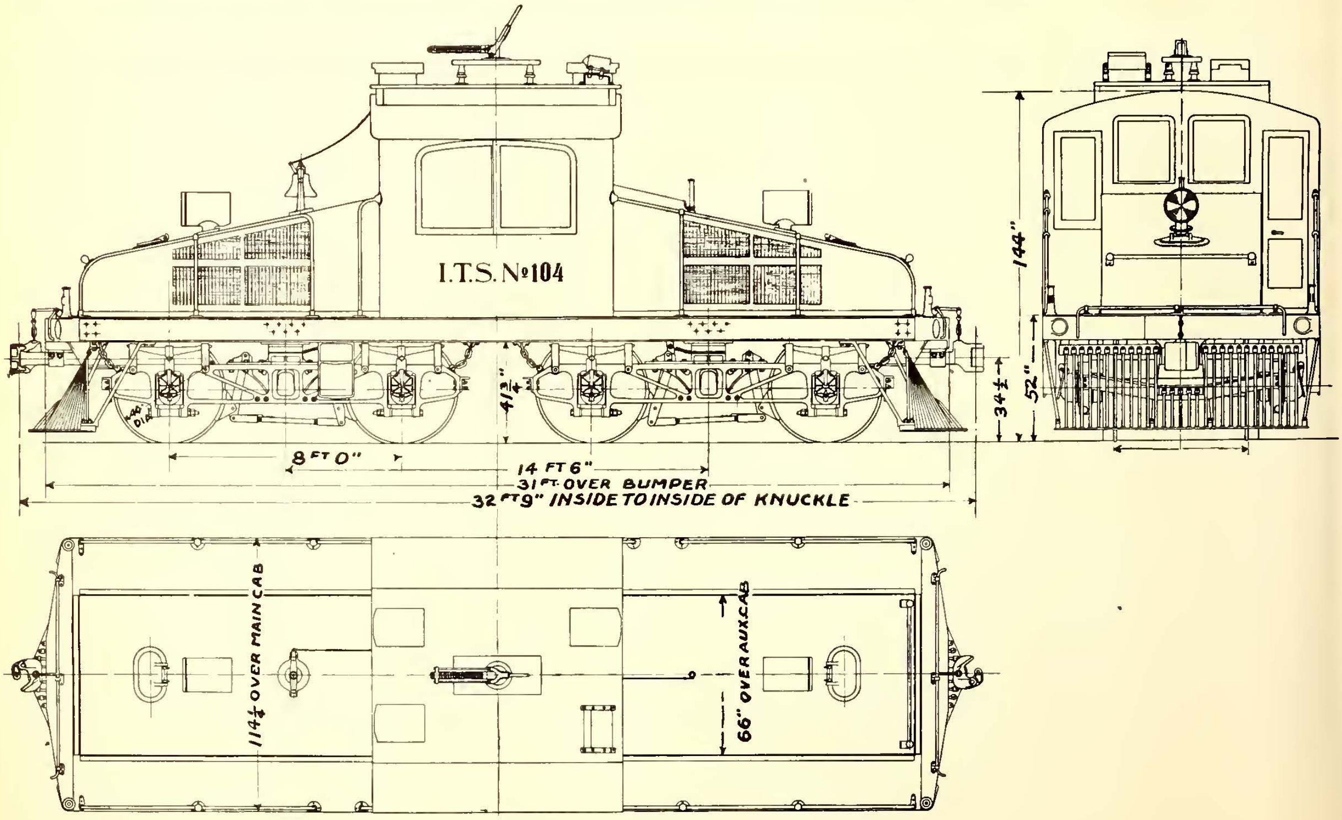


FIG. 27.—50-TON LOCOMOTIVE EQUIPPED WITH FOUR G E A-609 MOTORS

A. C. LOCOMOTIVE

The a. c. locomotive already referred to in the earlier part of this article will be used for hauling coal and miscellaneous freight over both the a. c. and d. c. sections of the system, it being equipped with a. c. motors and a. c. and d. c. control.

The total weight is approximately 50 tons, and it is equipped with four GEA 609 motors. These are slow-speed motors designed especially for locomotive service, and on their one-hour rating have a capacity of 150 hp each. At the full load rating of the motors, 600 hp, the locomotive develops a tractive effort of approximately 15,000 lbs., which is to say it will be capable of hauling a trailing load of 500 tons on a 1 per cent grade at a speed of 15 mph. On a level tangent track it will handle the same load at 27 mph.

The current collectors for both a. c. and d. c. are of the ordinary trolley wheel type, but the trolley base is specially insulated for 3300 volts. The control circuits of the locomotive are shifted from a. c. to d. c. power automatically by a selective system similar to that already described while dealing with the car equipments. The motors are wound for 200 volts, and are connected permanently two pairs in series. For d. c. control the motors are connected in the series parallel combination.

Fig. 28 will show the general shape of the locomotive. It has a main operating cab in the center of the platform which contains the air compressors, engineer's seat and all the operating mechanism. The sloping end cabs, which extend from the main cab to the ends of the locomotive, contain the air tank, the compensator for reducing the a. c. trolley voltage, and all the auxiliary apparatus. Narrow side platforms run from the cab to the ends, giving easy access from the cab to the couplers and switching steps, and, further, they enable the engineer at his seat to have an unobstructed view of the track or of the switchman standing at the coupler.

The trucks have cast steel side frames of the truss pattern. The weight of the trucks and motors is carried on semi-elliptic journal box springs. The motors are nose suspended, half the weight being carried by the axles and half by the truck bolsters. The over-all dimensions of the locomotive are: Length over all, 32 ft. 9 ins., and width, 9 ft. 6 ins.

EXTENSIONS

A list of the roads composing the Illinois Traction System, with the length and character of equipment, is appended.

STEAM BOILER EFFICIENCY

BY W. H. BOOTH.

There has been more technical error allowed to creep into the reports of boiler tests than into almost any other matters of steam engineering. Whenever an efficiency of over 80 per cent is given on test for a boiler alone very grave doubts may be felt. Yet one may find tests recorded where even 87 per cent efficiency has been reported for a boiler apart from the feed heater or superheater. There are numerous sources of error which any honest tester, however, would be careful to point out for his own credit if so unlucky as to run a test showing 86 or 87 per cent. In the first place, there is the huge possible error of misjudging the fire at each end of a run. Then there are possible misreadings of pressure gages and of water measurements and errors in coal weighing.

One of the worst features of the modern record-breaking boiler test is that from the figures put down it may be easily discovered that the boiler has shown a real efficiency of over 100 per cent. No engineer should, therefore, publish his test figures until he has checked them in such a way as to find just what they mean in real efficiency. Let us explain what we mean by ordinary and by real efficiency.

By ordinary efficiency we mean the percentage of the total calorific capacity of the fuel which appears in the steam and has been added by the boiler. If this is 80 per cent, then the remaining 20 per cent has gone in the chimney gases and in loss by radiation, and if a better result than 80 per eent is obtained the difference is either due to priming or to errors of observation. By real efficiency is meant that proportion of the heat presented to the boiler, at or above its own temperature, which appears in the steam. Thus the boiler has a temperature of 360 degs. F. It cannot possibly absorb heat of a lower temperature than this. In practice it will not absorb heat below about 560 degs. F.

If the heat in the gases below 360 degs. F. be calculated out it will be found considerable. Its amount will necessarily depend upon the ratio of air employed, and this may be found approximately by chemical analysis of the gases. In this way the amount of heat of the coal which goes to waste inevitably may be determined. Subtracted from the total heat of the coal we find the amount of heat actually offered to the boiler which it can in theory absorb. What it actually does absorb marks, therefore, the true efficiency of the boiler, for it is obviously wrong to base its efficiency on a datum to which it cannot conform. So the real efficiency is high at 87 per cent, yet tests have been published showing this much of ordinary efficiency, and some of these have been worked out and shown to represent a real efficiency of over 100 per cent.

The use of the real efficiency has been advocated in Great Britain on the ground first that it tends to place a check on the ridiculously high claims made for tested boilers and in order that a fairer comparison may be made between boilers tested at different pressures, for naturally a high-pressure boiler cannot show the ordinary efficiency of a lower pressure, and, therefore, lower temperature, boiler. But if put upon a basis of real efficiency the pressure difference becomes nullified by the shifting of the datum line to an approximately equivalent level for each case. Boiler test records had been getting out for which there was no excuse beyond the apathy of the public, who did not investigate the figures presented. Their analysis of the actual efficiency method made one of the more blatant of the apparatus sellers exceedingly angry, for it overturned many of his boldest and least truthful figures.

AUSTIN, TEX., SHOP NOTES

The Austin Electric Railway casts all its trolley wheels, journal brasses, and makes other brass castings in its own shop. The brass is melted in a No. 18 crucible over a fire similar to a blacksmith forge. The crucible holds only enough metal to pour about half a dozen trolley wheels. These wheels are cast in iron molds.

Cars are brought in the shop for a thorough inspection every ten days. The inspection is so thorough that if nothing is found the matter with the car an hour's time of two men is required to make it. With this method of inspection only two armatures have been lost during the past eighteen months and these were grounded on the same day. The motors are of the G. E. 54 type.

ANNUAL OUTING AT CINCINNATI

The annual outing of the Cincinnati Street Railway Employees' Mutual Protective Association took place at Chester, June 20. More than 90,000 tickets had been sold by the motormen and conductors, and it is said that at least one-fourth of them were used. W. Kelsey Schoepf, president of the company, was present, and aided in the entertainment features, as did Superintendent Lee and other officials. The car runs were arranged so that almost all the employees were present some time in the day or evening. A display of fireworks in the evening closed the event.

THE EFFECT OF THE TRANSMISSION LINE UPON THE RELIABILITY AND EFFICIENCY OF ELECTRIC INTERURBAN RAILWAY SERVICE

BY E. R. CUNNINGHAM,
Electrical Superintendent of the Des Moines City and the Inter-Urban Railway Companies.

Probably more interruptions to service on a modern interurban railway system come from a disturbance or disarrangement of one or more of the three wires composing the transmission line than from any other source. As these small wires nearly always stretch across long ranges of unguarded country where they are subjected not only to atmospheric disturbances, but to the malicious or thoughtless ever-present small boy with slingshot, stones and other missiles, and to the older ones, who ought to know better, with shot gun and rifle, a great deal of thought and care should be given to the construction and protection of the transmission line. But however well the line is constructed and however well protected, it will probably continue to remain the most sensitive part of the entire system.

Transmission systems for railway work are generally three-phase, three-wire, and all three wires must be in good condition to operate, so that the loss of any one of them usually interrupts the service until the repair crew can get over the line and repair the break. Interruptions of this kind are not only very annoying, but very disastrous to the service and the reputation of the line.

It is one of the objects of this paper to discuss the methods of connecting the transformers and starting the rotary converters in the sub-stations so that a loss of one, or even two, of the transmission wires will not interrupt the service, and also to consider other details affecting the reliability and efficiency of the service.

There are three methods in general use of starting rotary converters in sub-stations, all of which have their advantages. Two of them require alternating current to start and the other direct current. One method of starting a. c. is to introduce alternating current to the armature of the rotary from fractional transformer voltage taps, bringing the armature up to speed as an induction motor with a field induced by the a. c. armature current. When the armature comes up to speed, the d. c. field is closed, and the a. c. starting switch is thrown quickly to full voltage. The other a. c. method is to introduce alternating current to a small induction motor mounted on the shaft of the rotary, bringing the armature up to speed. The rotary is then synchronized with and thrown on to the a. c. line. With the d. c. method the rotary is started up as a direct-current motor, either from direct current from other rotaries running in the same station or from the d. c. trolley and feeder lines. It is then synchronized with and cut on to the a. c. lines.

Without attempting to discuss the relative merits of the three systems of starting, I will say that it is my experience that at least two methods should always be provided, and one of them, of course, should be the d. c. method. To start a. c., either by introducing alternating current to the armature of the rotary of to an induction motor, three-phase current must be available. If one transmission line is down and the transformers are connected delta-delta, it is impossible to start from the a. c. side. If means are provided for

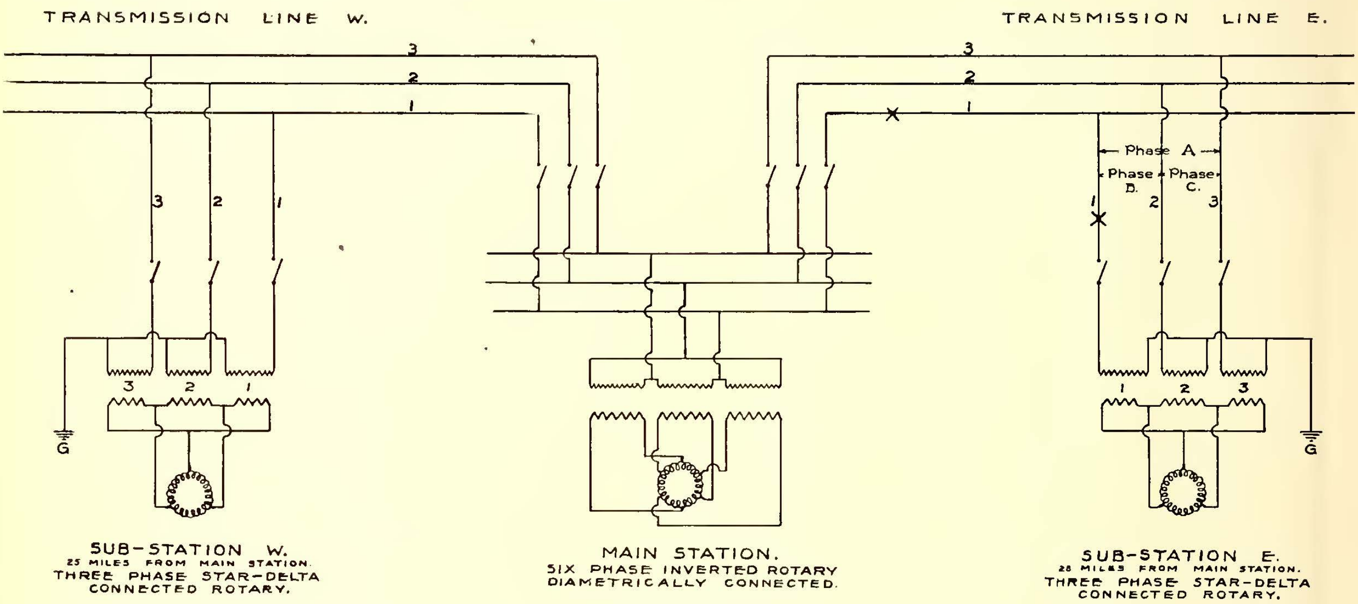


FIG. 1

starting d. c., the rotary can be brought to speed by direct current, synchronized on one phase and then operated single-phase. It is, therefore, essential that means be provided for starting d. c., even though the usual method of starting is a. c.

The reliability of the service is affected to a large extent by the method of transformer connections adopted, especially when one or more of the transmission wires are out of service. There are four methods in general use of connecting transformers between the transmission line and the rotary converter. The transformers can be connected delta-delta, star-star, delta-star or star-delta. In other words, both primary and secondary can be connected delta or both can be connected star, or one can be connected star and the other delta. While each system of connection has its advantages in special cases, the first and last mentioned are the ones in most general use.

With the delta-delta system, if a transformer burns out the rotary can still be operated three-phase on open delta, but if one of the transmission wires has to be cut out of service, it is impossible to operate at all unless the sub-stations are arranged for d. c. starting. In that case the rotaries can be run single-phase at one-third their capacity on one transformer and two transmission wires. With the star-delta arrangement the rotaries in a sub-station cannot only be operated three-phase with two transformers, but three-phase with two transmission wires, providing the nuetral point of the star connection is grounded at both the transmitting and receiving ends of the transmission line. It is also possible to operate single-phase with only one transmission wire, providing the sub-station is equipped for d. c. starting. Thus, in case of trouble on the transmission line, a sub-station can be run with one less wire with the star-delta connection than with the delta-delta connection.

The writer has gone still further and started up rotaries from the a. c. end with only two transmission wires in service when step-up transformers at the main station were connected delta-delta, and, of course, not grounded. This is accomplished by means of having a sub-station on at least two different lines leading from the main station in the same or different directions, connected star-delta, with the neutral point grounded, as illustrated in Fig. 1. If one wire breaks or becomes disabled on either transmission line E or W, the rotary on that line can be started up and operated three-phase with the two remaining wires and ground, providing a station with grounded neutral is running on the other transmission line. For example, if wire

star connected coils, although the voltage between lines L_1, L_2 and L_3 is the same in each case, being equal to the voltage of the delta connected coils. In the star connection, therefore, the line voltage is $\sqrt{3}$, or 1.73 times the voltage across any one transformer, and in the delta connection the line voltage is, of course, equal to the voltage across any one transformer. Stating it in another way, the voltage across the star connected transformer is only 58 per cent. of the voltage across the delta connected transformer, and only 58 per cent of the effective line voltage, and, as the neutral point G is grounded, the difference of potential between the transmission lines and the ground is only 58 per cent of the line voltage. With the same working voltage and the same line insulation, the transmission line is, therefore, much less liable to break down when the transformers are star connected on the high or line side.

What is true of the transmission line is equally true of the transformers themselves. The strain on the insulation of the transformers working on a given line voltage is very much less when star connected on the primary or line side than when delta connected. Moreover, the ratio of primary winding to secondary winding is only 58 per cent as great for the same ratio of transformation, and consequently a cheaper transformer can be used.

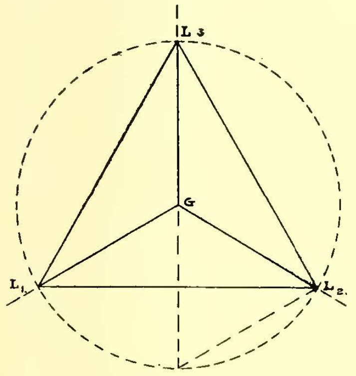


FIG. 2.

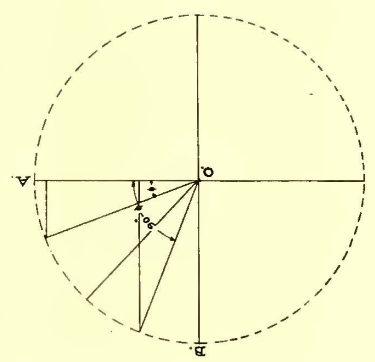


FIG 3.

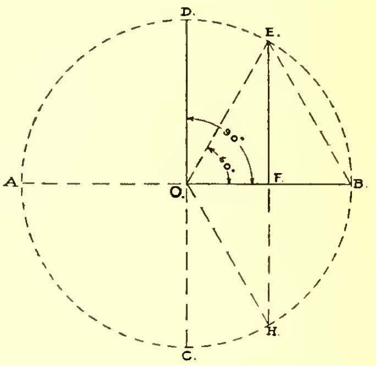


FIG. 4.

No. 1 on transmission line E is disabled and has to be cut out, the rotary in station E can be started from the a. c. end by means of three-phase current. On phase C the current, of course, passes in series through transformers 2 and 3 in station E. On phase B the current alternates between line 2 through transformer 2 in station E, through ground, and transformer 1 in station W and line 1. On phase A, the current alternates between line 3 through transformer 3 in station E through ground and transformer 1 in station W and line 1. On this phase transformer 1 in station W acts as a series transformer, receiving sufficient current to bring the rotary up to speed. The writer has operated stations in this manner for several days without any bad results except that a difference of potential is induced between the telephone lines and ground, due to the unbalanced condition of the transmission line.

The relations existing between the delta and star connections may be seen by reference to Fig. 2. Lines L_1 L_2, L_2 L_3, and L_3 L_1 represent either the primary or secondary coils of three transformer connected delta; lines L_1 G, L_2 G and L_3 G represent either the primary or secondary coils of three transformers connected star and grounded at G. It follows from the diagram, Fig. 2, that L_1 L_2 is $\sqrt{3}$, or 1.73 times L G. In other words, the voltage across the delta connected coils is $\sqrt{3}$ times the voltage across the

Combinations of delta and star connections furnish a very wide range in ratios of transformation, a condition which is often very convenient, especially if the voltage of transmission should be raised and it should be desirable to use transformers wound for different voltages on the same line. Since the primary can be connected star and the secondary delta, or vice-versa, a very wide range of transformation can be obtained, the ratio of star-delta connection being three times that of the delta-star connection. In other words, transformers wound for a line voltage of say, 34,640 volts primary and 360 volts secondary when delta connected, will operate on 6000-volt primary and 360-volt secondary lines when star-delta connected, and on 20,000-volt primary and 360-volt secondary lines when delta-star connected.

It is quite customary to buy transformers and connect them delta-delta for a given line voltage, expecting later on to connect them star-delta and thus raise the voltage 73 per cent. There seems to be no good reason for this practice, because with the higher line voltage one-third of the copper is required and the benefit could be derived at once. The strain on the line insulation and transformer is not appreciably greater at the higher star-delta voltage than it is at the delta-delta voltage, and the benefits to be derived from the higher voltage are very attractive, especially at the present price of copper. The fact that the strain on the line insulation, as well as that on the transformer insulation when transformers are star-delta connected, is but 58 per cent of what it would be if delta-connected, is, in the opinion of the writer, sufficient reason to commend it to the practical operator.

Although the maximum potential of any a. c. circuit is $\sqrt{2}$, or 1.42 times, an equally effective d. c. potential, the strain on the insulation of the circuit is not any greater than it is on the d. c. circuit. Sudden changes of load in direct-current operation and the making and breaking of the circuit under heavy load induce e. m. f.'s greatly exceeding the maximum e. m. f. of an equally effective a. c. potential.

In this connection it might not be out of place to review the relations between the maximum values and the mean effective values of the potentials on a. c. circuits. The mean effective value of an alternating-current wave, or the value representing the same effect as with direct current, is the square root of the mean square of the periodically varying wave, which for practical purposes can be assumed to be of sine form. Let *A O B*, Fig. 3, represent the quadrant of a circle. The square of the sine of any angle ϕ plus the square of the sine of the complimentary angle $(90° - \phi)$ $= 1$, thus $\sin^2 \phi + \sin^2 (90° - \phi) = 1$. Since all the sines in the quadrant *A O B* can be arranged into pairs so that the sum of the squares of each pair will equal 1, the mean square of all the sines would equal ½ and the square root of the mean square would be the square root of ½, or 0.707. This then, in a single-phase rotary, is the ratio between the d. c. and a. c. voltages.

In a three-phase rotary current is taken off at three equidistant points so that the maximum a. c. potential would be in proportion to ½ the cord of a full period, or 120 degs., or what is the same thing, the sine of the angle of a half period, or 60 degs. This is represented in Fig. 4 by the line *E F*, whose value will be seen by the diagram to be equal to $\frac{1}{2}\sqrt{3}$, or 0.867. Since the effective value of any sine function is the square root of ½, or 0.707 times the maximum value, the effective value or the voltage of the a. c. end of a three-phase rotary would be 0.707×0.867, or 0.613 times the voltage of the d. c. end.

In a two-phase rotary, since each phase is taken off at an angle of 180 degs., one phase being taken off 90 degs. behind the other, the voltage of the a. c. end would be 0.707 of the d. c. voltage, the same as for single phase. In a six-phase rotary diametrically connected, since the current is taken off 180 degs. apart, the a. c. voltage would also be 0.707 of the d. c. voltage, the same as for single phase. Stating the same thing in another way, the d. c. voltage in a single, two or six-phase rotary is 1.42 times the a. c. voltage, and 1.63 times the a. c. voltage for a three-phase rotary.

In practice the ratio of the d. c. to the a. c. voltage may be varied a little from these figures by changing the excitation of the fields; over-excitation increases the ratio and under-excitation diminishes it. It is, however, not good practice to attempt to regulate the d. c. voltage by the excitation of the fields, as over-excitation produces a leading current and under-excitation a lagging current, consequently a poor power factor, and causes the rotaries and transformers to heat up unnecessarily. If the d. c. voltage is not right, the transformer should be provided with suitable voltage taps, so that the proper voltage can be secured by changing the taps and not by changing the field excitation at the expense of the power factor.

ANOTHER TUBE FOR LONDON

With the opening of the Charing Cross, Euston & Hampstead Railway, the program of railway communication in London, planned by the Underground Electric Railways Company, has been completed. This line will exercise an important influence on the other tubes controlled by

ENTRANCE TO THE HIGHGATE STATION

the Underground Electric Railways Company (the Bakerloo & Piccadilly) and on the District Railway. The new tube exchanges traffic with all three of the above lines, in addition to linking up with the City & South London and Central London tubes, and the North-Western and South-Eastern Railways. By means of these connections, especially those given by the Piccadilly and Bakerloo tubes,

HIGHGATE TICKET OFFICE

the Hampstead tube will become part of the new system of through routes that enables direct journeys to be made between practically any of the London terminals. The new line will also enable the earning capacities of the other associated tubes to be shown for the first time, since the three tube lines in question cannot be said to be in thorough working order before the completion of all of them.

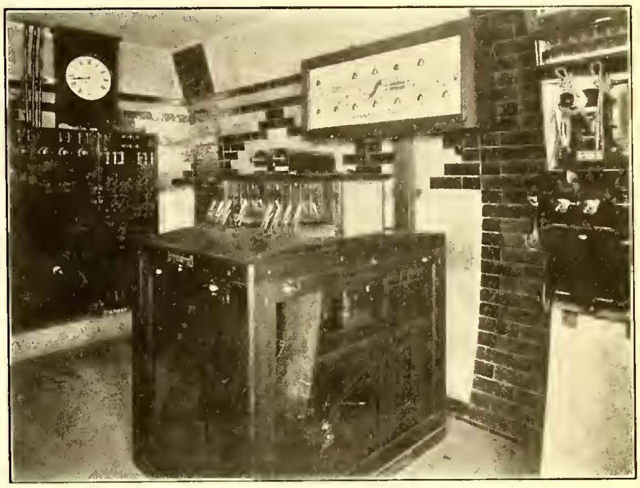
Everyone has heard of the great lack of means of intercommunication in London—many have learned it by weary experience. This has been especially the case in the central area, from which railways were debarred by Parliament more than half a century ago, just when the need for them was becoming apparent. The great initial step for reducing the evil was taken when the first "tube" railway was devised and constructed by the late J. H. Greathead. This pioneer line, the City & South London Railway (opened in 1890), proved that deep tunnel railways could be constructed through the center of London much more conveniently than railways on or just under the surface. After an interval of years came the Waterloo & City Railway, the Central London Railway and the Great Northern & City Railway. Several other tube lines were authorized, but delayed owing to difficulty in raising capital.

The Baker Street & Waterloo Railway was opened for public service on March 10, 1906, the Metropolitan District Railway has been worked electrically for over two years, the Great Northern, Piccadilly & Brompton Railway, which is a union of the two schemes previously mentioned, was opened on Dec. 15, 1906, whilst the Charing Cross, Euston & Hampstead Railway is now being opened for public use. Altogether, there are embraced in the enterprise 22 miles of tube railway (44 miles of single tunnel), about 40 track miles of the District Railway and its connections which have been electrified, and the London United Tramways, of which 48 miles have been constructed and are in operation. In round figures, the capital involved, including that for the Chelsea power station, approximates twenty-four million pounds.

The Charing Cross, Euston & Hampstead Railway, which has now an authorized capital of £5,768,000, including loan capital, was sanctioned by the Charing Cross, Euston & Hampstead Railway Acts of 1893 and 1899, and on the Underground Electric Railways Company acquiring the rights to construct the line, it obtained further powers from Parliament in 1902. Within its total length of 8.2 miles there are sixteen stations, giving an average interval between stations of about half a mile. The popular residential districts of Highgate, Hampstead and Golders Green are, for the first time, brought into direct communication with the ceneral area of London, whilst convenient subway connections with other tubes provide expeditious routes to the city and West End.

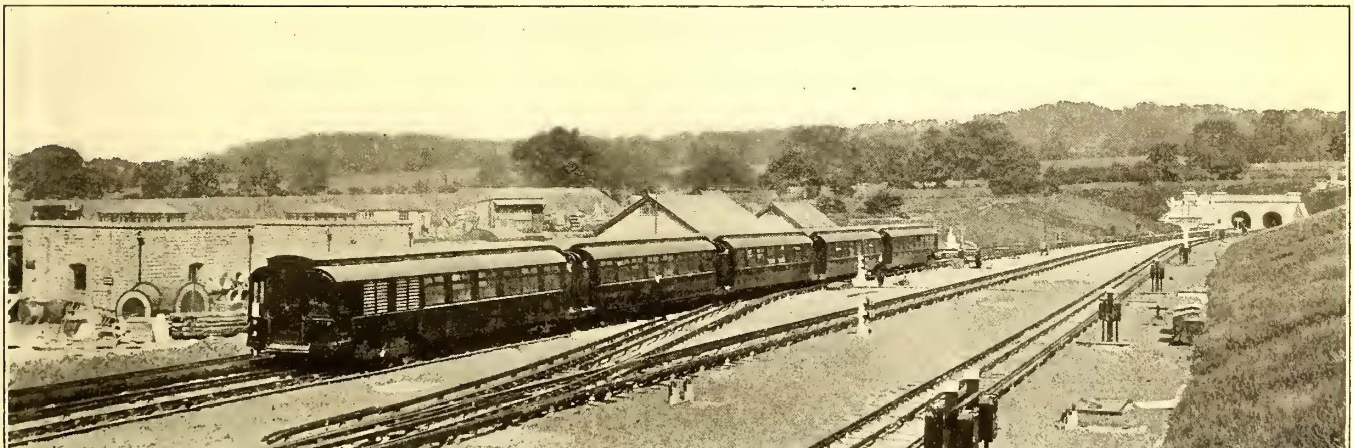
Trains will run, on week-days, every two minutes between Charing Cross and Camden Town, every four minutes over the Highgate branch, every four minutes to Hampstead, and every twelve minutes to Golders Green, the headway being slightly increased during slack hours. On Sundays the service will be based on three minutes' headway between Charing Cross and Camden Town, varied as traffic may require.

