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Heavy Electric Traction at the New York Railroad Club

Under the presidency of Mr. Vreeland, the New York Railroad Club has grown to be one of the most important organizations of its kind with which we are acquainted. The membership was originally made up almost entirely of steam railroad operating men, but during the last few years a number of those connected with electric railways have joined the club and papers on both branches of transportation are presented with impartiality at the monthly meetings. It is hardly necessary to say that the topic discussed last Friday evening was one which vitally touched both interests, as the attendance and list of speakers showed. Outside of the reference to the new gasoline motor car of the General Electric Company, Mr. Potter's paper was chiefly interesting on account of further details given of the single-phase motor system and d. c. locomotives manufactured by his company, and the estimates of comparative cost of electrical and steam operation. Other figures of this kind have been published, but as the latest available, and as representing the views of the author, the comparison contained in Mr. Potter's paper is most valuable. The discussion revealed a dissimilarity of views as to details of electrical equipment, but a noteworthy concord in the opinion that an important early development of electric traction on steam roads is impending. This seemed to be the conclusion alike of the advocates of a. c. and d. c. running, and of third-rail, overhead trolley and sliding bow. We should be glad to see all of the systems discussed at the meeting tried out carefully under the conditions for which each is most suitable, a plan which seems certain of early fulfillment. When this has been done, we shall have the data at our disposal by which the more doubtful cases, or those of the border line between a. c. and d. c. operation, can be considered. Certainly the speech by Mr. Wilgus defined in no uncertain way the advantages of electric power for New York Central conditions, and we shall be very much mistaken if the benefits described by him are not recognized by other roads, and if the conclusions reached by his board of directors in favor of electricity are not adopted by many other similar bodies during the next five years.

Keeping Sub-Station Records

It is safe to say that few tasks are more irksome to the general run of active street railway men than those which involve any species of bookkeeping. There is a feeling in many quarters that the writing of reports and keeping of systematic records are matters of small consequence in comparison with the important work of keeping the cars in motion. Over more than one employee and official an almost irresistible impulse comes to take to the woods when the time for preparing departmental records draws near, and yet every progressive manager realizes that without regular data of operation it is impossible to conduct properly the business of a road.

There is a great difference, however, between essential and non-essential records, and much may be done in the way of relieving employees of the work of preparation if a little thought is given to the matter. Thus, one firm of engineers controlling some two dozen railway and lighting properties, sends its local managers report blanks in which only the questions in black ink are to be filled out, the deductions being made at the home office by the statistical department. These deductions are posted in the records as answers to questions in red ink, and thus the local managers are relieved of a vast amount of burdensome work which is more properly handled by specialists. As an example of the refinement to which the division of labor has been carried, even in highly intellectual work, the foregoing practice is of interest.

A general agreement exists among managers as to the importance of keeping continuous records of power house loads, coal consumption, the use of water, oil, waste, car mileage and the like, but the usefulness of keeping simple data in regard to sub-stations is not so widely appreciated. At first sight, there appears little need of keeping sub-station records in cases where the power output of the generating plant is regularly tabulated, but when one realizes what a simple matter it is to put down the more important sub-station readings, the great value which such data acquires when future extensions and changes are planned and its usefulness in checking the operation of the system justify looking into the problem. There is little wisdom in installing a heterogeneous collection of power factor and frequency indicators, ammeters, voltmeters and wattmeters simply for occasional reference. What is wanted is a system of regular, simple readings, chiefly the energy output of the sub-station at the direct-current bus-bars, the daily rise and fall of load and striking variations in voltage, with an idea of the variations on the high-tension side as well. Sub-station attendants ordinarily have plenty of time to attend to these matters, and a few simple blank forms can easily be made up at headquarters for such uses.

In a rotary converter or motor-generator sub-station there is less need of installing automatic recording instruments, excepting wattmeters, than in sub-stations of the purely alternating-current type, which are coming into wider usefulness as the development of the single-phase motor roads proceeds. The cost of obtaining regular records from the former type is insignificant, but with the absence of attendance expected in the new type of sub-station, the importance of curve-drawing apparatus is bound to increase.

Aside from the readings of a sub-station showing conclusively when the machinery is beginning to be regularly overloaded, and when the usual course of operation is disturbed, they really constitute data of no small financial value when it is necessary to figure upon extensions. Too often such information is assumed by the parties who recommend the changes, or else drawn from a few hasty tests, rather than obtained from regular daily readings. The very inexpensiveness of obtaining sub-station records is certainly one of their chief advantages. Last but not least, the calibration of instruments should be looked after every year or oftener.

Costs of Power

We commented briefly last week on Mr. Richey's most valuable paper on the costs of power production on the Indiana railway systems, but the subject is of sufficient importance to call for more extended discussion. It is very difficult to generalize on power costs, since conditions vary so widely from place to place, and perhaps even averages cannot be fully trusted. But averages are the only attainable basis of comparison, and the data collected by Mr. Richey give at least a definite clue to the economic facts in the case. The question of the gains to be made by the consolidation of power production is one which we have often discussed. We have been disposed to take rather a conservative stand in this matter, and we are glad to see that Mr. Richey joins us in sounding a note of caution in the transmission question. His figure for the net efficiency of distribution through rotaries is even lower than we should have been inclined to put it. Fifty-four per cent is an efficiency that leaves much to be desired, and that leaves, too, a wide margin for competition by stations feeding the lines directly. The practical question which it raises is the saving in power station expense required to offset a clear loss of 25 per cent or 30 per cent in distribution, aside from the extra costs entailed in the extra investment and operating costs. In working the large consolidated stations there is to be considered, first, gain directly through working on a big scale, and second, gain through increase in the average load factor. To our minds, the latter is really far more important than the former, and also decidedly more difficult to evaluate.

One fact often overlooked in this connection is that the gain from increased load factor is relatively much greater in small than in large stations. This cuts both ways—on the one hand, it shows a relatively great saving in passing from small stations with bad load factors to large ones with good load factors. On the other hand, if the small stations are really well administered they can push the big ones very hard indeed. Mr. Richey's figures suggest that most of the stations with which he is concerned are pretty badly off in load factor. The costs which he quotes for power at the bus-bars are fairly low, but are subject to some uncertainty in the matter of relative bookkeeping. The conspicuous thing about them is the evidently large consumption of coal, which, in spite of low prices, cuts a very large figure indeed. The reported average of 5.56 lbs. of coal per kw-hour bespeaks very bad load conditions or poor utilization of fuel, or both. Even taking into consideration the fact that most of the coal is Indiana slack and run of mine, the fuel cost still looms up. In the figures from the individual stations of the Boston Elevated Company which we published last year, the fuel costs were about 10 per cent below Mr. Richey's average, although the Boston coal cost $3.60 per ton as against $1.89. Following up the costs further, it appears that the addition of sub-station operating expenses brings the average cost of power delivered to the direct-current feeders up to 0.964 cent per kw-hour. If to this must be added the fixed charges on the transmission systems, and proper allowances for up-keeps and depreciation upon them, it would appear that the roads concerned are hardly yet basking in the sunshine of cheap power. It is customary to report power costs free from fixed charges and depreciation, which is all right when comparing similar plants, but when, as in the case of high-voltage transmission, compared with direct supply, the variations in up-keep and fixed charges is a vital factor in the comparison—they should assuredly be included.

However, power transmission has come to stay, for long roads cannot be economically fed at 500 volts unless the traffic is much denser than can practically be expected. Transmission to rotaries in such cases is far from ideal, but it is the best present way out of a bad scrape. As regards its use, Mr. Richey raises one very interesting question. Granted that on certain roads, A, B. C. D, etc., individually feeding at 500 volts from separate stations is cheaper than transmission, at what, if any, point of consolidation will a general transmission to several or all of them pay? This is a question that constantly arises in practical engineering, and, so far as we can see, it admits of no general answer. If each road can save money by generating direct current at two or more points, it certainly does not follow that the same scheme will be economical after a consolidation, but, on the other hand, a common station may not pay. In the average case we are inclined to think that a single large generating station for the whole system is a mistake from an operative standpoint, and that two or more stations with interlocked transmissions will be both more economical and safer. If the alternating-current railway motors already in tentative use in that territory pan out, as we hope they will, the whole situation will be greatly relieved. They can be operated from high-tension working conductors, which is the key to long-distance railroading, and once this is possible the transmission and sub-station costs will drop so far as to clear up the majority of the puzzling cases now met with. It will also be possible to extend the transmission systems far more freely than at present, and thus to help out the load factors and to take advantage of the best station locations. In a coal-bearing country, the place for a station is over against a coal mine. Pending the determination of the working properties of these alternating-current motors, the wise man will be cautious in jumping into large transmission work, since it is a most painful thing to purchase a large amount of apparatus which one may wish to be rid of within a comparatively short time.

Interurban Railway Statistics

Information regarding the financial and traffic conditions of interurban electric railways is eagerly sought after these days, both by promoters of new interurban enterprises and would-be investors in their securities. The interurban electric railway, as it now exists in such large numbers in the Central States, is of such recent origin that its exact status has not been as thoroughly established as that of steam railroads. This is one reason probably why interurban railways securities have not commanded quite the confidence in the financial world that is enjoyed by steam road securities of much less intrinsic financial merit. We are not among those who are disposed to deny that the building of interurban electric railways has in some cases gone too far, and that the construction of certain systems has been a detriment to the electric railway business. But taking the interurban railway business as a whole, the condition of things is very satisfactory.

In this connection, the table of statistics of Ohio electric railways published in our issue of Dec. 31 last, affords one of the best opportunities for studying the relative earnings and capitalized liabilities of this class of roads that has yet been offered. There are several reasons why this table is so valuable. Ohio has more interurban electric railways than any other State, and the electric railways of that State are all required to make reports of earnings, capital stock and bonded indebtedness to the Auditor of State. It was therefore possible in the Ohio table which we compiled to average up the statistics of all the roads of a certain class in that State. Statistics of this kind are much more valuable than figures from a few interurban roads scattered here and there, for the reason that the roads publishing their earnings as a regular thing are quite likely to be the best earners, and those having earnings below the average often do not make public reports. It is therefore worth while to go somewhat into an analysis of the figures from Ohio roads to bring out some of the more important facts than can be derived from the table mentioned. It may be said incidentally that the conditions of interurban roads in Ohio in general correspond very nearly with those prevailing in neighboring States.

Of the roads given in the Ohio table, there are thirty-four which may be classed as purely interurban roads having 85 per cent or more of their mileage outside of cities, and which have been in operation long enough so that the annual earnings per track-mile can be obtained. The average gross earnings per mile of track for the year ending April 30, 1904, of these thirty-four interurban roads, was $3,960. The average bond issue per mile of track of twenty-seven of these thirty-four interurban roads was $22,880. The other seven roads either had no bond issue, were carrying on a lighting business also, or are partly outside of Ohio, so that the bond issue corresponding to the mileage of railway track operated in the State was not obtainable.

There is another class of road, namely, the mixed city and interurban railway, which operates the city systems in some of the smaller cities and some interurban mileage, the interurban mileage being over 85 per cent of the total. We find that the average annual gross earnings of the ten roads of this class is $6,035 per mile of track, and that the average bond issue per track-mile of eight of these ten is $29,889. As roads of the classes under discussion usually operate for from 50 per cent to 60 per cent of the gross receipts, the average earnings are sufficient to leave a good margin for depreciation and dividends after paying operating expenses and interest on the average bond issues.

In compiling the Ohio table, the earnings per capita of tributary population were given in two columns. In one column were given the earnings per capita, excluding terminal cities of over 75,000 inhabitants. In the other column, the earnings per capita of tributary population were given, including terminal cities. A study of the table shows the wisdom of drawing an arbitrary line of this kind. The earnings per capita where terminals of over 75,000 inhabitants are excluded, show no such confusing variations as do the earnings when large city terminals are taken into consideration, and also the earnings of roads having no terminals as large as 75,000 inhabitants are sufficiently uniform, so that an average of some value can be obtained. We have therefore averaged the per capita earnings of two classes of purely interurban roads. In one of these classes we have placed eleven interurban roads which have no terminals of over 75,000 inhabitants. The average is $2.90 per capita per annum. In the other class we have placed eighteen interurban roads having terminals of over 75,000 inhabitants. Excluding the terminal population, the average annual per capita earnings of these eighteen roads is $5.83. Both of these per capita figures apply only to interurban roads of the class having 85 per cent of their mileage outside of cities, and not to the mixed class. We have always considered that in figuring population, the roads operating out of very large city terminals should be considered on a different basis from those operating between small cities. It is a difficult matter to tell just where to draw the line as to what constitutes a large city terminal, but, judging from the results in the Ohio table, we are inclined to think that the classification made in that table is about correct. However, when one of the cities to be served by a projected interurban road is between 50,000 and 75,000, it would be well for the engineers reporting on such projects to figure both with and without such a terminal and compare these figures with those given on both classes of roads.

The per capita earnings vary greatly each way from the average. For example, taking the eleven roads having no terminals of over 75,000, the average, as before stated, is $2.90 per capita, while the maximum is $4.94, and the minimum $1.04; the latter, however, being on parallel roads between two cities. Taking the other class of interurban operating out of large cities of over 75,000, the average is $5.83 per capita, with the maximum $9.80, and the minimum $3.21. In these figures also the disastrous effect of parallel electric lines is shown. There are many special conditions which must be taken into account in figuring upon the possible traffic of any road, but these Ohio averages probably come very nearly to those in surrounding States. There is some reason to believe that further West, in Illinois and Iowa, the farming population will yield more revenue per capita than a farming population in Ohio, but the evidence on this point is as yet incomplete.

COMPLETION OF THE INTERURBAN LINK BETWEEN TOLEDO AND DETROIT

An important epoch in the development of interurban electric traction in this country was marked by the recent completion and opening for through traffic of another trunk line connecting two important electric railway centers. This line, the Detroit, Monroe & Toledo Short Line, will bear a special relation to interurban development in that it supplies the only missing link between the 1000 miles of interurban lines radiating into the State of Michigan from Detroit and the aggregation of electric lines in the State of Ohio, comprising over 1000 miles reached directly from Toledo and over 1500 miles reached by way of Cleveland. The possibilities of through ticket selling, and eventually the development of through traffic, that are thus made possible, are evident. In fact, only a short section of line remains to be completed east of Erie, Pa., when an unbroken trolley connection will be afforded through to Buffalo, N. Y.