Arrangements have been made for the issue of through



INTERIOR OF A SIGNALING STATION

tickets between stations on the Hampstead tube and stations on the Piccadilly, City & South London and London & North-Western lines, and through fares are in course of arrangement with other railways whose systems connect by interchange stations with that of the Hampstead tube. Season tickets are also issued at cheap rates, and through season tickets have been arranged with connecting lines.



A TRAIN OF CARS AT GOLDER'S GREEN

THE TUNNELS AND EQUIPMENT

Each track is contained in a separate circular tunnel, 11 ft. 8 ins. diameter, on the straight, and ranging up to 12 ft. 6 ins. on sharp curves. The ties on which the rails are laid are of Karri wood. The spaces between are filled with crushed granite. Besides the track rails there are two conductor rails. One of these is close to the tunnel wall and the other between the track rails. Should a train break down, the current would be instantly shut off from the conductor rails, but the tunnel lighting would not be affected, as that is supplied by wholly independent circuits.

The tunnels at the stations are enlarged to 21 ft. 2½ ins. in diameter. All the platforms are of concrete. The walls are lined with glazed tiles with patterns of different colors for each station.

The depth of the line from the surface varies considerably. At Hampstead station a depth of 192 ft. is reached and 1900 ft. north of that station the tunnel runs at a depth of 251 ft. below the surface.

The station buildings are very handsome, being faced with ruby-colored glazed blocks and schemed in a series of large arches. The walls of the booking halls are in green and white enameled tiles. At present each building has a ground and mezzanine floor with a flat roof, so that upper stories can be added as required. At sixteen stations forty-seven large passenger lifts have been provided, the station at which there are no lifts being Golders Green, where the platforms are on the surface. All the elevators are worked by electric winding gear, and they are provided with elaborate safety appliances. They are entirely constructed of steel, except the floors, which are of non-flammable wood. Each can take about seventy passengers at a time. The passengers leave by the opposite side from that at which they enter, and the exit gates are opened and closed by compressed air controlled by the lift attendant. At all stations emergency stairs are provided. The stations are lighted by arc lamps fed from the lift circuits; these lamps can, if necessary, be supplied from the conductor rails. The stations are also lighted by incandescent lamps on the same circuits as the tunnel lamps, and a third set of station lamps, also incandescent, are supplied with current from the local electric supply companies. Thus every precaution is taken against the stations ever being left in darkness. All the three sets of lamps are continually in use. The ventilation of the tunnels is through eleven large exhaust fans distributed among the underground stations. These collectively draw no less than about 3,200,000 cu. ft. of air per hour out of the tunnels.

An elaborate system of electro-pneumatic automatic signaling with automatic stops is employed for working the traffic. Semi-automatic signals at interlockings and also points at cross-overs are controlled from frames in signal cabins, and there also are to be found ingenious illuminated track diagrams, which show at a glance what sections of the railway in the neighborhood are occupied by trains. The occupied sections are dark on the diagram, and those unoccupied are illuminated. The little electric lamps behind the diagram light up or go out in unison with the working of the signals on the line. As an additional safety precaution there is a complete system of telephones over the whole railway. Every motorman is provided with a portable instrument which he hooks on to two bare wires running along the tunnel wall.

The rolling stock consists of 150 cars, 60 of which are motor cars and the remainder trailers. The carriages, with the exception of the inside fittings, are built entirely of steel and are absolutely fireproof. The mahogany paneling inside is only a thin veneer, but is chemically treated so as to be non-inflammable, and is mounted on asbestos slabs. The rattan seating is also non-inflammable. Each car is 50 ft. long, and has both cross and longitudinal seats. The motor car will seat forty-two and the trailer car fifty-two people. The cars are all fitted with Westinghouse pneumatic brakes. The cars are equipped with G. E. 69 200-hp motors and type M multiple-unit control.

Car houses and repair shops have been established at Golders Green, where everything necessary has been provided for cleaning, maintaining and repairing the rolling stock and equipment.

The engineers who designed the railway are Sir Douglas Fox and R. Galbraith. For carrying out the tunnel construction on behalf of the Underground Electric Railways Company, H. H. Dalrymple-Hay was the engineer, while James R. Chapman, engineer-in-chief of the Underground Electric Railways Company, was responsible for everything connected with the equipment.

INSTRUCTION FOR MOTORMEN AND SHOP MEN IN PHILADELPHIA

The Philadelphia Rapid Transit Company has recently opened a school at its Dauphin Street car house, where instruction is given to its motormen and shopmen in the nature and use of car equipment. The school is not employed for the preliminary training of motormen, but simply for rounding out their education after they have spent the usual time under the regular motorman instructor. The teaching, however, is not confined to new motormen, for any old employee who gets into trouble through lack of familiarity with his apparatus may be ordered by his division superintendent to attend one or more of these lectures and go through the course. The forms covering both cases are shown in Figs. 1 and 2. Fig. 3 is a record card made out and retained by the instructor for his own information.

Philadelphia Rapid Transit Company,
Office of General Superintendent.

Philadelphia, ______ 190

Mr. C. FLEISCHUT Division Sup't:

Mr. ✓ ______

Has received the appointment of **Motorman**, and is sent to you for instructions on the School-Car
Respectfully, etc.,

______ General Sup't.

Instructor:—The applicant referred to above is placed under you for instructions on the School-Car, after he has served the allotted time, return him and this paper to me, and oblige

______ Division Sup't.

On School-Car ______ Days. ______ Instructor.

Mr ______

Mr ______ Division Sup't

Mr. ______

The applicant referred to above is assigned to your Division as **Motorman**. After having him properly instructed in his duties, please place him on your working-list
Respectfully, etc.,

______ General Sup't.

Instructor:—The applicant referred to above is placed under you for instructions in the art of handling a Car. Believing that you fully realize the importance of the position prompts me to placing him with you, therefore your best efforts are solicited in the matter. After he has served the allotted time, as per instructions, return him and this paper to me, and oblige

______ Division Sup't.

Learned ______ Trips with ______ Instructor.
" ______ " " ______ "
" ______ " " ______ "
" ______ " " ______ "

Appl No. ______ Mr. ______

Badge No. ______ Address, ______

Received book of Rules and Regulations,

Date turned in, ______ 190 Signed, ______

INSTRUCTION DEPARTMENT,
810 Dauphin Street

Mr. ______

The applicant referred to is sent to you for instructions in handling the Car Equipment.

______ Division Sup't.

Mr ______ Division Sup't

I have this day, ______ instructed Mr. ______
the above-named applicant for position as **Motorman** in the handling of the Car Equipment

______ Instructor.

FIG. 1.—ASSIGNMENT CARD OF NEW MOTORMAN FOR INSTRUCTION

Philadelphia Rapid Transit Company.

Philadelphia, June 8th 190

To the INSTRUCTION DEPARTMENT.
8th and Dauphin Streets

Please instruct Motorman ______ No. ______

and oblige,

Respectfully,

Jno. H. Blagg ______ Superintendent
Hancock & Lehigh Division

Philadelphia ______ 190

Mr. ______

Superintendent ______

I have this day instructed Motorman ______

No. ______

Respectfully

______ Instructor

FIG. 2.—ASSIGNMENT OF OLD MOTORMEN FOR INSTRUCTION

No.	Name,	190
		Experienced
Division,		Not Experienced
Remarks,		

FIG. 3.—INSTRUCTOR'S RECORD CARD

The instruction is carried out with a skeleton car, on which a full motor and control equipment is mounted, together with a hood switch, circuit-breaker, lamps, headlight, wiring layout, etc. After explaining the functions of every part of the apparatus the instructor tests the knowledge of the student by surreptitiously pulling down the trolley pole, pushing the hood switch to the off position, watching the student's handling of the controller when given stop, start and reverse signals, and, in short, doing all he can to simulate the conditions arising in service. The motormen are also shown how to cut out defective motors, but, in general, no attempt is made to give them more knowledge than is necessary for their regular positions.

In addition to the foregoing work, which is carried out during the day, more elaborate instruction is given in the evening to shop mechanics. The attendance of the latter is entirely voluntary, and, in fact, this kind of instruction has greatly increased the interest of the shopmen in their daily duties. The principal instruction of these students relates to the location and correction of controller and motor troubles. Every type of controller used by the Philadelphia Rapid Transit Company is connected to a lamp board which is so wired that the different lamps show exactly what happens in the resistances and in the armatures and fields of either two or four-motor equipments when any given controller is moved from step to step. The board has snap switches to afford an almost endless variety of trouble-making circuits to enable the teacher to show different connections.

GROSS RECEIPTS FOR 1906

The publication of American Street Railway Investments, "The Red Book," for 1907 makes available the operating reports for 1906 of the principal electric railways of the country. The gross receipts for the past year, and also in most cases for 1905, of 481 companies, as printed in the Red Book, are presented herewith. In most cases the figures cover the reports of operating companies only, but the reports of a few holding companies are given. In a great many cases the size of the system has been increased by consolidation, so that in most cases the figures do not represent earnings of the same trackage. The fiscal year of the companies also varies. In the case of most of the Pennsylvania and New York companies the earnings given are for the fiscal year ending June 30. In the case of the Massachusetts companies the fiscal year, as a rule, is that ending Sept. 30, while in the case of many of the other roads it is the same as the calendar year.

The 1907 edition of the Red Book contains 453 pages of statistical matter, or an increase of 21 pages over the edition of 1906. There are forty-four maps this year, on which the systems of forty-seven companies are shown.

COMPANIES HAVING GROSS RECEIPTS FOR 1906 OF OVER $1,000,000.

NAME OF COMPANY.	1905.	1906.
Interborough Rapid Transit Co., New York..	$17,328,411	$20,411,097
New York City Ry. Co., New York	17,789,490	19,092,385
Brooklyn Rapid Transit Co., Brooklyn, N.Y.	16,585,530	18,797,264
Philadelphia Rapid Transit Co.	16,374,626	17,676,249
Boston Elevated Ry. Co., Boston, Mass.	12,741,569	13,634,612
Pittsburg Railways Co., Pittsburg, Pa.	9,762,867	10,316,523
Chicago Union Traction Co., Chicago, Ill...	9,208,530	10,091,968
United Railways Co. of St. Louis, St. Louis, Mo.	8,460,016	9,146,348
Chicago City Ry. Co., Chicago, Ill.	7,322,080	7,871,126
Massachusetts Elec. Companies, Boston, Mass.	6,734,128	7,518,240
United Ry. & Electric Co., Baltimore, Md...	6,023,698	6,587,827
Detroit United Ry., Detroit, Mich.	5,169,639	6,121,940
United Railroads of San Francisco, Cal.	7,066,892	†5,955,786
New Orleans Ry. & Lt. Co., New Orleans, La.	5,093,710	5,773,190
Twin City Rapid Transit Co., Minneapolis Minn.	4,759,263	5,644,988
International Traction Co., Buffalo, N. Y....	4,484,643	4,972,688
Kansas City Ry. & Lt. Co., Kansas City, Mo.	3,923,346	4,460,096
American Cities Ry. & Lt. Co., New York....	3,870,807	4,710,638
Boston & Northern St. Ry. Co., Boston, Mass.	3,961,954	4,412,035
Cincinnati Traction Co., Cleveland, O.	3,806,705	4,120,788
Consolidated Ry. Co. (The), New Haven, Conn.	2,122,460	3,989,542
Milwaukee Elec. Ry. & Lt. Co. (The), Milwaukee, Wis.	3,348,696	3,679,229
Rhode Island Co. (The), Providence, R. I....	$3,242,972	$3,561,242
Portland Ry., Light & Pwr. Co., Portland, Ore.		3,452,607
Washington Ry. & Elec. Co., Washington, D.C.	2,905,907	3,133,240
Toronto Ry. Co., Toronto, Ont., Can.	2,747,324	3,109,740
Seattle Electric Co., Seattle, Wash.	2,565,914	3,101,386
Montreal Street Ry. Co., Montreal, Can.	2,707,474	3,100,487
Illinois Traction Co., Danville, Ill.		3,013,107
Old Colony Street Ry. Co., Boston, Mass....	2,509,612	2,795,489
Metropolitan West Side El. Ry. Co., Chicago.	2,452,327	2,697,239
Louisville Ry. Co., Louisville, Ky.	2,355,820	2,523,343
Oakland Traction Oakland, Cal.	1,441,471	2,226,017
Rochester Ry. Co., Rochester, N. Y.	1,765,463	2,105,421
Toledo Railways & Light Co., Toledo, O....	1,913,456	2,047,610
East St. Louis Suburban Co., East St. Louis, Ill.	1,351,579	2,041,451
Connecticut Ry. & Ltg. Co., Bridgeport, Conn.	1,627,483	2,011,032
Birmingham Ry., Light & Power Co., Birmingham, Ala.	1,655,122	1,972,945
Northwestern Elev. R. R. Co., Chicago, Ill.	1,786,414	1,948,727
Columbus Ry. & Light Co., Columbus, O....	1,798,463	1,941,199
South Side Elevated R. R. Co., Chicago, Ill.	1,713,348	1,788,975
United Traction Co., Albany, N. Y.	1,732,452	1,785,113
Capitol Traction Co., Washington, D. C....	1,656,659	1,727,054
Northern Ohio Trac. & Light Co., Akron O.	1,552,970	1,703,340
Portland Ry. Co., Portland, Ore.		1,684,156
Public Service Corporation, Newark, N. J...	1,548,728	1,677,798
Mahoning & Shenango Ry. & Light Co., Youngstown, O.		1,670,088
Coney Island & Brooklyn R.R. Co., Brooklyn.	1,605,861	1,663,279
Havana Electric Ry. Co., Havana, Cuba.....	1,542,870	1,662,072
Norfolk & Portsmouth Trac. Co., Norfolk, Va.	1,498,366	1,657,941
Washington Water Power Co., Spokane, Wash.	1,277,919	1,615,004
Worcester Consolidated Street Ry. Co., Worcester, Mass.	1,379,015	1,523,964
Union Railway Co. of New York City.	1,399,634	1,521,182
Memphis Street Ry. Co., Memphis, Tenn....	1,114,022	1,429,046
Nashville Ry. & Light Co., Nashville, Tenn.	1,174,377	1,395,234
British Columbia Elec. Ry. Co., Vancouver, B. C.	903,014	1,290,671
Tri-City Rys. & Light Co., Davenport, Ia...	1,091,693	1,251,507
Springfield St. Ry. Co., Springfield, Mass....	1,013,696	1,229,028
Fort Wayne & Wabash Valley Traction Co., Fort Wayne, Ind	949,298	1,109,192
Hamilton Cataract Power, Light & Traction Co., Hamilton, Ont., Can.	878,164	1,039,342
Syracuse Rapid Transit Co., Syracuse, N. Y..	894,622	1,027,340
Dallas Electric Corporation, Dallas, Tex....	934,707	1,023,136
Forty-Second St., Manhattanville & St. Nicholas Ave. Ry. Co. (The), New York, N. Y..	879,083	1,004,103
Total, 63 companies.	$237,506,359	$275,245,406

†Decrease in 1906 due to earthquake.

COMPANIES HAVING GROSS RECEIPTS FOR 1906 BETWEEN $1,000,000 AND $500,000.

NAME OF COMPANY.	1905.	1906.
West Penn. Railways Co., Pittsburg, Pa.....		$997,098
Scranton Ry. Co., Scranton, Pa.	$916,684	989,178
Grand Rapids Ry. Co., Grand Rapids, Mich.	820,469	910,028
Manila Electric R. R. & Lt. Co., Manila, P.I.		909,080
Utica & Mohawk Valley Ry. Co., Utica, N.Y.	789,796	902,321
Chicago & Oak Park Elec. Ry. Co., Chicago	842,945	890,555
Chicago & Milwaukee Elec. R.R. Co., Chicago	594,873	884,207
Schenectady Ry. Co., Schenectady, N. Y....	726,542	882,206
Wilkes-Barre & Wyoming Valley Traction Co., Wilkes-Barre, Pa.	840,067	869,403
Lake Shore Electric Ry. Co., Cleveland, O..	788,268	866,970
Northern Texas Elec. Co., Ft. Worth, Tex...	661,037	854,135
New York & Queens County Ry. Co., Long Island City, N. Y.	745,734	852,193
St. Joseph Ry., Lt., Ht. & Pwr. Co., St. Joseph, Mo.	754,954	834,438
Terre Haute Trac. & Lt. Co., Terre Haute, Ind.	629,760	823,162
Tacoma Ry. & Power Co., Tacoma, Wash...	657,451	797,433
Fonda, Johnstown & Gloversville R. R. Co. Gloversville, N. Y.	705,583	776,885
Duluth Street Ry. Co., Duluth, Minn.		768,875
United Traction Co., Reading, Pa.	666,111	762,850
Northwestern Pacific R. R. Co., San Francisco, Cal	721,897	741,847
Milwaukee Light, Heat & Traction Co., Milwaukee, Wis.	639,129	733,049
Portland R. R. Co., Portland, Me.	724,798	727,979
San Francisco, Oakland & San Jose Ry., Oakland, Cal.	535,133	668,832
Central Pennsylvania Traction Co., Harrisburg, Pa.	529,526	665,966
Puget Sound Electric Ry. Co., Tacoma, Wash.	511,339	663,206
Charleston Consolidated Ry., Gas & Electric Co., Charleston, S. C.	614,963	654,390
Cleveland, Southwestern & Columbus Ry. Co., Cleveland, O.	543,226	645,849
Conestoga Traction Co., Lancaster, Pa.	525,078	629,320
Winnipeg Electric Ry. Co., Winnipeg, Man.		627,127

NAME OF COMPANY.	1905.	1906.
Savannah Electric Co., Savannah, Ga.	$586,236	$611,215
Houston Electric Co., Houston, Tex.	517,315	591,351
Hudson Valley Ry. Co., Glens Falls, N. Y.	506,317	570,689
Pueblo & Suburban Traction & Ltg. Co., Pueblo, Col.	524,559	553,606
Thirty-fourth Street Crosstown Ry. Co. New York City	529,254	553,417
Peoria Ry. Co., Peoria, Ill.		538,355
Little Rock Ry. & Elec. Co., Little Rock, Ark.	496,259	533,950
Mobile Light & R. R. Co., Mobile, Ala.	419,062	530,314
Ottawa Electric Ry. Co. (The), Ottawa, Can.	449,634	525,747
Cincinnati Northern Trac. Co., Cincinnati, O.	508,332	521,684
Boston & Worcester St. Ry. Co., Boston, Mass.	448,366	514,465
Altoona & Logan Valley Elec. Ry. Co., Altoona, Pa.	439,210	510,949
Rockford & Interurban Ry. Co., Rockford, Ill.	330,524	510,042
Knoxville Ry. & Lt. Co., Knoxville, Tenn.	394,036	505,341
Chicago, So. Bend & Northern Indiana Traction Co.,	394,514	503,275
Inter-State Ry. Co., Philadelphia, Pa.	405,584	502,278
Total, 44 companies,	$23,434,565	$30,905,269

COMPANIES HAVING GROSS RECEIPTS FOR 1906 BETWEEN $500,000 AND $100,000.

NAME OF COMPANY.	1905.	1906.
Lehigh Valley Transit Co., Allentown, Pa.	$616,346	$494,361
City Ry. Co. (The), Dayton, O.	442,174	493,661
Trenton Street Ry. Co., Trenton, N. J.	453,650	492,948
Lexington & Interurban Rys. Co., Lexington, Ky.	471,324	488,546
American Railways Co. (The), Phila., Pa.	444,254	486,712
Chattanooga Rys. Co. Chattanooga, Tenn.	424,262	481,831
Dry Dock, East Broadway & Battery R. R. Co., New York City	472,772	477,860
Tampa Electric Co., Tampa, Fla.	411,763	469,222
New Jersey & Hudson River Ry. & Ferry Co. (The), Hackensack, N. J.	376,618	450,686
Holyoke Street Ry. Co., Holyoke Mass.	420,652	446,921
Johnstown Passenger Ry. Co., Johnstown, Pa.	341,189	425,571
Southwest Missouri R. R. Co., Webb City, Mo.	317,812	423,705
Michigan United Rys. Co., Lansing, Mich.	363,966	410,407
Manchester Trac., Light & Power Co., Manchester, N. H.	358,505	406,673
Detroit, Jackson & Chicago Ry., Detroit, Mich.	202,440	406,539
Union Street Ry. Co., New Bedford, Mass.	371,563	396,093
El Paso Electric Co., El Paso, Tex.	288,943	391,656
Halifax Elec. T'way Co., Ltd., Halifax, N. S.	370,368	387,518
Chicago & Joliet Electric Ry. Co., Joliet, Ill.	341,030	378,223
Lincoln Traction Co., Lincoln, Neb.	316,922	372,461
Evansville & Southern Indiana Trac. Co., Evansville, Ind.	230,987	371,399
Newton St. Ry. Co., Newton, Mass.	323,743	361,596
Schuylkill Valley TractionCo., Norristown, Pa.	320,224	359,129
Honolulu Rapid Transit & Land Co., Honolulu, Hawaii	284,319	355,590
People's Railway Co. (The), Dayton, O.	308,391	351,666
Columbia Electric Street Ry., Light & Power Co., Columbia, S. C.	241,197	350,891
Toledo, Urban & Interurban Ry. Co., Toledo, O.	307,571	347,931
Yonkers R. R. Co. (The), Yonkers, N. Y.	305,917	341,258
Westchester Electric R.R.Co., New York City	327,536	332,273
Augusta Ry. & Electric Co., Augusta, Ga.	286,023	329,747
Jacksonville Electric Co., Jacksonville, Fla.	305,639	326,468
Chester Traction Co., Chester, Pa.	303,113	322,070
Springfield Ry. & Light Co., Springfield, Mo.	280,000	320,094
Galveston Electric Co., Galveston, Tex.		315,135
Manchester Street Ry. Co., Manchester, N. H.	291,730	313,013
Auburn & Syracuse Elec. R. R. Co., Auburn, N. Y.	269,574	311,109
Easton Transit Co., Easton, Pa.	251,365	309,925
Bangor Ry. & Electric Co., Bangor, Me.	193,866	303,609
Western Ohio Ry, Co. (The), Lima, O.	230,758	300,197
Erie Electric Motor Co., Erie, Pa.	262,367	299,546
Atlantic Coast Elec. Ry. Co., Asbury Park. N. J.	267,675	298,732
St. John's Ry. Co. (The), St. John's, Can.	280,569	296,898
Wilkes Barre & Hazelton R.R. Co., Hazelton, Pa.	279,839	294,592
Binghamton Ry. Co., Binghamton, N. Y.	277,032	291,943
East Liverpool Traction & Light Co. (The), East Liverpool, O.		294,100
Columbus Electric Co., Columbus, Ga.		291,244
Macon Ry. & Light Co., Macon, Ga.	273,673	290,345
Atlantic Shore Line Ry., Sanford, Me.	274,006	290,033
Topeka Ry. Co. (The), Topeka, Kan.	252,000	285,297
Kansas City Western Ry., Kansas City, Kan.		282,290
Fitchburg & Leominster Street Ry. Co., Fitchburg, Mass.	242,002	279,904
Whatcom County Ry. & Light Co., Bellingham, Wash.	195,009	279,469
Beaver Valley Traction Co., Beaver Falls, Pa.	248,248	276,941
Cleveland, Painesville & Eastern R. R. Co., Cleveland, O.	245,089	271,100

NAME OF COMPANY.	1905.	1906.
Indianapolis & Eastern Ry. Co., Indianapolis, Ind.		$270,909
Berkshire Street Ry. Co., Pittsfield, Mass.	$188,736	266,672
Albany & Hudson R. R. Co., Hudson, N. Y.	242,866	265,671
Niagara, St. Catharines & Toronto Ry. Co., St. Catharines, Ont., Can.	246,311	265,071
Lynchburg Trac. & Lt.Co., Lynchburg, Va.	178,925	264,967
Richmond Lt. & R. R. Co., Richmond, N. Y.	329,355	264,539
Scioto Valley Traction Co., Columbus, O.		263,766
Cape Breton Electric Co., Ltd., Sydney, N. S.	211,980	258,417
Pottsville Union Traction Co., Pottsville, Pa.	251,123	256,002
Lewiston, Brunswick & Bath Street Ry. Co., Lewiston, Me.	237,814	254,343
Washington, Alexandria & Mt. Vernon Ry. Co., Washington, D. C.	148,726	252,999
Eastern Ohio Traction Co., Cleveland, O.	230,765	240,108
Indianapolis, Columbus & Southern Traction Co., Indianapolis, Ind.	210,259	240,034
Asheville Electric Co., Asheville, N. C.	203,026	239,099
Rochester & Eastern Rapid Ry. Co., Canandaigua, N. Y.	221,331	237,905
Wisconsin Lt., Ht.& Pwr. Co., Appleton, Wis.	218,671	235,787
Springfield Ry. Co., Springfield, O.	212,839	231,280
Quebec Ry., Lt. & Pwr., Que., Ont., Can.		229,754
Illinois Central Traction, Co., Springfield, Ill.		229,691
Houghton County St. Ry. Co., Hancock, Mich.	167,067	229,245
Paducah Traction & Lt. Co., Inc., Paducah, Ky.	168,345	227,279
Consolidated Rys., Lt. & Pwr Co., Wilmington, N. C.	192,198	226,467
Interurban Ry. & Terminal Co., Cincinnati, O.	208,614	226,055
Phila.& West Chester Traction Co., Phila., Pa.	182,737	219,122
Montreal Park & Island Ry. Co., Montreal	179,559	218,604
New York & Long Island Traction Co. (The), Long Island City, N. Y.	104,806	207,301
Elmira Water, Light & R. R. Co., Elmira, N.Y.	194,334	206,570
London Street Ry. Co., London, Ont.	194,026	202,911
Pittsburg, McKeesport & Greensburg Ry. Co., Greensburg, Pa.	168,541	201,209
Staten Island Midland R. R. Co., S. I., N. Y.	170,049	196,266
Schuylkill Ry. Co., Girardville, Pa.	165,260	194,431
Pennsylvania & Mahoning Valley Ry. Co. Youngstown, O.		194,102
Wichita R. R. & Light Co., Wichita, Kan.	166,910	194,002
Venango Power & Traction Co., Oil City, Pa.	173,172	191,705
Eastern Wisconsin Ry. & Lt. Co., Fond du Lac, Wis.		189,996
Mansfield Ry., Light & Power Co., Mansfield, O	179,938	189,906
Newport & Fall River St. Ry. Co., Newport, R. I.	187,461	187,392
Pittsfield Electric St. Ry. Co., Palmer, Mass.	161,635	187,283
Long Island Electric Ry. Co., Jamaica, Long Island, N. Y.	162,416	184,808
Cincinnati, Georgetown & Portsmouth R. R. Co., Cincinnati, O.	157,464	184,731
Dayton & Troy Electric Ry. Co., Dayton, O.	154,098	184,646
Toledo & Indiana Ry. Co., Toledo, O.	135,641	183,640
Fries Manufacturing & Power Co. (The), Winston-Salem, N. C.	148,997	181,867
Valley Traction Co., Lemoyne, Pa.	143,643	179,304
Oklahoma City Ry. Co., Oklahoma City, Okla.	125,768	178,726
Twin City Gas & Electric Co., Brattleboro, Vt.		176,667
Milford & Uxbridge St. Ry. Co., Milford, Mass.	150,927	176,590
Camden & Trenton Ry. Co., Camden, N. J.	131,318	175,933
Dartmouth & Westport St. Ry. Co., New Bedford, Mass.	154,499	175,204
Connecticut Valley Light & Ry. Co., Northampton, Mass.	119,803	173,622
Interstate Consolidated Street Ry. Co., North Attleboro, Mass.	152,036	170,855
Stark Electric R. R. Co., Alliance, O.	142,883	172,296
Hartford & Springfield Street Ry. Co., Warehouse Pt., Conn.	128,169	170,277
Meridian Light & Ry. Co., Meridian, Miss.	142,168	169,625
Kokomo, Marion & Western Traction Co., Kokomo, Ind.	122,860	168,872
Interurban Ry. Co., Des Moines, Ia.	144,042	168,360
Steubenville & East Liverpool Ry. & Light Co., Steubenville, O.	153,437	166,325
Allentown & Reading Trac. Co., Allentown, Pa.	145,699	165,576
Waterloo, Cedar Falls & Northern Ry. Co., Waterloo, Ia.	152,658	163,763
Lehigh Traction Co., Hazleton, Pa.	166,544	163,734
Northampton St. Ry. Co., Northampton, Mass.	151,205	163,705
Twenty-Eighth & Twenty-Ninth Sts. Crosstown R. R. Co.	153,070	162,037
Lexington & Boston St. Ry. Co., Boston, Mass.	162,404	160,582
Jamestown St. Ry. Co., Jamestown, N. Y.	153,358	157,794
Worcester & Southbridge Street Ry. Co., Worcester, Mass.	120,958	152,221
Cincinnati, Lawrenceburg & Aurora Electric Street R. R. Co., Cincinnati, O.	118,971	151,914
Atchison Ry., Lt. & Pwr. Co., Atchison, Kan.	114,003	151,552
Grays Harbor Ry. & Lt. Co., Aberdeen, Wash.	106,171	150,072
York Street Ry. Co., York, Pa.	150,363	148,499

Name of Company	1905.	1906.
Quincy H. Ry. & Carrying Co., Quincy, Ill...	$140,617	$147,821
Boston & Maine R. R., Concord, N. H......	141,685	147,459
Indianapolis & Martinsville Rapid Transit Co., Indianapolis, Ind..........................	127,778	147,117
Lorain Street R. R. Co., Lorain, O..........	108,240	146,878
Winnebago Traction Co., Oshkosh, Wis......	126,746	144,315
Niagara Gorge R. R. Co., Niagara Falls, N.Y.	122,311	143,272
Oakwood Street Ry. Co., Dayton, O.........	125,240	142,122
Kingston Consol. R. R. Co., Kingston, N. Y.	126,230	140,303
Benton Harbor-St. Joe Ry. & Light Co., Benton Harbor, Mich....................		139,990
Wilkes Barre & Hazleton Ry.Co.,Hazleton,Pa.		139,206
Sheboygan Lt.,Pwr.& Ry.Co.,Sheboygan,Wis.	124,271	138,835
Green Bay Traction Co., Green Bay, Wis....	120,887	137,989
New York & Stamford Ry. Co , Port Chester, N. Y..	125,894	137,477
Railways Company General, New York, N,Y.	38,125	135,512
Fairmount Park Transp't'n Co., Phila., Pa...	128,166	134,501
Rockland, Thomaston & Camden St. Ry. Co. Rockland, Me..............................	125,225	134,151
Tamaqua & Lansford St. Ry. Co.,Lansford,Pa.	128,758	133,483
Bridgeton & Millville Trac.Co.Bridgeton,N.J.	119,233	132,656
Anniston Electric & Gas Co., Anniston, Ala..	106,015	130,659
Madison & Interurban Trac.Co.,Madison,Wis.	108,684	130,255
Orange County Traction Co., Newburgh,N.Y.	119,731	129,991
Olean Street Ry. Co., Olean, N. Y..........	118,306	128,465
Tarrytown, White Plains & Mamaroneck Ry. Co., White Plains, N. Y..................	106,880	128,548
Hamburg Ry. Co., Hamburg, N. Y..........	104,930	126,696
Portsmouth St. R. R.& Lt.Co.,Portsmouth,O.	97,867	125,724
Jackson Consolidated Trac.Co.,Jackson,Mich.	112,067	125,566
Jefferson Traction Co., Punxsutawney, Pa..:	104,975	124,092
Haverhill & Amesbury St. Ry. Co.,Haverhill, Mass......................................	111,486	123,009
Williamsport Pass. Ry. Co., Williamsport, Pa.	116,231	122,956
Sandwich, Windsor & Amhurstburg Ry. Co., Windsor, Ont..............................	107,783	122,000
Woonsocket St. Ry. Co., Woonsocket, R. I..	102,567	121,133
Louisville & Eastern R.R. Co., Louisville,Ky.	106,976	120,262
Austin Electric Ry. Co., Austin, Tex.........		118,476
Indianapolis & Cincinnati Traction Co. (The), Indianapolis, Ind..........................	104,721	117,444
Oneonta & Mohawk Valley R. R. Co., Oneonta, N. Y....................................	118,362	116,767
Washington & Canonsburg Ry. Co., Washington, Pa...	106,756	116,244
Pennsylvania & Ohio Ry. Co., Ashtabula, O.	98,000	115,825
La Crosse City Ry. Co., La Crosse, Wis.....	105,750	115,459
Darby, Media & Chester Ry.Co., Chester,Pa.	91,206	115,288
Boston & Worcester Elec. Cos., Boston,Mass.	108,043	114,473
Brockton & Plymouth Street Ry. Co., Brockton, Mass..................................	104,406	114,429
Vicksburg Ry. & Light Co., Vicksburg, Miss.		114,116
Sydney & Glace Bay Ry. Co., Sydney, N. S..	87,118	113,129
Holmesburg, Tacony & Frankford Electric Ry. Co. (The), Philadelphia, Pa...........	100,954	113,019
Groton & Stonington St.Ry.Co.,Groton,Conn.	35,122	112,711
Dayton & Xenia Transit Co., Dayton, O... .	109,961	111,596
Ithaca Street Ry. Co., Ithaca, N. Y..........	103,946	110,944
Southern Lt. & Trac. Co., Natchez, Miss....	97,955	107,505
Washington, Arlington & Falls Church Ry. Co., Washington,D. C......................	87,456	107,422
Ponce Elec. Co., Ponce, P. R................	88,574	107,327
Poughkeepsie City & Wappingers Falls Electric Ry. Co., Poughkeepsie, N. Y.........	106,712	107,152
Lewistown & Reedsville Electric Ry. Co., Lewistown, Pa............................	78,193	106,564
Syracuse & Suburban R.R. Co.,Syracuse,N.Y.	92,678	106,078
Citizens' Electric Street Ry. Co., Newburyport, Mass...................................	96,227	105,657
New Jersey & Pennsylvania Traction Co., Trenton, N. J.............................	101,326	104,259
Augusta, Winthrop & Gardiner Ry. Co., Augusta, Me..................................	97,989	103,596
Cleveland, Painesville & Ashtabula R. R. Co., Cleveland, O........................	98,558	103,095
Augusta & Aiken Ry. Co., Augusta, Ga.....	91,753	102,722
Woronoco Street Ry. Co., Westfield, Mass...	92,720	101,631
Danbury & Bethel St. Ry. Co.,Danbury,Conn.	92,747	101,563
Peekskill Lighting & R. R. Co.,Peekskill,N.Y.	88,698	100,699
Natick & Cochituate St. Ry.Co.,Natick,Mass.	90,138	100,494
Total, 184 companies.......	$32,658,939	$40,645,004

COMPANIES HAVING GROSS RECEIPTS FOR 1906 BETWEEN $100,000 AND $50,000.

Name of Company.	1905.	1906.
Astoria Electric Co., Astorio, Ore....		$99,422
Burlington Traction Co., Burlington, Vt.....	$85,862	99,207
Lebanon Valley Street Ry. Co., Lebanon, Pa.	82,148	98,596
Shamokin & Mt. Carmel Transit Co., Shamokin, Pa..	113,569	98,475
Northampton Traction Co., Easton, Pa......	91,949	98,333
Iowa & Illinois Ry. Co., Clinton, Ia.........	$40,486	$98,249
Delaware Co. and Philadelphia Electric Ry. Co., Philadelphia, Pa	89,986	97,241
Rutland Ry., Lt. & Pwr. Co., Rutland, Vt....	87,574	96,847
New Bedford & Onset St. Ry. Co., New Bedford, Mass.......................................	75,706	96,426
DeKalb-Sycamore & Interurban Traction Co., DeKalb, Ill....................................		95,898
Warren St. Ry. Co., Warren, Pa............	90,147	94,231
Hudson, Pelham & Salem Electric Ry. Co., Hudson, N.H....................................	84,126	94,147
Athens Electric Ry. Co., Athens, Ga........	76,321	93,728
Bristol & Plainville T'way Co., Bristol, Conn.	85,788	93,168
Pascagoula St. Ry.& Pwr.Co.,Scranton,Miss.	79,701	92,248
Dayton, Covington & Piqua Traction Co., Dayton, O..	85,637	92,228
Dover, Somersworth & Rochester St. Ry. Co., Dover, N. H...................................	82,945	91,882
Cedar Rapids & Iowa City Ry. & Lt. Co.....	71,597	91,609
Electric Ry.,Lt.& Ice Co., Cedar Rapids, Ia..	73,548	91,449
Milford, Attleboro & Woonsocket Ry. Co., Milford, Mass..................................	77,928	91,342
Galt, Preston & Hespler St. Ry. Co., Ltd., Galt, Ont...	68,562	91,091
Geneva, Waterloo, Seneca Falls & Cayuga Lake Traction Co., Geneva, N. Y.........	86,414	90,755
Montreal Terminal Ry. Co., Montreal, Ont..	82,297	88,536
South Middlesex St. Ry. Co., Natick, Mass..	70,812	88,289
Providence & Danielson Ry. Co., Providence, R. I..	85,970	88,194
Kingsbridge Ry. Co., New York City.......	83,795	88,120
Blue Hill Street Ry. Co., Canton, Mass.....	78,294	86,344
Springfield, Troy & Piqua Ry. Co., Springfield, O..	54,202	86,125
West Chester St. Ry. Co., West Chester, Pa..	66,532	85,374
Ohio Central Traction Co., Galion, O........	80,098	85,752
Atlantic City & Suburban Traction Co., Atlantic City, N. J.....................................	82,363	85,060
Pittsburg Ry. & Lt. Co. (The),Pittsburg, Kan.		83,703
Hudson River Traction Co., Rutherford, N.J.	75,897	83,252
Conneaut & Erie Trac. Co., Erie, Pa........		82,955
Sea View R. R. Co., Wakefield, R. I.........	63,614	82,279
Philadelphia & Eastern Ry. Co., Doylestown, Pa..	57,220	81,559
Chippewa Valley Elec. R. R. Co. (The), Eau Claire, Wis...................................	69,170	81,290
Hull Electric Co. (The), Aylmer, Que., Can..	83,532	81,221
Freeport Ry., Lt. & Power Co., Freeport, Ill.	64,289	80,727
Philadelphia, Bristol & Trenton St. Ry. Co., Philadelphia, Pa..............................	76,348	80,681
Black River Traction Co., Watertown, N. Y..	68,843	79,338
Nashua Street Ry. Co., Nashua, N. H.......	72,458	78,602
Columbia & Montour Electric Ry. Co., Bloomsburg, Pa................................	71,225	78,270
Meriden, Southington & Compounce Tramway Co., Meriden, Conn.............	62,553	77,738
Lawrence & Methuen Street Ry. Co., Lawrence, Mass......................................	63,867	77,079
Toledo, Fostoria & Findlay Electric Ry. Co., Findlay, O......................................	58,542	76,623
Worcester & Blackstone Valley Street Ry. Co., Worcester, Mass.......................	67,064	75,750
Rochester & Suburban Ry. Co., Rochester, N. Y..	58,907	74,388
Erie Traction Co., Erie, Pa.................	65,279	73,930
Waterville-Fairfield Ry. & Light Co., Waterville, Me.......................................	50,402	73,674
Matoon City Ry. Co., Matoon, Ill...........		73,500
Waverly, Sayre & Athens Traction Co., Waverly, N. Y......................................	64,593	72,738
Allegheny Valley St. Ry. Co., Tarentum, Pa.	64,859	72,156
Trenton & New Brunswick R. R. Co., Trenton, N. J..	75,152	71,582
Georgetown, Rowley & Ipswich Street Ry., Georgetown, Mass............................	52,662	71,507
Chautauqua Traction Co., Jamestown, N. Y.	46,061	70,750
Youngstown Park & Falls Street Ry. Co., Youngstown, O...............................	63,908	70,418
Butler Passenger Ry. Co., Butler, Pa........	64,264	70,296
Gardner, Westminster & Fitchburg Street Ry. Co., Gardner, Mass..................	62,300	68,620
Norfolk & Bristol St. Ry. Co., Norwood,Mass.	55,719	68,135
Warren, Brookfield & Spencer Street Ry. Co., Brookfield, Mass........................	61,416	65,741
Steubenville & Wheeling Traction Co., Steubenville, O..	58,291	65,261
Portsmouth Electric Ry., Portsmouth, N. H..	63 864	65,083
Dunkirk & Fredonia R. R. Co.,Fredonia, N.Y.	58,789	64,945
Newport & Providence Ry.Co., Newport,R.I.		64,925
Jersey Central Traction Co., Keyport, N. J...	54,277	64,713
Wilkes-Barre, Dallas & Harvey's Lake Ry. Co., Wilkes-Barre Pa..........................	57,090	63,900
Newton & Boston Street Ry., Newton, Mass.	63,323	63,658
Biddeford & Saco R. R. Co., Biddeford, Me..	60,990	63,490

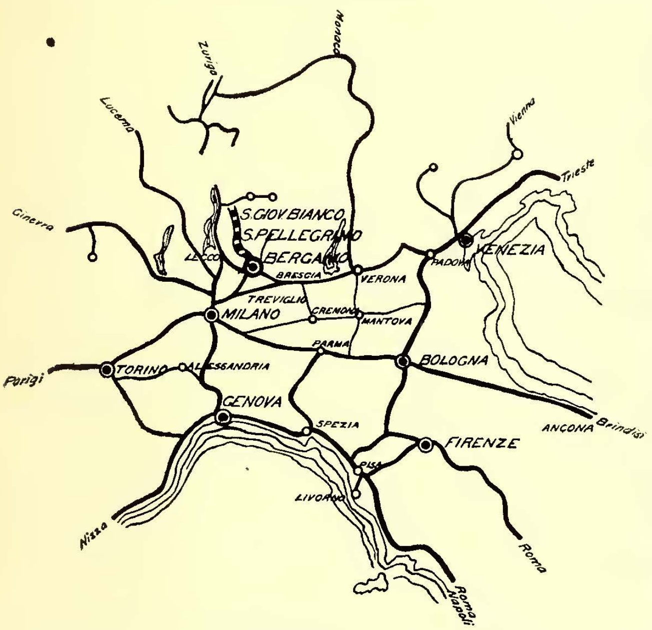
NAME OF COMPANY.	1905.	1906.
Burlington County Ry. Co., Mt. Holly, N. J.	$62,162	$62,798
Southwestern Street Ry. Co., Phila., Pa.	55,804	62,538
Chillicothe Elec. R. R., Light & Power Co., Chillicothe, O.	56,229	62,355
Springfield & Xenia Ry. Co. (The), Xenia, O.	57,816	61,989
Providence & Fall River Street Ry. Co., Swansea Centre, Mass.	50,537	61,746
Sharon & Wheatland St. Ry. Co., Sharon, Pa.	46,433	61,413
Bristol Gas & Electric Co., Bristol, Tenn.	53,455	60,738
Concord, Maynard & Hudson Street Ry. Co., Maynard, Mass.	50,556	60,130
Ashtabula Rapid Transit Co., Ashtabula, O.	50,489	59,738
Trenton, New Hope & Lambertsville St. Ry. Co., Yardly, Pa.		59,399
Wrightsville & York St. Ry. Co., York, Pa.	56,065	59,382
Cortland County Traction Co., Cortland. N. Y.	49,627	59,143
Ohio River Elec' Ry. & Pwr. Co., Pomeroy, O.	53,197	58,980
Newtown Electric St. Ry. Co., Newtown, Pa.	56,820	58,637
Monmouth County Elec. Co., Red Bank, N. J.	50,408	57,809
Van Brunt St. & Erie Basin R. R. Co., New York City	55,010	57,541
Oshawa Ry. Co. (The), Oshawa, Ont., Can.	43,442	58,511
Kittanning & Leechburg Rys. Co., Kittanning, Pa.	44,015	57,321
Farmington Street Ry. Co., Hartford, Conn.	51,029	56,220
York & Dallastown Electric Ry. Co., York, Pa.	32,343	55,564
Cohoes Ry. Co., Cohoes, N. Y.		55,063
Norton & Taunton St. Ry. Co., Norton, Mass.	52,930	55,000
Torrington & Winchester Street Ry. Co., Torrington, Conn.	50,251	54,835
Tiffin, Fostoria & Eastern Electric Ry. Co., Tiffin, O.	50,115	54,648
Oswego Traction Co., Oswego, N. Y.	49,585	54,501
Ocean Electric Ry. Co., Rockaway, N. Y.	42,120	54,281
Walkill Transit Co (The), Middletown, N. Y.	44,619	54,225
Levis County Ry., Levis, Que., Can.	11,903	52,829
Columbus, New Albany & Johnstown Ry. Co., Columbus, O.	34,513	52,582
Nahant & Lynn St. Ry. Co., Lynn, Mass.		50,032
Centre & Clearfield Street Ry. Co. (The), Phillipsburg, Pa.	48,979	50,612
Slate Belt Electric St. Ry. Co., Bethlehem, Pa.	44,586	50,642
Evansville Suburban & Newburg Ry. Co., Evansville, Ind.		52,793
Exeter, Hampton & Amesbury Street Ry. Co., Exeter, N. H.	45,226	52,496
Taunton & Pawtucket St. Ry. Co., Taunton, Mass.	35,361	52,338
Valley Street Ry. Co. (The), Sharon, Pa.	43,091	52,273
Port Arthur Electric St. Ry., Port Arthur, Que.	39,279	51,984
Warren & Jamestown Street Ry. Co.		51,677
Kenosha Electric Ry. Co., Kenosha, Wis.	42,214	51,660
Morris County Traction Co., Morristown, N. J.	29,751	51,045
Citizens' Electric Co., Eureka Springs, Ark.	43,080	50,225
Total 100 companies	$6,160,105	$7,959,936

COMPANIES HAVING GROSS RECEIPTS FOR 1906 BETWEEN $50,000 AND $25,000.

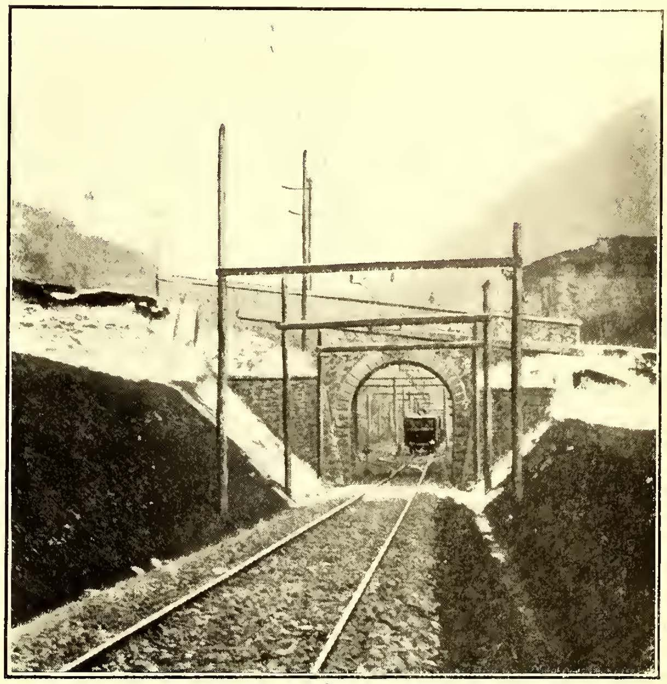
NAME OF COMPANY.	1905.	1906.
People's Street Ry. Co., Nanticoke, Pa.	$52,609	$49,895
Phillipsburg Horse Car R. R. Co., Phillipsburg, N. J.	42,868	49,437
Uniontown & Monongahela Valley Electric Ry. Co., Uniontown, Pa.	59,825	49,249
Haverhill & Southern New Hampshire Street Ry. Co., Haverhill, Mass.	42,409	48,228
Corning & Painted Post Street Ry. Co., Corning, N. Y.	42,005	48,157
Coney Island & Gravesend Ry. Co., Brooklyn, N. Y.	46,339	48,028
Chambersburg, Greencastle & Waynesboro Street Ry. Co., Waynesboro, Pa.	65,337	47,516
Erie Rapid Transit Street Ry. Co., Erie, Pa.	43,318	47,435
Bennington & Hoosick Valley Ry. Co., Hoosick Falls, N. Y.	41,673	47,332
Fishkill Electric Ry. Co., Fishkill, N. Y.		47,303
Escanaba Electric St. Ry. Co., Escanaba, Mich.	45,907	47,043
Westchester, Kennett & Wilmington Electric Ry. Co., Westchester, Pa.		46,972
Southern Boulevard R. R. Co., New York.	51,361	46,785
Barre & Montpelier Traction & Power Co., Barre, Vt.	41,676	46,748
Mason City & Clear Lake Ry. Co., Mason City, Ia.	35,921	46,486
Pottstown Passenger Ry. Co., Pottstown, Pa.	44,262	45,585
Athol & Orange Street Ry. Co., Athol, Mass.	40,654	44,958
Worcester & Holden St. Ry. Co., Holden, Mass.	41,598	44,854
Vincennes Trac. & Lt. Co., Vincennes, Ind.	41,376	44,913
Berlin Street Ry. Co (The), Berlin, N. H.	40,569	44,654
Claremont Ry. & Ltg. Co., Claremont, N. H.	36,672	44,415
Buffalo Southern Ry. Co., Buffalo, N. Y.	33,352	44,266
Portland & Brunswick Street Ry. Co., Brunswick, Me.	42,604	43,371
Westmoreland County Ry. Co., Pittsburg, Pa.	$10,403	$43,217
Shamokin & Edgewood Electric Ry. Co., Shamokin, Pa.	31,970	42,667
Templeton Street Ry. Co., Templeton, Mass.	36,394	42,653
Cedar Rapids & Marion City Ry. Co., Cedar Rapids, Ia.	38,194	42,610
Meadville Traction Co., Meadville, Pa.	40,329	42,471
Pottstown & Reading Street Ry. Co., Pottstown, Pa.		42,420
Grand Valley Ry. Co., Brantford, Ont., Can.	29,742	42,161
Titusville Electric Traction Co., Titusville, Pa.	39,103	42,077
Belton & Temple Trac. Co., Temple, Tex.	37,209	42,028
International Transit Co. (The), Sault Ste Marie, Ont.	56,517	42,024
York-Haven Street Ry. Co., York, Pa.	38,692	40,209
Columbian Street Ry. Co., Pascoag, R. I.	33,791	40,040
Eastern New York R. R. Co., Ballston Spa.	39,258	39,771
DuBois Traction Co., DuBois, Pa.	35,977	39,694
Meadville & Cambridge Springs Street Ry. Co., Meadville, Pa.	42,043	39,646
Chambersburg & Gettysburg Electric Ry. Co., Chambersburg, Pa.	34,900	39,377
Galesburg & Kewanee Electric Ry. Co., Galesburg, Ill.	27,439	38,934
Amherst & Sunderland Street Ry. Co. (The,) Amherst, Mass.	31,423	38,363
Springfield Electric Ry. Co., Springfield, Vt.	39,578	38,283
Egerton Tramway Co., Sydney, N. S., Can.		38,103
Montgomery Traction Co., Norristown, Pa.	32,948	37,660
East Taunton Street Ry. Co., Taunton, Mass.	33,721	37,304
Webster, Monessen, Belle Vernon & Fayette City Street Ry. Co., Webster, Pa.	30,883	36,981
Anderson Traction Co., Anderson, S. C.		36,844
Sarnia Street Ry Co., Sarnia, Can.	36,962	36,234
Millville Traction Co., Millville, N. J.	32,810	35,394
Western Massachusetts St. Ry. Co., Westfield.		35,049
Vallamont Traction Co., Wilkes-Barre, Pa.	33,798	34,532
Marlborough & Westborough Street Ry. Co., Westborough, Mass.	31,884	33,933
Buffalo & Williamsville Electric Ry. Co., Williamsville, N. Y.	29,575	33,872
Menominee & Marinette Light & Traction Co., Menominee, Mich.	31,526	33,803
Lancaster & York Furnace Street Ry. Co., Lancaster, Pa.	28,335	33,606
Haverhill, Plaistow & Newton St. Ry. Co., Plaistow, N. H.		33,042
Troy & New England R. R. Co., Troy, N. Y.	31,631	32,958
Carbon Street Ry. Co., Mauch Chunk, Pa.	14,060	32,520
Price Hill Inclined Plane R. R. Co., Cincinnati, O.	29,332	31,401
Sharon & Newcastle St Ry. Co., Sharon, Pa.	29,401	31,350
Toronto Suburban Street Ry. Co., Toronto Junction, Ont.	31,679	31,051
Henderson City Ry. Co., Henderson, Ky.	30,416	30,988
Fulton Street R. R. Co., New York City.	29,400	30,931
Danville & Bloomsburg Street Ry. Co., Grovanna, Pa.	16,369	30,914
Waterville & Oakland St. Ry., Waterville, Me.	30,204	30,896
Ogdensburg Street Ry. Co., Ogdensburg, N. Y.	27,686	30,655
Laconia Street Ry., Laconia, N. H.	26,487	30,493
Berlin & Waterloo St. Ry. Co., Berlin, Ont., Can.	25,776	30,371
Lancaster Trac. & Pwr. Co., Lancaster, O.	25,316	29,933
Peterborough Radial Ry. Co., Peterborough, Ont.	17,646	29,701
Calais Street Ry. Co., Calais, Me.	27,855	29,099
Five Mile Beach Elect Ry. Co., Anglesea, N. J.	22,024	29,074
Brantford Street Ry. Co., Brantford, Ont.	23,848	28,983
Chicago, Harvard & Geneva Lake Ry. Co., Walworth, Wis.	23,842	28,717
Guelph Radial Ry. Co., Ltd., Guelph, Ont.	24,619	28,509
York & Dover Electric Ry. Co., York, Pa.	26,695	28,344
People's Traction Co., Galesburg, Ill.		28,339
Uxbridge & Blackstone Street Ry. Co., Uxbridge, Mass.	24,355	28,028
Sherbrook St. Ry. Co., Sherbrook, Que., Can.	25,975	28,000
Susquehanna Traction Co., Lock Haven, Pa.	26,586	27,882
Radford Water Power Co., Radford, Va.		27,583
Kingston, Portsmouth & Cataraqui Electric Ry. Co., Kingston, Ont., Can.		27,555
Providence & Burrillville Street Ry. Co., Woonsocket, R. I.		27,628
Philadelphia & Chester Ry. Co., Chester, Pa.	24,008	27,188
Keene Electric Ry. Co., Keene, N. H.	27,312	26,530
Latrobe Street Ry. Co., Latrobe, Pa.	25,005	26,497
Banger & Portland Traction Co., Bangor, Pa.	22,495	26,201
Penn Yann, Keuka Park & Branchport Ry., Penn Yann, N. Y.	25,594	26,195
Hornellsville & Canisteo Ry. Co., Hornell, N. Y.	22,550	25,689
Medfield & Medway St. Ry. Co., Westwood, Mass.	22,937	25,385
Total, 90 companies	$2,658,842	$3,287,458

THE BREMBANA VALLEY SINGLE-PHASE ELECTRIC RAILWAY

Lombardy, in Northern Italy, has been the scene of a great amount of electrical progress. Milan, its principality, is noted for its enterprise and industry, and one of the first Edison illuminating central stations in Europe was established in that city. In the early part of the present century the direct-current, third-rail line between Milan and Gallarate and Porto Ceresio constituted the first large installation of this system, and it is probably still the most extensive in Europe. The Valtellina three-phase railway, just north of Milan, is still the most conspicuous example of that form of traction, and the Bergamo & Brembana Valley Railway, which has recently been put in operation, is one of the first examples of single-phase traction on a large scale in Europe.

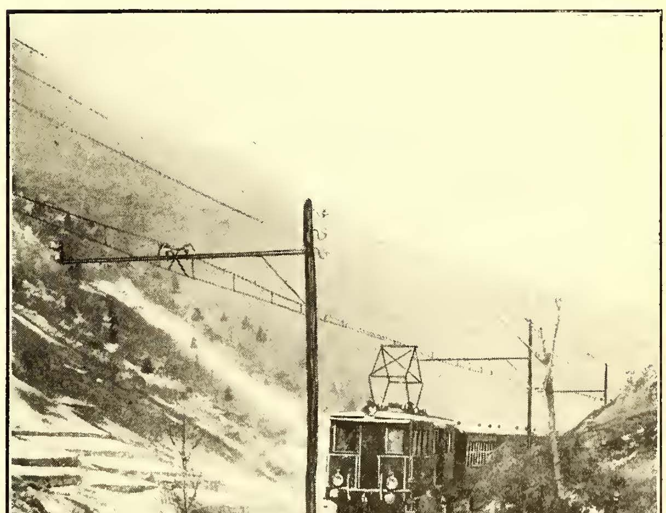


MAP SHOWING THE BREMBANA VALLEY RAILWAY AND STEAM CONNECTIONS SHOWN IN FULL LINES



CATENARY CONSTRUCTION, WITH WOODEN BRIDGES, ON THE BREMBANA VALLEY RAILWAY

CATENARY CONSTRUCTION WITH LATTICE POLES ON THE BREMBANA VALLEY RAILWAY

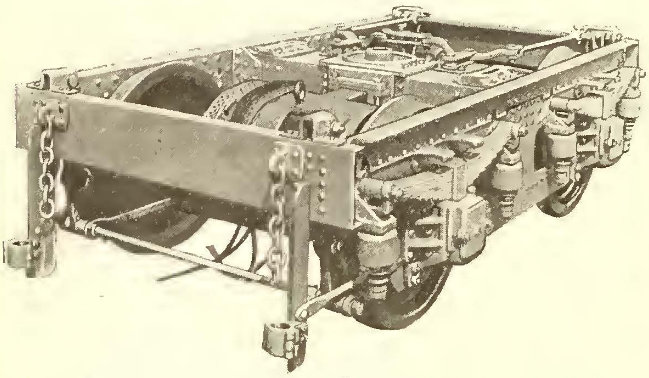


ELECTRIC TRAIN IN THE BREMBANA VALLEY, SHOWING WOODEN BRACKET POLES

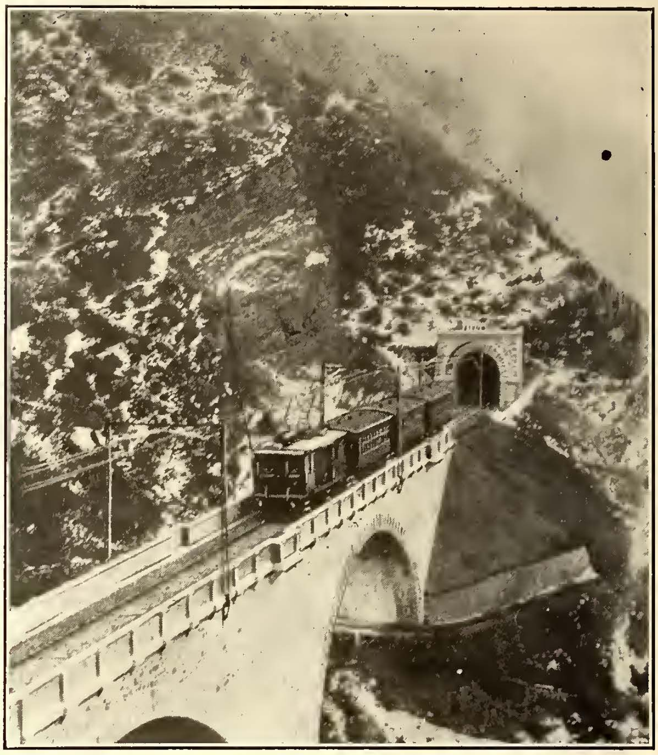
Bergamo, with a population of 45,000 inhabitants, as shown on the accompanying map, is not far from Lecco, the southern extremity of the Ganz three-phase road, and lies in one of the picturesque valleys which are situated on the southern slope of the Alps. The Bergamo & Brembana Valley Railway, the subject of this article, connects Bergamo, 810 ft. above sea level, with the village of San Giovanno Bianco at an altitude of 1300 ft. The length of the line is 30 km, or a little over 16 miles. It is laid with a single track of standard gage. The minimum curve radius is 150 m. (about 500 ft.) and the maximum grade is 2.4 per cent. There are seventeen tunnels on the line, some of them more than 200 m., or one-eighth of a mile, in length, and the road crosses the Brembo River at various points.