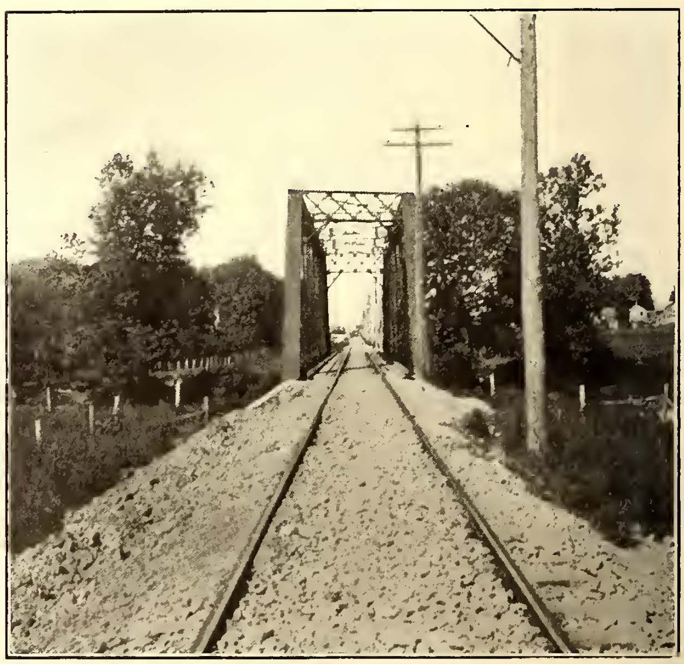
MAP OF THE COMPLETED LINE OF THE DETROIT, MONROE & TOLEDO SHORT LINE, SHOWING ELECTRIC RAILWAY CONNECTIONS AT DETROIT AND TOLEDO

The importance of this event was signalized by a special through trip on Nov. 15 from Cleveland to Detroit and return. H. A. Everett, president of the Toledo Railways & Light Company, took a party of electric railway officials over the new route, making the run from Cleveland to Toledo over the lines of the Lake Shore Electric Railway Company, and from Toledo to Detroit over the new Detroit, Monroe & Toledo Short Line. The initial portion of the trip, a distance of 119 miles, was made in three hours and thirty-five minutes, and that over the new line, 56 miles, in one hour and thirty-seven minutes, the total time from Cleveland to Detroit, 175 miles, thus consuming only five hours and twelve minutes. This trip was considered more than usually significant by those in attendance. Mr. Everett's party included a representative from every electric line running out of Cleveland, among whom were: Warren Bicknell, president of the Lake Shore Electric Railway; F. J. Pomeroy, president of the Cleveland & Southwestern; C. W. Wason, president of the Cleveland, Painesville & Eastern, and J. J. Stanley, general manager of the Cleveland Electric Railway Company. J. C. Hutchins, president; F. W. Brooks, general manager, and E. W. Moore, director, of the Detroit United Railway, were also present. The new system was represented by Matthew Slush, president, and Judge C. J. Reilly, president of the Detroit & Toledo Construction Company, the company which has carried out the construction work.

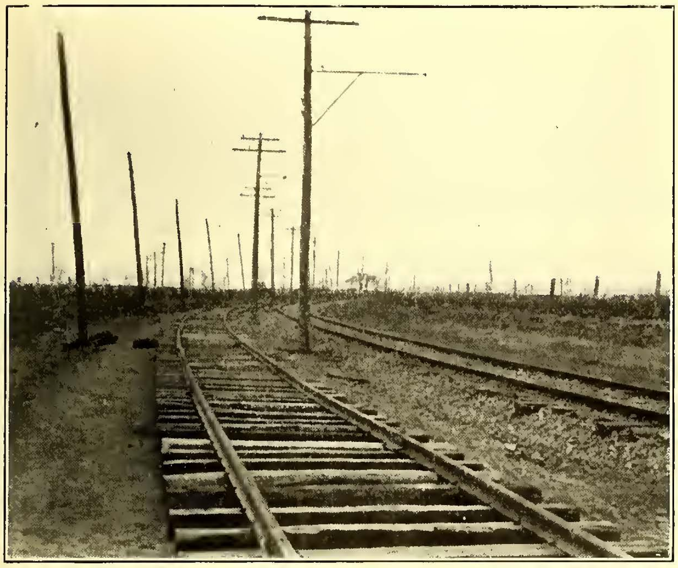
The new work upon the Detroit, Monroe & Toledo Short Line embraces properly an extension from Monroe to Detroit, the section from Toledo to Monroe having been built in 1901 under the name of the Toledo & Monroe Railway, as described in the Aug. 3, 1901, issue of the STREET RAILWAY JOURNAL. For the past year or so, however, subsequent to the abandonment of actual work upon the Everett-Moore line between Toledo and Detroit and the sale of its completed right of way and trackage to the Grand Trunk Railway, construction work upon the extension has been actively pushed by the company, as reorganized under the name of the Detroit, Monroe & Toledo Short Line, and the various sections have been opened up for service as rapidly as completed. The system has been operating as far north as Wyandotte, 12 miles south of Detroit, for several months past, pending the settlement of the difficulties connected with the entrance into the city of Detroit. This was finally arranged peacefully, and upon Nov. 5 through service was inaugurated.

THE NEW CONSTRUCTION

The total length of the system as now operated is 56 miles, the newly completed extension from Monroe to Detroit embracing 35 miles of this distance. Upon the extension, as well as upon the older portion of the system, the road is built over a private right of way. Only in the three cities reached does the line operate over city streets; in Monroe the line traverses one

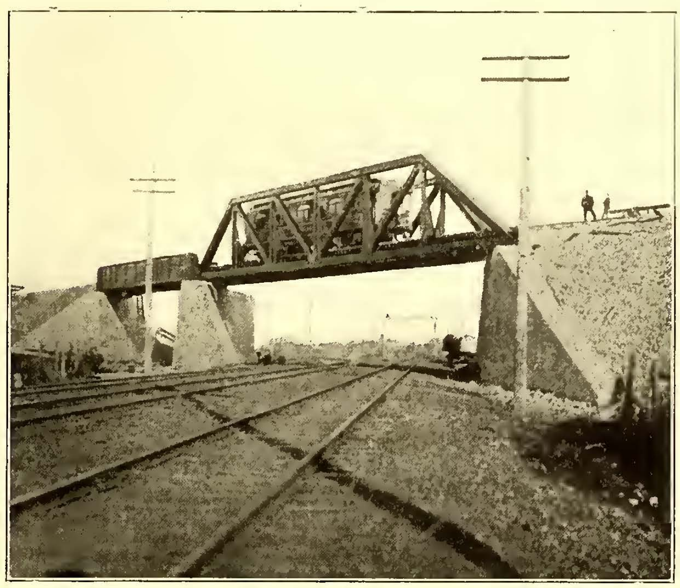


TYPICAL SINGLE-TRACK CONSTRUCTION NEAR ROCKWOOD, SHOWING ALSO BRIDGE OVER THE HURON RIVER of the main streets for a distance of 2 or 3 miles, while in Toledo and Detroit the last 5 miles of the run to the terminal is made over the tracks of the local street railway company. In Detroit the company has provided a ticket office and waiting room at 28 Cadillac Square, past which the cars run in turning for the return trip, while in Toledo the union interurban station near the corner of Superior and Adams Streets (described Oct. 25, 1902, page 704) is made use of as the terminal; in both cities these stations are convenient to the retail shopping districts and to all local city cars.

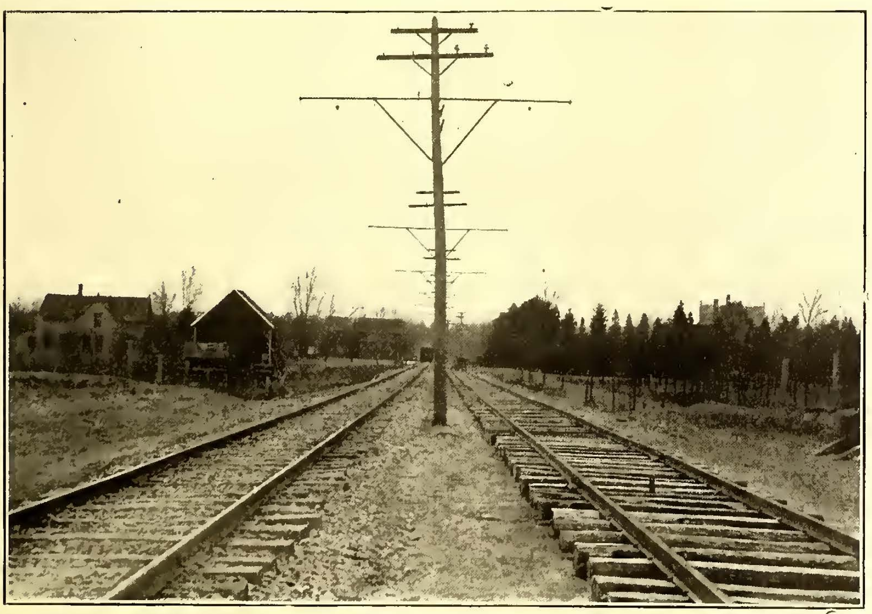


VIEW ILLUSTRATING TYPICAL USE OF DOUBLE-TRACK CONSTRUCTION ON CURVES, TO AVOID POSSIBILITY OF COLLISIONS, CARS TAKING RIGHT-HAND TRACK

The construction work upon the extension corresponds in general to that upon the older portion of the road, as illustrated in the above-mentioned article descriptive of the Toledo & Monroe section. The advantage of a somewhat wider right of way, however, is to be had on the extension, which follows a minimum of 66 ft. throughout; this will permit of double-tracking with the least possible trouble. In fact, the purpose of the general method of construction adopted is to provide for double-tracking without rearranging tracks or poles. As may be noted from views along the line, the present track is located toward one side of the center of the right of way, the side-bracket pole line occupying the center—in this way to add the second track in double-tracking, it is only necessary to build it on the opposite side of the pole line and add the trolley hanger brackets for that side. That double-tracking is to be attempted is evident from the fact that in the vicinity of Wyandotte the double track is completed for 10 miles. Also at many meeting points the turn-outs are being made of unusual length, 1 mile or over, so that a direct approach is being made to double-track conditions.



OVERHEAD CROSSING OF THE WABASH AND MICHIGAN CENTRAL RAILROADS NEAR DETROIT, SHOWING USE OF CONCRETE ABUTMENTS

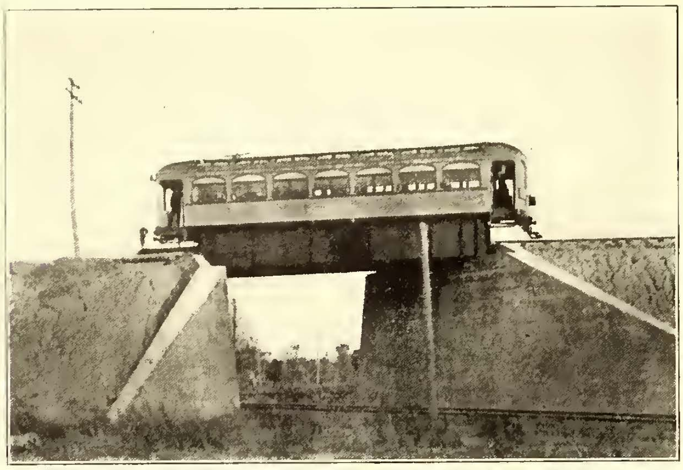


DOUBLE-TRACK LINE CONSTRUCTION AS USED AT ALL TURN-OUTS TO PERMIT CARS PASSING AT SPEED

As in the case of the Toledo & Monroe section, the roadbed is of the very best order, involving a construction that rivals the latest and most approved steam road practice. A 70-lb. standard A. S. C. E. section T-rail is used, while the ties are of cedar and oak, spaced 24 ins. between centers. The track is very heavily ballasted with broken limestone, which makes a very heavy and firm bedding; even at the beginning the cars operate with a characteristic smoothness, which indicates what may be expected from the line after settling in time to its ultimate level. The rails are pressed bonded for the return circuit with crown bonds, supplied by the American Steel & Wire Company, located inside the fish-plates. No all-copper return was considered necessary in the original installation, but the rails and the negative rotary lead at the power house are given an effective running water ground in the adjacent river bed.

All culverts and bridge abutments are of concrete, with steel superstructures, and embrace the very best types of construction. Two accompanying views show the character of the bridge work, both bridges being overhead crossings of steam railroads. These filled inclines also involve the heaviest gradients encountered (from 1 per cent to 2 per cent) upon the line, as the country traversed is so generally level and the line so nearly straight that no grades or curves of any importance are necessary. All steam railroads are crossed either above or below grade, with two exceptions, one a side track leading to a quarry and the other the main line of the Pere Marquette Railway in the city of Detroit, where an overhead crossing would be impossible. A view of the heavy double-track drawbridge over the River Rouge, just outside of Detroit, is also given to indicate the permanent character of the steel work used. There is a considerable amount of marine traffic in this river, which necessitated the installation of a drawbridge—this was built for double-tracking to provide in advance for the inevitable rapid development which such thorough and excellent methods will produce.

The drawbridge is mounted upon a center pier of great stability, and is provided with an electrically-driven turning mechanism. The pier is of solid concrete, resting upon piles driven to a depth of 60 ft. below the bottom of the river. The turning motor is of the railway type, taking current through a submarine cable, which also supplies the trolley wires upon the bridge. The motor-controlling mechanism is conveniently housed and arranged for facilitating operation. The two-span overhead crossing illustrated involves the combined crossing of the three-track right of way of the Wabash Railroad and a single-track branch of the Michigan Central Railroad. The other plate-girder overhead crossing is over the main line of the Detroit Southern Railroad, 2 miles south of Trenton.



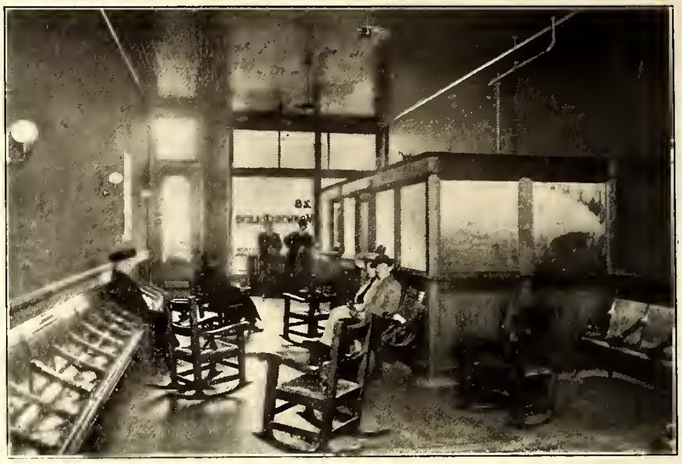
OVERHEAD CROSSING OF THE LINE OF THE DETROIT SOUTHERN RAILROAD NEAR TRENTON

The standards of overhead construction adopted for the extension also follow closely those used upon the Toledo & Monroe end. The poles are of cedar, in general 35-ft. poles being used, set 6 ft. into the ground. Two cross arms, located near the top of the pole, carry the high-tension feeders, while the direct-current feeders are carried upon the bracket arm. The high-tension feeders are of No. 4 bare copper, while the direct-current feeders are of 500,000-circ. mils copper, bare also except in cities. The grooved section wire, No. 000, is used for the trolley line, and is installed in duplicate on all single-track sections. Two telephone circuits are carried upon the pole line in each direction from the power house, for use in the despatching system.

DISTRIBUTION SYSTEM

The operation of the extension required the addition of two sub-stations to the former electrical distribution equipment. One is installed at South Rockwood and the other at Ecorse. The former is illustrated in an accompanying photograph. The building used here serves for the combined purpose of a sub-station and freight and passenger station, this style of architecture being the adopted standard of the company for new construction. The sizes and arrangement of the rooms in the building are shown in an accompanying plan; the construction is of steel, brick and concrete, with tile roofing, the result being as nearly fireproof as is possible.

Current is received from the transmission lines at the sub-stations at 15,000 volts, three-phase alternating, being stepped-down in oil transformers to 380 volts before entrance to the rotary converters. The rotaries deliver to the trolley lines at 650 volts direct current. Each sub-station has two 300-kw rotaries, which are fed by three 200-kw step-down transformers. The switchboard equipment is very simple and conveniently arranged for uninterrupted operation, consisting of one transformer, two rotary and two feeder panels. Each sub station feeds 3 miles to either side. The sub-station electrical equipment, as well as that in the power plant, was supplied by the Westinghouse Electric & Manufacturing Company.