The adoption of electric power was dictated largely by the amount of available water-power in the neighborhood. Current is generated at 25 cycles at a hydro-electric power station high in the mountains, 3300 ft. above the terminal station at San Giovanno Bianco. It contains three 500-k. v. a. turbo-units for traction service and one 50-k. v. a. alternator for power and lighting purposes. The turbines were supplied by Riva Monneret & Company, of Milan, and Westinghouse six-pole, 6000-volt, 25-cycle alternators are used. The potential on the line is 6000 volts.

The overhead construction is of the catenary type. At some points it is carried on steel span bridges of a light and tasteful design, as shown in two of the engravings, at other points on wooden bridges and at still other points on bracket poles. The trolley wire itself is 8 mm in diameter, Fig. 8 in section, and is supported from the messenger cable by fourteen hangers to a span of 35 m (115 ft.). As the sag is 30 cm (6 ft. 3 ins.), the tension in the messenger cable is 450 kg at 0 deg. C. The messenger cable consists of seven strands of steel wire. At curves the poles or supporting structures are placed closer together than elsewhere

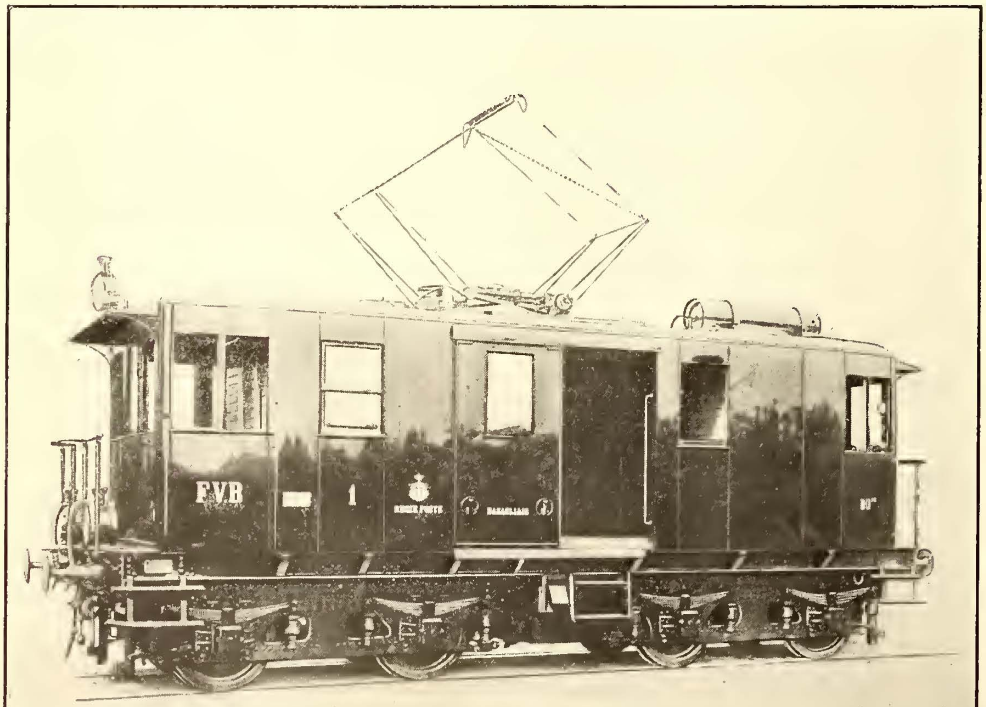


LOCOMOTIVE TRUCK WITH TWO 75-HP SINGLE-PHASE MOTORS



ELECTRIC TRAIN CROSSING A BRIDGE OVER THE BREMBO RIVER

In addition to the trolley wire there is a feeder of 50 sq. mm, or about a No. 0 section, and a lighting circuit of two copper wires of No. 8 wire or 4 mm in diameter each.



ELECTRIC LOCOMOTIVE FOR THE BREMBANA VALLEY RAILWAY, WITH AIR TANK ON THE ROOF

For the return circuit the rails are bonded with Chicago bonds and ground connections are made at distances of 1 km, or two-thirds of a mile apart.

Electric locomotives are used. Five are required to operate the line and each is equipped with four 75-hp Westinghouse single-phase motors with a maximum speed of 700 r. p. m. and a gear ratio of 70:15. The usual pneumatically-operated pantograph trolley is employed. The motors are equipped with the standard pneumatic unit switch control system and Wurtz lightning arresters. The average weight of train is 90 tons, but the locomotives have hauled loads of 120 tons on a 2 per cent grade at a speed of 18 km per hour. Tests have shown an aceleration exceeding 50 cm per second (1½ m. p. h.) per second.

The line is owned by the Società per la Ferrovia Elettrica di Valle Brembana.

PROCEEDINGS OF THE CANADIAN STREET RAILWAY ASSOCIATION AT WINDSOR, ONTARIO, JUNE 14-15.

ANNUAL MEETING OF THE CANADIAN STREET RAILWAY ASSOCIATION

The annual meeting of the Canadian Street Railway Association was held at Windsor, Ont., on June 14-15, and was attended by representatives from Montreal, Toronto, Ottawa, Amherstburg and other cities in Canada, as well as from Detroit and other cities in the United States. W. H. Moore, assistant to the president of the Toronto Railway Company and manager of the Toronto & York Radial Railway Company, is president of the association this year, and presided at the meetings.

The report of the executive committee and the secretary-treasurer dealt with a number of important matters, particularly the legislation affecting electric railway interests passed at the last session of the Ontario Legislature and the proceedings of the Ontario Railway and Municipal Board. Papers were read on the standardization of electric railway equipment by C. B. King and on electric railway development in Ontario and Quebec by R. J. Clark and P. Dubee. These papers appear in full or in abstract below.

In the evening of June 14 the members of the association, on the invitation of J. Anderson, manager Sandwich, Windsor & Amherstburg Railway, and accompanied by several prominent Windsor citizens and officials of the Detroit United Railway Company, which owns the S. W. & A. Railway, went by special car from Windsor to Amherstburg and dined in the pavilion on Bois Blanc Island, in the Detroit River, a charming outing spot, which is a favorite rendezvous for Detroit and Windsor people. A number of interesting speeches were made.

On Saturday afternoon, upon invitation of the Detroit United Railway Company, the members visited Detroit and inspected the railway repair shops, power stations and offices of the company there. Later a trip was taken on the Lake Shore line in one of the private cars of the Detroit United Railway Company.

The next meeting of the association will be held at Montreal in September, at the same time as the Canadian Electrical Exhibition, which is to be held in that city.

STANDARDIZATION OF ELECTRIC RAILWAY EQUIPMENT

BY C. B. KING
Manager London (Ont.) Street Railway

The word "standard," like the word "arbitration," the expression "municipal ownership," and some others, have a very peculiar and subtle effect upon one, especially when an effort is made by a traveling salesman, a labor agitator or a politician to be captivating. When we hear the word "standard," the impression is immediately conveyed that the most nearly perfect has been obtained and that there need be no further argument. But as perfection is impossible, complete standardization is likewise impossible from the fact that about the time we adopt a standard an improvement is made which we must adopt, and so we lose our standard. There are, however, certain elements, consisting almost entirely of dimensions, in our present electric railway equipments, which can be successfully standardized, for the reason that so many similar parts of so nearly the same sizes have been in use so long that our experience has shown that one set of dimensions can be selected that would suit all. It is to this class of standardizing that my interest inclines, and to which I beg to call your attention. A great deal in this line has already been done by the Master Car Builders' Association and by the American Society of Civil Engineers which has been of benefit to electric railways, and which I think we should follow where possible or point out some good reason why we should not. Similar organizations to the Canadian Street Railway Assciation, such as the American Street and Interurban Railway Association, The New York Street Railway Association and the Central Electric Railway Association, have also done something, the most thorough and effective work having been done by the latter association.

The M. C. B. Association was impelled to determine upon its well-known standards because of its interchange of cars and the necessity of one road repairing cars belonging to another. Electric railways hardly need it for this reason now, but they will soon, because of the development of interurban lines and their several connections. But I think we have a reason which is very similar to that which caused the A. S. C. E. to determine upon rail sections, and that is, that we are getting so many motors of different designs which must be kept in repair. Each design has its own particular gear, pinion, bearings, etc., and so we must add to our stock of supplies, and thereby add to our storeroom difficulties. To reduce these difficulties, if for no other reason, I beg to suggest that we classify motors and adopt standard designs for all the wearing parts possible. Electric railways are connecting, to an increasing extent, with steam railways, and so I think electric railway associations should adopt the M. C. B. standards as far as possible. The electric railway associations have enough to do to establish standards for the electric equipment, which, if they do their work well, will in turn be adopted by the M. C. B. Association when the steam railways adopt electric operation.

The Central Electric Railway Association appointed a committee last September to recommend standards for various parts, and at its meeting last month this committee reported upon the subjects of rails, wheels, journals, journal boxes, axles and brake-shoes. I believe it is to yet report upon various other parts. As you have no doubt read the reports, as recently published in the journals, I will only review, with perhaps some criticisms, what it has suggested.

Its adoption of the 70-lb. American Society standard rail for interurban work is all right for the present, but I have no doubt that the time will come when the association will consider this rail too light. Then, of course, it can adopt the next size, or the 80-lb. American Society standard. Its adoption of a 7-in. high T-rail for city work suits its local conditions, for most of the cities in that territory permit the use of T-rail. However, I think a grooved girder rail and a guard rail should be standardized, so that the repair and replacement of track work will not be so troublesome and expensive as it is at present, when we find it very difficult to get rails of the same section as those we may have in use at present. Two other things about track work which might be standardized to advantage are the tongue switch pieces and the frogs in the special work. As tongue switch pieces having a radius of either 100 ft. or 150 ft. are suitable for the beginning of curves of almost any radius, it would be a great advantage in the replacement of these parts if the radius of the tongue switch piece and its length were standardized, and so made by the manufacturers. The tongues should also be of the standard length, so that they will be interchangeable. In the frogs, the length of the arms is about the only thing that could be standardized, but even this would be of some advantage, for then we should know that a frog made for a 50-ft. radius curve would fit at any intersection where there is a 50-ft. radius curve, without regard to the length of the arms.

One more thing which I have in mind regarding track work is that of paving block. Those who have had any experience with this kind of paving must have found how troublesome it is to do any patching if the old bricks are broken to any extent when track repairs have to be made, and you find the new block which you have to be of a different size. I am a believer in large paving blocks, for the reason that these blocks wear at the edges first, and, therefore, the less number of edges, the less will be the wear. I would suggest that a paving block 4 ins. thick, 6 ins. wide and 12⅛ ins. long would be a very good one for track work, the 4 ins. in depth being enough to give it body, and being just about the right thickness for paving over ties with a 6-in. rail. The 6 ins. in width would give a good broad wearing surface, while the 12⅛ ins. in length would be just right for fitting with two blocks laid sideways, if it should at any time be desired to lay them this way.

Coming back, for a moment, to the subject of rails, I have often thought that a good method of standardizing rails might be to adopt such rails as the American Society standards for all work in the country, in unpaved streets or roadways, and then to use this same rail in the paved streets or roadways by making what might be termed a compound rail, consisting of an upper section of the ordinary A. S. C. E. standard rail, and of a lower section consisting of a specially rolled I-beam, very much like the Carnegie steel tie, having an upper flange 4⅝ ins., which is the same as the base of the 70-lb. rail, a lower flange of about 6 ins. wide, and a height of about 5 ins.

These two sections would be held together, at frequent intervals, by rolled steel clamps, bolted through the webs. By laying the two sections so that the joints of the upper section and the joints of the lower section would not come together, a very good form of continuous rail would be obtained, which would yet have sufficient joints to allow for the necessary contraction and expansion. Where a groove section rail is required, a very light guard could be rolled and bolted to the inside of the ordinary T-rail. If it were desired to use a regularly rolled girder groove rail, one very similar to the Lorain Steel Company's section 80, No. 337 could be used and clamped to the lower section just as well. This method of construction would save ties, because a less number of ties would be necessary, and as the ties could be buried deeper in the foundation of concrete or otherwise if desired, the roadbed should stand the wear better than when light rail is used and the ties are laid close under the pavement. Then, when it became necessary to renew the rails because of wear, only the upper section would have to be replaced. This would be particularly advantageous in special work at curves and intersections, for the reason that they wear so much more rapidly than rail on straight track. The amount of material used in the replacements would then be reduced to a minimum. The depth of the upper section, 4⅝ ins., would still be sufficient to use the hard steel centers or the solid manganese pieces, as might be desired. All of these pieces, for special work, should have a section of a standard design, so that no matter what manufacturer they might be obtained from the one would fit with the other, using the same kind of fish plates or splice bars. This kind of track would, of course, cost from 25 to 50 per cent more; but I believe that, in the course of ten to fifteen years' wear and repair, the benefits to be derived would greatly repay this difference.

With regard to the truck parts which might be standardized, I hope you will agree with the suggestion that, as far as possible, the M. C. B. standards be adapted to all those parts of the truck not influenced by the electric equipment. We cannot, of course, adopt the M. C. B. wheel, and so I think the one selected by the Central Electric Railway Association to be the wheel which is about correct, being not too large for city work, and yet plenty large enough for interurban work. That association has also adopted the M. C. B. journals, making some of them smaller, of course, than those actually used by the Master Car Builders, but yet of the same design. It has also adopted a brake-shoe very similar to the M. C. B. design, and until I learn the reason for not adopting the regular M. C. B. design I think the latter should be adopted; but, of course, the M. C. B. design would have to be modified to suit the smaller wheel, and if this is the only difference, the shoe adopted will, of course, be all right. The axles which the association has adopted seem to be for heavier work than that to which we are accustomed in ordinary street railway work; however, it might pay to adopt these heavier axles, even for light street car work, for there is no doubt that some breakage would be saved by so doing. I find very little reason for adopting the standard journal box, except in order that it may contain the standard journal, as the journal box itself wears very little, and is, therefore, not subject to frequent replacement.

When it comes to standardizing certain parts of the electrical equipment of cars, some difficulty may be encountered, for the reason that the two or three large manufacturers of railway equipment may want to maintain their individuality in certain details. However, as it is only the wearing parts which I propose to standardize, and such parts as are now so nearly alike, I do not see that this difficulty should be considered insurmountable. My desire for standardizing these parts is not so much that we may all use the same thing, as it is to make these wearing parts interchangeable between motors of different design but of about the same size. To this end I would suggest that those wearing parts be designed for three different sized motors, of 50, 75 and 100-hp sizes, respectively. Motors ranging in horse-power under 50 would then be designed to use those wearing parts which would be just large enough for a 50-hp motor. Those motors rated between 50 and 75 hp would use wearing parts just large enough for 75-hp motors, but which, I think, would not be too large for anything between 60 and 75. I make the 50-hp class the smallest, for the reason that no modern street railway motors are now built of less than 35 hp, and I take it that the gears, pinions and bearings of a 50-hp motor would not be objectionably large for a 35-hp motor. Gears and pinions, beside being classed into 50, 75 and 100-hp sizes, would have to be also classed according to gear ratio desired.

Axle and armature bearings, however, could be simply classed into 50, 75 and 100-hp sizes, the motor frames being bored out for these respective sizes, and then if it might be desired to use a 50-hp motor in a two-motor equipment on a truck having a smaller axle, the only difference would be in the cast-iron shell of the babbitt-lined bearing, and the change could be readily made. Standardization of motor parts might be carried even further to commutators and brushes, which, however, would require the same number of coils in the armature. Commutators of the General Electric and of the Westinghouse motors, of relatively the same size, are now so nearly alike that I see no reason why the armature shafts might not be turned to a standard size and the commutators likewise made of a standard size, so that one would be interchangeable with the other, and the same might apply to brushes, bearing in mind all the time that they are to be classed into the above-mentioned sizes, or something similar. On our small road we have three kinds of motors, all of approximately the same size, viz., G. E. 800, G. E. 1000 and Westinghouse 92-A, and anyone can readily see what a saving in supplies to be carried on hand and in the flexibility of repairs would be brought about were it possible to use the same gears, pinions, bearings, commutators and brushes on any of these motors. And if we would go this far, why might we not go the entire length of the rope and draw up complete specifications for motors of 40, 50, 60, 75 and 100-hp sizes, so that armature coils, field coils, and, in fact, all parts, would be interchangeable? Surely the several master mechanics and electricians who have had many years of experience with the use of motors could get together and sift down their several opinions so that a motor design satisfactory to all would be obtained. Controllers should also be so constructed that the contact fingers, especially that part of the finger which wears the most rapidly, could be standardized so that they also would be interchangeable with any other controller of similar size. Trolley bases should be standardized with regard to pins, and the socket into which the pole is to fit, so that bases and poles would be interchangeable. If the sockets are standardized, of course the poles would naturally become so. Trolley harps and wheels should also be standardized, so that they might be interchangeable.

As before stated, my reason for desiring that these various wearing parts be standardized is to facilitate repairs and the expenses thereof, on any one road or system where it seems we cannot get away from several different designs of motors, and not so much simply for the sake of using the same size or style parts that other roads do. However, I readily recognize that this state of affairs can never be brought about until such associations as our own, and others of like nature in the United States, get together, establish the standard dimensions necessary and demand of the several manufacturers that they be produced. Of course, I understand that the manufacturers will object, as they may not then be in such a good position to continue supplying repair parts; however, I believe that if this matter is handled properly enough pressure can be brought to bear upon the manufacturers to produce the motors and parts as we want them. I am a little disappointed that the largest organization of the kind, the American Street and Interurban Railway Association, has not already taken hold of this subject more vigorously than it appears to have done, for I believe that the best results are to be obtained through action by the largest organization. However, if the minor organizations, such as our own, the New York State Association, the Central States Association and others, take hold of the subject themselves, or urge upon the large association to take hold of it, the agitation of the subject and the work that may be put upon it can hardly fail to bear fruit, and we may ere long have the electric railway standards which will no doubt be commonly known as the E. R. standards.

ELECTRIC RAILWAY DEVELOPMENT IN EASTERN CANADA

BY PATRICK DUBEE
Secretary Montreal Street Railway Company

The question of the introduction of cars propelled by electricity in Eastern Canada was taken up in the principal cities almost simultaneously with the various systems in the United States. The introduction of the system, however, was regarded as exceedingly doubtful, owing to the general belief that the climatic conditions were such as would prevent the successful operation of the system in the winter months. The writer remembers that when the Montreal Street Railway Company accepted the franchise to operate in the city of Montreal the majority of the shareholders sold out their holdings in the company and predicted that within a few years at the most the company would be bankrupt. In fact, were it not for the strong financial backing of such men as the Hon. L. J. Forget, Jas. Ross, R. B. Angus and others, it is questionable whether the same would have been carried through successfully. This incident is given in order that the members may more fully appreciate the marked difference in the climatic conditions existing between the different cities in the Dominion.

The first city in Eastern Canada to adopt the electric system was Ottawa, the first car being in operation on June 24, 1891. In the fall of the following year electric cars were in operation in Montreal; in September, 1892, in St. John, N. B.; in 1896 in Halifax, and in 1897 in Quebec, and since then in Cornwall, Levis, Sherbrooke, Yarmouth, etc.

The progress of the electric system in Eastern Canada, when the difficulties and the large expense to be met in operating in the winter months is considered, has been very satisfactory, as can be seen by the following statement:

	1892	1906
Miles of single track.........	92	351
Passengers carried	28,392,450	103,232,140
Gross earnings	$860,000.00	$5,578,494.00
Capital invested	$4,000,000.00	$22,782,133.00

In considering these figures, it is important to bear in mind that there are practically no suburban lines in Eastern Canada, and that there are only four cities of a population of over the 50,000 mark, and twelve cities in which electric cars are in service.

The success of the electric railway system is due to the fact that the different companies succeeded in keeping in operation and maintaining a good service during the winter months, although the climatic conditions are so adverse to it. During the first two winters it was doubted whether success would crown their efforts. The snow-fighting equipments in the early days were not as competent to do their work as to-day, but now the improved sweeper with its standard equipments, the snow-plow and salt cars, together with the heavier cars in use, materially assist in making the work easier for the men, and it is seldom that the service is affected, no matter how serious the storm. To give the members an idea of the volume of snow which falls during the course of a year, it is only necessary to mention that statistics kept at McGill University show that the average yearly snowfall for the last fifteen years was 117 ins. It will also be of interest to know that the average cost of operation in winter for the last ten years on the Montreal Street Railway system has been about 70 per cent against about 52 per cent during the summer for the same period. Other factors which have assisted in making the electric system so successful have been the great improvements made in the roadbed and track construction, rolling stock and supply of electric current, as may be readily seen in the following brief resume:

The present rail is 87 lbs. per yard, T section, and laid in paved streets with tie rods and steel ties, the groove for the flange of the wheels being cut out of the blocks, making less noise in operation than the grooved rail and a better surface. The rail is well surfaced with concrete stringers. The 87-lb. T-rail in macadam is laid on well-spaced wooden ties, and with the tie rods every 6 ft., and well surfaced and packed with good, clean macadam. On hills and in some locations 96-lb. girder rail is used, but T-rail is used wherever practicable. Intersection work is now made of the best manganese steel, and switches, crosses, and diamonds are now all of one piece, instead of built-up work, or insert pieces, as formerly.

A few comparisons showing changes in cars during the last ten years are interesting:

	1897	1907
Length of body..................	21	35 ft.
Length over all.................	30	50 ft.
Motor equipment	60	180 h.p.
Seating capacity	28	50
Weight empty	16,000	50,000 lbs.
Weight per passenger............	570	1,000 lbs.
Cost	$2,500.00	$6,000.00

It will be noticed that, first, the deadweight of car per passenger seat has almost doubled. This would indicate a very large increase in the amount of power consumed and in the wear and tear of equipment and roadbed per passenger. To offset these items, there has been a decrease in the amount of platform labor required. The latter influence seems to have overshadowed all others in later developments on account of the great increase in the cost of labor during the last decade. There is no doubt that low cost of power and maintenance have been more or less sacrificed to permanency of construction and limitation of pay-rolls. It is also evident that although there has been a very great advance in the standards of comfort, durability, elegance and continuity of service, there has not been a very great increase in the cost of cars per seated passenger.

ELECTRIC RAILWAY DEVELOPMENT IN ONTARIO

BY R. J. CLARK
Assistant to the Comptroller, Toronto Railway

It is customary to hear the layman state that electricity is yet in its infancy. If this is the case, it must be added that the child is precocious and rapidly maturing. Moreover, no part of the child's anatomy shows a hardier muscle, combined with greater vigor and endeavor, than the limb of electric traction. In this country of ours the progress of electric traction has been very marked, and the future holds out vast possibilities to our view—possibilities which will soon, no doubt, become probabilities and later on accomplished facts.

Before passing on to any historical details of the pioneer lines of Ontario and other matters which may be of interest, it will not be amiss to give some figures showing the general growth of railways in the Dominion. In 1895 there were twenty-one electric railway companies, with a capital of $13,035,263, operating 354½ miles of track, carrying 55,348,612 passengers. In 1898 there were thirty-five companies, with a capital of $28,763,328, operating 635 miles of track, carrying 94,616,344 passengers. In 1901 there were forty-three companies, with a capital of $38,637,495, operating 672 miles of track, with gross earnings of $5,422,539. In 1905 there were forty-six companies, with a capital of over $50,000,000, operating 793 miles of track, with gross earnings of $9,357,126, and net earnings of $3,438,931.

To show, moreover, that the ever rapid increase shown above gives every sign of being continued, the following figures are given:

Year.	Total Train Mileage.	Passengers Carried.	Freight Carried.	Earnings.	
				Gross.	Net.
1901............	31,750,754	120,934,656	287,926	$5,768,283	$2,333,120
1902............	35,833,841	137,681,402	266,182	6,486,438	$2,683,583
1903............	38,023,529	155,662,812	371,286	7,233,677	2,760,819
1904............	42,066,124	181,689,998	400,161	8,453,609	3,127,092
1905............	45,959,101	203,467,317	510,350	9,357,126	3,438,931

Such has been the growth of electric railways in Canada, indicating a remarkable extension of systems, successful and efficient operation, and remunerative business, without disappointments in the way of setbacks.

EARNINGS AND OPERATING EXPENSES

	1895.		1898.	
	Gross.	Op. Exp.	Gross.	Op. Exp.
Halifax............	......	......	......	......
Ottawa............	......	......	$231,802	$159,159
Montreal............	$1,110,000	$650,000	1,450,000	760,000
Toronto............	976,031	......	1,210,618	578,857
London, 1896............	94,194	54,171	113,812	65,665
N. S. & T............	......	......	......	......
Winnipeg............	......	......	......	......
Vancouver............	......	......	187,274	......

	1901.		1906.	
	Gross.	Op. Exp.	Gross.	Op. Exp.
Halifax............	$251,644	$142,412	$387,518	$215,709
Ottawa............	313,172	235,128	525,747	345,062
Montreal............	1,900,680	1,105,267	3,100,487	1,850,720
Toronto............	1,661,017	857,612	3,109,740	1,646,515
London, 1896............	141,846	84,557	202,912	159,428
N. S. & T............	172,840	126,973	265,071	174,051
Winnipeg............	831,737	427,754	1,416,305	701,964
Vancouver............	413,923	Not stated.	698,305	Not stated.

PASSENGERS CARRIED

	1895.	1898.	1901.	1906.
Halifax............	......	......	3,037,268	3,783,801
Ottawa............	......	5,133,938	7,188,781	11,408,422
Montreal............	26,000,000	35,000,000	46,741,660	76,356,099
Toronto............	23,353,228	28,710,388	39,848,087	76,958,488
Hamilton............	......	......	4,810,237	8,018,350
London, 1896............	2,432,416	2,841,568	3,744,469	5,502,555
N. S. & T............	......	......	1,368,252	2,167,102
Winnipeg............	......	......	9,504,051	17,229,554
Vancouver............	......	......	7,670,468	12,395,582

The figures for Hamilton include Hamilton Street Railway, Hamilton Radial Railway, Hamilton & Dundas Railway. The passengers carried are exclusive of transfers. The figures given for Halifax cover income from all sources.

Manifestly, it would prove an arduous task to cover the history of all the electric railways in the Dominion, consequently the committee deemed it advisable to limit this paper to a brief history of the growth of electric railways in Ontario. The people of Ontario are indebted to the late Charles Vandepoele for the installation of the first electric line in Canada, which was also the second on the American Continent. Mr. Vandepoele was a Belgian by birth, and came to America in 1869. In 1883, in the United States, he had equipped a small track, 400 ft. long with a single car running thereon, operated by a 3-hp motor. Later in the year he constructed an overhead line for the Chicago State Fair, which remained in operation for six or seven weeks. It was in Toronto in 1884 that Mr. Vandepoele operated the first electric railway in the Dominion. Toronto had at that time a population of 100,000. In July of that year he installed the exhibition line from the foot of Strachan Avenue along the G. T. R. tracks to the eastern entrance of the Industrial Exhibition—a distance of 3000 ft. There appears to have been a single motor car with three trailers. The car was equipped with a 30-hp motor, and 200 people altogether could be carried at a time.

In 1885 Mr. Vandepoele used an overhead trolley and during the last five days of that year's fair 50,000 people were carried to and fro.

The second electric railway was the Windsor Electric Railway, where the underground conduit was used. This line was laid down in 1886 also by Mr. Vandepoele. The first attempt on this railway to operate by electricity was not successful, and electricity was finally abandoned and horses once more drew the cars. In 1891 the Sandwich, Windsor & Amherstburg Railway was electrified between Windsor and Sandwich, and in 1893 the line between Windsor and Walkerville was purchased.

In 1887 Mr. Vandepoele was able to make the proud boast that "as the matter now stands, we have more miles of electric railway in successful operation than all the electrical railways in the world combined." It only required six roads and 14¾ miles of track to verify this boast.