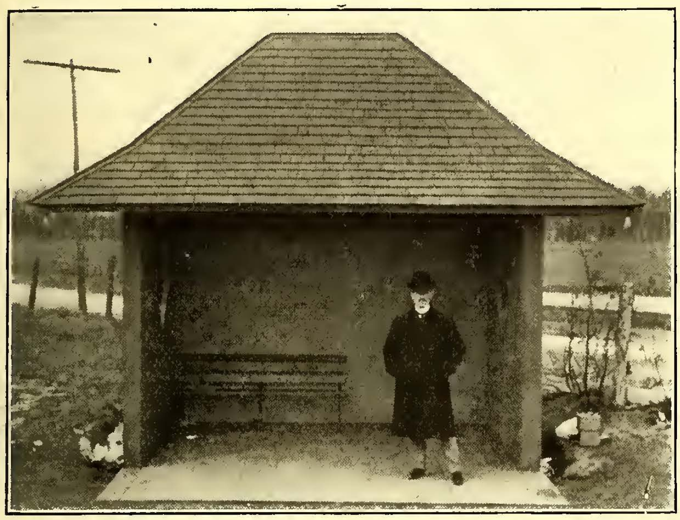


INTERIOR OF THE PASSENGER WAITING ROOM, RECENTLY ESTABLISHED AT DETROIT

POWER PLANT EXTENSION

The power plant at Monroe, as originally built for the Toledo & Monroe Railway, provided for an equipment of considerably greater capacity than necessary to operate the entire system, and the wisdom of this provision was made evident by the facility with which the increase of size was made. An idea of the extensions made in the power plant may be had from the plans of the same presented in the descriptive article of the Toledo & Munroe Railway on page 122 of the Aug. 3, 1901, issue. In the drawings of the plant there presented, the entire projected equipment, embracing five boilers and four generating units, are shown, but, while the building was built to its full

THE DOUBLE-TRACK DRAW-BRIDGE CROSSING THE RIVER ROUGE, NEAR DETROIT size at first, only the two boilers and two engines and generators at the switchboard end of the plant were installed. Recently, however, an additional boiler has been installed beyond the stack, leaving space still for two more, and also the third generating unit. The remainder of the space in the engine room is now partitioned off and occupied for the offices of the company, here being located the office of Mr. Tarkington, the superintendent, the auditor's and the despatcher's offices, besides, also, a locker room and recreation and bath rooms for the car service employees.

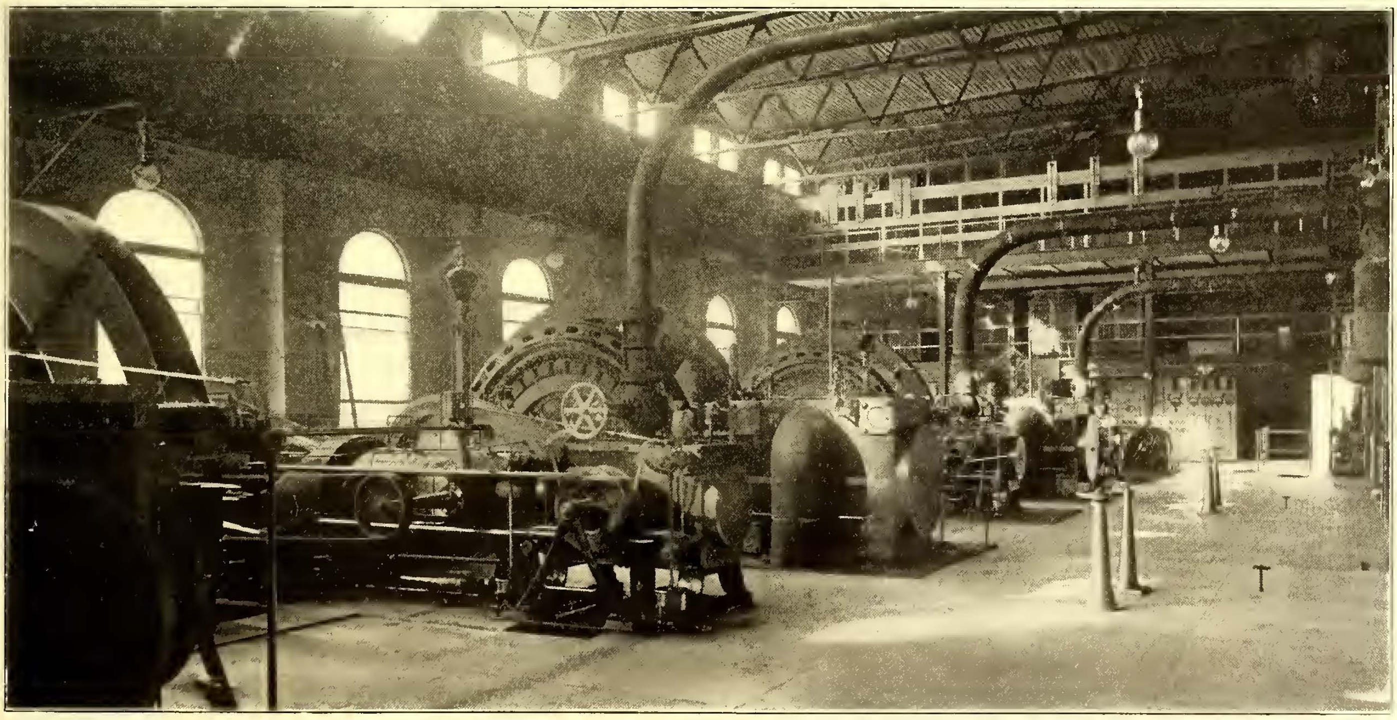


THE STANDARD TYPE OF SHELTER HOUSE USED AT ALL ROAD CROSSINGS FOR PROTECTION TO WAITING PASSENGERS

EXTERIOR VIEW OF THE MAIN POWER PLANT AND OFFICE BUILDING AT MONROE

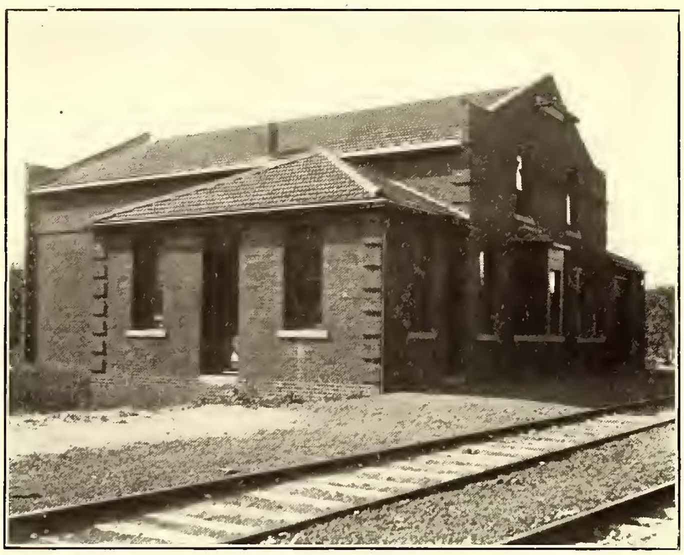
The power house is a large, convenient structure, 150 ft. x 109 ft., and is located about 250 ft. from the river, whence condensing water is had. It has a 165-ft. self-supporting steel stack, with draft controlled by Spencer draft regulators, and is mounted upon a massive foundation. The original boilers are 400-hp Babcock & Wilcox water-tube boilers with extension furnaces, but the new boiler is a Cahall horizontal water-tube boiler, of similar size, with traveling chain grate, all of which was furnished by the Aultman & Taylor Machinery Company, Mansfield, Ohio. The extension furnaces under the original Babcock & Wilcox boilers are also now being replaced by standard furnace construction, with similar traveling chain grate stokers. A very flexible system of piping connections was provided, not only for boiler feeding and boiler room auxiliaries, but also for the high-pressure steam supply to the engines and pumps.

The engines are all, including the new one recently added, 18-in. and 36-in. x 42-in. compound-condensing Hamilton-Corliss engines of the heavy-duty type, built by Hooven, Owens & Rentschler Company, Hamilton, Ohio, and each is direct connected to a 400-kw three-phase 25-cycle Westinghouse generator. The engines are rated at 600 ihp, at one-quarter cut-off and a speed of 100 r. p. m. The generators deliver at 380 volts, which passes directly through the switchboard to the rotary converters at the station or to the step-up transformers. There are two 300-kw rotaries located in the power plant, this rotary equipment being in duplicate of that at the new sub-stations. The exciters include a steam and a motor-driven unit, the latter being used in preference to the steam-driven unit.



VIEW IN ENGINE ROOM OF THE ENLARGED POWER PLANT, SHOWING ARRANGEMENT OF GENERATING APPARATUS

The switchboard equipment is located at the north end of the building beneath the gallery which carries the step-up transformers. It contains thirteen panels at present, including, from left to right, two exciter panels, three generator panels, four high-tension feeder panels and four 650-volt direct-current rotary and feeder panels. Spaces are left for one more generator panel and two more high-tension feeder panels. The step-up transformer equipment consists at present of three 135-kw and three 300-kw transformers. The electrical apparatus was supplied by the Westinghouse Electric & Manufacturing Company.



THE DEPOT AND SUB-STATION AT SOUTH ROCKWOOD, SHOWING STANDARD COMBINED CONSTRUCTION

ROLLING STOCK

The rolling-stock equipment now includes twenty-one passenger cars, two express cars and two freight or construction locomotives. The company also owns thirty-five freight cars, including box, flat, gondola and ballast cars, with which it is carrying on a considerable freight business; these were used in the construction work upon the road, but are now being retained for regular service.

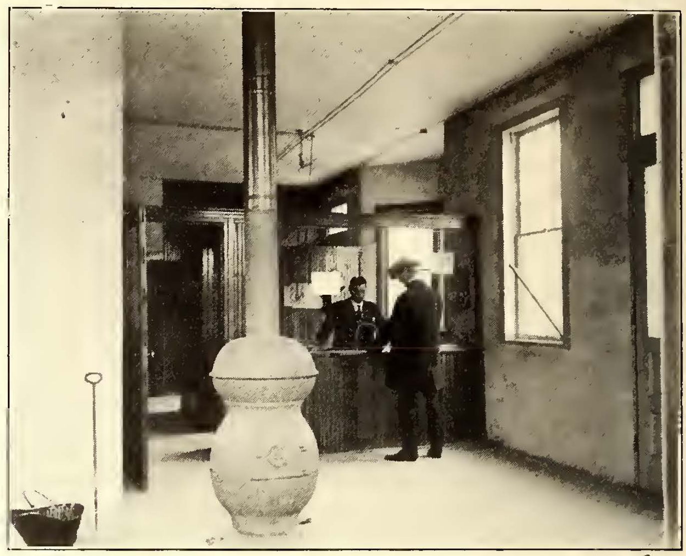
The new cars bought to provide for the extension include twelve 30-ton cars, 52 ft. long, which were built by the John Stephenson Company. They are mounted on Peckham extra heavy M. C. B. trucks, and are equipped with four No. 76 Westinghouse motors (75 hp) and L-4 Westinghouse controllers. The cars are all equipped single-ended, with the control apparatus located in the enclosed front platform, used as a cab; this greatly simplifies the car wiring and, under the system of operation adopted, is found to be fully as effectual. Furthermore, it may be stated that the plan of using single-ended cars and turning them at terminals, is meeting with favor in many other interurban installations.

The cars have interiors nicely finished in dark mahogany, and are divided in two compartments, that in front being the smoking room (seating sixteen), while the rear portion is the main passenger section (seating thirty-eight). At the rear of the main compartment is located a water closet compartment. The seats are finished in red plush in the main compartment and rattan or pantasote in the smoker. The cars present a beautiful external appearance, being finished in bright yellow; an external view of one of the cars is presented in an accompanying engraving.

The total weight per car is 60,000 lbs., of which only 25,000 lbs. is in the car body, the remainder, 35,000 lbs., being below, thus bringing the center of mass very low. Of the 35,000 lbs. below the car body, the trucks weigh 16,000 lbs. and the motors 16,000 lbs., while the air-brake equipment, storage tanks, etc., make the remaining 3000 lbs. The cars are all equipped with the Holland roller-bearing trolley base, supplied by the Holland Roller Bearing Trolley Company, Cleveland, Ohio. Other features to be noted are United States headlights of the Moshier type, Knutson trolley retrievers and Van Dorn No. 11 radial type couplers.

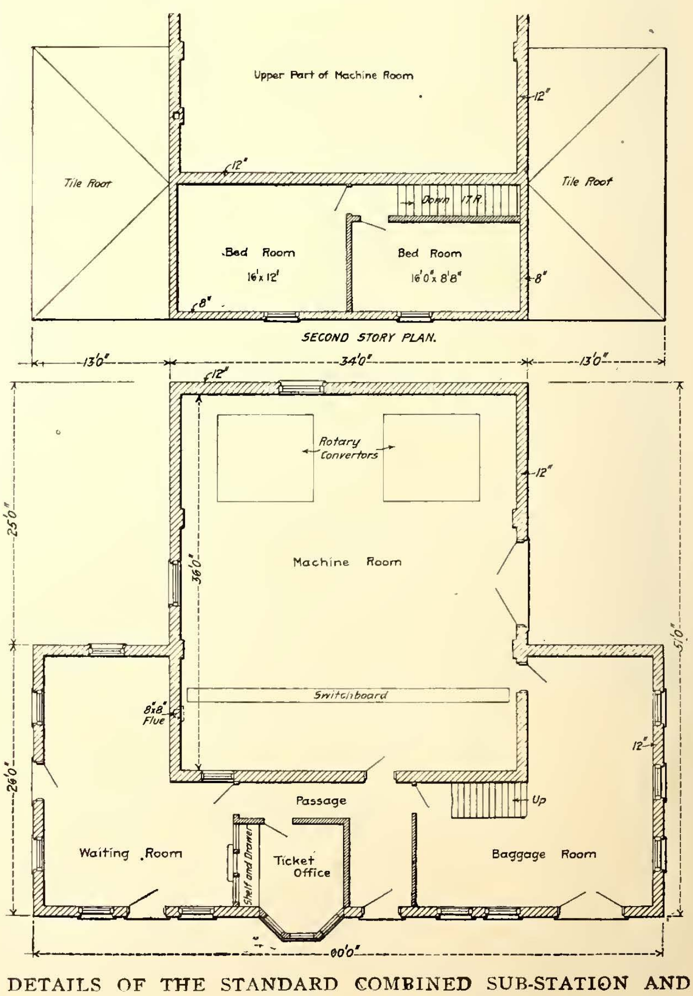
STORAGE AIR BRAKES

A novel feature of this road's equipment is to be noted in the use of the storage air-brake system. This method was installed some time ago upon the older cars used upon the Toledo & Monroe section, after quite a thorough investigation by the officials of prevailing braking systems. It was thought that the advantages to be gained from the use of the large central air compressor plant, from which storage tanks upon the cars should be filled occasionally, seemed to weigh out of consideration any other scheme. The new system has proven very economical, and in practical operation is very satisfactory.



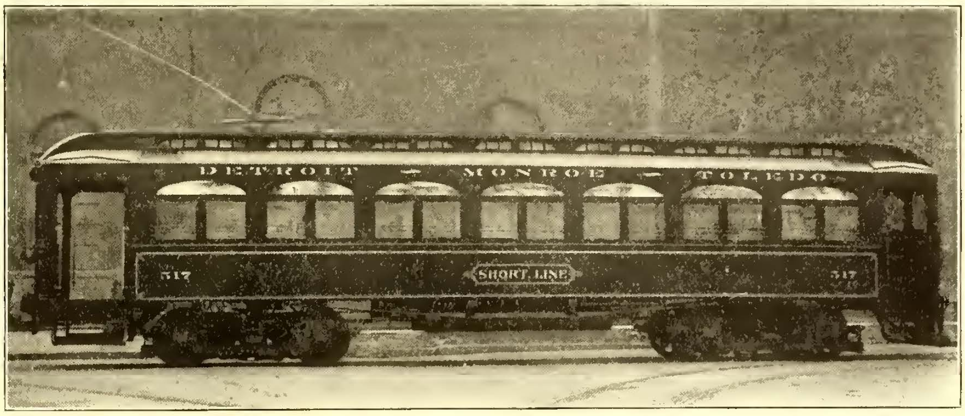
VIEW IN WAITING ROOM OF THE SOUTH ROCKWOOD DEPOT, LOOKING TOWARD TICKET OFFICE

The details of the system follow in general the lines of the systems that have been installed in Detroit, St. Louis and else-



DETAILS OF THE STANDARD COMBINED SUB-STATION AND DEPOT BUILDING CONSTRUCTION USED UPON THIS SYSTEM where. Each car is equipped with two large storage tanks; these tanks deliver at a pressure of 250 lbs., through a pressure-reducing valve to a small service reservoir, from which the brake connections are made in the usual manner. The air-brake equipment was supplied by the Westinghouse Traction Brake Company, the style of system used being the Westinghouse straight-air system, type SM-1.