The third electric railway in the Dominion (also a Vandepoele) was the old Port Dalhousie, St. Catharines & Thorold Electric Street Railway, originally a horse car line, which was converted to an electric line in 1887, the first car running on October 6 of that year. In January, 1893, the Niagara Falls Park & River Railway was commenced, and was opened May 24, 1893. In that week as many as 17,500 passengers were carried in a single day. In 1891 the Ottawa Electric Street Railway system was inaugurated with a capital of $1,000,000, and between 1891 and 1894 22 miles of single track were laid down by Ahearn & Soper. In 1893, 2,700,000 passengers were carried, and the number of cars in operation was sixty-five. It was the first line to demonstrate the practicability of giving an uninterrupted service throughout the winter season. A clause had been inserted in the contract with the city, providing for the use of sleighs in the event of its being impossible to run electric cars. Happily the occasion for using them never came, and in 1893 the road amalgamated with the Ottawa City Passenger Railway Company, which had been operating horse cars since 1870, and electricity was adopted throughout the whole system. To-day the company may be congratulated on having a higher percentage of net earnings than any other in Canada.

The Toronto Railway Company was incorporated by special act of the Ontario Legislature on April 14, 1892, after the expiration of the original charter for the street railway system granted in 1861. In 1891 the city did not renew the franchise, but bought the property of the retiring company for $1,500,000; the plant and franchise were then sold to the highest bidder, and were purchased at the appraisement of arbitrators, the city making certain reservations which have ever since proved bones of contention. The group of pioneers who in 1892 incorporated the present system comprised Wm. Mackenzie, H. A. Everett, Jas. Ross and others, who have since become famous. The syndicate undertook to convert the existing horse lines into electric lines as rapidly as possible and to pay the city $800 per mile of single track per annum and the following percentage on gross profits:

From 1 to 1,000,000	8%
From 1,000,000 to 1,500,000	10%
From 1,500,000 to 2,000,000	12%
From 2,000,000 to 3,000,000	15%
From 3,000,000 upwards	20%

This agreement, while the envy of less fortunate municipalities, has ever been the subject of much litigation, but that the city was not always in the right is now shown by the recent decision of the Privy Council, which fully substantiated the company's interpretation of the agreement on many points at issue.

CAMBRIDGE SUBWAY PLANS PRESENTED

The Boston Elevated Railway Company has presented its plans of the proposed Cambridge subway to Mayor Wardwell, of Cambridge, Mass. The plans provide for two stations, one being at Harvard Square and the other at Central Square. At Harvard Square the station will be under Massachusetts Avenue, extending from Dunster Street to Linden Street, with exits and entrances at either end. The station will be 500 ft. long. Surface cars from Arlington Heights, North Cambridge and Huron Avenue will enter the subway via an incline east of Garden Street, and cars from Newton, Mt. Auburn, Waverley and Belmont will enter at a point west of Brattle Square. The station for all these lines will be under Harvard Row.

Transfer between this station and the subway trains will be made by a sub-subway passage. To transfer from the outward bound subway cars to the sub-surface cars at Harvard Square the outbound subway tracks will be at a higher grade than the inbound tracks, and a staggered platform will connect the subway station on the east side with the station for the sub-surface cars. It is probable that the present Arlington Heights surface cars will be run to Newton and back via Harvard Square, transferring of passengers to and from Boston being made at the latter point.

The subway station at Central Square will probably be located between Essex and Pearl Streets, with exits and entrances in the middle. This station is also planned 500 ft. long with double-track subway lines, but at this point the surface cars will not be carried below the street level. Transfer checks will be given at this station.

In reference to the report of W. B. Parsons, of New York, on the number and location of stations desirable, the company points out that the recommended location at Sixth Street would not accommodate the manufacturing district, which is near Kendall Square. The latter point is very near Boston, and most of the passengers are as well served by surface cars as they would be by a subway station. Most of the passengers in this neighborhood travel to Boudoin Square or South Boston, and not to Park Street.

NOTES FROM BUENOS-AIRES

The most recent order for street railway equipments placed in Buenos-Aires is that of the Tramways Electricos del Sud, which last week closed with the St. Louis Car Company for forty-two new cars for the new line from Buenos-Aires to Adrogué, which will be inaugurated next November. These cars will be equipped with two G. E. 87 motors of 60 hp each.

The La Capital Company has recently installed on a number of cars a protective device invented by J. K. Forrest, of that company. This is a sort of fender for use between the motor car and the trailer, and is intended to prevent the possibility of passengers alighting from the former being struck by the latter, which it does most effectually. Its great advantages over those now in use are that it does not project beyond the line of the cars themselves, as do the present ones.

The German Transatlantic Electricity Company, which supplies the entire street railway current of the city, is putting Jones underfeed stokers under all the boilers in its Boca station, as a result of the excellent showing made by the initial installation at their three-phase station, where the economy shown was something like 35 per cent over hand firing, using the best Cardiff steam coal. This company is preparing to build a 120,000-hp turbine-operated power station, which will be located in the Darsena Sud.

An order has just been closed by the St. Louis Car Company, through its representative, Ralph Morrison, for sixty large passenger coaches for the Chilian State Railways. The order represents a value of some $900,000 gold. Mr. Morrison is also understood to have secured the order for nine coaches for Peru.

The Gandulfo franchises for the construction and operation of a double-track electric railway along the Port Works have been turned over to the Port & City Electric Railway Company, who will carry out the work. This is a system of about 7 miles of single track.

During April, 1907, the number of passengers carried by the tramway companies of Buenos-Aires was 18,156,210.

INTERURBAN ELECTRIC WORK AROUND LOS ANGELES

The new power station being built by the Los Angeles-Pacific Railway Company at Ivy, a short distance from this city, is now almost completed. The building is 100 ft. long by 80 ft. wide, stands just west of the present power plant and will house four sets of machinery, furnishing 3300 kw, as against 300 kw which are now produced. The equipment of Vineyard station and the Sunset Avenue and Sherman plants are being increased. All of the new standard gage cars are equipped with 5-hp motors. The new car house at Sherman is now completed, and contains trackage for one hundred cars. The building is of brick, with many modern improvements. Other immediate plans for this station include a carpenter shop, 100 ft. by 140 ft. The third rail is now being laid on the Sherman and Sawtelle line from the shops to the brickyard spur at Twenty-Sixth Street in Santa Monica, so that the new standard gage cars may be hauled there for alterations that must be made.

One of the projects recently conceived by the engineering department of the road is a scenic line extending from the Laurel Canyon route west through Hacienda Heights along the border of Sherman Heights, through Beverly Hills and connecting with the Brentwood line, which runs to Santa Monica and the sea. Surveys have already been made for this line, which will afford passengers an unsurpassed view of mountains, sea and fertile valleys. It is this route that report connects with the Malibu line now being built on the Rindge estate in the Santa Monica mountains.

The Los Angeles-Pacific Company is conceded by railroad contractors and others who have studied the question to have solved the problem of keeping day laborers contented as well as it is possible to do. Houses are provided for all the Mexicans employed in track-laying and other hard labor, and little difficulty is experienced in keeping steady service. The improvements already begun by the road will take several years, and it is the purpose of the company to keep the same force if possible. More than 700 Mexicans are now working and many more will be employed in the next four months. Three camps of one-story frame houses have been built for these men. One is located at Ivy Park station, and is called Campa Lawton; another is at Ocean Park near the Sunset Avenue car houses, and the third is at Sherman. The Mexicans are paid $1.50 per day, and are given house room, electric light and water by the company. Commissaries are maintained at each camp and supplies sold at current prices. Much of the cooking is done out of doors after the Mexican fashion, a stove of brick and sheet iron being used.

The company has petitioned the Board of Supervisors to advertise for sale a franchise for an electric railroad to extend from Santa Monica Avenue on Western Avenue to Prospect Avenue. This is for a new connection between the Colegrove branch and the Hollywood branch of the company's system. The proposed franchise contains the freight-carrying clause. The board ordered the franchise offered for sale.

FRANCHISE TAXES IN LOS ANGELES

Los Angeles is just beginning to reap the benefit of the franchise law. The Los Angeles Interurban Railway Company has been notified that the 2 per cent assessment on the gross income of its Jefferson Street extension is now delinquent. Under the Broughten law this assessment must be paid forthwith or the franchise is forfeited to the city. A similar notice has been served on J. W. Eddy, holder of the franchise for the Angel's Flight Railway franchise. These franchises are the first on which companies are required to pay to the city 2 per cent of the gross receipts. The city's revenue from franchises this year will be but a few thousand dollars, but the amount will increase rapidly as the years roll by. At the end of five years the city will receive 2 per cent of the gross receipts from the operation of fifty-six franchises. At the expiration of ten years it is estimated that the 2 per cent on the gross franchise earnings will net the city $250,000 a year.

"By Trolley and Boat Between Boston and New York" is the title of a special four-page folder issued by the Old Colony Street Railway Company, of Boston. The trip can be made for $1.75, and is by trolley from Boston to Fall River and thence to New York by boat. The cars of the Old Colony Street Railway Company start from Post Office Square, Boston, daily at 2:30 p. m., except Sundays. The boats of the Enterprise Transportation Company leave the pier at Fall River at 6:30 p. m. The boats leave Pier 10, East River, New York, at the foot of Wall Street, at 5 p. m. every day but Sunday. The trolley car leaves Fall River in the morning on the arrival of the boat.

MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS AT NIAGARA FALLS, JUNE 25-28

The following three abstracts of papers read at the Niagara Falls meeting of the American Institute of Electrical Engineers are in addition to the papers and abstracts published in last week's Street Railway Journal. This issue also includes a condensed report of the discussion on high-tension transmission, lightning protection, insulators, etc., as well as on the railway papers relating to interpole motors and choice of frequency published last week.

ONE-PHASE, HIGH-TENSION POWER TRANSMISSION

E. J. Young presented a paper discussing the advantageous features of a high-tension one-phase system, and compared it with equivalent three-phase and direct-current systems. In the one-phase system assumed one-phase generating apparatus is used for supplying energy to step-up transformers. The center of the high-tension winding is permanently grounded, thereby reducing the e. m. f. from line to ground to one-half that between the line wires. With this connection the one-phase transmission system is on a par with the three-phase system in the matter of economy of conducting material. In comparing the different systems a case was assumed in which 15,000 kw was to be transmitted 100 miles with 10 per cent loss, the e. m. f. to be 70,700 volts maximum between line and ground at the receiving end. For three-phase equipment the weight of the copper per mile of line would be 6875 lbs.; the weight for one-phase would be the same, the effective value of the e. m. f. in each case being 50,000 volts. The direct-current system under the same conditions as the alternating current could use an e. m. f. of 70,700 volts, so that the weight of copper per mile of line would be 2792 lbs. It is seen, therefore, that as far as transmission material is concerned, the direct-current system is far more economical than either the three-phase or the one-phase system. In comparison with the three-phase system the one-phase requires fewer insulators and less expense in stringing the wires. Moreover, by taking advantage of the ground as a return circuit, the single-phase system can be operated in emergencies under conditions which would render the three-phase inoperative. Thus the necessity of a duplicate line is less with one-phase than with three-phase. The ability to operate with a grounded circuit can more readily be availed of with the one-phase system than with the direct-current system. The author stated that where very long lines are contemplated, such as the 250-mile line in France, the one-phase system is not only the simplest, but it unites the maximum reliability of service with the minimum number of transmission wires.

PROTECTION OF TRANSFORMERS

Two introductions to the discussion of choke coils versus extra insulation of the end windings of aransformers were presented by S. M. Kintner and W. S. Moody, the former presenting the advantages of the choke coil and the latter the advantages of extra insulation. Mr. Kintner stated that separate choke coils possess the following advantageous features: First, on a choke coil there is normally no voltage between turns, and consequently no tendency to hold a short circuit in the event of a momentary surface discharge. Second, the choke coil permits the construction of a transformer with uniform insulation throughout. Third, the choke coil allows the safe use of a cheaper transformer. Fourth, the choke coil can be insulated much more strongly than can a transformer. The recognized disadvantages are an increase in the number of pieces of apparatus and an increase in complication of separate wiring when externl choke coils are used. Each of the advantages and disadvantages was discussed in detail. For some installations it is possible to use choke coils mounted out in the air and thereby made a part of the station wiring, but in general an oil-insulated coil is to be preferred. It has been customary to use oil-insulated choke coils, each mounted in its own tank, but there seems to be no good reason why the coils cannot be placed inside the transformer tank and thus save considerable floor space, as well as outside wiring. Mr. Kintner expressed the opinion that for a given expenditure to provide protection against surges better results can be obtained by the use of choke coils than by extra insulation on the transformer.

Mr. Moody stated that although choke coils are quite effective in protecting transformers, their use is attended with some objections. If the reactance is such as to be effective against moderately high frequency oscillations it must, since it is connected between the lightning arrester and the transformer, offer a very high impedance to the high frequency of the oscillatory currents which will usually be set up within the transformer itself when a bound charge within it is released by a stroke of lightning relieving some overhanging cloud. Under such conditions it is almost as bad to hold back a charge in the transformer as to keep it from entering under other conditions. Experience during the last four years shows that very little preventive reactance is necessary for protecting the windings of a transformer whose outer turns are heavily insulated. It is practicable to reinforce a considerable portion of the turns of a large transformer coil so that it will withstand from 2000 to 20,000 volts per turn, without greatly decreasing the space factor of the winding or causing any considerable increase in cost. In thus providing protection for a transformer one should aim to use, not a given insulation strength per turn in the reinforced portion of the winding, but a certain strength per foot. In large transformers wound for 75,000 volts or less, it is practicable to resist a high frequency wave whose magnitude is equal to the working voltage in some hundred feet or less.

Few transformers for transmission work are built at the present time with taps to admit of operation with different ratios of transformation. Frequently such taps cover a range from 10 to 30 per cent of the winding, and if they are located so as to cut out the end portions of the turns one must reinforce the insulation well inside the inside tap, or perhaps some 40 per cent of the total winding. It has been the practice of the General Electric Company for some years so to locate tap connections that they will cut out centrally located turns instead of end turns, thereby not only placing them in an essentially safer position, but also avoiding the necessity of any more reinforcement than is required when all of the winding is in service. Mr. Moody stated that transformers having a total rating of about 750,000 kw, embodying the above-mentioned construction, have been built in sizes ranging from 300 to 7500 kw and wound for voltages from 5000 to 80,000, in both the air-blast and the oil-immersed types. Most of these have been installed with a small protective reactance, but many without such protection, and not one of these transformers has yet failed from any weakness of the internal insulation, although a considerable portion of the transformers has been installed for three years.

PROTECTION OF TRANSMISSION LINES

A paper by Norman Rowe described certain experiences with lightning rods and grounded cables as a means for protecting transmission lines against lightning. The paper gave a summary of lightning trouble during the years 1904, 1905 and 1906 on a steel-tower, long-span transmission line in the States of Michaocan and Guanajuato, Mexico. The transmission line towers are of standard type, the height being 40 ft. from the top of the cross-arm to the ground. When the wires were first installed they were placed upon the towers at the vertices of an equilateral triangle, the upper wires being supported upon a 3-in. extra heavy pipe, which forms the continuation of the tower, the other two being placed at the ends of a double-channel iron cross-arm approximately 7 ft. in length, the sides of the triangle being 6 ft. Throughout the rainy season of 1904 the only protection against any high voltage due to lightning discharges was afforded by the line insulators. During 1905, however, lightning rods were placed in pairs on the pole tops.. During 1906 the transmission wire was removed from the top of the tower and for it was substituted a steel cable grounded at each tower over the entire line. The transmission line was placed on a special bracket located at a proper distance below the other two transmission lines. During the season of 1904 there was considerable trouble with lightning; during the next season there was less, and during the season of 1906 comparatively little trouble was experienced. On the strength of the experience during the three seasons, Mr. Rowe offered the following suggestions: First, insulators should not be disposed upon poles or towers so that they will be in the path of bolts of lightning going to ground by way of the supporting structure. Second, a grounded cable, strung above the transmission wires at the highest point of the tower, is certainly more effective than lightning rods in protecting the insulators and conductors from direct bolts of lightning. Third, lightning arresters for discharging the line in case very high voltages are present on the wires would be of some value if located along the line at frequent intervals. Fourth, on steel construction the insulator should have a margin of safety against puncture and arcing over.

Following are abstracts of the discussion of some papers read Wednesday, Thursday and Friday, June 26, 27 and 28:

TRANSFORMERS

This discussion was opened by A. H. Pikler, who expressed the opinion that neither the extra insulation of the end turns of a transformer nor the use of choke coils can be considered as a perfect preventive of troubles from lightning, when used alone. It is far preferable to provide a moderate amount of extra insulation for the end turns and to use a small amount of external inductance. K. C. Randall stated that it is extremely desirable in any event to use a certain amount of external inductance.

D. B. Rushmore discussed in detail the disastrous effect of an arcing ground in producing high potential strains in a transformer. Under some conditions a choke coil is undoubtedly desirable, but there are cases where it in itself may cause excessive voltage rises. P. M. Lincoln agreed with the conclusions of Mr. Kintner as to the value of an external choke coil, because, although there is an active voltage between each turn of a transformer, and a short circuit between such turns may produce an enormous current, an exactly equal short circuit in a choke coil due to any excessive voltage across such coil can produce no result worse than eliminating the coil from the circuit.

W. M. Smith called attention to the increased expense of repairing any defects in a transformer which depends upon the extra insulation of the end turns for protection in comparison with the expense connected with replacing a damaged choke coil. The time has arrived when choke coils should be standardized. Each coil should be placed where no flash can reach it, and where it can cause no damage in itself. C. W. Stone stated that choke coils have not been found advantageous for use with cables on account of their inability to protect a cable from internal disturbance. Prof. E. E. F. Creighton explained, on the basis of resonance, the phenomenon sometimes observed of a higher voltage being produced at the transformer terminals inside of the choke coil and at the outside of the choke coils nearer the transmission line. He stated that cases have been known where inner turns of a transformer have been damaged without injuring the insulation of the end turns, even when the inner turns were equally as well protected as the outer turns. William McClellan expressed the opinion that it will be necessary to continue the use of choke coils in connection with transformers until there has been produced an arrester having the essential characteristics of a safety valve. Such a transformer is promised in the new electrolytic type.

Prof. Morgan Brooks reported the results of a series of observations which showed that excessive voltages may be produced in the secondary of a transformer by closing the primary circuit at certain points of the e. m. f. wave. W. S. Lee expressed his preference for the installation of both choke coils and extra insulation of the end turns in connection with lightning arresters. Experience has shown that the weakest point of the high potential transformer is in the terminals, rather than in either the end turns or in the choke coils. Ray P. Jackson stated that the effectiveness of a choke coil depends almost exclusively upon its inductance. The experience seems to indicate that the inductance should have a value of about 0.04 or 0.05 henries. If the end turns of a transformer are insulated and used for protection, the extra insulation should cover such a length of turn as to include this amount of inductance.

Dr. C. P. Steinmetz said that choke coils may be advantageously located within the transformer tank when oil insulation is used. They should, however, be so placed as to protect all of the apparatus within the station or substation. Thus, if a switch is located between the transformer and the external line a choke coil in the transformer case will not protect the switch. For most installations it is preferable to place the choke coil out of doors and depend upon air insulation. The transformer itself should also be protected by means other than the choke coil itself. At a very high frequency, such as 30,000 cycles per second, there may be an enormous rise of e. m. f. inside of a choke coil due to resonance. It is desirable in most cases to use only that amount of inductance which is absolutely essential to the operation of the lightning arrester equipment. R. D. Mershon called attention to the fact that even in case a transformer is wound for two voltages, one having half the value of the other, it is not necessary to use an extra amount of insulation for the end turns, because the turns which are given extra insulation may be designed for the largest current which the transformer will carry and may be used to carry such current both when the coils are connected in series and in parallel. In any event, however, the best results will be obtained when a choke coil is used and such choke coil should be of the air-insulated type and placed out of doors.

TRANSMISSION LINES

D. R. Scholes presented a paper on "Transmission Line Towers and Economical Span," which was followed by a paper by Norman Rowe on "Lightning Rods and Grounded Cables as a Means of Protecting Transmission Lines Against Lightning." These papers were discussed by Messrs. Hoopes, Fleming, Neall, Mershon, Thomas, Lee, Paine and Ricker. Mr. Mershon stated that the Niagara, Lockport & Ontario Power Company is now employing horn arresters, which are so arranged as to act both as arresters and as lightning rods; that is to say, the side of the horn arrester which is connected to the ground is extended upward above the transmission line so as to act in the capacity of a lightning rod.

At the session of Wednesday evening William McClellan stated that the durability and effectiveness of a transmission installation depends to a large extent upon the insulators. The insulator described by Mr. Hewlett seems to be almost ideal in this respect. Mr. Hewlett stated that each of the disks of the link insulator is capable of withstanding a voltage of about 65,000. It is rated at 25,000 volts, so that a large factor of safety is used. For 60,000-volt transmission work either two or three disks are placed in series.

THE ELECTRIC RAILWAY

The papers relating to electric railways gave rise to an interesting discussion. The titles of the papers are as follows: "Single-phase versus Three-phase Generators" and "Choice of Frequency for Single-phase Railways," by A. H. Armstrong; "Twenty-five versus Fifteen Cycles for Heavy Railways," by N. W. Storer; "Commutating-Pole Direct-Current Railway Motors," by E. H. Anderson. The discussion was opened by Paul M. Lincoln, who said that in the electrification of steam railroads the electrical equipment used for propulsion will not be connected in any way with other electrical equipments, so that any discussion of the limitations of a certain equipment for combined duties is irrelevant. H. G. Stott showed that a three-phase star-connected generator can supply power to single-phase and three-phase loads by using the equivalent of a four-wire system for single-phase loads, and a three-wire system for the polyphase loads. Wm. McClellan showed that some simplicity is obtained by using a T-connection, because in this event the load need be divided into only two instead of three parts, and an inequality of the two parts does not seriously affect the operation of the system.

Prof. C. P. Steinmetz explained that an induction regulator cannot be employed for supplying a balanced load on a polyphase generator when the load on the system is single-phase. He showed that the effect of a single-phase load between two leads on a three-phase system tends to decrease the voltage between these two leads and between one of these leads and the third lead; the voltage between the other lead and the third lead is, however, affected very little. Any lamp load should be placed across between the latter two leads. E. J. Berg called attention to the fact that the speed limitations in low-frequency generator design have been overcome in the Stanley alternator, which is a special type of generator supplied with low-frequency alternating excitation.

Dr. Steinmetz showed that for each type of alternating-current apparatus there is a certain range of frequency at which it operates most advantageously. Small induction motors can be built more economically for 60 cycles than for 25 cycles, while the reverse is true of large motors. The proper frequency for rotary converters is about 25 cycles. The single-phase series motor operates more and more economically the lower the frequency. Such is not true, however, of the alternating-current railway motor invented by E. F. W. Alexanderson. This motor operates more economically at 25 cycles than at 15 cycles and the commutation is excellent. In this motor the improvement in commutation is due to the neutralization of the e. m. f. in the short-circuited coil, rather than to a lowering of the frequency for a given flux of the insertion of resistance to decrease the short-circuit current.

In reply to a question as to the extent to which high-voltage railway motors have been employed, Mr. Anderson stated that although no 1200-volt railway motors are yet in service, many orders have been received for such machines and the motors have been built and tested. Even at an e. m. f. of 1800 volts the commutation has been found to be entirely satisfactory. The danger of flashing has been eliminated by removing the prime cause therefor, namely, the collection of carbon dust on the commutator and neighboring insulated parts. A commutating-pole motor is subject to so little disintegration of the brushes that there is no accumulation of carbon dust.

ALTERNATING-CURRENT MOTORS

In the discussion of a paper by William Cooper on the "Regeneration of Power with Single-Phase Railway Motors," W. I. Slichter said that the method outlined by Mr. Cooper is exceptionally advantageous for heavy railway work. He showed that the amount of power returned during retardation can conveniently be varied by changing the excitation of the exciting motor. L. B. Stillwell stated that the most advantageous feature of regeneration is in the minimizing of wear and tear on the rolling stock. Even with three-phase motors, the regeneration is of considerable importance. Thus it is possible with such motors to maintain an average speed equal to that with series-wound motors and yet obtain a large saving in energy. For example, instead of climbing a hill at 20 miles per hour and descending at 40 miles per hour, it is preferable to travel at the mean speed of 30 miles per hour, requiring extra power for ascending and returning power in descending. In reply to a question by J. A. Lincoln, Mr. Cooper stated that when a railway motor is used both for propelling and for braking the wear on the gear is somewhat increased over that during simple motor operation, but the increase is not large and is of no importance.

ELECTRIC POWER TRANSMISSION

"One-Phase High-Tension Power Transmission" was the subject of a paper presented by E. J. Young. In its discussion, Dr. Steinmetz said that in the early days of low-tension transmission, when wooden poles and cross-arms were in use, the limiting factor in the increase in the voltage was the e. m. f. between wires; on the basis of such e. m. f. the three-phase system requires only three-fourths as much copper as the one-phase. Under modern conditions the limiting factor is the voltage between each line wire and the grounded insulator pin; on the basis of this e. m. f. the one-phase system is equally as economical as the three-phase. Much discussion has arisen as to whether the one-phase and the direct-current system should be compared on the basis of the maximum, the effective e. m. f. or some value between these two. In any event, it is not probable that the direct-current transmission system will be used in this country in preference to the three-phase system.

CORRESPONDENCE

METHODS OF REGULATING SUPERHEATERS

111 BROADWAY, NEW YORK, July 2, 1907.

Editors STREET RAILWAY JOURNAL:

We notice on page 1050 of your issue of June 15 that you have an editorial on superheated steam, in which you divide all superheaters into two classes, "controllable" and "uncontrollable," and define the "control" as by means of hot water circulating through pipes, etc.

We desire to call your attention to the fact that there are other means of controlling superheaters besides this, and in one which we advocate a damper regulates the amount of heat given to the superheater. The damper is operated by thermostatic control.

POWER SPECIALTY COMPANY,
E. H. FOSTER, Vice-President.

DROP SASH FOR VESTIBULE DOORS

NEW YORK, June 29, 1907.

Editors STREET RAILWAY JOURNAL:

As an "ex"-locomotive engineman now running an electric train, I believe that it would be very advisable that cars should be built so that the sash in the side vestibule door next the motorman could be dropped or taken out. This would afford the motorman a convenient window to lean out of and see the rear of his train. The usual plan of placing the door in the half-open position is a very poor substitute for a cab window. It seems strange that passengers may raise or lower the side car windows and lean out, although, of course, at their risk, while the man at the head of the train should be boxed up in a closed vestibule. I hope the designers of cars for this service will notice this article and remedy this oversight on their part. The change would cost very little in a new car, and by making the door a little thicker a convenience would be afforded to the motorman which would be very much appreciated by him.

A SUBSCRIBER.

MEETING OF EMPIRE STATE GAS AND ELECTRIC ASSOCIATION

Following the annual meeting of the New York State Street Railway Association at Hotel Champlain, Lake Champlain, reported last week, a meeting was held at the same place on June 27 by the Empire State Gas and Electric Association, to consider the relationship of the traction and lighting interests to the new public utilities law. Delegates to the street railway convention were invited to stay over for the meeting, and many of them did so. In the absence of President Palmer, the meeting was called to order by T. R. Beal, who stated briefly the objects sought.

The first business was the reading, by H. H. Curran, of a paper or report on the publicity work of the association, showing how much had been done to secure the publication of facts and data in the newspapers, informing the public and helpful to public service corporations. Details were given as to the wide use of a number of special articles on facts connected with the industry. On the political side also good work had been done in combating misrepresentation as to the results of municipal ownership, alleged fires caused by electricity, etc. An average circulation of about 300,000 had been enjoyed by the articles issued by the bureau for the association. This work is estimated to cost about $10,000 a year, including the maintenance of the association secretary's office and staff. Arthur Williams, of the New York Edison Company, pointed out various ways in whieh the work might be extended.

J. N. Shannahan, ex-president of the New York Street Railway Association, gave, by request, a brief diseussion of the scope and bearing of the public utilities law, in regard to which he felt that the companies in allied fields must work together, possibly through some joint organization that could handle the subject efficiently and present a common front for them to the people who legislate or who seek legislation at Albany. Where there is no concerted aetion, bad measures slip through.

Mr. Beal suggested that as the law treated them all in the same manner, it might be well to combine all interests in one federal association. Indeed, many of the companies were interested in three or four fields of public service.

Arthur Williams pointed out that among the national associations that was virtually accomplished not by amalgamating, but through "public policy" committees that worked together. That seemed to him a better way. Each industry had its own problems. At the recent meeting of the National Electric Light Association seventy papers were read on as many topics.

W. W. Freeman returned to the main topic of the new law, which many of them, he said, regarded as unduly harsh and drastic. He thought that the association ought to have a clearing house whereby a report could be had on the general operation of the law, enabling the body to suggest proper and necessary modifications. It would be helpful to keep a complete record of every transaction of the members with the commission as a basis for future effort.

A brief discussion then ensued as to the Massachusetts law and as to one or two features of the New York law.

James M. Wakeman then suggested the desirability of a State public utilities committee, an idea which was generally approved. He made a motion to the effect that the meeting refer to the executive committee of the association, for consideration and action, the appointment of such a committee composed of representatives from the association to collect information relative to the action of the public utilities commission in regard to applications made to it during the year; that the committee suggest to the executive committee of the Street Railway Association of New York State that it also should appoint such a committee; that these two committees shall meet jointly and make a report which shall be read by the secretary of each association at its annual meetings; that the committee consist of three members from each of the associations, the secretary of each being a member ex-officio, and that the secretaries obtain the information presented to the committee and make reports to the respective associations. This was unanimously adopted. There was a little further discussion, but no other action on the subject.