The compressor, which is a Hall two-stage steam-driven machine, is installed in the basement of the engine room, together with the storage and cooling tanks. It has ample capacity for the operation of the road, and is controlled automatically by the pressure in the storage tanks. Delivery is made to cars at the side of the power house, next to the car house, through a long hose which is usually kept in a box alongside the sidewalk. It is found that the tank capacity, provided upon each car, is sufficient to supply braking for more than two complete round trips under normal conditions of operation.



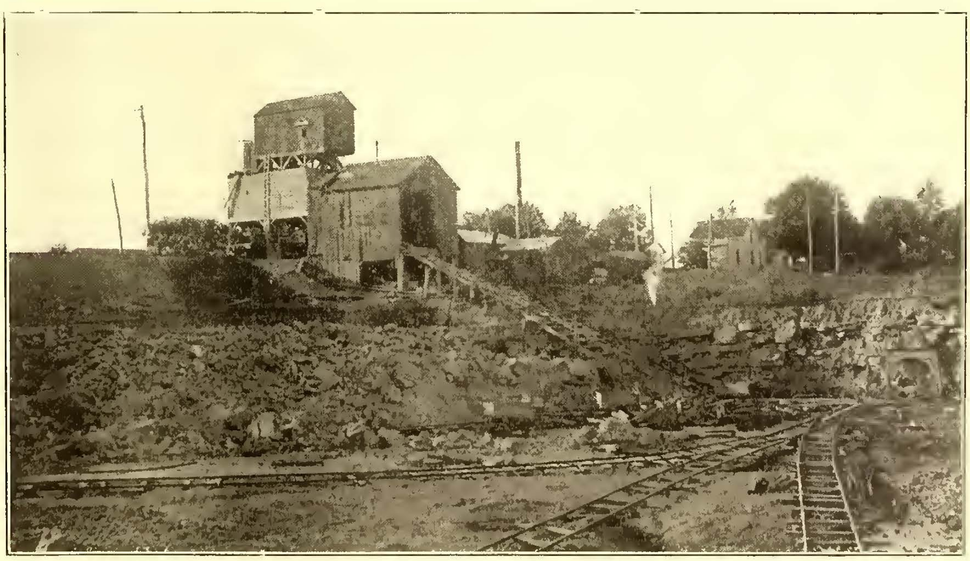
THE NEW STANDARD OF PASSENGER CAR FOR HIGH-SPEED OPERATION

VIEW OF CAR AT THE STORAGE-AIR SYSTEM STATION AT THE MAIN POWER STATION IN MONROE, SHOWING METHOD OF CHARGING THE CAR RESERVOIRS WITH THE HIGH-PRESSURE AIR

OPERATION

The very favorable physical conditions offered for high-speed operation by the level nature of the country traversed are of great importance, yet, on the other hand, it is interesting to note the careful preparations that have been made in construction to further the possibilities of a high-speed schedule. All switches at turn-outs are laid out with long leads and No. 12 frogs, so as to permit passage to either side at high speed, while passing tracks, which are spaced 2½ miles apart throughout, are, in many cases, lengthened out to a mile or so in length to permit cars to continue on their run in passing—an impossibility with short passing sidings. Furthermore, additional safety is insured by the use of a despatching system. Telephone booths are located at every passing track from which the motormen call up the despatcher and receive orders for proceeding in case of disarranged schedule, etc. These telephone booths are lighted electrically at night, in connection with the switch lights.

The amount of both through and local traffic that has already been worked up is remarkable—in fact, it may truly be stated that here a large amount of traffic has been created. Considering, for instance, that the through round trip rate between Detroit and Toledo is $1.50, as compared with $2.60 upon the two steam roads which it parallels, and, in addition, that hourly service is given, the reason is not hard to discover. Furthermore, the electric line lands the passenger at any point he may desire within the city and not in a depot at one side and out of the way. The time consumed per trip (two and one-half hours, according to the present schedule) is not excessive as compared with that of the steam roads, the latter being slightly over two hours. While the trip time of two and one-half hours has been determined upon for the coming season, the extreme ease with which the schedule

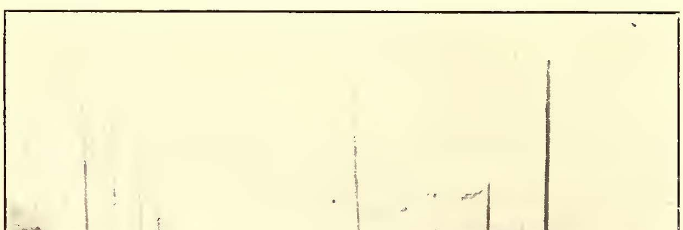


THE QUARRY AND STONE-CRUSHER PLANT AT NEWPORT, OPERATED BY THE RAILROAD COMPANY, FROM WHICH 60,000 CU. YDS. OF STONE BALLAST HAS BEEN REMOVED FOR TRACK BALLASTING is maintained tends to indicate that it would be no hardship for the cars to make the run in less than two hours. After the roadbed is thoroughly settled, it is intended to cut the schedule time per trip down to two hours.

THE BATHING BEACH AT MONROE PIERS, A SUMMER RESORT ON LAKE ERIE, REACHED BY A BRANCH OF THE SYSTEM AT MONROE

In addition to passenger and express traffic, the road is handling a large amount of freight, thirty-five miscellaneous freight cars having been provided for the purpose. The first attempt in this direction was made in hauling coal from Toledo to the power plant, and subsequently a very considerable amount of freight traffic has developed, and this with very little effort on the part of the officials. Direct access is given to many industries, as a result of which shipments will be much more convenient over the electric line than by the steam roads. The city of Wyandotte, 12 miles south of Detroit, stands third among the cities of Michigan in point of freight shipments, while the country traversed further to the south is notable for being a prosperous farming district. Recently a contract was carried out for delivering 4,000,000 brick for the construction of the new St. Mary's Academy at Monroe, involving the delivery of 800 carloads up to date. At present two freight trips are being made each way daily, but it is evident that the rapid development will soon demand an increase.

A valuable industry in the form of a limestone quarry is owned and operated by the company at Newport, having thus far been operated to the extreme of its capacity to supply crushed stone for ballasting the new track. But, subsequently,



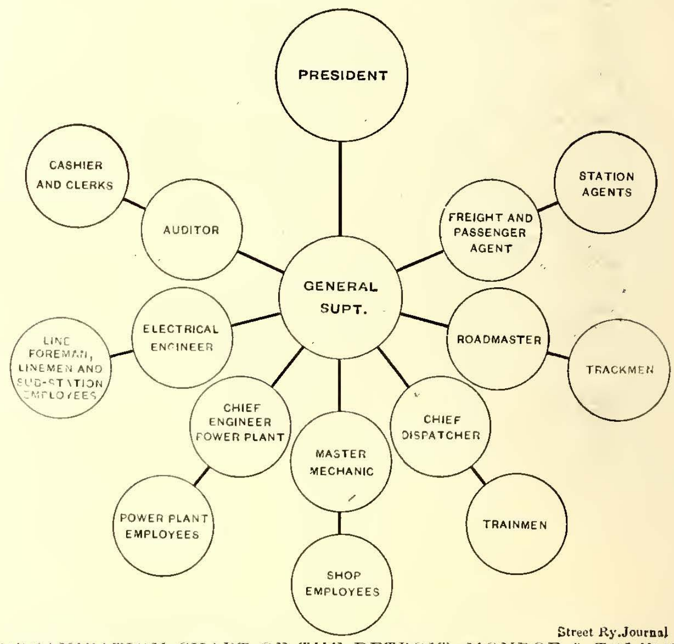
TYPICAL YACHTING SCENE AT MONROE PIERS IN SUMMER

it is expected to operate the quarry as a separate company for supplying stone in carload lots anywhere along the line; it is already found that there will be a large demand for the stone in the various grades. Adjacent to the right of way is located the steam power plant for operation of the rock drills in the quarry, the crusher and storage bins for the various grades of stone being electrically operated—this, together with a general view of the quarry, is illustrated in a photograph on the opposite page.

PARK DEVELOPMENT

A valuable side extension of the system was built a year ago at Monroe, which will serve as an important traffic feeder in summer time. This is a branch 4 miles long leading from the main line to Monroe Piers, a beautiful summer resort upon Lake Erie. The accompanying photographs give an excellent idea of the advantages of this location as a watering place, and illustrate the popularity which it developed last summer as a result of the accessibility given it by the entrance of the trolley system.

Monroe Piers is one of the most popular summer resorts of the Middle West, and every summer visitors flock there from the South and West. Around the Piers and Monroe, the descendants of the old French settlers have made a last stand for individuality, and there is a halo of romance and adventure spun around the country. In the days before Toledo appeared upon the map, the mouth of the Raisin was famous as a fishing and hunting ground. To-day the different clubs along the River Raisin own the thousands of acres of marsh land and the game



ORGANIZATION CHART OF THE DETROIT, MONROE & TOLEDO SHORT LINE

is carefully protected. Pleasant Bay, a cove at one side of the Piers, is an ideal hunting ground for ducks; snipe, plover and woodcock are bagged there during the year. Also, from early spring till late fall, fish are plentiful, and the Raisin River and the lake are dotted with fishing parties. At this point also is to be found the only desirable bathing beach upon the western end of Lake Erie, which will make the resort especially attractive.

It is the intention of the company to develop this resort as rapidly as possible. Increased facilities will be provided for handling passengers and through cars from Toledo and other points will be run to the Piers as travel warrants. The public in the vicinity of the line have welcomed the advent of this branch, particularly on account of the general lack of watering places in that country, and the company will anticipate the demands of this traffic by establishing a schedule which will be adequate for safely and effectively handling it.

The officials of the Detroit, Monroe & Toledo Short Line are as follows: President, Matthew Slush; vice-president, C. A. Black; secretary, Elisha H. Flynn; treasurer, Charles R. Hannan; general superintendent and purchasing agent, W. B. Tarkington. Mr. Slush has been prominently identified with the organization of several important electric railway properties, while Judge Reilly, president of the construction company, built the first interurban line out of Detroit, the Rapid Railway System, to Port Huron. Mr. Hannan, who was also closely identified with this important development, is a well-known financier of Boston, Mass. The operating staff consists of: Auditor, V. R. Ronk; passenger and freight agent, G. M. Henry; electrical engineer, C. R. Osgood; chief engineer power plant, Lewis Wonn; master mechanic, Eugene Youngs; train despatchers, E. H. Raupp and H. A. Charter; roadmaster, A. J. Law, and foreman electric lines, Robert Bell, all of whom are under the supervision of the president and general superintendent, as shown in the accompanying organization chart. Acknowledgement for this interesting information is due Mr. Tarkington.

MEASURES ADOPTED BY THE CLEVELAND & SOUTHWESTERN TRACTION COMPANY TO OBVIATE THE SPITTING NUISANCE

General Manager Nichol, of the Cleveland & Southwestern Traction Company, has started a crusade against men who expectorate on the floor of cars. Cars have signs warning against the practice, and conductors are instructed to warn violators of the rule. This has not stopped the practice and the company is now securing the names of habitual violators, and proposes to arrest some of them. Some time ago, General Manager Nichol adopted the policy of removing cuspidors from the smoking compartments of cars, believing that such receptacles were unsanitary and obnoxious, also believing that if a man did not find a cuspidor he would be apt to expectorate out a door or window.

This theory worked well in summer when all the windows of the car are open, but resulted in spitting on the floor during the winter.

THE EQUIPMENT OF THE EAST BOSTON TUNNEL

The larger engineering problems met in the construction of the recently completed East Boston Tunnel have been discussed to a greater or less extent in the technical press and in the reports of the Boston Transit Commission, but comparatively little has been printed in regard to the equipment of the tunnel. In considering some of the particular features of interest in connection with the roadbed, track, lighting, power supply and ventilation systems, the main physical characteristics of the tunnel will first be outlined.

The length of the tunnel is about 7450 ft., measured along the tracks from Maverick Square, East Boston, to Court Street, in the city proper. There are two tracks in the tunnel, one for eastbound and the other for westbound traffic. The tunnel is noteworthy by reason of the absence of sharp curves, its liberal size, depth and extended length under the harbor. The shortest radius curve is 230 ft. in central radius. The next sharpest curve has a radius of 2000 ft., and the next 3000 ft. At its deepest point the tunnel's bottom is approximately 40 ft. below the 40 ft. dredging line at the bottom of the harbor. The maximum grade is 5 per cent. On the east end of the tunnel grades vary from 4.7 to 5 per cent through a continuous run of about 2000 ft. In point of cross-section the tunnel is designed to accommodate the elevated cars in use on the Boston Elevated Railway Company's system, although the present plan is the operation of the company's standard type of surface car in the tunnel. Two underground stations, Court Street and Devonshire Street, are at present in use, and one at Atlantic Avenue will be opened for business as soon as it can be completed. The tunnel walls, including the upper arch and the invert, are made of concrete, which is reinforced by steel tie rods at a few special points. The tunnel is below ground throughout its entire length, except where it comes to the surface at Maverick Square. At present there is no physical connection between the tunnel tracks at Court Street station and

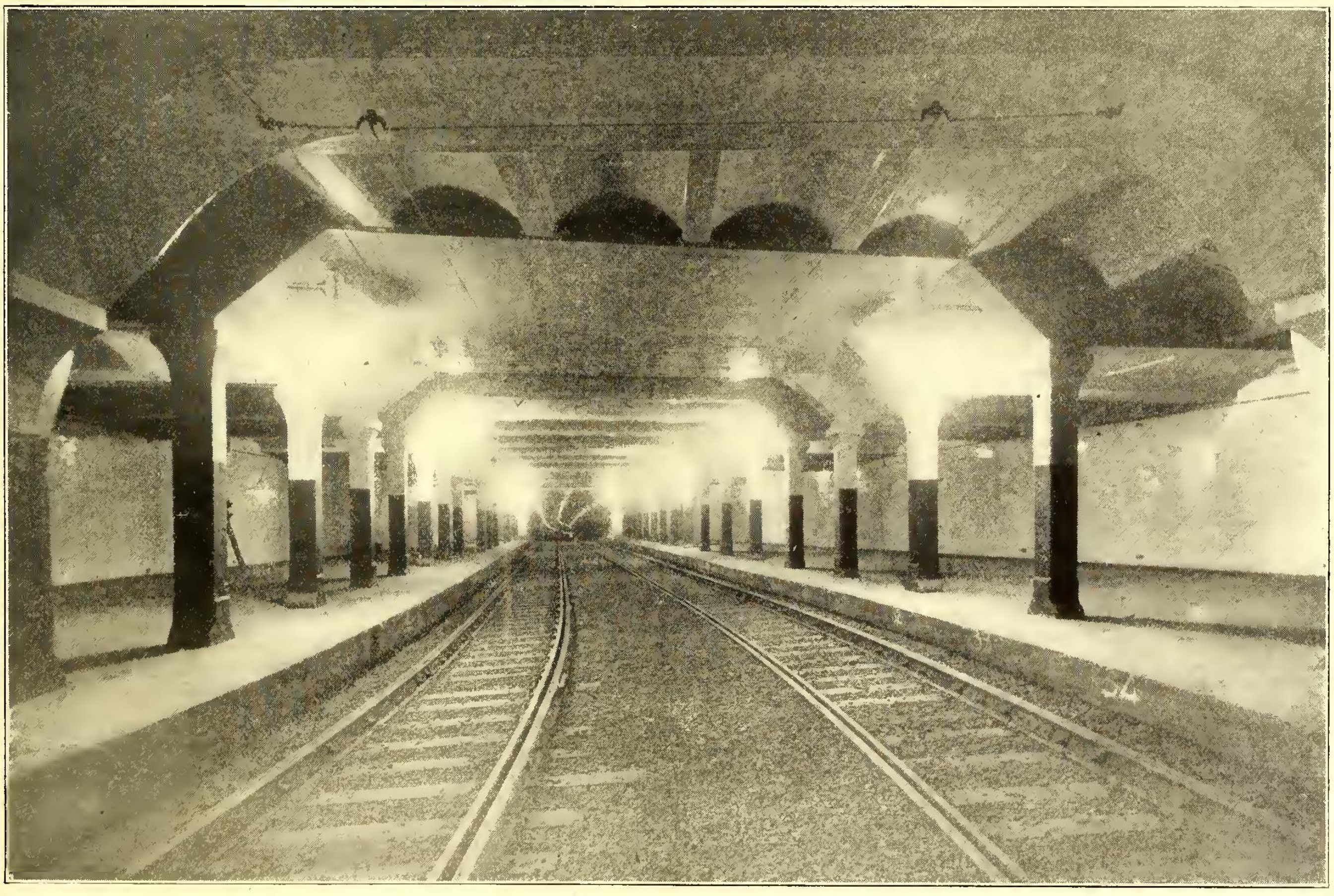


FIG. 1.—EAST BOSTON TUNNEL, DEVONSHIRE STREET STATION

the Tremont Street subway tracks at Scollay Square. Passengers going between the subway and the tunnel transfer through foot passageways. Special provision was taken to strengthen the foundations of the tall office buildings on State Street, which might otherwise have been endangered by the construction of the tunnel. About four years and seven months were occupied in the building of the tunnel.