The next matter treated was that of uniform accounting. Prof. B. V. Swenson, secretary of the American Street and Interurban Railway Association, referred to the general adoption of a standard system by street railways, recognized also by State boards and by the United States Census Office.

The subject of gas accounting in its relation to the requirements of the law was also discussed, and the topic was also treated in a paper by C. H. Hart, who submitted a scheme and general outline for gas and electric companies. It was finally agreed to recommend to the executive committee the appointment of a committee of three accountants to work in conjunction with corresponding committees of the American Gas Light Association and the American

Street and Interurban Railway Association for the purpose of formulating a method of accounting to meet as nearly as possible the conditions found in the various lighting companies of the State.

R. A. Davidson then read a brief paper on "Fire and Liability Insurance for Gas and Electric Companies," suggesting methods by which the companies could secure lower rates than are now accorded them. There was a brief discussion on mutual insurance, and such practice in Cleveland as to street railways and in New York as to lighting plants was cited by different members. The meeting then adjourned.

ESTABLISHMENT OF THROUGH ELECTRIC SERVICE ON THE NEW YORK CENTRAL

On July 1 the New York Central & Hudson River Railroad took off its last steam trains, ten in number, which were running into its Forty-Second Street terminal, and substituted electric locomotives for them, thus completing the electrification of the system to High Bridge on the Central Division and Wakefield on the Harlem Division. The New Haven trains are still being run into the Grand Central Station by steam.

PROPOSED ELECTRIFICATION IN VICTORIA

Thomas Tait, of Australia, chairman of the Victorian Railway Commission, has been making an extensive tour in Europe, where he has visited the important railways which have been changed from steam to electric power, and is now returning to Melbourne by way of the United States. Upon reaching Melbourne he expects to make a report on the technical studies undertaken by him, as the electrification of the Victorian suburban steam railways and of the cable system in Melbourne is under consideration by the Railway Commission. The commission has also engaged Charles H. Merz, the well-known engineer, of London, to visit Victoria and make an exhaustive report on the proposed electrification.

The following statistics relate to the suburban mileage of the Victorian railways, whose conversion to electric power is now being considered by the commission. They are for the year ended June 30, 1906:

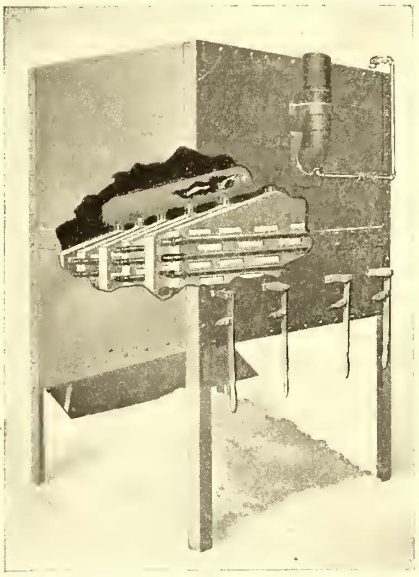
Mileage of suburban railways	147
Mileage of suburban tracks	262
Suburban passenger revenue (not including parcels mails and miscellaneous)	£595,669
Suburban passenger train-mileage	2,863,124
Suburban passenger car-mileage	23,075,648
Suburban passenger journeys	59,477,123
Miles traveled by passengers in suburban passenger trains	286,679,733
Average distance traveled by each suburban passenger, miles	4.82
Average fare paid by each suburban passenger	2.40
Revenue per passenger per mile	0.50d
Population of Melbourne and suburbs, Dec. 31, 1905	515,350
Approximate amount paid in fares for Melbourne and suburban traveling by suburban railways and tramways per head of population per annum	£2.083
Approximate number of passengers per week-day arriving at and departing from Central Suburban Station	140,000
Number of trains carrying suburban passengers arriving at and leaving Central Station per week-day	1,332
Number of suburban stations	145

NEW TRAFFIC AGREEMENT AT ATLANTIC CITY

Under a new traffic arrangement entered into between the West Jersey & Seashore and the Shore Fast Line, Superintendent S. S. Neff, at present in charge of the Atlantic City & Shore Railroad, described in the last issue of this paper, will become the managing director of the allied trolley lines in Atlantic City. This arrangement will take effect, it is said, on July 15. This announcement indicates the close relations of the Shore Railroad interests and those of the Pennsylvania Railroad Company.

A STEAM SAND DRYER

Although many steam sand dryers have been devised, few have been entirely successful in drawing the moisture from the sand. This and other desirable features are claimed for the Howe steam sand dryer, which is being sold to railroad companies in large numbers by Towne & Phymister, of Binghamton, N. Y. The dryer furnished by this company consists of a series of live steam pipes with vapor boxes arranged vertically between the steam pipes. The sand to be dried is dumped into the steel hopper surmounting the dryer and passes down between the steam pipes and the vapor boxes. As the moisture in the sand is vaporized,



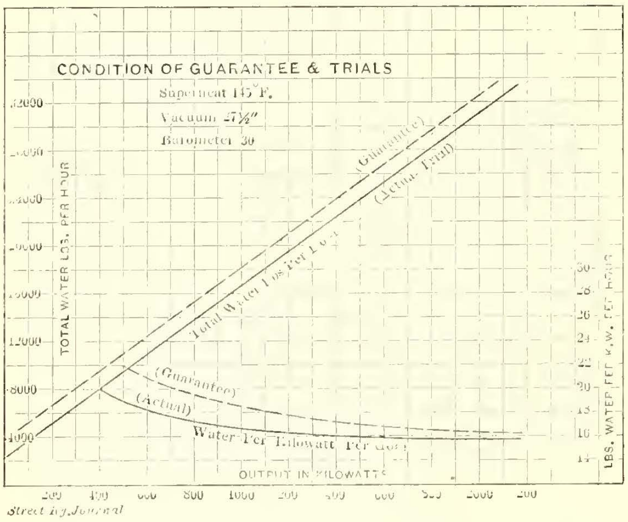
PART INTERIOR VIEW OF STEAM DRYER

it is drawn through numerous apertures into the vapor boxes and out of the body of hot sand through the main exhaust pipe, the dry sand falling through the adjustable openings in the bottom of the dryer. The important feature of this dryer lies, of course, in the vapor boxes, for as soon as the sand is heated the vapor is drawn into these boxes and out through the main exhaust pipe by the draft created by turning on the small steam blow cock shown. The dryers are made in two standard sizes, one for 5 and the other 10 tons daily capacity. They are substantially constructed and possess in their design a greater degree of refinement than is usually found in apparatus for this work; consequently they should last much longer than home-made devices and be more economical in steam consumption.

The blank report sent out by the Ohio State Railroad Commission, upon which steam, electric and street railroad companies are to make their annual reports, contains eighty-seven pages of questions, and is bound in board. All the details of operation, construction, maintenance, passenger and freight earnings and every item and feature that enter into the business are included. A description of the equipment is required and the officials are required to go minutely into all matters in question. The report must be in the hands of the commission by Sept. 15. The work of tabulating the information required by the commission will be something enormous, but there is no question as to the minute detail the members will have at hand, fresh and reliable every year.

STEAM TURBINES FOR SYDNEY, NEW SOUTH WALES

Willans & Robinson, Ltd., of Rugby, England, have recently completed two 2000-kw steam turbines built for the Sydney municipality, and for whom T. Rooke is electrical engineer. The entire contract was given to Dick, Kerr & Co., while the turbines and surface condensers were sublet to Willans & Robinson, Ltd. The interests of the municipality of Sydney in England are in the hands of Preece & Cardew, who have witnessed the necessary tests on the plant prior to shipment.



TEST CURVES ON A 2000-KW TURBO-ALTERNATOR

The turbines are arranged to give an overload of 20 per cent for periods of two hours. To obtain the full load non-condensing the turbines are fitted with pass valves. The normal working pressure at the boilers is 150 lbs. per square inch, while the steam is superheated between the limits of 85 degs. F. and 145 degs. F. The turbines are arranged for a speed of 1500 r. p. m. and exhaust into a vacuum of 27½ ins.

The complete condensing plant is arranged to maintain a vacuum of 27½ ins. at the normal full load of the turbine, and a vacuum of 26 ins. at the overload, the temperature of the circulating water being 70 degs. F. The air pump is built on the Edwards principle and is of the three-throw type running at a speed of 108 r. p. m. It is driven through single reduction gearing by a three-phase, 22-hp motor running at 585 r. p. m. The circulating pump circulates 2950 gals. per minute when working against a head of 22 ft. It is driven by a three-phase, 35-bhp motor running at 580 r. p. m.

The alternators are of the Dick-Kerr three-phase type, arranged for 5200 volts and 50 cycles, and give an output of 2000 kw when working on 85 per cent power factor. Each alternator has a 100-volt exciter direct coupled on its shaft.

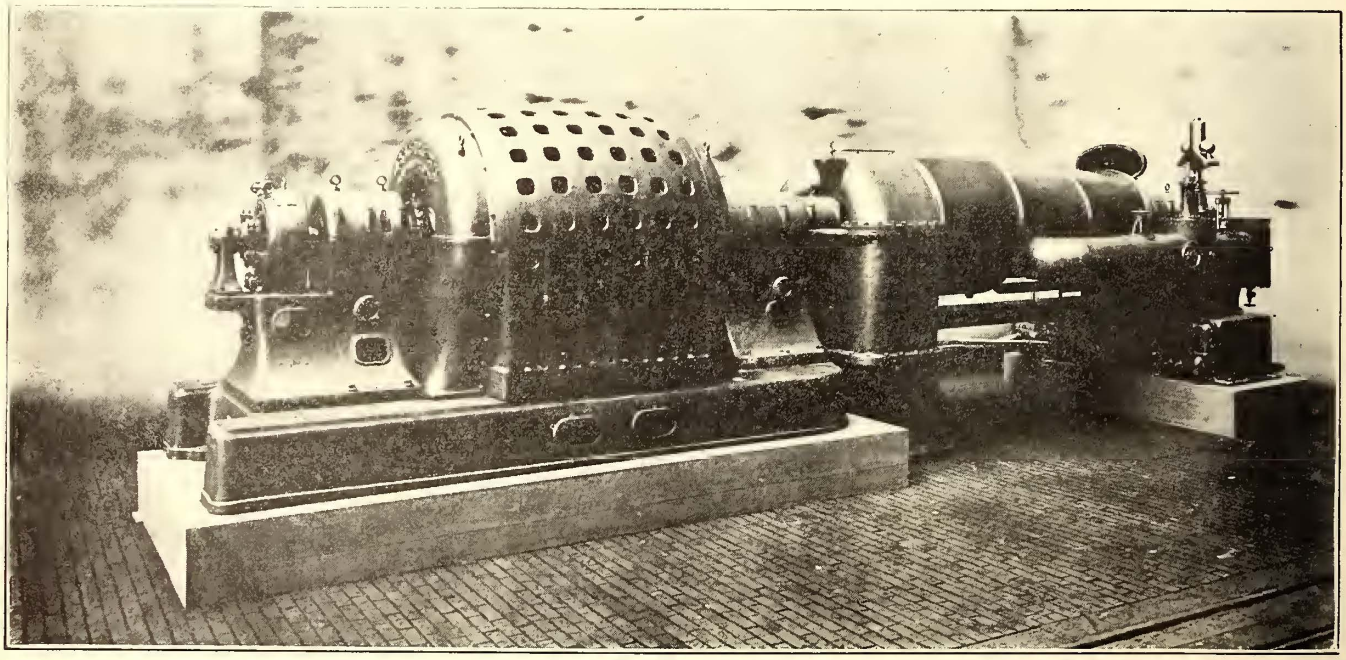
THE TURBINE

Although the Willans-Parsons turbine is now fairly generally known, attention might be drawn to the following points in which it differs from others manufactured under the same license.

It is arranged with two balance pistons in place of three. In the ordinary design of turbine the three balance pistons are placed on the high-pressure end of the turbine; in this it is considered an advantage to dispense with the third and large diameter balance piston on the steam end (which is essentially the small diameter end), and to utilize the low-pressure end of the turbine in place of the third balance piston. For this purpose steam is admitted through the interior of the rotor to the low-pressure end, which acts as a third balance piston. This arrangement allows the turbine to be made somewhat shorter and enables a more symmetrical casting to be used in view of the diameter of the low-pressure end being reduced.

The body of the turbine is built up in three sections instead of being cast in one piece. The advantage of this construction lies in the direction of being able to machine each section to a very much finer limit than would be possible if the complete case had to be machined in one length.

The merits of the blading lie first in being able to build up the blades in half rings ready for assembly in the rotor and casing which permits the blading to be treated as a separately manufactured article completed and carried in stock ready for immediate use. The method of building up the blades in sections makes possible the use of the chan-



2000-KW STEAM TURBINE FOR SYDNEY, NEW SOUTH WALES, AUSTRALIA nel section shrouding. This shrouding, into which the ends of the blades are riveted, strengthens the blading and also makes possible larger clearances with the same resulting steam economy.

In the event of contact between the blading and the stationary portion the thin edges of the shrouding will wear down in preference to damaging the blades, because of the greater strength of the blading as a whole, and to the thin edges of the shrouding presenting less surface for contact than the section of a blade itself. That the latter point has been appreciated would seem to be borne out by other turbine makers having adopted the precaution of thinning down the tips of their blades. The channel section shrouding is also asserted to have economical advantages which result in a higher degree of economy being possible than with the ordinary method of blading.

In governing this turbine, oil and steam relays are omitted, and an ordinary centrifugal governor acts direct on to a throttle valve. The result of this is that the gear is very much simplified, while the governing is as perfect as it is possible to obtain with more complicated methods.

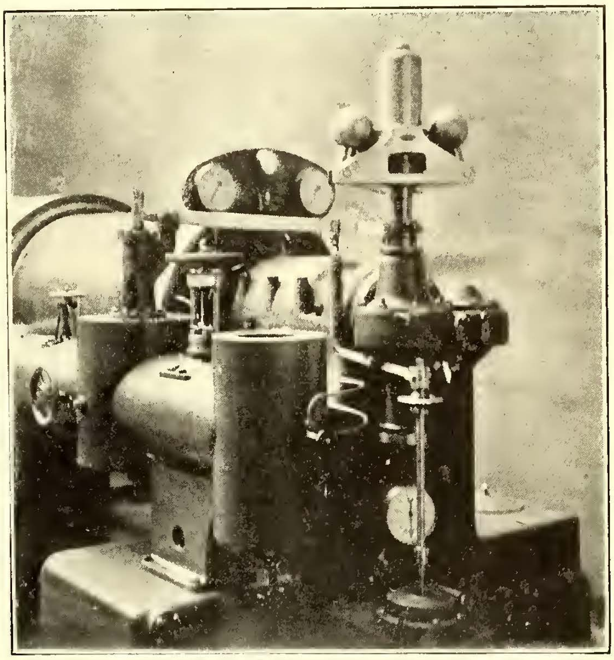
As to the general constructional arrangement of the turbine, it may be stated that in the smaller sizes the casing is hinged, so that the top can be opened up in the minimum possible time. An oil tank with the water circulating through it forms the end bearing pedestal, and contains the necessary oil for circulating through the different bearings. The rotary oil pump for circulating this oil is driven by a spindle actuated by worm gear from the main turbine spindle. The steam chest, with the necessary valves, etc., is arranged separately on one side of the turbine, and in no way tends to distort the casing of the turbine proper by being attached to it. The governor gear, etc., is mounted clear of the cover of the end bearing, and does not tend to obstruct access to the bearing proper. The rotor, after being machined to one-one-thousandth of an inch limits of accuracy both inside and outside, can be relied upon to be in perfect balance. The end shaft on the steam end of the rotor is forged solid in one piece with the rotor itself in all except the largest sizes of turbine. The usual practice is to force the end shaft into the rotor. The latter method is considered objectionable in view of the high temperature prevailing at the steam end, the difference in temperature between hot and cold tending to loosen the shaft in the rotor, and thus being likely to give trouble at the joint.

All the rotors and casings are "machined" after the blading is completed and in position, and it is a point of considerable advantage in favor of the shrouding that this should be possible.

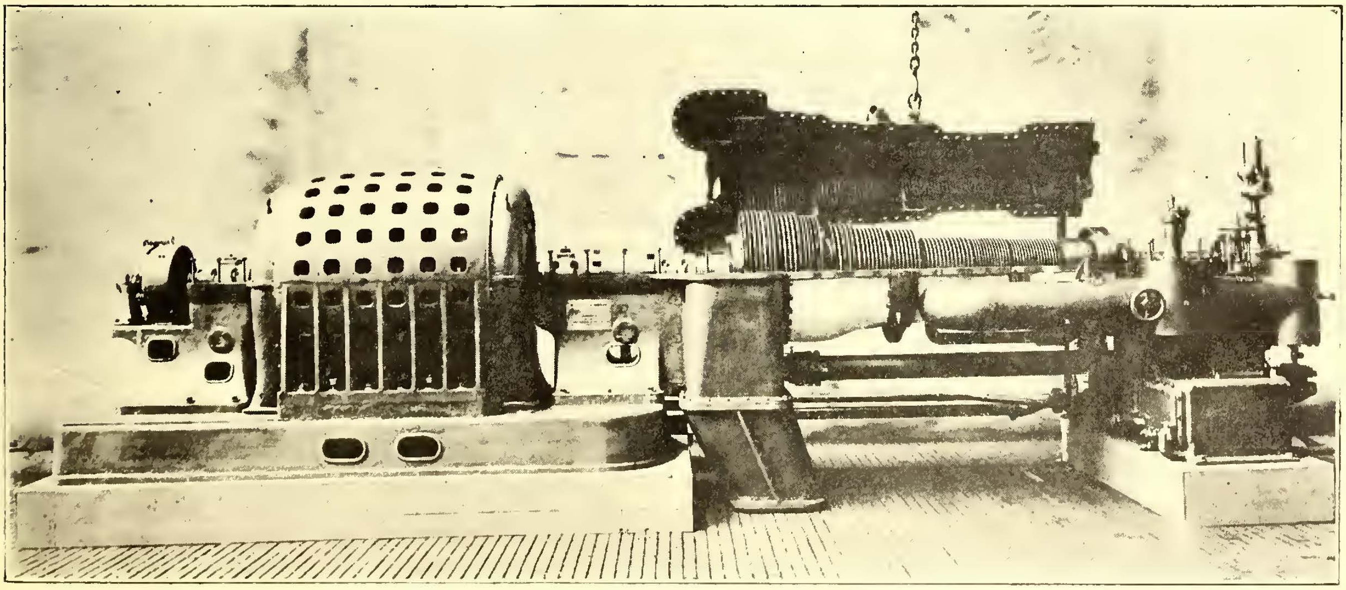
The result of being able to turn the blading in a lathe in the case of the rotors and in a horizontal boring machine in the case of the casings is that the desired clearances between the rotating and stationary portions are accurate. All parts, including the bladed rotors, are interchangeable.

THE ALTERNATOR

The main features of the Dick-Kerr turbo-alternator are fairly well known, but the most recent designs embody slight improvements which are worthy of note. As distinguished from other turbo-alternators of foreign origin, this is of the salient pole type, which is found to have a better inherent regulation owing to lower magnetic leakage in field and armatures. It enables machines to be designed with lower stator iron losses, and, in conjunction



VIEW OF GOVERNING MECHANISM



TURBINE OPENED TO SHOW ARRANGEMENT OF BLADING with the possibility of using a larger amount of copper in the rotating field, increases the efficiency. All windings subject to heating are freely exposed to air currents, yet this result is obtained without the use of forced draft. A departure in the Sydney machine is the use of solid end shields to reduce the noise and prevent dirt being drawn into the machine.

The frame of the stator is made of strong cast iron and supports the stator laminations. The winding is embedded in slots and insulated by mica. Special ventilating ducts are provided in the frame, and laminations stiffening fingers on the outside of the laminations obviating danger of vibration. The feet of the alternator frame are bolted to a sole plate, so made that it is possible to slide the stator in a direction parallel to the shaft to uncover the rotor for easy inspection.

The rotor body is built up of a central solid steel casting cast under pressure with projecting poles. This central body is machined and bored out to a diameter larger than the shaft. Two cross-shaped pieces are built at each end of the central body and carry the rotor on the shaft. The pole tips are laminated and are dovetailed on the steel casting of the central body. Special end pieces dovetailed on the steel casting retain the laminated tips in position, and also act as checks against centrifugal force to keep the spools in position.

The field winding is of solid copper strip wound on edge, insulated between turns by paper and mica, and supported in a special copper spool with heavy insulated flanges. The copper winding of the fields bears flat on the insulation to avoid danger of cutting. The terminal leads of each spool are carried out on the bottom of the spool, and are composed of very thin and flexible copper strips. Special wedges are provided between the spools against the horizontal component of the centrifugal force, which tends to open the spools. The latter, after being assembled and connected up, are finished on the outside surface, where otherwise the copper would be bare, by an oil and waterproof varnish, presenting a very hard and glossy surface to make it easier to clean the machine. The shaft is of pressed steel.

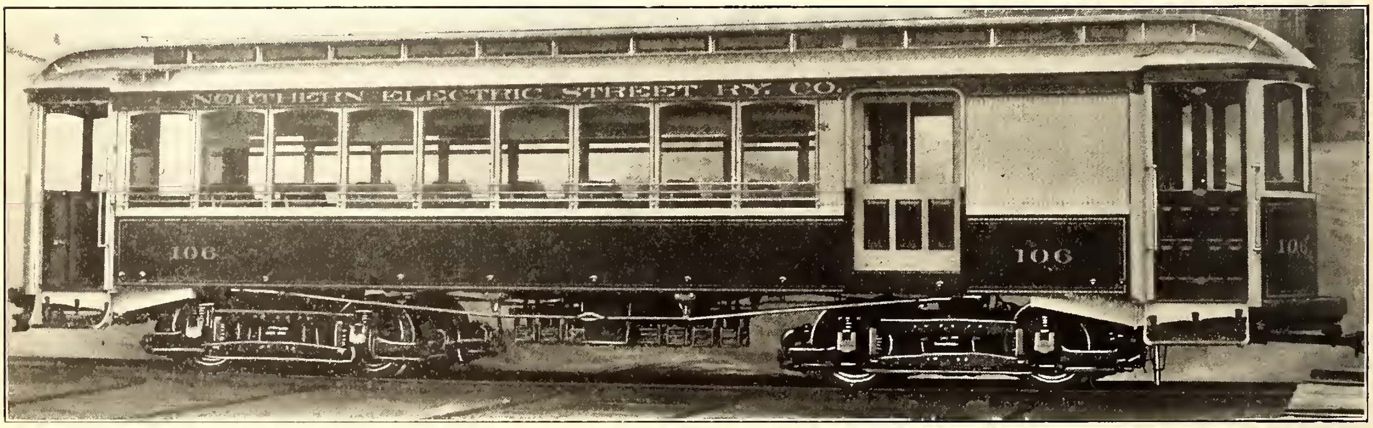
The collector rings are of cast iron, fixed over a solid steel sleeve, and of special construction as to make it impossible to be subject to deformation under working conditions, the collector rings being shrunk hot over special micanite rings built up directly on the steel shell of the collector ring. The leads from the field coils are carried to the collector rings and are protected by metallic caps fitted over the shaft and to the end of the rotor body. The connection of the leads to the collector rings is also protected by a cap, which is easily removable for inspection if necessary.

It may be added that the design of the machine embraces sizes from 500 up to 10,000 kw, and the variation in periodicity which obtains anywhere imposes no special difficulties in construction. Already machines have been supplied under extremely varying conditions of periodicity and voltage, in one case the conditions calling for single-phase machine at a periodicity of 100.

The brushes are of low-friction graphite, coefficient and high conductivity. The brushes belonging to one collector ring are kept separate from the brushes belonging to the other. Ample contact is provided on the brushes, and they may be adjusted and replaced, if necessary, while the machine is running.

EQUIPMENT FOR NEW LINE RUNNING OUT OF SCRANTON

The two types of cars of which illustrations are presented were built by the J. G. Brill Company for the Northern Electric Street Railway Company, and represent the present rolling stock of that company. There were five of the combination passenger and smoking cars in the order and one of the passenger and baggage type, both having the grooveless post, semi-convertible window system. The Northern Electric Railway is a new system, and, when completed, will connect Scranton with Chinchilla, Clark's Summit, Clark's Green, Glenburn, Waverly, Dalton, La Plume, Factoryville, Mill City and Lake Winola, the latter place being about 20 miles distant from Scranton. The proposed extensions (17 miles) will take in Tunkhannock, Hillside Home and Nicholson via Lake Sheridan. During the past year the road has been completed for more than one-half the distance, the power house and car house erected and the machinery installed. The electrical equipment for the power house and sub-station includes the following: Two-kw, 370-volt, three-phase, 25-cycle generators, 150 r. p. m.; two 17½-kw, 125-volt direct-current engine type exciters, 400 r. p. m.; four 200-kw, 600-volt, three-phase, 25-cycle, 750-r. p. m. rotary converters; three 200-kw, O. I. S. C. single-phase transformers, 16,500-406 volts; six 75-kw O. I. S. C. transformers, single-phase, 16,500-370-volt; one nine-panel main switchboard and one switchboard for sub-station; two of the rotary converters are for the sub-station. There are two 500-kw non-condensing engines arranged for direct



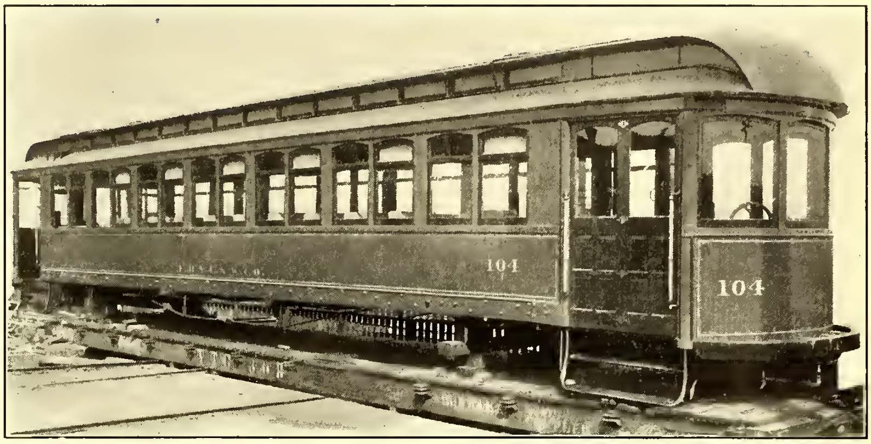
COMBINATION PASSENGER AND BAGGAGE CAR FOR THE NORTHERN ELECTRIC STREET RAILWAY COMPANY, SCRANTON, PA.

connection to generators, and three 300-hp boilers. The portion of the system now in operation connects La Plume borough with Lackawanna Avenue, Scranton, a distance of 12½ miles, and between these points a thirty-minute service is maintained.

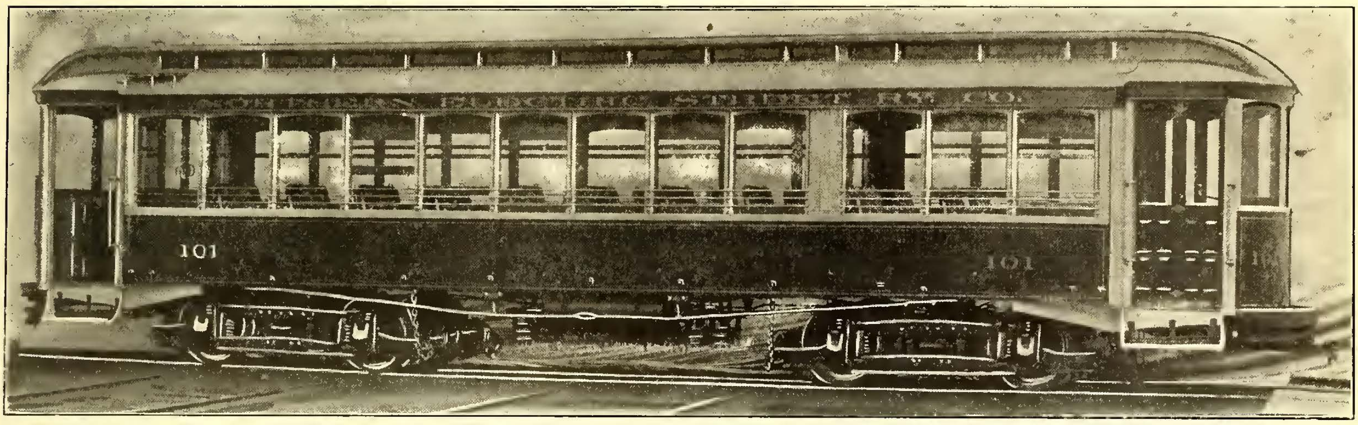
Following is a description of one of the combination passenger and smoking cars, the dimensions of which are generally the same as the car having the baggage compartments; the equipment throughout of the two types is identical. Length over end panels, 34 ft. 4 ins.; over crown pieces, 43 ft. 9 ins.; width over sills, including sheathing, 8 ft. 6 ins.; size of side sills, 4 ins. x 7¾ ins.; end sills, 5¼ ins. x 6⅞ ins.; sill plates, 15 ins. x ⅜ in. The interiors, with their big windows, wide aisle space and extreme length of seat, due to the adoption of the grooveless post, semi-convertible window system, make the cars well suited for excursion service. The seats are of Brill make, those in the passenger compartment being of plush, while a leather covering is used in the smoking compartment. The cherry-stained interior finish and Nile-green ceilings of poplar make a pleasing combination. Push buttons, arm rests and basket racks are among the accessories which add to the comfort of the passengers. The trucks, with 6-ft. wheel-base, are of the builders' 27-E1 type. The motors are of 45 hp capacity each. The car weighs without trucks, but with electrical equipment excepting the air brakes, 27,000 lbs.