Fig. 1. is a view taken looking eastward, at the Devonshire Street Station. The photograph was made by the illumination given by the station lights, which are arc lamps of the direct current, 6 amp., 110 volt type. It will be noted that there are no island platforms at the station, which is of the most liberal design. The platforms are of concrete, and the station walls are faced with enameled tile. The track ballast is of trap-rock, and the tunnel proper, beyond the station, is illuminated by three parallel rows of 16-cp incandescent lamps. Since the photograph was taken, sheet-iron shields painted white on one side and dark on the other, have been installed at each lamp in the side rows, so that the light is cut off from the motorman's eyes as he approaches. The two left-hand rows of lights are visible in each direction. The only lights intended to be seen at the motorman's right side are the block signal lights, which will be described later. The radical difference in the station design, as compared with the subway and elevated stations in Boston, is immediately apparent from the illustration.

Fig. 2 is a cross section of the tunnel beneath the harbor. Guard rails are laid throughout the entire tunnel. The center conduits carry power cables belonging to the railway company; those at the right, looking east, contain circuits of the Boston Edison Company, and those at the left, cables of the New England Telephone & Telegraph Company. The conduits are of the 3-in. single duct vitrified clay type.

The general layout of the track and roadbed is shown in Fig. 3. Service rails are of the A. S. C. E. T-section, 85 lbs. per yard. Weber joints are used, 24 ins. long, with four bolts. The rail lengths are 60 ft. with the service and 30 ft. with the guard-rails. Goldie tie plates are used at each service rail-joint, 6 ins. x 8 ins. x 5-16 in. The guard-rails weigh 57½ lbs. per yard, and are of the Pennsylvania No. 262 section. The tie plates at the guard-rail joints are 4½ ins. x 5 ins. x 5-16 in. Plain four-bolt joints, with splice bars, are used. Spacing blocks of malleable iron 3½ ins. long are installed every 5 ft. between the running and the guard-rail. These blocks are held by ⅞-in. steel bolts. On the sharp curve, previously mentioned, and at special work, the blocks are spaced 2 ft. 6 ins. apart on centers. The ties are 7 ft. and 8 ft. long, the cross section being 6 ins. x 8 ins. They are of hard pine and are spaced sixteen to every 30 ft. Every third tie is longer than the preceding two, so that third-rail insulators may be readily installed in the tunnel in case it becomes desirable to operate trains in it. Goldie spikes 5½ ins. x 9-16 in. are used upon both service and guard-rails.

The arrangement of the guard-rail is of special interest. Its section and installation gives a flange space of 1¾ ins. between it and the service rail, and the top of the guard-rail is 9-16 in. higher than the top of the running rail. It was considered vitally important by the officials of the Boston Elevated and the railroad commissioners to avoid all possibility of derailment in the tunnel, and it is believed that the arrangement of guard and service rails installed precludes such accident. An advantage further occurs in the facility of repairs possible by the layout. Either rail may be taken up without putting the other out of service. Two grades of ballast are used, the larger grade passings through a 2½-in. mesh, and the smaller through a 1 in. mesh. The smaller ballast is used below the ties to a depth of 2 ins., and it is also tamped around the ties and levelled off at their tops. The larger grade of ballast is used below the smaller grade, with particular reference to the better drainage obtained through the 2½-in. size. Fig. 2 shows the drainage channel at the bottom of the tunnel. A shoulder, along which authorized persons can walk, is provided on the conduits at each side of the tunnel.

The trolley wire is circular in section, No. 00 B. and S. gage. The method of its support is shown in Fig. 4. A Brooklyn strain insulator is anchored into the concrete of the tunnel by an expansion bolt. The stranded steel span wire is attached to the other end of this insulator. It terminates in a globe insulator, which in turn is fastened to the concrete of the tunnel ventilation duct. The hanger is attached to the span wire, supporting the trolley 13 ft. 6 ins. above the top of the rail. The spans are 20 ft. apart. Above the trolley, throughout the tunnel, is a fireproofed guard-strip, designed to keep the trolley and wire away from the concrete. It is made of North Carolina pine, and is 10 ins. wide and 1¼-in. thick. Above this strip is an additional strip ¼-in. thick. Round trolley was used instead of "Fig. 8" trolley on account of the greater ease with which it can be handled on the reels. There are no section insulators in the trolley at any point in the tunnel.

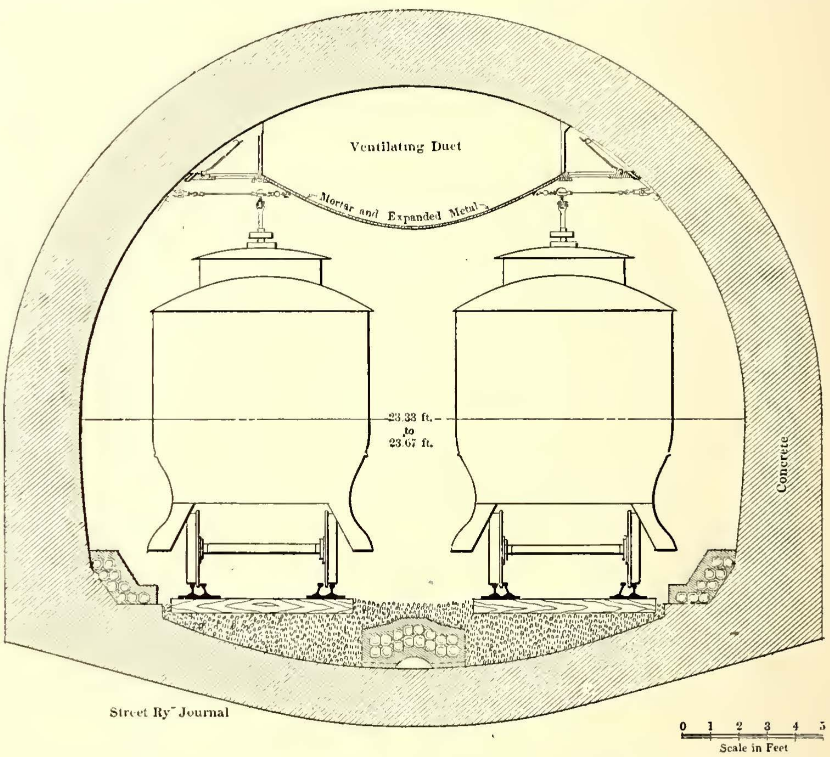


FIG. 2.—CROSS-SECTION OF EAST BOSTON TUNNEL UNDER THE HARBOR

The feeder system of the tunnel is shown in Fig. 5. Two cables of 1,000,000-circ. mil cross section each are run southward from Lincoln power station on Atlantic Avenue along the elevated railway structure to the Atlantic Avenue station of the tunnel. Additional cables, used by surface and subway lines, are also run from Lincoln power station to this point. Here all the cables for the tunnel conduits pass down the structure to a distributing switchboard located in that part of the Atlantic Avenue tunnel station, known as the Atlantic "Chambers," shown at the right centre of the diagram. From the switchboard the cables feeding the tunnel pass into the conduits, the cables being four in number and each of 500,000-circ. mil cross section. Two of these 500,000-circ. mil cables pass through the tunnel eastward, one being laid in each of the center conduits. A brick fire wall has been built to separate the center conduits into two groups. The other two 500,000-circ. mil tunnel cables pass through the tunnel to the westward, both being laid in the south conduit. At Devonshire Street the conduit gives a connection with Central Power Station, and here the surface feeders carried through the tunnel are brought to the street conduit. Throughout the tunnel the trolley is alternately fed by taps from first one and then the other feeder. In each of these taps is inserted a switch which enables the feeder to be open-circuited for testing purposes.

The lighting of the tunnel is one of its most interesting features. There are three rows of 16-cp, 110-volt incandescent lamps spaced 12 ft. apart throughout the tunnel. All told, there are 600 incandescents in service. Fig. 6 shows the general scheme of lighting. The one point most kept in mind by the engineers was the importance of providing continuous illumination. The current supply for lighting may be drawn from three sources, i. e., Central Power Station, Lincoln Power Station and the Edison Electric Illuminating Company's system. The lighting of the station and tunnel sections is controlled locally instead of from a central switchboard, as in the Tremont Street subway. Normally the lights are supplied from Lincoln Power Station through a No. 0000 B. and S. lead-covered rubber insulated cable. Five lamps are in service in each circuit. The lamps in the tunnel may also be thrown upon the trolley circuit in the tunnel and fed from that, if desired. The trolley feeder, Edison, Lincoln and Central Power Station lines are all brought to a main distribution board at the Devonshire Street station, as shown in the diagram. The Edison current is drawn from a transformer as 500-volt, 60-cycle, single-phase supply.

Turning to Fig. 6 the reader will note the various switches mounted on the distribution board. Switch No. 8 is a single-pole double-throw knife switch, which throws the tunnel lights upon either of the company's power stations. No. 9 is normally closed, so that Edison current will be instantly available in case the Elevated supply fails. No. 10 is an automatic switch with two blades at right angles. It is fitted with a no-voltage release coil, which permits a powerful spring to throw the upper switch-blade into the top jaw in case the current from the Elevated Power Station fails. At the same time the lower blade is pulled away from the lower jaw to a horizontal position. The transfer of the tunnel lights is made so quickly by this switch that the eye does not notice the slightest flicker unless one is watching very closely and expecting the change. From switches No. 6 and No. 7 the distribution circuits pass into the tunnel conduits. All the fuses are of the enclosed type. Switch No. 11 controls the trolley connection. Both the station and the tunnel lights may be operated from any one of the sources of current above mentioned. At each station in the tunnel is a switchboard panel controlling the lights at that particular station by suitable snap switches and fuses. Several arc lights are also installed at each station, and wired independently of the other circuits, on the Edison three-wire system through the switch-box shown in the diagram, thereby preventing the total darkness at stations which might otherwise result from the loss of the regular power supply.

As will be seen from the diagram, the leads from switches No. 6 and No. 7 are No. 3 B. and S. cables carried in the underground conduits of the tunnel, while the No. 8 B. and S. emergency trolley supply is run in two parallel lines through overhead pipes along the tunnel sides. At regular intervals in the tunnel distribution, boxes are installed as shown, each box feeding six groups of five lamps each, through enclosed fuses and suitable circuit wires. On the north side of the tunnel are eleven such boxes; on the south side there are nine. Alternate lamps are fed from the same circuit. In each box is a single-pole double-throw knife switch for throwing the tunnel incandescents in that section upon either trolley or regular elevated power. The iron pipe is ¾ in. "electroduct." Ticket offices are lighted by two 16-cp incandescent lamps each, with frosted globes.

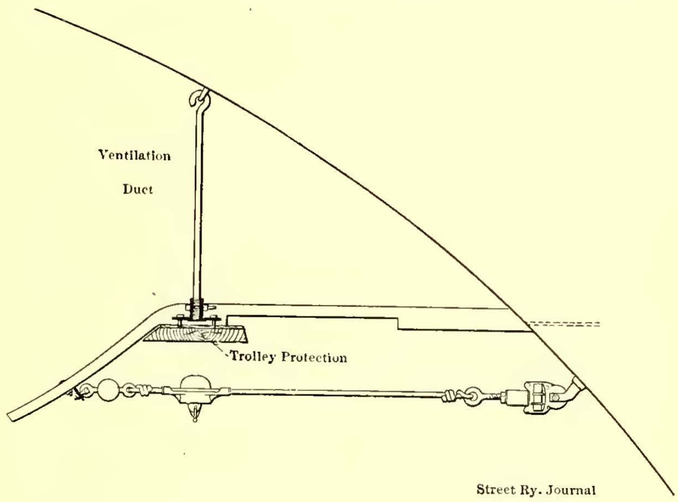


FIG. 4.—DETAILS OF TROLLEY PROTECTION

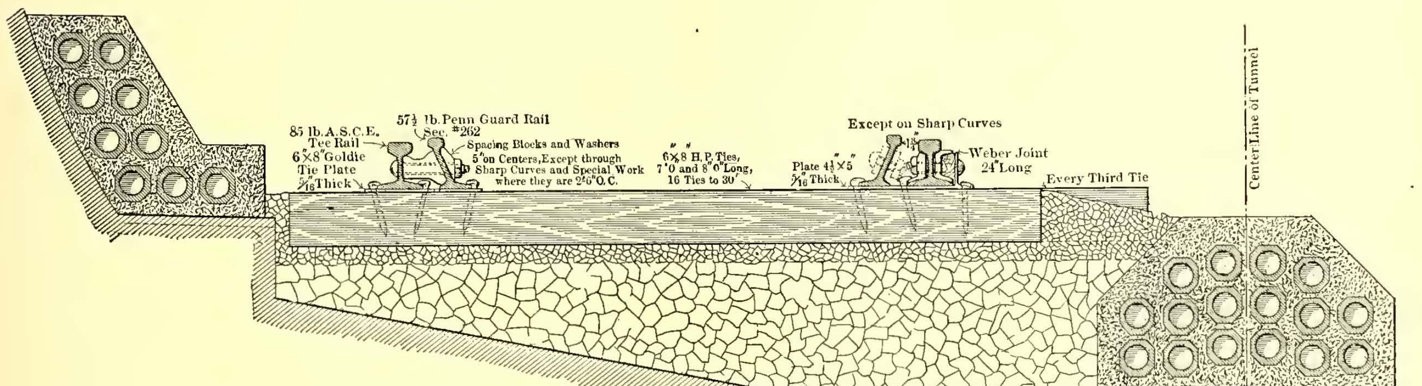


FIG. 3.—A TYPICAL HALF CROSS-SECTION BETWEEN STATIONS

The only heating done in the tunnel is in connection with the ticket offices. Each of these is equipped with two Simplex enameled electric double heaters taking 2.05 amps. at 560 volts.