CLOSED CARS FOR EVERETT, WASH.

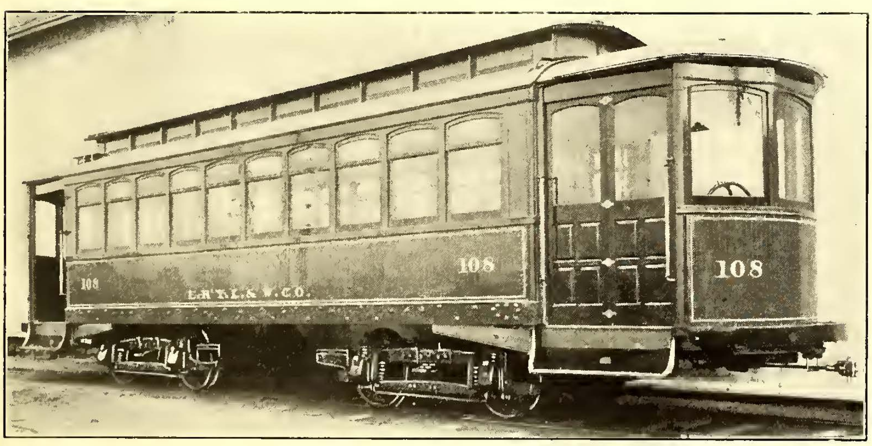
Two good examples of cars having the drop-sash window arrangement are afforded in the cars shipped by the American Car Company last month to Everett, Wash., for operation on the lines of the Everett Railway, Light & Water Company. The larger of the two types is intended for interurban travel on the Northern Pacific branch line which is leased by the street railway company and electrified; the road connects Lowell and Snohomish, the latter place being the chief town of Snohomish County, one of the richest in the State in agricultural produce and in lumber and mining industries. Everett, with a population of about 21,000, is situated 35 miles north of Seattle on one of the best harbors of Puget Sound, and the interurban portion of the system is an important link in the chain of towns visited so much by tourists and excursionists.



BODY OF INTERURBAN CAR FOR THE EVERETT RAILWAY, LIGHT & WATER COMPANY



STANDARD PASSENGER CAR OF THE NORTHERN ELECTRIC STREET RAILWAY COMPANY



CITY CAR FOR EVERETT, WASH.

The chief features of these new cars are brought out clearly in the illustrations. The interurbans measure 43 ft. over the end panels and 5 ft. over crown pieces; over bumpers, 58 ft.; width over sills, including sheathing, 8 ft. 6 ins.; centers of posts, 29½ ins.; height from floor to ceiling, 8 ft. 6 ins. The smaller cars (four in number) measure 28 ft. 8 ins. over the end panels and 41 ft. 8 ins. over crown pieces, and other dimensions are generally similar to the car described.

LONDON LETTER

(*From Our Regular Correspondent.*)

During the past month the Incorporated Municipal Electrical Association, of which S. E. Fedden, of Sheffield, is the president this year, held its annual convention at the Royal Victoria Hotel, Sheffield. After the presidential address was delivered, R. L. Acland, electrical engineer of Chesterfield, presented the following paper: "Extension of Electricity Supply to Outlying Districts." After luncheon special tram cars conveyed the members and visitors to the River Don Works of Messrs. Vickers, Sons & Maxim, which, by kind permission of Douglas Vickers, were opened for inspection by the visitors. In the evening a reception and dance was given by the Right Hon. the Lord Mayor at the Town Hall. The following day was devoted entirely to pleasure, a special train leaving Sheffield in the morning for an excursion to the Dukeries, members and their friends proceeding by this train to Worksop, from which place they proceeded to Welbeck Abbey, Cuckney and Budby Forest to Edwinstowe (a Saxon village), and so on to Ollerton, where luncheon was served. After luncheon they proceeded to the Normanton Inn, Clumber, Carburton, and back to Worksop for tea at the Town Hall, after which a return was made to Sheffield in the evening. The route followed by the delegates, so called the "Dukeries," because at one time as many as five Dukes resided in the neighborhood, lies in the immediate vicinity of Sherwood Forest and is probably one of the most beautiful parts of England. The following day was devoted to the annual general meeting, the afternoon being occupied by the reading and discussion of the following papers: 1. "Cheap Power Supply by Municipalities," by C. E. C. Shawfield, electrical engineer of Wolverhampton; and "The Costs of, or Charges for, Electricity Supply," by H. R. Burnett, electrical engineer of Barrow-in-Furness." 2. "Depreciation," by C. H. Yeaman, electrical engineer of Hanley. In the evening the annual association dinner was held at the Royal Victoria Hotel, which proved as successful as ever. On the last day of the meeting the following papers were read and discussed in the forenoon: "The Value of Photometry in Central Station Work," by R. McCourt, assistant electrical engineer of Harrogate, and "Alternating Current Distribution," by A. J. Cridge, assistant electrical engineer of Sheffield. In the afternoon a visit was made to the Kelham Island Tramway power station and to the Neepsend power house.

We published in a recent issue of the STREET RAILWAY JOURNAL an article descriptive of the Johannesburg Tramways, so far as it related to the equipment of the overhead line, track construction and rolling stock. It may have seemed strange to some of our readers at that time that practically no reference was made to the power house, the equipment of which, as is well known, was to include a gas plant. It has also been a matter of general knowledge for some time that there was trouble in Johannesburg about this plant, and for the past year or so efforts have been made by the contractors to get the plant into running order. All kinds of trouble have arisen, however, and some accidents have occurred, and now it is no surprise to learn that the Town Council about a month ago held a special meeting to consider the situation, the whole of the gas portion of the plant having been shut down until further notice a day or two previously. The contractors have evidently come to the conclusion that nothing further can be done to put the plant into working order, and it is therefore to be abandoned, and the bond for the due performance of the contract, namely, £105,134, will now be demanded from the contractors, as also most likely the sums already paid, amounting to over £143,000. The whole situation is a deplorable one, and it is at present difficult to see just where the trouble lies. At the beginning criticism was aroused by the recommendation and adoption of gas engine plant for this particular installation. At the same time it is difficult to understand why the failure has been so complete, as certainly gas engines of equal size and of the same type are in most successful operation elsewhere. In the meantime a certain number of new steam engines and new electric generators have been ordered, and will be delivered as soon as practicable, so as not to stop the operation of the tramways any longer than is necessary. Temporary arrangements have also been made with the Rand Central Electric Works.

The question of fares on tramways is constantly cropping up on account of agitation on the part of the public. In Glasgow, for instance, there has been suggested that the distance of the halfpenny car fares be extended. Mr. Dalrymple, the manager, has just issued a long report, which makes it very clear that to extend that distance would be to court financial disaster. Glasgow is perhaps the strongest exponent of the halfpenny fare, but the only reason that it has been a success in that city is because the short distance, namely, about ½ mile, is rigidly adhered to. To lengthen this to three-quarters of a mile would be practically to transfer a large proportion of the penny passengers into halfpenny passengers. The matter has recently come before the committee, which have agreed with the manager that no change shall be made for the present. Arthur Ellis, of Cardiff, has also been making various experiments and changes relating to the fares in that city, as the revenue from these tramways has not been what it should be. Mr. Ellis has now instituted a system of transfer tickets for short distances, but has not introduced halfpenny fares. This transfer ticket would enable a passenger to travel over two ½-mile sections, so that he could either go and come on the same section or continue his journey over some other section for a short distance. The Hull City Council is also considering the fare question, and has started a six months experiment to use penny tickets, which enable passengers to travel over two sections for the price of one, which, in other words, is a transfer ticket system. The Hull Tramways, however, are making most satisfactory profits, and the agitation in this city has arisen on account of these profits, many believing that the best way to equalize things is by reducing the fares. R. R. Fairbairn, of Worcester, also proposes to make an experiment, with the object of popularizing the tramways. His intention is to give a double short journey for a penny, which is really equivalent to halfpenny fares for short sections, without having any single fare for which a halfpenny is valid. These tickets can also be used either as transfer tickets or double journey tickets. At Aberdeen a proposition had been made to the Council to establish a universal penny fare; that is, a fare of 1 penny, by which a passenger can travel any distance on any one car for that sum. The committee, however, has decided not to entertain this proposal, but has determined instead to adopt the system of a 1-penny fare from the center of the city to any terminus, a system which has been successful in other towns. Mr. Pilcher in a long report recommended this system, and though there would be losses on certain of the longer routes on which up to three pence had previously been charged, it was confidently expected that these would be more than made up by the increase of passengers in other directions. The question of fares is also a very acute one with the various electric railways in London, none of which is making as much money as necessary, and it is interesting to note that after long negotiations between the companies, the long-distance fares are to be raised sufficiently to assist the companies, but not to put any hardship on the public.

The Halifax Tramways are at present being operated at a loss, and F. Spencer, the manager, in a report which was recently given to the committee, has suggested that the recent accidents were largely responsible for the decrease in the traffic, a certain amount of timidity of the riding public having resulted. Though Halifax tramway cars are all equipped with slipper brakes, Mr. Spencer, in view of the recent accidents, has recommended an improved slipper brake. Most slipper brakes are operated by steel shafts parallel with the car axle. Mr. Spencer believes that there is too much elasticity in this shaft, and now proposes that it should be dispensed with, and the downward pressure taken by four bearings fixed on the truck side close to the axle-box. Halifax, as is well known, is one of the most hilly cities operating tramways, so that anything that will increase the safety of the passengers will undoubtedly help to build up traffic.

Last month the adjourned debate relating to the London County Council Electric Supply bill was resumed in the House of Commons, and after discussion by various members the bill was read a second time, and was then referred to a hybrid committee, which was instructed by Lloyd George that if power be conferred on the London County Council to transfer or lease to any company local authority, body, or person, any of the powers, duties, or liabilities entrusted to it by the bill, the conditions on which such power should be exercised should be embodied in the bill or in a subsequent bill. This special committee has now held several sittings, and it would appear that the present bill is based largely on the report of the parliamentary committee which considered the matter last year. The recommendation of the old committee that the Council lease the undertaking to a private company has been adopted by the new Council. The area now comprises 451 square miles, of which 117 are within the administrative county and 334 in the surrounding districts. Powers were originally sought to acquire the undertakings of the local authorities, but the present Council thinks that it would not be right to allow the lessee to acquire these undertakings, and this clause has accordingly been struck out. Instead of seeking compulsory powers therefor, the present bill makes acquirement of the existing undertakings a matter of agreement. The chairman of the London County Council has also given a decided denial to the suggestion that the Council meant to reinstate the administrative county of London Company by making them the transferees of the powers sought under the bill, and stated that the intention of the Council was to invite tenders for those powers, and that so far as the Council was concerned there would be an open field and no favor. He also stated that the suggestion of the London County Council to cut up the area into various sections was untrue, and denied that there was any intention to repurchase from the lessee in two or three years' time. At the moment of writing, the committee has again adjourned, and at present it is difficult to foretell the actual fate of the bill.

A decision of importance to tramway companies and to local authorities and ratepayers has been given by the president of Local Government Board. Some time ago the Fleetwood Urban District Council constructed a road alongside the Blackpool & Fleetwood Tramroad Company's lines, beginning at a point where the tramways leave the street, and are fenced in with iron railings. The apportionment of cost was duly made, and a notiee requiring payment of the cost of that portion of the road adjoining their lines was served upon the tramways company, as owners adjoining and abutting.

Mr. Burns, president of the Local Government Board, has now intimated that the decision of the board is that the tramroad company cannot be properly charged with the £1,588 3s. 2d. apportioned as the cost of that half of the road adjoining or abutting on the tram lines.

Sir F. Cory-Wright, chairman of the light railways committee of the Middlesex County Council, opened recently the new line of electric tramways from Wood Green to Palmer's Green. The line will eventually be carried as far as Enfield. Wood Green is now the center of direct communication with Tottenham, Muswell Hill, Finsbury Park, New Southgate and Palmer's Green.

Through running on the tramway systems between Bolton and Bury was recently formally inaugurated. The ceremony was performed on the Bolton borough boundary at Ainsworth, where cords were cut by Alderman Miles (chairman of the Bolton tramways committee) and Col. Hall (chairman of the Bury tramways committee). In the evening the members of the Bolton and Bury tramways committee and the Radcliffe Urban District Council met at dinner, and at night an illuminated car passed through Bolton, and left for Bury at 9 o'clock.

The sub-committee of the Leyton tramways committee recently decided that the practice of passes over the Council's tramways should be abolished, and all the officials pay their own fares, including the traffic manager and the electrical engineer, both of whom have frequently to go over the system in connection with their duties. The tramways committee has since reconsidered the matter, refused to confirm the sub-committee's recommendation. and decided that in future free passes should be provided to the traffic manager, the electrical engineer and two other officials.

The annual conference of the manager's section of the Municipal Tramways Association was held this month in Blackpool Town Hall, under the presidency of J. L. McElroy, of Manchester. The Mayor of Blackpool welcomed the delegates from all parts of the country, and the president, in acknowledgement, said every municipality that controlled a tram system was represented in the association. The proceedings were private.

The Ealing Corporation has addressed a letter to the district councils of Acton and Chiswick on the subject of the alleged nuisance occasioned by the noise of the electric ears of the London United Tramways Company, Ltd., and asking whether or not they would be willing to join in taking proceedings against the company to abate the nuisance complained of. The letter states that Ealing has already made representations to the Board of Trade on the subject, and that in their last communication on the subject the Board of Trade stated that the matter was one in respect of whieh they had no compulsory powers.

The negotiations between Dundee Town Council and the Harbor Board with regard to the site in the vicinity of the Fish Dock for the new electric station house have now been amicably settled at the price put forward by the Town Council, which has obtained a perpetual fee, so that for all time coming it cannot be disturbed by change of circumstances.

It is understood that the agreement for the running of through tram cars between Croydon, Penge and the Crystal Palace has been signed. It will take effect as soon as certain necessary arrangements are complete. The Croydon Corporation will provide the cars to run between Croydon and the Penge terminus, and the South Metropolitan Tramways Company will supply the cars for service between Croydon and the Crystal Palace.

Renfew County Council has now formulated its petition to the Scottish Secretary against the proposed extension of the Paisley District Tramway Company's system from Barhead to Thornliebank. In the petition the Council submits that there is no public necessity for the proposed tramways, and objects to powers being conferred on the company to construct tramways on the roads within their district.

The Board of Trade, in a letter to the Exeter tramways committee, announce that it has come to the conclusion that authorities operating tramways have rightly understood the desires of the people, and are not disposed hereafter to offer any objections to a reasonable number of people standing in electric cars. This will remove a great and unjust restriction of tramway managers, who, despite all they can do, cannot possibly provide cars enough to give every person a seat at the rush hours. Such restrictions were all right in the days of the horse car, but they had long become obsolete.

The last of the Yerkes Tubes, the one known as the Charing Cross, Euston and Hampstead Railway, was formally opened this June and has immediately sprung into popularity. This tube has its southern terminus under the Charing Cross station of the South Eastern and Chatham Railway, where it has connections with the District Railway, the Baker Street and Waterloo Railway and practically the whole system controlled by the Yerkes syndicate. From Charing Cross it proceeds northwards by way of Leicester Square, Oxford Street and Euston to Camden Town, at which point it branches into two, the one branch going in a northwesterly direction by way of Chalk Farm and Hampstead to Golders Green, where it comes to the surface, and the other branch going in a northerly direction by way of Kentish Town and Tufnell Park to Highgate. At Leicester Square it will be in connection with the Hammersmith, Brompton and Piccadilly tube; at Euston it will communicate with the main line of the London and North Railway, and be in the vicinity of the other important main line termini at St. Pancras and King's Cross. At Camden Town and Kentish Town it will also be in the vicinity of these main lines a little further out, and at Highgate will communicate with the tramways of the Metropolitan Railway Company which proceed still further north. On the day of the opening, the guests assembled at Charing Cross and were conveyed by a special train to Golders Green, where the ceremonies took place under the Hon. David Lloyd George, M. P., President of the Board of Trade. Luncheon was then served, and arrangements were made by which the company's guests were conveyed by special train from Paddington to Windsor. A brief description of the line is published elsewhere in this issue. A. C. S.

STONE & WEBSTER EXTENSION ON PUGET SOUND

The Puget Sound International Railway & Power Company has been incorporated in Washington to carry out the plans for the interurban electric railway extension proposed by Stone & Webster on Puget Sound. This announcement has been made in Seattle by C. D. Wyman, of Boston, member of the Stone & Webster executive committee. Mr. Wyman is vice-president of the Seattle Electric Company, vice-president of the Puget Sound Electric Railway Company and president of the Whatcom County Railway & Light Company. Mr. Wyman is quoted as follows: "Our interests are negotiating an affiliation with the Everett Street railway properties, which will give us control of them. The new company will immediately begin carrying out plans for the building of interurban roads from Bellingham to Seattle. It has always been our plan to afford the Puget Sound cities an interurban service eventually from the International boundary to Olympia and Chehalis, and perhaps finally to Portland and the Grays Harbor country. Our first step was the Puget Sound Electric Railway, between Seattle and Tacoma. That has developed the valley through which it runs. Another region to the north, with Bellingham as the center, we shall develop with similar lines as rapidly as conditions permit, as the money is raised, the franchises and rights of way acquired, and other plans perfected. This, necessarily, can not be done in a day, especially when the construction including equipment costs from $40,000 to $50,000 a mile for single track road. The interurban project necessarily involved Everett's necessities and led to the negotiations which will give us the control of that system. The statement that we have bought the road there is not true, but the arrangement under way will give us the control. We shall build such extensions and connections as the conditions in that city seem to justify, giving it the advantage of a more elaborate interurban system. We shall put surveyors in the field with the idea of locating accurate and positive routes for lines through to Seattle. Our engineers have already made surveys 30 or 40 miles south of Bellingham and these will be continued in this direction. The Nooksack power plant will be used to operate the northern portion of the system, and will probably soon be increased in capacity. It is our policy to develop the interurban system from each center, until we shall have completed a through line from the boundary south. Thus we commenced from Seattle. We have already extended from Tacoma south to American Lake and will continue to Olympia. Our next step is the system from Bellingham, and we shall make plans for reaching out from Everett. We also expect to push the extension of our Puget Sound Electric Railway Company's system from Brookville to Puyallup, thence to Sumner, and finally to Orting and up that valley."

THE SAN FRANCISCO SITUATION

The condition in San Francisco continues to improve gradually in regard to the operation of street cars as well as in other industrial and in financial lines. The United Railroads is beginning to furnish complete service during the evenings, with the exception of the owl cars, on all the electric lines north of Market. This means a service until about 1.00 A. M.

The company now has 1,100 permanent men in its employ, and this the officials regard as a sufficient number to operate late cars on all the lines north of Market Street. More men are being employed in the East and are arriving in the city in small bodies every day. The men on the late cars are carrying arms openly. As the practice is general, it is presumed that it is with the consent of the company.

In regard to the company's attitude toward the old employees an official is quoting as saying: "The strikers doubtless believe that our men were hired for temporary service and that they will get their places back as soon as these men leave. They are mistaken. We have a thousand permanent men in our employ, and not one of them will be discharged to make room for a striker. Moreover, the new men have been given the choice of runs, and the strikers, when they return, will have to take such runs as are left. Very soon, though, there will be no runs whatever left, as we are employing men at the rate of 30 or 40 a day, and it will not take long to fill all the places of the strikers."

The effort on the part of the leaders of the strike to discourage riding on the cars by placing pickets along the lines is not meeting with much success.

The United Railroads has placed its Eighth and Eighteenth Streets line to Sixteenth, South and Railroad Avenues in operation as well as the Sixteenth and South Street line. Work is being hastened on the track and overhead trolley of the Kentucky Street line, and as soon as it is finished the line will be operated from Twenty-third Avenue South to Fifth and Market Streets, via Brannan Street.

The California Street Cable Railroad Company has placed its Hyde and O'Farrell Streets cable line in operation, and its California Street road will be placed in service in a very few days. In regard to its employees President Stetson says: "We are going to establish the open shop on the California Street line. We have had some men in our employ for a long time and we would prefer to have them run the cars for us again. But we will deal with them individually only. If they are not willing to come back on that basis we will have to fill their places. We cannot afford to pay more than the old rate, which was established by arbitration at 30, 31 and 32 cents, but will pay new men 25 cents an hour. We should have started the line sooner if it had not been necessary to do certain repair work, but as soon as this is completed we will begin immediately. We will have nothing further to do with the carmen's union. The men individually are good men, and we should prefer to have them in our employ again. But we will not deal with them as an organization. I want that to be made perfectly plain. Some of our men have promised to return and, as a matter of fact, most of them would like to go to work again. We will have no trouble in getting all the men we need."

LEGISLATION IN CONNECTICUT

The Connecticut Legislature, on July 2, passed the Consolidated Railway Company's general charter amendment bill, but it was amended at the instance of Representative Gunn so that the franchises for undeveloped road, which it was said aggregate over 800 miles, must be utilized before Oct. 31, 1908, or they lapse. No further action was taken on the East Haven & Morris Cove charter, which is being advocated by Representative Griswold, of Guilford, in opposition to the Consolidated.

CLEVELAND TRACTION MATTERS

Notwithstanding all overtures made to him the past week, City Clerk Peter Witt persistently refused to allow representatives of the Cleveland Electric Railway Company to see and examine the consents of property owners at Quincy Street and Central Avenue for the new companies. Mayor Johnson urged him to accede to the request of the officials of the old company, saying they had a right under the law to examine and copy them, but Mr. Witt would not listen, seemingly inviting a suit. After another trial Friday morning, the attorneys for the company filed mandamus proceedings in Judge Ford's court and an order was issued at once. On Saturday when Attorney Harry J. Crawford and Robert B. Rifenberick, representing the Cleveland Electric Railway Company, called upon Mr. Witt with the order, he at once turned the consents over to them for examination. This is only another peculiar act on the part of a city official in the fight that is being made for consents.

The City Council has passed the ordinance providing for compensation to the Cleveland Electric by the Low Fare Railway Company for the use of its tracks. When the ordinance becomes operative it is expected that an injunction suit will be brought to test the right of the Council to prescribe the compensation.

The portion of the value fixed for the Low Fare Railway Company to pay on each section of the track are as follows: Euclid Ave., from East Fourteenth St. to Ontario St., $19,000; through Public Square to Superior Ave., $2,650; four tracks on Superior St., from Ontario St. to the viaduct, $21,500; overhead wires over the viaduct and the tracks on West 25th St. and from the viaduct to Detroit St., $5,500; circling the Public Square, $9,000.

The council is fixing the valuation, following the refusal of the Cleveland Electric to treat with the Low Fare Company as to compensation for joint use of its tracks in what is called free territory. The company claims that the city council has no authority to fix the compensation. Under this claim, it is probable that the company will resist any attempt to operate cars over these tracks, other than the ones now being used on Superior St. in consequence of the injunction having not been enforced by the Cleveland Electric since the suspension of hostilities some months ago.

BOND ISSUE AT BIRMINGHAM

The amount of the bond issue authorized at the recent meeting of the stockholders of the Birmingham Railway, Light & Power Company, of Birmingham, Ala., is $25,000,000, not $35,000,000, as stated in the issue of June 22. Among other improvements made possible by this issue are a new power station and a number of new cars for interurban service.

PERSONNEL OF THE NEW YORK PUBLIC UTILITIES COMMISSION—OTHER MATTERS

In the Street Railway Journal of June 29 brief mention was made of the two commissions which Governor Hughes, of New York, has appointed in accordance with the provisions of the Public Utilities Bill. In view of the wide scope of the powers conferred by this bill it may be of interest to present the following brief sketches of the gentlemen who have been selected to carry out the work.

The bill provides for ten commissioners, five of whom will take care of the public service interests in what will be known as the First District, composed of New York, Kings, Queens and Richmond Counties, while the Second District, made up of the remaining counties, will have a separate commission of five. The commissioners of the First District are the following: W. R. Wilcox, Wm. McCarroll, Edward M. Bassett, Milo R. Maltbie and John E. Eustis: For the Second District, Frank W. Stevens, Charles H. Keep, Thomas M. Osborne, James E. Sague and Martin S. Decker.

William R. Wilcox, chairman of the commission for the first district, was until his appointment postmaster of the City of New York. In Mayor Low's administration he was appointed a park commissioner, and in that position established many public playgrounds and gymnasiums. On January 1, 1905, President Roosevelt appointed him postmaster of New York City. Mr. Wilcox was born in Smyrna, N. Y., in 1863, and was educated at Rochester University and the Columbia Law School.

William McCarroll was born in Belfast, Ireland, in 1851, where he also received an academic education. In 1869 he emigrated to New York to enter the leather trade and continued in this line of business, becoming in 1902 president of the American Leather Company. He is a resident of Brooklyn.

Edward M. Bassett was born in Brooklyn in 1863, and educated in the public schools of that city until his family moved to Watertown, N. Y., where he graduated from the high school. Later he went to Hamilton College and Amherst, graduating from the latter in 1884, after which he spent two years at the Columbia Law School, from which he graduated and was made a member of the New York bar. After his graduation he took care of the legal work of a Buffalo contracting firm, but returned to New York in 1892 to take up the general practice of law. Mr. Bassett has been a member of the local board of education and other educational bodies.

Milo Roy Maltbie, of New York, has been a prominent figure in recent years, owing to the work he has done in behalf of civic bodies with reference to the relation between public service corporations and municipalities. He investigated the street railway franchises of Chicago for the Civic Federation of that city, the Ramapo water contract for the Merchants' Association of New York and municipal questions in Great Britain for the United States Bureau of Labor. He was also a member of the commission recently sent by the National Civic Federation to study municipal ownership in Great Britain. Mr. Maltbie was born in 1871, and studied in several American universities. He was professor of mechanics and mathematics in Mt. Morris College from 1893 to 1895 and a fellow in administrative law in Columbia University from 1895 to 1897. He served as secretary of the Reform Clubs committee on city affairs from 1897 to 1902.

Charles Edwin Eustis is a resident of the Bronx or northern section of New York City. He is a lawyer and for many years has been deeply interested in transportation problems. Mr. Eustis was born in Limerick, N. Y., and attended the public schools of Hammond in the same State. Later he enlisted in the New York cavalry and served two years, but on retirement from military service took a scientific course at Wesleyan University at Middletown, Conn. He graduated in 1874 and was appointed city surveyor of New York. In 1875 he entered the Dwight Law School, graduating in 1877.

Frank W. Stevens, who is chairman of the commission for the Second District, is a resident of Jamestown, N. Y., and is known as one of the foremost public spirited lawyers in western New York. He was born in Leon, Cataraugus County, in 1847, and after receiving a common school education entered the Harvard Law School. He has been practicing since 1872. He was assitant district attorney of Cattaraaugus County from 1876 to 1883, a member of the Jamestown Board of Education from 1891 to 1897, and now holds that office for the second time. He has been a member of the board of water commissioners of Jamestown since 1903.

Charles Hallam Keep, of Buffalo, was until his present appointment Superintendent of Banks, to which position Governor Hughes had appointed him to succeed F. D. Kilburn. Mr. Keep was born in Lockport, N. Y., in 1861, graduated from Harvard in 1882 and from the Harvard Law School in 1885. He practiced law in Buffalo until 1903, when he was appointed assistant secretary of the treasury of the United States. He has always taken a prominent part in business and civic activities in Buffalo, having been secretary of the Buffalo Chamber of Commerce and the Lake Carriers' Association.

Thomas Motts Osborn, of Auburn, N. Y., was born in that city in 1859. He was educated in the schools of his home town and later in Adams Academy, at Quincy, Mass., and also at Harvard, from which he graduated in 1884. After his graduation Mr. Osborn became a clerk in his father's farm tool factory and later became president of the company. He has always taken considerable interest in civic affairs and was Mayor of Auburn from 1902 to 1905.

James E. Sague, of New Hamburg, N. Y., is a well known steam railroad man. He was born in 1862 and graduated as a mechanical engineer from Stevens Institute in 1883, immediately entering the service of the Chicago, Burlington & Quincy Railroad, where he remained ten years. He spent four years with the Erie Railroad, two years with the Jamaican Railroad in the West Indies and ten years with the Schenectady Locomotive Works. He served as chief mechanical engineer for six years in the American Locomotive Company's works at Schenectady, becoming assistant vice-president and then first vice- president in charge of engineering and manufacturing. He resigned this position last March.

Martin S. Decker, of New Paltz, N. Y., is at present the assistant secretary of the Interstate Commerce Commission in Washington, having held that position since the organization of the commission in 1887. He is therefore very familiar with the federal law and has frequently sat as a deputy commissioner for taking evidence. He is a lawyer and was born in Rosendale, Ulster County, in 1858, where he received a public school education and began life as a telegrapher. During the American occupation of Cuba Mr. Decker assisted in drafting the Cuban railway law.

The members for the first district met on July 2 in the offices of the old Rapid Transit Commission and elected Travis H. Whitney secretary. The announcement was made that the office of the Commission will be open from 8 a. m. to 11 p. m. every day in the year.

The new secretary was born in Gentryville, Ind., thirty-two years ago. He attended Baker University and was graduated from the Harvard Law School in 1903. Immediately thereafter he became connected with the New York Citizens' Union as secretary. Chief Engineer Rice of the old board has been retained, temporarily at least.

The new board was notified that it had inherited $400,000 from the Rapid Transit Commission, which had not expended quite half of its allowance for the year.

The Commission received on July 2 its first application for a franchise from Edward Dixon, on behalf of F. H. Behr, the mono-rail man, who wants to build a line in Brooklyn from the East River to Coney Island. The application referred to the records of the old board and asked speedy action.