The bonding is carried out with particular thoroughness, the Chase-Shawmut soldered type of bond being used. Two of the four service rails are bonded with two 350,000-circ. mil bond under the fish-plate at each joint. Each of the four guard-rails is equipped with two 350,000-circ. mil bonds, one being placed on the head of the rail and the other at the foot. The copper con-

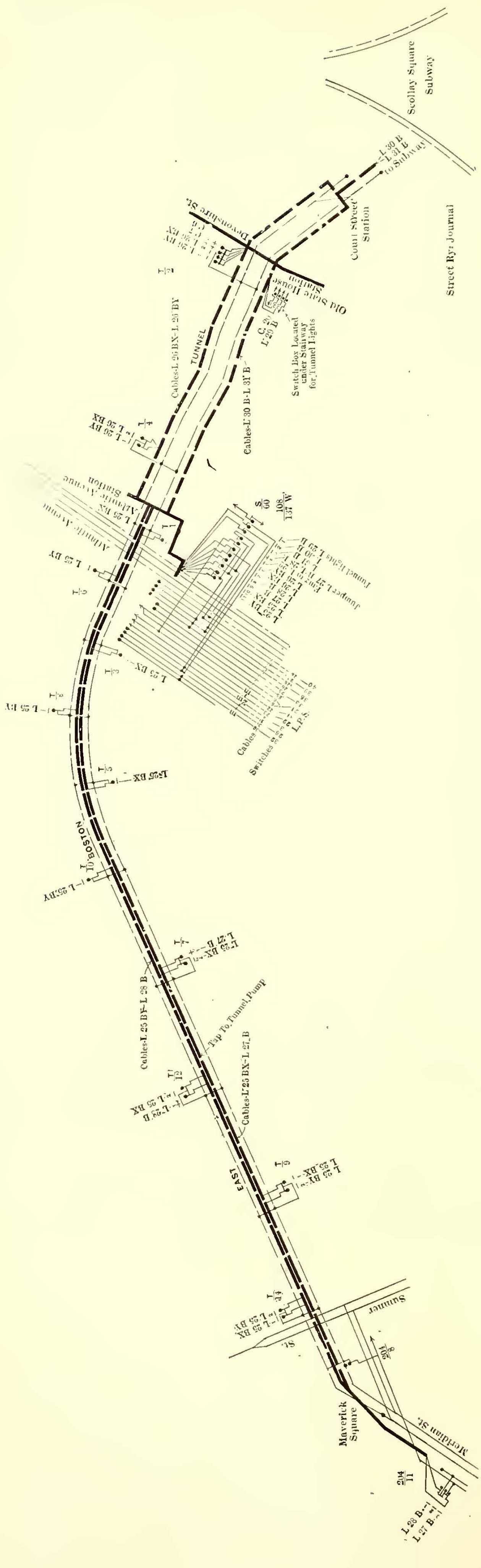


FIG. 5.—PLAN OF FEEDERS IN EAST BOSTON SUBWAY

necting strips of each bond are fastened together in two bunches for the sake of flexibility. No supplementary return circuit is at present installed. The other two service rails are bonded with one 600,000-circ. mil bond.

As soon as possible the tunnel will be equipped with a new alternating-current block signal system, designed by the Union Switch and Signal Company. There will be, according to the present plans, twelve automatic track circuit home signals, with two distant signals working therewith, and four fixed yellow station signals. There is also an interlocking signal at the Court Street crossover (where the westbound cars switch back to the eastbound track), operated by the station master with a push button. The longest block is about 1800 ft. and the shortest 500 ft. in length of track. The signals are so designed as to permit three eastbound cars at the same time on the long grade leading up into Maverick Square, and two westbound cars at the same time on the downward run over the same grade. The first home signal beyond each station platform is located about 100 ft. beyond, so that loaded cars can leave the platform as soon as the passengers are aboard, move down the track to the signal and lose no time in getting under way after the signal clears. The stations are not included in the track circuits, which accounts for the fixed caution signals above mentioned.

Perhaps the most interesting point about the signals is the fact that the running rails are both used for the return power circuit from the cars. On the Elevated division of the company one of the running rails is given up entirely to signal purposes. In the East Boston Tunnel the two rails of the track are divided by insulated joints at each block section. The joints are spanned by a connecting wire attached to the central points of two pairs of differentially wound coils. Each pair of coils bridges across the track, one on each side of the rail-joint, so that the whole arrangement, in diagram form, looks like the letter H, the two sides being perpendicular to the rails and the middle bar, parallel to them. The coils are wound upon iron cores to give a high impedance. Consequently, the trolley return current flows through them with little hindrance, but the alternating current used in the signal circuit is debarred practically as successfully as though there were no electrical connection between the adjacent rails. The current supply for the signal system is to be derived from a 500-volt, 60-cycle alternating circuit, and then transformed to 3 volts for the track circuit. As a duplicate source of supply, a 5-kw motor-generator set will probably be installed at the Atlantic Chambers. The motor-generator capacity is based upon not over 200 watts per block, including the signal lights. When a car enters a block its wheels short circuit an alternating-current track relay in the corresponding signal, closing the circuit through a pair of 4-cp, 50-volt lamps, located behind a red bullseye and lens. The signal remains at danger until the car leaves the block, when the release of the short circuit establishes current in another similar pair of lamps, located behind a green bullseye, the lamps behind the red bullseye going out as the relay armature changes its position. One bullseye is located above the other, in the signal case.

The tunnel is equipped with a ventilating duct, extending from East Boston, under the harbor, to the Atlantic Avenue station. The duct has a cross section of about 38 sq. ft., and it is divided into two portions by a separating wall located midway between the two ends. On each side of the partition there are fourteen openings, each 4 ft. x 1 ft. 5 ins. in area, in the flat portion of the duct, and at intervals of about 550 ft. there are other groups of openings, diminishing in number as they approach the fan chambers. The latter are located at the discharge ends of the ducts. These openings are equipped with doors which can be opened or closed from the tunnel below. They are opened and closed according to the direction and force of the wind outside the tunnel. Fresh air enters the tunnel proper from the East Boston portal and through the station near Atlantic Avenue; it moves through the tunnel to the middle or near it, and is then drawn to the east and west, being finally discharged at the Atlantic Avenue fan chambers and at Lewis Street, East Boston. This duct is about 4335 ft. long. There are six fans, each of the centrifugal type, and driven by 4-15 hp and 2-10 hp, 580 volt direct connected motors from the elevated power circuits. Each fan is capable of exhausting 18,000 cu. ft. of air per minute. The two 10-hp fans are located at India Street, the other four being at East Boston and Atlantic Avenue. The India Street and East Boston fans have vertical shafts and the Atlantic Avenue fans horizontal shafts.

The tunnel is drained into pump-wells located at the lowest point under the harbor. This drainage is then pumped out by an equipment of two 4-in. x 6-in. Goulds triplex plunger pumps, geared to 2-hp, 580-volt direct-current Holtzer-Cabot motors. The pumping plant operates automatically, the motors being controlled by Cutler-Hammer rheostats, and switches operated by floats in the pump well. The pumps each have a capacity of 32 gals. per minute, and they pump the water into the harbor on the East Boston side through a 4-in. discharge pipe, which leaves the tunnel through the East Boston ventilating chamber. The combined efficiency of the pumps and motors is given as 47 per cent, and the pump wells have an emergency storage capacity of 4000 cu. ft. The normal leakage of the tunnel is less than 8 gals. per minute, according to the tenth annual report of the Boston Transit Commission.

The Atlantic Avenue station is to be equipped with four electric elevators, which will run from the platforms to the street level, a vertical rise of about 56 ft., and to a landing about 14 ft. above the street. This landing will be connected with the present State Street elevated station by a bridge. A peculiar feature of these elevators is that they are required to have a horizontal travel of about 6 ft. in travelling this vertical distance of 56 ft. They are to run on curved guides, so that the car floors will be kept level at all times. The maximum speed of the cars is to be about 250 ft. per minute, and each will have a platform area of about 60 sq. ft. and a capacity of forty or fifty passengers.

Summing up the equipment of the East Boston Tunnel, the most striking feature of its design and arrangement is the matter of safety to passengers. At every point precautions have been taken to prevent accidents, failure of the lighting system, stoppage of the power supply, poor ventilation, etc. As the tunnel stands completed it illustrates the best practice of the present day in operating street cars beneath large bodies of water.

Acknowledgements are due to C. S. Sergeant, vice-president of the Boston Elevated Railway Company, and to H. A. Carson, chief engineer of the Boston Transit Commission, for courtesies extended in the preparation of this article.

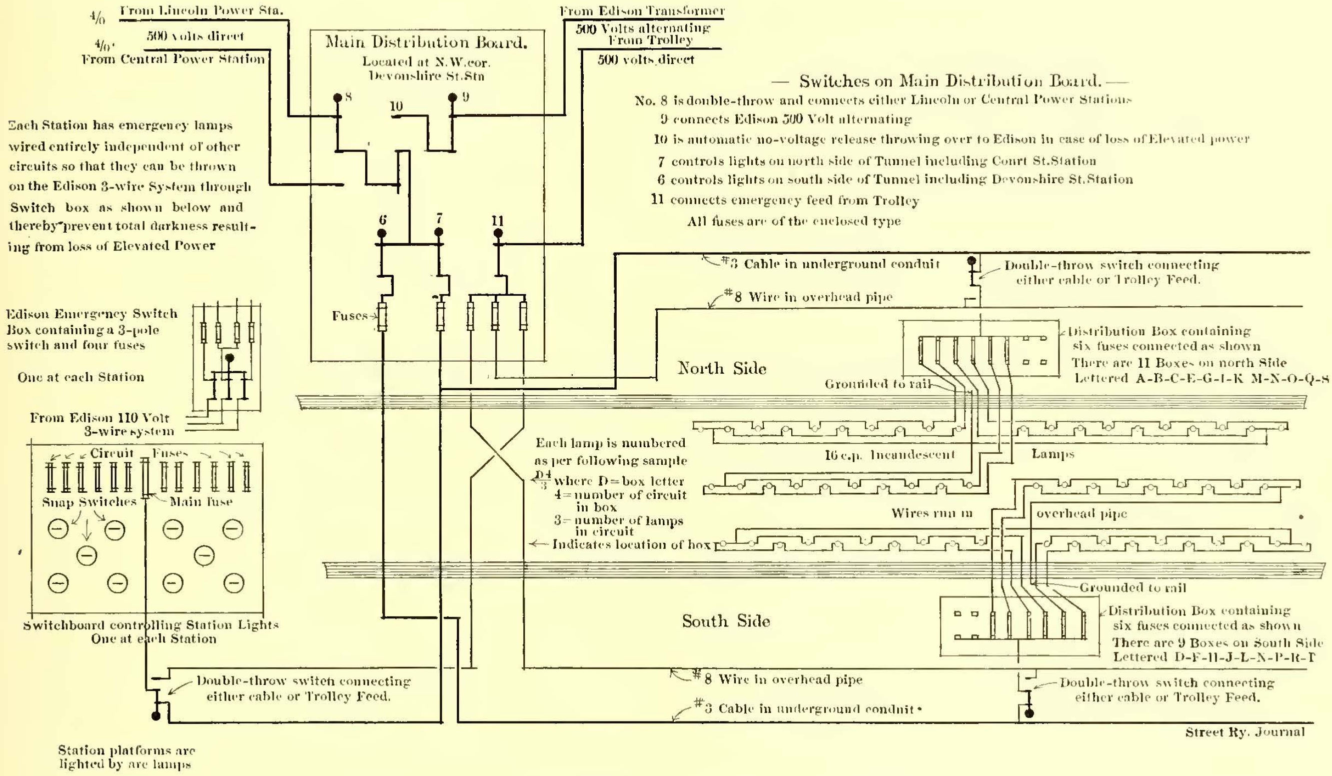


FIG. 6.—DIAGRAM OF LIGHTING SYSTEM OF EAST BOSTON TUNNEL

THE NORTHWESTERN ELECTRICAL ASSOCIATION CONVENTION

The Northwestern Electrical Association held its thirteenth annual convention at the Hotel Pfister, Milwaukee, Jan. 18 and 19. Street railway men were invited to take part in this convention this year, but because of the heavy snowfall over the Northwest many electric railway men were kept at home.

At the opening session President T. F. Grover, of Fond du Lac, general manager of the Eastern Wisconsin Railway & Light Company, referred to the recent decision to enlarge the scope of the association so as to take in the street and interurban railway men, and spoke of the opening of the New York Subway and the advent of the single-phase railway as important steps in the art during the past year.

The only paper on the programme devoted to an electric railway subject was one by Clarence Renshaw, of Pittsburg, on "Single-Phase Railways and Their Possibilities." This paper described the Westinghouse single-phase railway apparatus and auxiliary appliances.

The Long Island Railroad Company, now electrifying some of its lines, has filed for public record plans for an extensive electric repair shop to be located at Morris Park, where its other shops are. The building will be 425 ft. long x 75 ft. wide, and will be of fireproof construction throughout.

DEVELOPMENTS IN ELECTRIC TRACTION*

BY W. B. POTTER

The developments in electric traction are doubtless attracting more attention than any other subject in the electrical, or, indeed, entire engineering world. This is partly due to the many schemes and systems which have been and are being devised by engineers, both in Europe and America. A vast amount of literature has been written concerning these, but it would be wearisome and beyond the scope of this paper to discuss even one-half of the schemes that have been suggested.

The recent advances made in electric traction have made it possible to deal with many classes of traffic which would not have been considered a few years ago; and, although we recognize that there are still many long-distance lines handling a certain description of traffic which is unfavorable to electric haulage, these cases are being reduced each year by the progress of invention, and also by the changes which are taking place in traffic conditions. By this is meant that the passenger service on many lines, which was of a concentrated nature a few years back, is now becoming more distributed, and is, therefore, favorable to the installation of an electric system.

It is impossible to enter into this great question in too detailed a manner; but, broadly speaking, it is probable that, taking into consideration the many different electrical schemes now developed, and being developed, there are few steam railroads which would not find the partial electrification of their lines, and in some cases the entire electrification, a profitable undertaking. To what extent such equipment is justified is rather a financial consideration than one involving technical difficulties. Not only is the amount of capital invested in steam railroad rolling stock a point to be considered, but also the expense of electrical equipment. But at the same time it must be remembered that although electrification involves a greater capital outlay, it is cheaper to operate and maintain, and, what is more important, it is capable of earning a greater percentage of interest on invested capital.

Electric traction is peculiarly adapted to suburban and interurban railways, and the general increase in this class of traffic has been enormous since the inauguration of electric service. The old city limits in vogue when the street railways were operated by horse traction and the suburban lines by steam locomotives are limits no longer. Throughout the entire country we find electrically operated suburban lines, handling a great amount of traffic in a manner profitable to themselves and at the same time opening up new districts to the great advantage of the community at large.

The ultimate profits to be derived from any new traction scheme, whether steam or electric, must, of necessity, depend upon the resulting effect on traffic. This is, in many cases, a more or less unknown quantity when the proposition of electrification is first considered; but both history and experience have proved that in the past, the amount of traffic has increased approximately in proportion to the facilities given the public, and that it is quite possible to create a new traffic, as well as to provide for that already existing. It is the function of a railway not only to deal with the business community, for whom it is imperative to travel, but to give the greater comforts and facilities which will induce people to patronize their lines who would either stay at home or travel by other means if no such improved conditions existed.

For this reason, in considering the electrification of a steam system as a whole, or the electrification of its branch or suburban lines, it is not sufficient to obtain figures showing the likely profits to be derived from such an undertaking merely by compiling data showing the cost of installation and the traffic receipts based upon the number of passengers traveling at that time. A margin may be allowed in favor of electrification, due to the extra traffic that the increased facilities are practically sure to induce. The most profitable method of handling a distributed passenger service is by running many short or long trains, as the case may be, at frequent intervals, whereas with steam locomotives it is the general practice to deal with the traffic with only long trains capable of conveying a comparatively large number of people at one time. I draw your attention to this fact, as it shows very forcibly that in a great number of instances where the traffic is of a concentrated nature at the present time, and therefore considered as unfitted for being handled electrically, were an electric system installed, the traffic would naturally change from the concentrated to the distributed form.

Electricity as a motive power has been considered for traction in many different ways; but, broadly speaking, these may be divided under two main headings—direct-current ("d. c.") and alternating-current ("a. c.") systems. These expressions are somewhat misleading, as, strictly speaking, the term "d. c. system" should be reserved for a system using direct current only, and therefore should not be applied to one employing three-phase generators and transmission lines. However, since the single-phase motor has entered the traction field, it has become common practice to style a system as either d. c. or a. c., according to the type of motors used on the car.

The d. c. system, with a central station feeding numerous rotary converters, through the medium of three-phase high-tension transmission lines, which in turn supply an overhead trolley network with direct current at a pressure of from 550 volts to 600 volts, is without doubt the most highly developed and best known system in this country. The a. c. system may either employ single or three-phase generators and transformers. Both the generators and transformers will be three-phase where three-phase induction motors are used on the cars; and in such cases the line is equipped with two overhead trolley lines and the track rails serve as the third conductor. When single-phase motors are used on the cars, either three-phase or single-phase generators and transformers may be used, the choice being dependent on local conditions.

Three-phase systems have been extensively used in Europe, especially in Switzerland, Italy and Germany. The three-phase induction motor is particularly well adapted for service in which it is desired to control the speed of the car by means of the motors on down grades, either for the purpose of returning energy to the line or as a measure of safety.

A great deal has been written concerning the possibilities of single-phase traction, and, as is often the case with the development of a new principle, many appear to have formed too optimistic ideas of its capabilities. While we recognize the advantage of such a system in many cases, it is a mistake to imagine that it will be a cure for all ills and will revolutionize the railway world. It is well, therefore, to have a clearer idea of the advantages and disadvantages of single-phase traction, and also to analyze the reasons governing the choice of such a system. It is self-evident that the relative expenditure for equipment, operation and maintenance should be the fundamental reason governing the selection of a system for any particular service.

The single-phase a. c. system possesses two features which recommend its use—economy of trolley copper, due to the higher trolley voltages, and the elimination of the rotary converter. The chief advantage gained by these features is a saving in the initial cost of equipment; factors which increase in importance in proportion to the amount of power required by each car or train and with the length of the trolley line. On the other hand, the a. c. car equipments cost more than the d. c. equipments for a similar service and the same given rise in temperature of the motors. It is therefore apparent that the

* A paper presented at a meeting of the New York Railroad Club Jan. 20, 1905.

relative cost of an a. c. or d. c. system will be materially affected by the number of cars employed.

The saving in power resulting from the elimination of the rotaries is about offset by the greater weight and slightly lower efficiency of the a. c. motor.

The efficiency of the a. c. control during acceleration will, generally speaking, be somewhat higher than that of the d. c. system with series parallel control. With the a. c. system fractional voltages can be obtained from the transformer on the car. Each step of the a. c. controller therefore gives a running position which corresponds with the series and parallel positions in a d. c. controller.

The potential of the transmission lines from the power station may be selected, as in the case of the d. c. system, without reference to the trolley or secondary voltage. The trolley voltage must, however, be considered from a different basis than that of the d. c. system, for the reason that, in addition to the ohmic resistance of the trolley and track circuit, there is an apparent increase in resistance, due to the alternating current. This increase in apparent resistance for 25-cycle alternating current, as compared to direct current, is about 50 per cent greater in the trolley wire and between six and seven times greater in the rail return. The rails being steel, the increase in apparent resistance is relatively much greater than in the trolley wire.

As the resistance of the track return with large steel rails is proportionately much less than that of the trolley wire, the apparent increase in resistance for the latter and the track taken together will be, roughly, from one-half to twice that for direct current. An alternating current at 1000 volts is therefore about equivalent to 600 volts direct current so far as affecting the amount of trolley copper, and to secure the advantages of the a. c. system to a reasonable degree at least 3000 volts, or, for heavier service, perhaps 5000 volts must be employed.

The design of an a. c. motor as regards length of air gap and armature speed is affected by the lower average flux density. For this reason an a. c. motor is larger and heavier than a d. c. unit of the same output. The commercial a. c. motor represents a compromise, in which the armature speed is somewhat higher and the air gap slightly less than would be the case in a d. c. motor of corresponding capacity. I have mentioned these facts to indicate that the maintenance of an a. c. motor will, in all probability, be greater than that of an equivalent d. c. motor, due both to the higher armature speed and the smaller air gap.

The equipment of heavy locomotives with a. c. motors for high-speed passenger service is a possibility, but owing to the limitations imposed by the space available for the motors, it seems probable that two locomotives, each with four motors, would be required for service which could be performed by a single d. c. locomotive with four gearless motors. For locomotives in slow-speed work, such as freight or shifting, a double-gear reduction will, in many cases, be required, owing to the difficulty of winding an a. c. motor of large size for slow speeds.

In view of the extensive application of the d. c. system, it is fortunate that the a. c. motor and its control may be so arranged as to be well adapted for operation on either high-potential alternating or 600-volt direct-current lines. This adaptability is an important factor in the net earnings, as the equipments are not necessarily limited at all times to a particular route, and, further, where d. c. trolley lines are available, the expense of installing a special a. c. trolley is saved.

The above comparisons relating to a. c. and d. c. systems indicate certain financial and technical differences which have to be met. There is no question as to the successful operation of a. c. apparatus, and the advisability of its use when such an installation will prove financially advantageous.

The power required per ton-mile for moving trains varies so greatly with conditions of traffic that any direct comparisons between electricity and steam as a motive power can only be made by assuming a given class of service. The suburban type of traffic is generally recognized as being more especially suited to electrification, and a comparison in such service of the steam locomotive and an electrically equipped train of equal seating capacity may be of interest.

It is admitted that the first cost of equipping a railroad electrically is higher than the initial outlay for equipping the same road with steam locomotives; but it is well-nigh impossible to make a general comparative statement as to the relative first cost. This will depend on the number of locomotives required to handle the traffic in the one case, and in the other upon the density of the traffic, and it is the latter factor upon which the size of the generating station and transmission lines are dependent.

For example, assume a suburban train of four cars hauled by a steam locomotive and a similar train operated by electric motors under the cars:

	Tons
Weight of steam locomotive	110
Four cars, 40 tons each	160
Total weight of steam train	270

The electric equipment for these four cars to perform the same service would weigh, approximately, 50 tons.

	Tons
Electric equipment	50
Four cars, 40 tons each	160
Total weight of electric train	210

Tests on a steam locomotive in this class of service have shown, approximately, .07 ihp-hours per ton-mile and a coal consumption of 6.86 lbs. per ihp-hour, charging up the full amount of coal used during the twenty-four hours, whether running or idle. On the above basis, assuming coal at $2.50 per ton, we have the following as cost of coal per train-mile:

Ihp-hours per ton-mile	.07
Ihp-hours per train-mile	18.9
Pounds coal per ihp-hour	6.86
Pounds coal per train-mile	130.
Cost of coal per train-mile	14.5 cents

The cost of electric power per kw-hour is well established by records from many power stations. The following is a typical record from a station in railway service:

Coal ($2.85 per ton)	.00286
Water	.00036
Labor	.00158
Supplies	.00011
Maintenance	.00009
Total	$.00500

As the cost of coal and labor is a variable quantity, we will assume $.006 as a basis. The labor and maintenance of sub-stations may be taken as 10 per cent additional, making a total cost per kw-hour of $.0066. The efficiency of transmission and sub-stations may be taken as 78 per cent. The cost of power for the electric train would therefore be as follows:

Weight of train	210 tons
Watt-hours per ton-mile (equivalent to above .07 ihp-hours)	58
Kw-hours per train-mile at train	12.2
Kw-hours per train-mile at power station	15.6
Power per kw-hour at train	$ .0066
Cost of power per train-mile	10.3 cents

The wages per day for a train crew in steam service may be taken as follows:

Engineer	$3.50
Conductor	3.00
Fireman	2.00
Two train hands	3.50
Total	$12.00

The crew for the electric train will be the same, omitting the fireman. In steam service this crew will make a train mileage of, approximately, 100 miles per day. In an electric service, due to its greater flexibility, it is a reasonable assumption that the crew will make a mileage of 150 miles per day. Under this assumption the wages per train-mile will be:

Steam	12 cents
Electric	6.7 "

The maintenance of steam locomotives varies, but in this class of service 6.5 cents per locomotive-mile seems a fair basis from the records available. The maintenance of the electrical equipment per car-mile on the Manhattan is about $.0025, and as these equipments are larger, we will assume 1 cent per car or 4 cents per train-mile.

A summary of the comparative cost per train-mile is as follows:

	Steam	Electric
Coal or equivalent electric power	14.5	10.3
Water	.5	
Train crew	12.	6.7
Maintenance	6.5	4.
Supplies	.5	.2
	34.0	21.2 cts.

Assuming a yearly mileage of 50,000 miles, which is a reasonable assumption for the electric train, the yearly difference in cost of operation, in favor of electricity, would amount to $6,400, representing an interest on the total investment per train which would be more than sufficient for that usually required for the car equipment and the proportionate part of the power station and transmission. Furthermore, to this capitalized investment should be credited the cost of a steam locomotive equipment capable of making 50,000 miles per year.

As this is a brief consideration of a general example, it is hardly worth while to enter into refinement, but in nearly every case the use of electric power will make it possible to secure many incidental economies, both in utilization of rolling stock and cost of operation, the aggregate of which may be a large item.

The following comparison from statistics covering the steam and electric operation of the Manhattan Elevated shows the increase in traffic and the lower cost of operation per car-mile, resulting from electrical equipment. The probable increase in traffic was not sufficiently recognized, prior to the electrical equipment, as to be reckoned an important factor in the earnings of the road, but its influence to this end will be better appreciated when it is remembered that during the latter period of steam service the number of passengers carried decreased each year.

Date	Steam 1896	Electric 1904
Operating ratio, per cent	58.1	41.2
Passengers carried	185,138,000	286,634,000
Car mileage	43,241,000	61,743,000
Receipts per car-mile, cents	21.6	22.95
Total operating expenses per car-mile	13.2	9.5
Total operating expenses per passenger	2.92	2.04

Careful calculations should be made on each individual road considering electrification, as actual results will vary with every new set of conditions. The point at issue is whether the traffic is, or is likely to be, of such a character that the saving in operation or increased receipts will show a proper return upon the required capital.

In considering the application of electric power to freight service, the subject may be considered more strictly from the standpoint of existing traffic, as the reasons which influence the growth of passenger traffic will apply only in so far as the movement of freight may be facilitated and cheapened. Electric power in a single unit, such as a locomotive, is best suited for general freight, although there may be special cases where it will be advantageous to equip several or all of the cars in a train and control from the leading car.

The following table has been prepared as an illustration of the use of electric locomotives. Three typical freight roads have been selected, the cost of steam locomotives being taken from the actual records, so far as obtainable. The costs of electric operation are being derived from the records of existing electric locomotives, and from a study of the service conditions to which they would be subjected in each particular case. Details of the present operating expenses with steam and the estimated cost of operation of an electrical installation to duplicate the present service are given in parallel columns:

	ROAD A.		ROAD B.		ROAD C.	
	Steam Operation.	Electric Operation.	Steam Operation.	Electric Operation.	Steam Operation.	Electric Operation.
Length of Road	15.4	15.4	34.5	34.5	113	113
Character of Service	Pusher	Pusher	Gen.Frt	Gen.Frt	Ore	Ore
Trains—Daily Number—Total	20	20			44	44
—Average Number Cars	40- 60	40- 60	8- 20	8- 20	30.4	30.4
—Average Weight Trailing Load	275-600	275-600	240-690	240-690	2070-547	2070-547
Locomotives—Weight—Total	145	85	130	90	130	80
—Weight on Drivers	86	85	70	90	80	80
—Number—Total	23	12	43	27	35	20
—Number in Daily Service	18.8	10	39	24	30	18
—Daily Mileage—Regular	455	455	1150	1150	5000	5000
—Daily Mileage—Switching	560	560	450	450		
—Daily Mileage per Locomotive	54.4	102	41	67	160	278
Cost of Coal per Ton	$1.26	$1.26	$1.87	$1.87	$3.25	$3.25
Daily Number 1000 Ton Miles—Gross	288	261	1109	1047	7155	6896
Operating Expense per Engine Mile:						
—Fuel	$0.0852		$0.1620		$0.1665	
—Power		$0.0422		$0.1400		$0.0903
—Engine Crew	.1058	.0651	.1310	.0488	.0620	.0398
—Maintenance and Repair	.0883	.0243	.1010	.0258	.0524	.0250
—Round House and Inspection	.0168		.0339		.0090	
—Oil, Waste and Supplies	.0084	.0014	.0092	.0020	.0038	.0020
—Total	.3045	.1330	.4371	.2166	2937	.1571
—Depreciation	.0518	.0500	.0680	.1265	.0293	.0453
Total per Engine Mile	.3563	.1830	.5051	.3431	.3230	.2024
Operating Exp. per 1000 Ton Miles						
—Fuel	.3030		.2340		.1165	
—Power		.1640		.2150		.0655
—Engine Crew	.3770	.2530	.1895	.0747	.0434	.0285
—Maintenance and Repair	.3140	.0945	.1460	.0396	.0367	.0181
—Round House and Inspection	.0599		.0477		.0063	
—Oil, Waste and Supplies	.0295	.0055	.0133	.0052	.0026	.0015
—Total	1.0834	.5170	.6305	.3345	.2055	.1136
—Depreciation	.1820	.1950	.0985	.1940	.0205	. 0328
Total per 1000 Ton Mile	1.1654	.7120	.7290	.5285	.2260	.1464

In the above table, road "A" uses locomotives for pushers over a heavy grade, and the second column shows the estimated economy which could be obtained by substituting electric locomotives for steam over the short section on which these pushers are operated. Road "B" handles general freight over a section in which a large part of the traffic originates, where the service demands a great proportion of switching and short runs. Road "C" hauls ore over a section with heavy loads in one direction and empty trains in the other.

These results further emphasize that every case demands an intimate study of itself. For example, considering the cost of depreciation per engine-mile under road "A," the cost of depreciation with steam operation is $.0518 per engine-mile, while with electrical operation it is estimated at $.05 per engine-mile. In the other two cases, the cost of depreciation with electric operation is greater than with steam. The reason for this being that on road "A," due to the excessively severe service, the life of steam locomotives is short and their repair and maintenance account very high. At the same time, being a short line, the cost of electric equipment is relatively low. In the other cases the lines are more extensive and the cost of electric equipment is greater proportionally than in the case of road "A."

As with the steam locomotive, the design of the electric locomotive is influenced by the service for which it is to be used. The bogie truck type, following the precedent of the motor car, was the first to come into general use, and it has become a well established type for general service in high-speed haulage, or for yard shifting where there are many curves.

The articulated type is well represented by the locomotives originally supplied to the Baltimore & Ohio Railroad for the Baltimore tunnel. This type is shown diagrammatically in Fig. 1. It is much the same as two coupled locomotives, with the disadvantage of not being two independent units, either of which can be operated or repaired independently of the other.

The rigid frame type, as exemplified in Fig. 2,* is one in which all axles are held square with the frame and parallel to one another. The mechanical design is strong and simple and well adapted for heavy slow-speed haulage. The additional equipments for the Baltimore & Ohio tunnel are of this type. Two of these locomotives, with a total weight of 160 tons on the drivers, are ordinarily coupled together and controlled as a single unit.