The first active steps toward perfecting the organization of the Public Service Commission for the second district were taken in Albany July 2, when several expert attachés of the old State Board of Railroad Commissioners were designated to places and sub-committees of the board were assigned to look after certain details of the work.

Commissioner Decker was named as chairman of a committee to confer with the freight agents of the railroads regarding the form to be used for tariff schedules. Commissioner Sague was named as chairman of the committee on instructions for the expert attachés of the office. Commissioner Keep is to head the committee on arrangement of quarters. Chairman Stevens is the second member of each of these sub-committees. Chairman Stevens announced later that these assignments of old attachés of the Railroad Commission had been made: Steam railroad inspector, J. D. Schultz; electrical expert, Charles D. Barnes; expert inspector of accidents, E. F. Van Hoesen; inspector of locomotive boilers, G. P. Robinson; superintendent of grade crossings, Arnold H. Sutermeister; inspector of grade crossings, James E. Brazee. These men are to serve at their present salaries for the present.

THE PHILADELPHIA TRACTION ORDINANCE SIGNED

Mayor Reyburn signed at noon on July 1, the ordinance whereby Philadelphia becomes a partner in the management of the Philadelphia Rapid Transit Company, and in fifty years may become sole owner of the entire traction system. Subsequently, City Councils elected Clarence Wolf and William H. Carpenter as the city's representatives on the Board of Directors of the Transit Company. The Mayor is also a member of the board.

Under the ordinance the city is to have half of all the company's dividends over 6 per cent. The company must establish a sinking fund to extinguish its capital of $30,000,000 at the end of fifty years. When this sinking fund reaches $5,000,000 it is to be paid to the city, when it becomes the property of the city. The company is required to call in all unpaid capital and expend the whole amount in improvements. The city will have a right on any July 1, after July 1, 1957, to take over the whole property, subject to all indebtedness now existing or hereafter lawfully created, upon six months' notice. This right is assignable.

The ordinance to regulate passenger railways approved July 7, 1857, together with all other ordinances on this subject are repealed, but the city retains the right to make all rules and regulations relating to the operation and management of the company's lines necessary for public health and safety.

For paving of streets and car licenses the company will pay an annual charge running from $500,000 in the beginning to $700,000 in the last ten years of the contract. Other fixed payments are provided. The company cannot assume further leases or obligations or part with its property without the consent of the city, or issue stock or bonds without consent.

Councils may determine upon routes of new surface, elevated or subway lines, and if the company fails to accept the same within ninety days the city may offer the franchises to those who will undertake them. As a means of assuring payment of part earnings to the city, the Controller is to have access to the company's books, accounts and vouchers to verify its financial statements by examination and report the result to the Councils.

A special meeting of the stockholders of the Philadelphia Rapid Transit Company has been called for July 18 to ratify this ordinance.

CLEVELAND, SOUTHWESTERN & COLUMBUS TO CONTROL MANSFIELD RAILWAY & LIGHT COMPANY

The directors of the Cleveland, Southwestern & Columbus Railway Company have approved the plan to purchase a controlling interest in the Mansfield Railway Light & Power Company of Mansfield from F. L. Fuller, who secured control of the company some time ago. It is understood that Mr. Fuller represented the company in the purchase of this property at the time, but nothing of the kind was made public then. There are 10,000 shares of common and preferred stock outstanding and the Cleveland, Southwestern & Columbus secured 5050 of them.

At this time it is not the intention to merge this property with the others, but, the ownership being the same, they will be operated as one system when the Cleveland, Ashland & Mansfield line is completed. Besides eight miles of track in Mansfield, the company operates a line between that place and Shelby, a distance of twelve miles. The Central Ohio traction lines, owned by the Cleveland, Southwestern & Columbus, extend from Mansfield to Galion and Bucyrus, to which point the Webb line from Columbus is being built.

This company operates the lighting plant at Mansfield also, and its acquisition will place the Cleveland, Southwestern & Columbus in control of the greater part of the lighting business within the territory covered by its roads.

In all the company has $350,000 preferred stock and $650,000 common stock, with $942,000 in 5 per cent bonds outstanding. Its business is in excellent condition and will, no doubt, be of much benefit to the larger company in many ways. It is said the gross earnings this year will be $207,000.

DENVER TRAMWAY'S CHANGES HANDS

Control of the Denver City Tramway Company has passed to the East by the sale of the holdings of David H. Moffatt, president of the First National Bank of Denver. It is reported that about 68 per cent of the stock is now held by D. C. Clark and W. L. Bull, of New York, and Marsden J. Perry, Benjamin A. Jackson and Samuel M. Colt, of Providence, R. I.

PERTINENT REMARKS BY PRESIDENT OF A NEW YORK AND PENNSYLVANIA TRACTION COMPANY

W. A. Page, president of the Western New York & Pennsylvania Traction Company, addressed the Board of Trade at Bradford, Pa., last week by special invitation of that body, which is seeking the extension of the company's system to various points in that territory. Mr. Page gave it as his judgment that street railways in cities of less than 50,000 population were operated at a loss. He informed his auditors that his company intends to improve and extend the system, and contemplates building several extensions, notably from Bradford to Carrollton via Limestone and Clarkdale, the contract for which has been let to the James A. Hart Company, of New York City. Work on this extension has begun at Clarkdale. The company also contemplates a line from Eldred to State Line, which will be an extension of the Rock City line, and is now building a large sub-station at East Bradford. The lines on all paved streets in Bradford and the Lewis Run line will be reconstructed. The latter line will also be extended, just how far has not been definitely determined.

Mr. Page stated that one difficulty his company had encountered in raising funds for improvements and extensions was the fact that the Bradford franchise has a life of but thirty-seven more years, whereas the bonds are for a term of fifty years. He objected to the car tax in Bradford as wrong in principle, saying that it has a tendency to limit the number of cars operated. Mr. Page pointed out the great advantage accruing to any city possessing an interurban electric railway system, and argued that Bradford should show its appreciation by voting the company an unlimited franchise. The attention of Mr. Page was called to the desirability of building a line from Bradford to Mt. Jewett and Smethport via Kane and Hazlehurst. The Board passed a resolution of thanks for the presence and address of Mr. Page, and decided to refer to City Council with a favorable recommendation.

PERSONAL MENTION

MESSRS. A. F. BENTLEY AND P. L. DOWNS have been elected first and second vice-presidents, respectively, of the Belton Temple Traction Company, of Temple, Tex., and Lewistown, Pa.

MR. HENRY G. BRADLEE was elected on June 30 a partner in the firm of Stone & Webster. The firm now consists of Messrs. Charles A. Stone, Edwin S. Webster, Russell Robb and Henry G. Bradlee.

MR. A. V. SCHROEDER has resigned as general superintendent of the Springfield Railway & Light Company of Springfield, Mo., to become general manager of the Winona Railway & Light Company of Winona, Minn.

MR. WILLIAM H. FORSE, JR., heretofore assistant treasurer of Indiana Union Traction Company, has been appointed secretary and treasurer of the company, succeeding Mr. William C. Sampson, secretary, and Mr. John J. Collier, treasurer.

MR. RALPH L. CRUMP has been appointed resident engineer of Ford, Bacon & Davis, in charge of their work at Pine Bluff, Ark., where a contract has been taken by the firm for the enlargement and rehabilitation of the gas, water and light plants in that city.

MR. WARREN BICKNELL, formerly president of the Lake Shore Electric Railway here, was elected president of the Havana Electric Railway Company, the largest electric railway company in Cuba. Six months ago he became identified with the New York interests which backed the reorganization of the old lines in the Cuban city.

MR. PERRY A. RANDALL, of Ft. Wayne, Ind., has been elected president of the Ft. Wayne & South Bend Railway Company of Ft. Wayne, Ind., to succeed Mr. G. A. Wulkup. Mr. J. H. Grisamer, of Churubusco, Ind., was elected temporary secretary to succeed Mr. Wm. F. Dinnen.

MR. SAMUEL McROBERTS, president of the Sioux City Traction Company, has been elected president of the Illinois Tunnel Company of Chicago, to succeed Mr. A. G. Wheeler, resigned. Mr. W. J. Kenyon has been elected general manager and Mr. J. O. Armour has become a director.

MR. H. M. BEUGLER, formerly superintendent of railways for Ford Bacon & Davis' Operating Department, operating the Newman properties in Houston, Texas, Memphis, Little Rock, Birmingham, Nashville, Knoxville, has taken a position with the firm of Dodge & Day, the well-known engineers and constructors of Philadelphia and New York.

MR. HOWARD E. HUNTINGTON, son of Henry E. Huntington, and H. O. Pratt, general land agent for the Huntington electric railway systems, have been appointed to the directorate of the San Bernardino Valley Traction Company in place of J. S. Wood and W. D. Brookings, resigned. These appointments remove all doubt as to the Huntington control of this property.

MR. E. C. RUTHERFORD, who was recently connected with the National Brake Company of Buffalo, has been appointed sales manager of the Magann Air Brake Company, of Detroit and Toronto. Before his connection with the National Brake Company, Mr. Rutherford was associated with the Magann Company, which was the pioneer manufacturer in the storage air brake field.

MR. S. N. FORD has been elected president of the Mansfield Railway, Light & Power Company of Mansfield, Ohio, to succeed Mr. Leopold Kleyboldt of Cincinnati. Mr. C. F. Ackerman of Mansfield succeeds Mr. A. S. Huey of Chicago as vice-president, and Mr. S. A. Foltz of Mansfield now is the secretary as well as manager of the company, succeeding Mr. G. H. Koehler in the first-named position.

MR. F. J. J. SLOAT, general manager of the Cincinnati Northern Traction Company, while retaining his present position, has been made division manager of the Indiana, Columbus & Eastern, with headquarters at Dayton, instead of Hamilton. He will have charge of the division between Dayton and Union City, Ind., and the Dayton & Western. Superintendent C. E. Palmer will have charge of the Hamilton offices.

MR. ARTHUR B. SHEPARD has resigned as manager of the General Electric Company's Cleveland office to spend most of his time looking after his own properties. He is president of the Toledo & Chicago (single-phase) Interurban Railway, operating from Ft. Wayne to Garrett, Kendallville, Auburn and Waterloo, and which will later be extended to Goshen. Mr. Shepard will retain connection with the General Electric Company in a consulting capacity.

MR. H. A. HILDEBRANDT, after three years' service in the mechanical and electrical testing departments of the Brooklyn Rapid Transit Company, has resigned to become superintendent and chief engineer of the department of electric light and water works of St. Peter, Minn. During his stay in Brooklyn Mr. Hildebrandt has the opportunity of carrying out tests on a wide line of electrical apparatus, particularly on motors and in connection with cable installation and maintenance.

MR. J. M. BRAMLETTE, who as previously noted in the Street Railway Journal has been appointed general manager of the Michigan United Railways Company, has held the position of general superintendent of the company for more than a year past and the appointment is a well merited recognition of his efficient services. Mr. Bramlette's headquarters will continue to be in Kalamazoo, the western terminus of the system. The office of general superintendent has been abolished.

MR. GEORGE B. DUSINBERRE has resigned as Cleveland manager of the Westinghouse Electric & Manufacturing Company, to become a consulting engineer in power and railway work. Mr. Dusinberre worked his way up through the company from wireman to the position he has just relinquished. He is a graduate of Cornell University with the degree of mechanical engineer. Mr. Dusinberre's successor is Mr. G. E. Miller, now assistant to the manager of the railway and lighting department at the Pittsburg works of the Westinghouse Company.

MR. E. F. DAVIS, who as recently noted in the Street Railway Journal has resigned as superintendent of the southern district of the Brooklyn Rapid Transit Company, was tendered a farewell dinner on Wednesday evening, June 26, at Feltman's Coney Island, by a party comprising the depot organizations of the southern district of company. Mr. H. Bongard, assistant superintendent of the Ninth Avenue and Fifty-Eighth Street car houses acted as toastmaster. Mr. J. J. Riley, who succeeds Mr. Davis as district superintendent, and the representatives of each depot made speeches, followed by Mr. Davis, who expressed regret at severing his connection with the company. Mr. and Mrs. Davis plan to leave for Minneapolis about June 1.

MR. S. B. STORER, of the Niagara, Lockport & Ontario Power Company, has resigned from that corporation to establish an office as consulting electrical engineer at Syracuse. Mr. Storer has taken an active part in the development of high-tension power distribution in New York State during the last few years, as manager of the sales department of the Niagara Falls, Lockport & Ontario Power Company, and his several papers on this subject before the New York State association have attracted wide attention. Mr. Storer is a graduate of Ohio State University, in the class of 1893. Soon after graduation he became connected with the Niagara Falls Power Company, from which he resigned to become associated with the power transmission department of the Westinghouse Electric & Manufacturing Company. He resigned from this company to join the Ontario Power Company.

PRESIDENT ROBERT JEMISON, of the Birmingham Railway, Light & Power Company, has resigned the presidency of the company, after six years in that position, to become the chairman of the executive board. The new position gives him greater powers but relieves him of the active duties of directing the actual workings of the local system. The resignation will take effect September 1, at which time President Jemison will be succeeded as president by Mr. A. H. Ford, who is now president of the American Cities Railways Company, with headquarters in New York. For twenty years President Jemison has been connected in an official capacity with the street railway system of Birmingham and has been closely identified with the development of the system from a few important lines to the present splendid system of local and interurban lines.

MR. BENAGE S. JOSSELYN has resigned as vice-president and general manager of the Baltimore Electric and Maryland Telephone Companies to become president of the Portland Railway, Light and Power Company of Portland, Ore. The Portland Company is controlled principally by E. W. Clark & Company of Philadelphia, J. W. Seligman and Pratt & Company of New York, and the properties it owns represent an investment of about $40,000,000. Mr. Josselyn will succeed Mr. H. W. Goode, who died last April. Mr. Josselyn went to Baltimore about two years ago to become assistant to the president of the Maryland Telephone Company, and two months later was elected vice-president. Mr. Josselyn is a native of Illinois and has had an extensive experience in the management of steam and electric railways, electric light and telephone enterprises. He is known to many Baltimoreans through his connection with the Union Terminal at Sioux City, Iowa, which he succeeded in disposing of to the benfit of those financially interested.

MR. WILLIAM L. DERR has just been appointed general superintendent of the New York City Railway Company, an office which has been created for him. Mr. Derr's headquarters will be at the car house of the company at 761 Seventh Avenue. As general superintendent of the company he will receive reports from the superintendent of transportation, the general master mechanic, the engineer of maintenance of way, the superintendent of buildings, the superintendent of electrical car houses and the master mechanic of the One Hundred and Forty-Sixth Street shop. He will report to the vice-president and general manager of the company, Mr. Oren Root, Jr. Mr. Derr has had an extended experience in railroad affairs, although for the most part with steam operation. He was educated in private and public schools at Havre-de-Grace, Md., and at the Polytechnic College of the State of Pennsylvania at Philadelphia. He entered in railway service in 1876 and has been continuously in it ever since. Briefly, Mr. Derr's railway connections may be summed up as follows: 1876 to 1878, assistant engineer Susquehanna Bridge, Philadelphia, Wilmington & Baltimore Railroad; 1878 to 1880, in maintenance of way department Pittsburg, Cincinnati & St. Louis Railway; 1880 to 1883, assistant engineer maintenance of way New York & New England Railroad in charge of relocation of the line between Boston and Newburgh; 1883 to 1884, roadmaster Woonsocket & Valley Falls division and 1884 to 1886, assistant superintendent Woonsocket division same road; 1886, roadmaster Buffalo division New York, Lake Erie & Western Railroad; 1886 to 1888, roadmaster Delaware division same road; 1888 to 1889, assistant superintendent Susquehanna division; 1889 to 1890, superintendent Jefferson division, and 1890 to March 1899, superintendent of the Delaware division of the Erie Railroad at Port Jervis, N. Y.; March, 1899, to August, 1901, superintendent of the Susquehanna division at Elmira, N. Y.; August, 1901, to May, 1903, superintendent of the New York division; May, 1903, to March, 1905, chief engineer of the same road; March, 1905, to February 15, 1907, superintendent of the Hartford division New York, New Haven & Hartford Railroad at Hartford, Conn.; February 15, 1907 to June 30, 1907, superintendent of the Chicago & Alton Railroad Company at Bloomington, Ill. His experience, as outlined, has included both engineering and operation and has been with such important corporations as the Erie and New Haven roads.

TABLE OF OPERATING STATISTICS

Notice.—These statistics will be carefully revised from month to month, upon information received from the companies direct, or from official sources. The table should be used in connection with our Financial Supplement, "American Street Railway Investments," which contains the annual operating reports to the ends of the various financial years. Similar statistics in regard to roads not reporting are solicited by the editors. * Including taxes. † Deficit. ‡ Including Rapid Railway system, Sandwich, Windsor & Amherstburg Railway, and Detroit, Monroe & Toledo Short Line Railway.

Company.	Period.	Total Gross Earnings.	Operating Expenses.	Net Earnings.	Deductions From Income.	Net Income, Amount Available for Dividends.
AKRON, O.	1 m., May '07	158,288	94,202	64,087	42,754	21,333
Northern Ohio Tr. &	1 " " '06	140,233	85,363	54,870	39,947	14,923
Light Co. . . .	5 " " '07	667,015	412,598	254,418	209,185	45,232
	5 " " '07	592,208	387,936	204,272	199,735	4,537
BINGHAMTON, N. Y.	1 m., Apr., '07	20,240	13,377	6,844	8,128	†1,284
Binghamton Railway	1 " " '06	22,012	12,461	9,550	7,363	2,188
Co.	10 " " '07	248,989	137,249	111,740	78,596	33,145
	10 " " '06	236,951	124,312	112,638	72,936	39,703
CHAMPAIGN, ILL.	1 m., May '07	293,875	*168,755	125,120	. . . .	. . . .
Illinois Traction Co.	1 " " '06	229,497	*130,057	99,440	. . . .	. . . .
	5 " " '07	1,399,198	*798,774	600,424	. . . .	. . . .
	5 " " '06	1,122,882	*641,046	481,836	. . . .	. . . .
CHARLESTON, S. C.	1 m., May '07	61,399	37,638	23,761	13,516	10,245
Charleston Consolidated Ry., Gas &	1 " " '06	52,879	32,649	20,230	12,967	7,263
Elec. Co.	3 " " '07	172,858	109,858	63,000	40,550	22,450
	3 " " '06	154,875	96,000	58,875	38,901	19,974
CHICAGO, ILL.	1 m., May '07	116,415	61,872	54,543	26,414	28,129
Aurora Elgin & Chicago Ry. Co.	1 " " '06	102,533	55,730	46,803	24,939	21,864
	11 " " '07	1,196,047	651,826	544,221	291,311	252 910
	11 " " '06	1,062,666	585,350	477,317	269,079	208,238
Chicago & Milwaukee	1 m., May '07	89,283	33,259	56,024	. . . .	. . . .
Elec. R.R. Co. .	1 " " '06	69,813	26,445	43,368	. . . .	. . . .
	5 " " '07	337,517	160,528	176,989	. . . .	. . . .
	5 " " '06	247,318	116,538	130,779	. . . .	. . . .
CLEVELAND, O.	1 m., May '07	19,470	*11,349	8,121	7,213	908
Cleveland, Painesville	1 " " '06	18,202	*12,118	6,084	6,789	†705
& Eastern R.R. Co.	5 " " '07	71,543	*41,489	30,053	28,851	1,203
	5 " " '06	63,440	*39,703	23,737	26,989	†3,251
Cleveland, Southwestern & Columbus	1 m., May '07	66,993	38,819	28,174	. . . . .	. . . . .
Ry. Co. (Incl. Ohio	1 " " '06	54,219	30,202	24,017	. . . . .	. . . . .
Central).	5 " " '07	270,721	164,917	105,804	. . . . .	. . . . .n
	5 " " '06	230,219	141,383	88,837	. . . . .	. . . . .
COLUMBUS, GA.	1 m., Apr., '07	28,030	*17,328	10,702	10,083	619
Columbus Elec. Co.	1 " " '06	23,489	*12,800	10,689	8 762	1,927
	12 " " '07	324,111	*177,284	146,827	109,852	36,975
DALLAS, TEX.	1 m., Apr., '07	84,171	*64,821	19,350	17 747	1,603
Dallas Elec. Corp'n. . .	1 " " '06	81,502	*51,383	30,119	15,660	14,459
	12 " " '07	1,052,788	*758,161	294,628	192,544	102,084
	12 " " '06	985,532	*608,380	377,152	183,095	194,057
DETROIT, MICH.	1 m., Apr., '07	32,133	*27,047	5,086	15,012	†9,926
Detroit, Jackson &	1 " May '07	36,343	*29,570	6,773	15,012	†8,239
Chicago Ry.	4 " " '07	128,950	*104,582	24,368	60,050	†35,682
‡Detroit United Ry.	1 m., May '07	556,305	*338,179	218,126	113,897	104,229
Co.	1 " " '06	506,055	*314,373	191,682	105,478	86,204
	5 " " '07	2,519,101	*1,601,714	917,387	562,035	355,352
	5 " " '06	2,222,940	*1,354,612	868,328	499,447	368,881
DULUTH, MINN.	1 m., Apr., '07	67,291	33,523	33,768	17,645	16,123
Duluth St. Ry. Co. .	1 " " '06	62,181	31,841	30,339	17,524	12,815
	4 " " '07	243,989	131,322	112,667	70,366	42,301
	4 " " '06	225,355	129,190	96,165	70,007	26,158
EAST ST. LOUIS, ILL.	1 m., May '07	178,988	95,535	83,453	. . . . .	. . . . .
East St. Louis & Suburban Co.	1 " " '06	159,183	79,022	80,161	. . . . .	. . . . .
	5 " " '07	814,750	449.198	365,552	. . . . .	. . . . .
	5 " " '06	733,138	375,868	357,270	. . . . .	. . . . .
EL PASO TEX.	1 m., Apr., '07	37,966	*31,303	6,664	4,816	1,848
E Paso Cos.	1 " " '06	31,449	*20,092	11,357	3,809	7,548
	12 " " '07	426,789	*319,787	107,002	50,641	56,361
	12 " " '06	314,690	*211,946	102,744	44,758	57,985
FT. WAYNE, IND.	1 m., Apr., '07	93,940	58,282	35,658	. . . . .	. . . . .
Ft. Wayne & Wabash	1 " " '06	79,543	50,947	28,595	. . . . .	. . . . .
Valley Tr. Co.	4 " " '07	360,958	224,192	136,767	. . . . .	. . . . .
	4 " " '06	311,631	194,680	116,951	. . . . .	. . . . .
FT. WORTH, TEX.	1 m., Apr., '07	79,052	*49,981	29,071	10,313	18,758
Northern Texas Tr.	1 " " '06	64,925	*39,633	25,292	9,942	15,350
Co.	12 " " '07	934,426	*590,369	344,057	120,878	223,179
	12 " " '06	706,147	*428,530	277,617	120,044	157,573
GALVESTON, TEX.	1 m., Apr., '07	26,267	*17,227	9,040	4,167	4,873
Galveston Elec. Co. . . .	1 " " '06	22,618	*15,111	7,507	4,167	3,340
	12 " " '07	337,877	*199,931	137,946	50,000	87,946
	12 " " '06	274,173	*175,011	99,163	50,000	49,163
HOUGHTON, MICH.	1 m., Apr., '07	19,387	*12,163	7,224	3,946	3,278
Houghton County St.	1 " " '06	17,966	*11,647	6,318	3,937	2,382
Ry. Co.	12 " " '07	238,472	*151,193	87,278	47,133	40,146
	12 " " '06	198,460	*144,527	53,933	45,303	8,630
HOUSTON, TEX.	1 m., Apr., '07	53,541	*35,285	18,256	8,351	9,905
Houston Electric Co.	1 " " '06	47,173	*30,811	16,362	7,692	8,670
	12 " " '07	621,643	*395,643	226,000	94,460	131,540
	12 " " '06	546,457	*339,441	207,016	102,547	104,469
KANSAS CITY, MO.	1 m., Apr., '07	472,666	245,720	226,946	149,826	77,120
Kansas City Ry. & Lt.	1 " " '06	435,908	220,589	215,319	138,446	76,873
Co.	11 " " '07	5,226,282	2,631,668	2,594,614	1,613,890	980,724
	11 " " '06	4,701,659	2,343,742	2,357,916	1,503,508	854,409
LEXINGTON, KY.	1 m., Apr., '07	40,853	27,922	12,930	. . . . .	. . . . .
Lexington & Interurban Rys. Co. . .	1 " " '06	40,049	29,478	10,571	. . . . .	. . . . .
	4 " " '07	157,572	107,749	49,823	. . . . .	. . . . .
	4 " " '06	137,557	102,391	35,166	. . . . .	. . . . .
MILWAUKEE, WIS.	1 m., May '07	321,402	158,689	162,713	92,424	70,290
Milwaukee Elec. Ry.	1 " " '06	284,499	153,428	131,070	89,719	41,351
& Lt. Co.	5 " " '07	1,529,734	780,506	749,228	468,165	281,064
	5 " " '06	1,370,866	693,811	677,055	437,411	239,645
Milwaukee Lt. Ht. &	1 m., May '07	58,009	25,741	32,269	32,656	†388
Tr. Co.	1 " " '06	50,167	22,068	28,099	25,454	2,645
	5 " " '07	266,705	128,347	138,358	153,227	†14,869
	5 " " '06	227,490	98,585	128,905	117,954	10,951
MINNEAPOLIS, MINN.	1 m., Apr., '07	465,221	218,089	247,132	115,258	131,873
Twin City R. T. Co. .	1 " " '06	415,414	197,157	218,257	109,708	108,548
	4 " " '07	1,821,162	912,386	908,776	461,033	447,743
	4 " " '06	1,621,914	789,575	832,339	438,833	393,506
MONTREAL, CAN.	1 m, May '07	295,952	170,496	125,456	49,633	75,824
Montreal St. Ry. Co. . .	1 " " '06	264,252	149,074	115,178	47,236	67,942
	9 " " '07	2,169,636	1,410,568	759,068	333,829	425,239
	9 " " '06	1,906,190	1,214,359	691,832	266,975	424,857
NEW ORLEANS, LA.	1 m., Apr., '07	482,128	253,266	228,862	167,261	61,601
New Orleans Ry. & Lt.	1 " " '06	490,578	252,342	238,235	152,297	85,938
Co.	4 " " '07	2,077,841	1,020,561	1,057,281	666,703	390,578
	4 " " '06	1,981,909	1,018,102	963,808	608,297	355,511
NORFOLK, VA.	1 m., Apr., '07	187,097	117,192	69,905	. . . . .	. . . . .
Norfolk & Portsmouth	1 " " '06	128,606	84,095	44,511	. . . . .	. . . . .
Tr. Co.	4 " " '07	629,014	411,163	217,851	. . . . .	. . . . .
	4 " " '06	495,379	321,499	173,879	. . . . .	. . . . .
PEEKSKILL, N. Y.	1 m., May '07	12,424	7,561	4,863	. . . . .	. . . . .
Peekskill Lt. & R. R.	1 " " '06	11,023	6,225	4,798	. . . . .	. . . . .
Co	5 " " '07	59,311	35,724	23,587	. . . . .	. . . . .
	5 " " '06	50,757	28,919	21,838	. . . . .	. . . . .
PHILADELPHIA, PA.	1 m., May '07	249,155	. . . . .	. . . . .	. . . . .	. . . . .
American Rys. Co.	1 " " '06	225,687	. . . . .	. . . . .	. . . . .	. . . . .
	11 " " '07	2,593,903	. . . . .	. . . . .	. . . . .	. . . . .
	11 " " '06	2,363,219	. . . . .	. . . . .	. . . . .	. . . . .
PLYMOUTH, MASS.	1 m., Apr., '07	7,815	*6,398	1,417	1,811	†394
Brockton & Plymouth	1 " " '06	7,248	*5,571	1,677	1,851	†174
St. Ry. Co.	12 " " '07	113,890	*72,367	41,522	21,692	19,831
	12 " " '06	103,389	*71,908	31,480	21,376	10,104
ST. LOUIS, MO.	1 m., May '07	947,337	*622,048	325,289	230,831	94.458
United Railways Co.	1 " " '06	911,673	*558,504	353,169	231,842	121,327
of St. Louis	5 " " '07	4,326,422	*2,927,682	1,398,740	1,155,458	243,282
	5 " " '06	4,050,558	*2,566,548	1,484,010	1,159,068	324,942
SAVANNAH, GA.	1 m., Apr., '07	46,913	*30,752	16,161	11,828	4,333
Savannah Electric Co.	1 " " '06	49,872	*29,982	19,891	10,978	8,913
	12 " " '07	602,072	*377,800	224,272	137,396	86,876
	12 " " '06	607,130	*366,706	240,424	129,169	111,256
SYRACUSE, N. Y.	1 m., May '07	103,072	60,609	42,463	25,201	17,262
Syracuse R. T. Co.	1 " " '06	87,628	50,609	37,019	23,257	13,762
	5 " " '07	490,98[illegible]	277,866	213,116	125,577	87,539
	5 " " '06	428,125	244,199	183,926	112,401	71,525
TACOMA, WASH. Puget Sound El. Ry.	1 m., Apr., '07	134,516	*86,831	47,685	29,841	17,844
Co.	1 " " '06	105,133	*69,828	35,305	24,371	10,934
TOLEDO, O. Toledo Rys. & Lt. Co. .	1 m., May '07	173,990	*106,632	67,358	47,397	19,961
	1 " " '06	167,847	*93,855	73,992	42,243	31,749
	5 " " '07	834,881	*490,132	344,749	229,111	115,638
	5 " " '06	784,391	*420,494	363,897	211,451	152,446