The requirements of high-speed passenger service are especially severe, demanding a locomotive of large power and, consequently, of heavy weight, as well as one possessing a reasonably flexible wheel base.

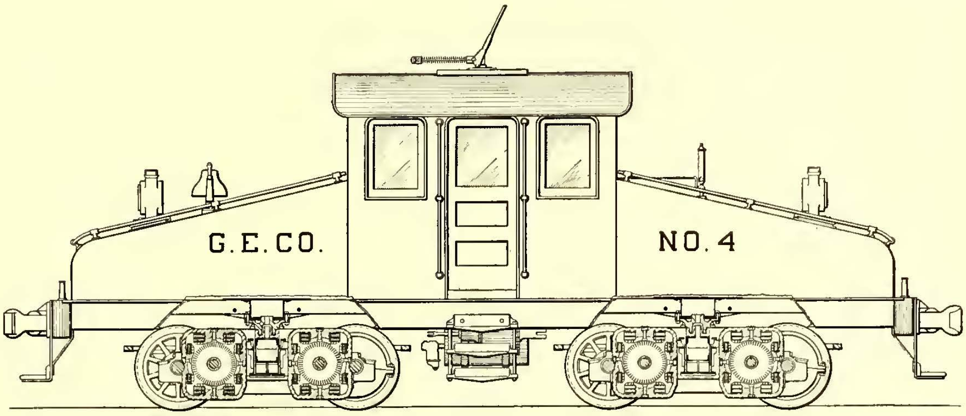


FIG. 1.—SECTIONAL ELEVATION OF ARTICULATED TYPE OF ELECTRIC LOCOMOTIVE

The locomotive recently designed and built by the General Electric Company and the American Locomotive Company for the New York Central Railroad,† is the result of a careful study of many different types. This electric locomotive differs from any that have previously been built, in having a rigid frame for the drivers and pony trucks at each end for guiding. It is also an innovation with respect to the type of motors. The high speed for which the motors were designed made it possible to economically utilize material in the form of bi-polar units. The poles of the motors are provided with flat faces, between which the armature can move in a vertical direction. The commutation of the motors is not affected to any appreciable extent by such a movement, and this arrangement enables the locomotive frame being utilized as the magnetic circuit, as well as permitting all the magnetic material and the field coils being supported on the main springs. The armatures, wheels, axles and journal boxes are the only parts of the motor or locomotive frame which are not borne upon the springs.

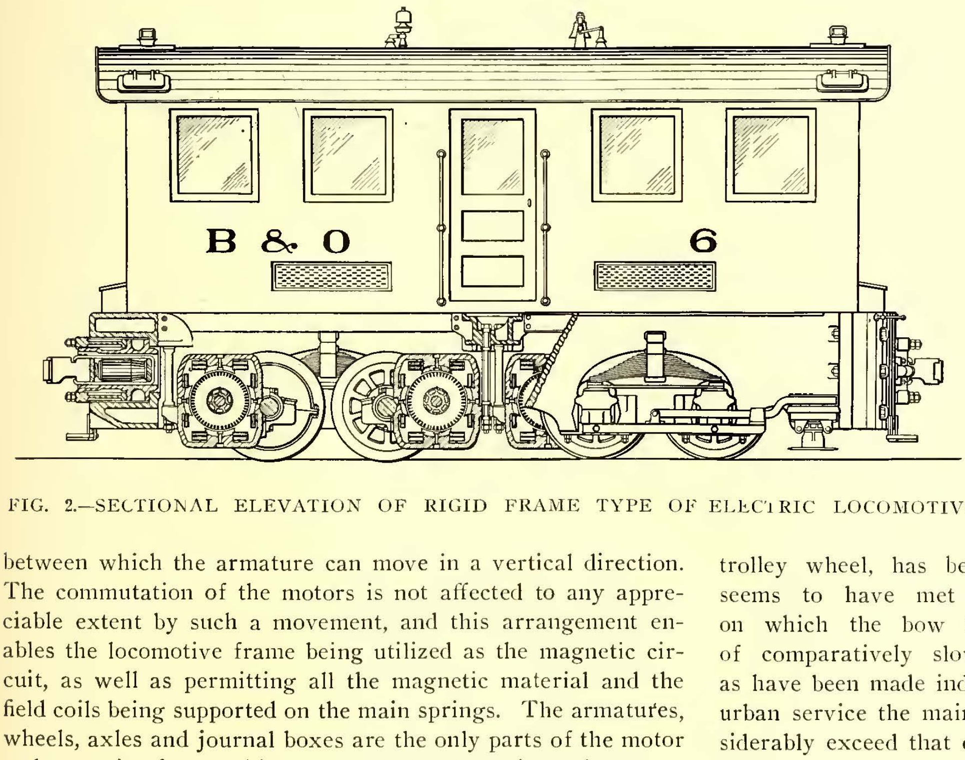


FIG. 2.—SECTIONAL ELEVATION OF RIGID FRAME TYPE OF ELECTRIC LOCOMOTIVE

The air compressor for the New York Central locomotive is a new direct-connected design running at 175 revolutions and with a piston displacement of 75 cu. ft. per minute. This compressor supplies air at 130 lbs., both for blowing the whistle and braking the train. A sectional view is shown in Fig. 3. To economize space and simplify the bearings, the compressor is provided with two motors, which, by reason of the low speed, are connected in series with each other. The air pressure is maintained by a governor, which automatically starts and stops the compressor within a variation of about 10 lbs. pressure.

The method of conveying electric power to a car or train is influenced by the size of equipment and conditions under which it operates. The simple trolley and wheel in general use has been surprisingly satisfactory in service much more severe than that for which the trolley wheel was originally considered. The limitation of its capacity is rather in the life of the wheel than from any particular difficulty in collecting the current. With cars of medium size, at moderate speed, an upward pressure of 15 lbs. or 20 lbs. against the trolley wire is sufficient, and the life of the wheel is frequently 10,000 miles or over. At car speeds of 50 miles to 60 miles an hour, an upward pressure of 35 lbs. to 40 lbs. appears necessary to insure the wheel maintaining close contact with the wire over the irregularities of the suspension. This greater pressure, coupled with the larger amount of current commonly taken at such speeds, results in the rapid wearing of the trolley wheels, which is more especially noticeable on account of the large daily car mileage common to high-speed service.

Considerable attention is being given to the development of a collector for heavy service which will cost less to maintain than the present trolley wheel. The bow form of trolley, in which a sliding bar of copper or aluminum at right angles to the trolley wire replaces the trolley wheel, has been used to some extent abroad and seems to have met with considerable favor. The cars on which the bow trolley has generally been used are of comparatively slow speed and power, and such tests as have been made indicate that in the equivalent of our suburban service the maintenance of the bow trolley would considerably exceed that of the trolley wheel. A modification of the bow trolley, in which a roller replaces the sliding bar, has been used in a number of cases, with excellent results. Where the trolley wire is maintained within a foot or two of uniform height, a reversible trolley contact with a pantagraph mechanism, carrying a roller for contact with the wire, can readily be applied. Where the variation in height of the trolley wire is considerable, on different parts of the same line, the panta-

* See also STREET RAILWAY JOURNAL, Aug. 22, 1903.
† See STREET RAILWAY JOURNAL, Nov. 19, 1904.

graph construction must necessarily be of considerable size. The first electrical equipment of the Brooklyn Bridge was provided with this pantagraph form of trolley, prior to the installation of the third rail. Another instance of the use of this

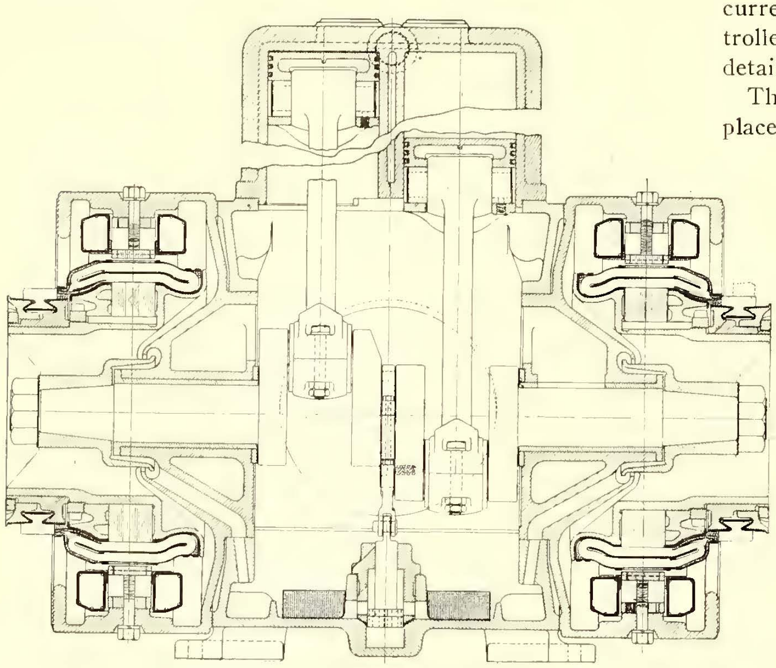


FIG. 3.—SECTION OF MOTOR AIR COMPRESSOR

type of trolley is on the San Francisco, Oakland & San Jose Railway, illustrated in the STREET RAILWAY JOURNAL for Feb. 20, 1904. It is customary to install two pantagraph trolleys, each collecting its share of the current, and where necessary to collect a larger amount, as might be the case in locomotive work, additional trolley contacts may be installed to any extent required. A pantagraph type of trolley, provided with a shoe instead of a roller, is well adapted for use in connection with third-rail operation, where it is desired to make overhead contact through special track work or road crossings where the third rail cannot be conveniently installed. On the New York Central locomotive, this particular contact device is fitted with an air piston to provide a convenient means of depressing the contact shoe.

The ordinary methods of trolley wire suspension and insulation are not well adapted for high potential alternating trolley lines, and what is known as a catenary suspension of the trolley

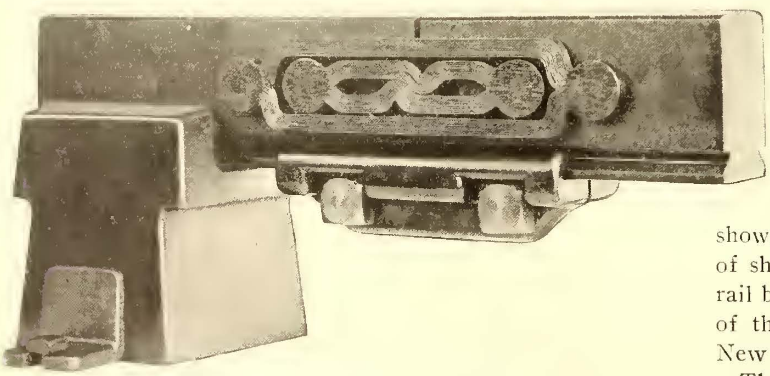


FIG. 5.—PROPOSED FORM OF THIRD RAIL

wire will probably be more generally used. In the catenary suspension, the supporting cable or catenary is carried over the top of high potential insulators at the point of support and the trolley wire is attached by clips and hangers directly to the catenary without intervening insulation. The catenary thus serves as a supplemental conductor to the trolley wire, and it may be of either steel or copper. As the trolley wire is supported at frequent intervals, the poles for the catenary can be spaced at longer distances than common with the ordinary type of trolley construction. While especially advantageous for high potential work, there is no reason why the catenary form of suspension should not be more generally employed for direct-current work, and it provides a means for supporting a larger trolley wire, if desired, than is now commonly used. Several details of the catenary construction are shown in Fig. 4.

The third rail, although used to a considerable extent in place of the trolley, has been criticised, particularly from the standpoint of danger and trouble from sleet. The unprotected rail is open to both these objections, but with a suitable protection against accidental contact and from sleet, these objections are to a great extent overcome. A protection providing these features is in use on the Wilkesbarre & Hazleton Railway, Interborough Subway, and one is under construction for the New York Central.

The location of the third rail, with reference to the track, would seem to be a simple question, but owing to local conditions, nearly every installation has been different. Between clearing the low-pressure cylinders of compound locomotives, the hoppers on the large steel coal cars and keeping within the bridge abutments and tunnels, the location is generally a case of compromise. It will be advantageous to facilitate the interchange of equipments by establishing a uniform location of the third rail, and the importance of such a standard and difficulty of finally determining it will increase with every new installation.

Fig. 5 shows a suggested section of third rail, which has the merit of providing large conductivity with a minimum of height. As the amount of insulation that can be provided is in a measure dependent upon the distance between bottom of the third rail and the tie, a minimum height is for this reason advantageous.

The subdivision of the third rail into sections which will be normally disconnected from the supply circuit and automatically connected when in the immediate vicinity of the car, has many times been proposed. Such an arrangement appears to have little or no advantage, as apart from the complication introduced, the sectional third rail should be protected by a covering to the same degree as an ordinary third rail. Unless the sections are very short, the rail will be energized for some distance beyond the car, and persons getting on or off, or working about the car, would be likely to receive shocks, and more especially so as the rail would ordinarily be considered harmless. Another important reason for protecting the rail is that the cover will form a shield from sleet, which is much more troublesome on a sectional third rail than on the ordinary third rail.

The third-rail contact shoe, which has been quite generally used, depends on gravity for its contact with the rail; therefore, at high speeds with any unevenness on surface of the third rail, this type of shoe shows a disposition to jump and arc excessively. A better form of shoe is one in which the contact is held against the third rail by a spring, this principle being applied to the hinged type of third-rail shoes in use on the Interborough Subway and New York Central locomotive.

The Boston Elevated Railway was originally equipped with gravity shoes, which have been replaced with others provided with a spring, as described in the STREET RAILWAY JOURNAL of Feb. 6, 1904.

The initial expense of electrical equipment, more especially that due to the cost of power station and trolley line, has deterred many steam railroads from electrifying branch lines in sparsely populated districts. Such lines could be served more profitably by independent cars than by steam trains, as the possibility of economically operating single cars on frequent head-way, by providing a better service, would have an important influence upon the development of the traffic.

To meet the requirements of this class of service, a self-propelled car, independent of any feeder system, seems particularly well suited. With this end in view, there have been numerous schemes suggested and tried, some employing steam and others compressed air as a motive power; and again, storage batteries and gasoline engines have been used. Without discussing the relative merits of these different methods, it may be briefly stated that the gasoline engine seems to have the advantage of possessing the greatest power for a given weight, and is also able to cover considerable distances, owing to the concentrated nature of the fuel and the high efficiency of the engine in relatively small sizes.

A number of such equipments are in operation abroad, some being provided with a mechanical transmission to the wheels similar to an automobile, and others having a generator direct connected to the engine, with the electric motors mounted on the trucks in the usual way. For cars of the weight commonly used on steam railroads in this country, and those which have bogie trucks, the gasoline-electric combination seems in many respects the better suited.

The principal difficulty that has been experienced with this type of equipment is the insufficient capacity of the engine; and this is not surprising when we appreciate that the motors of a 40-ton electric car under ordinary service conditions are frequently required to develop 500 hp during acceleration. The building of a successful car of this description is a problem depending entirely upon the engine; and there seems reasonable ground for the belief that an engine well adapted to this class of work can be produced.

The General Electric Company has under construction an equipment of this character which, if successful, should be well adapted to meet the requirements of the class of service under consideration. The engine was purchased abroad. This car is provided with passenger, smoking, toilet and baggage compartments, and is 65 ft. over all. The engine room is at one end, and a motorman's compartment is provided at each end of the car, to permit its being operated in both directions. The car complete will weigh, approximately, 55 tons. A general idea of such an equipment may be obtained from Fig. 6, showing plan and elevation of the car body. This print is partially in section to show the arrangement of engine and generator.

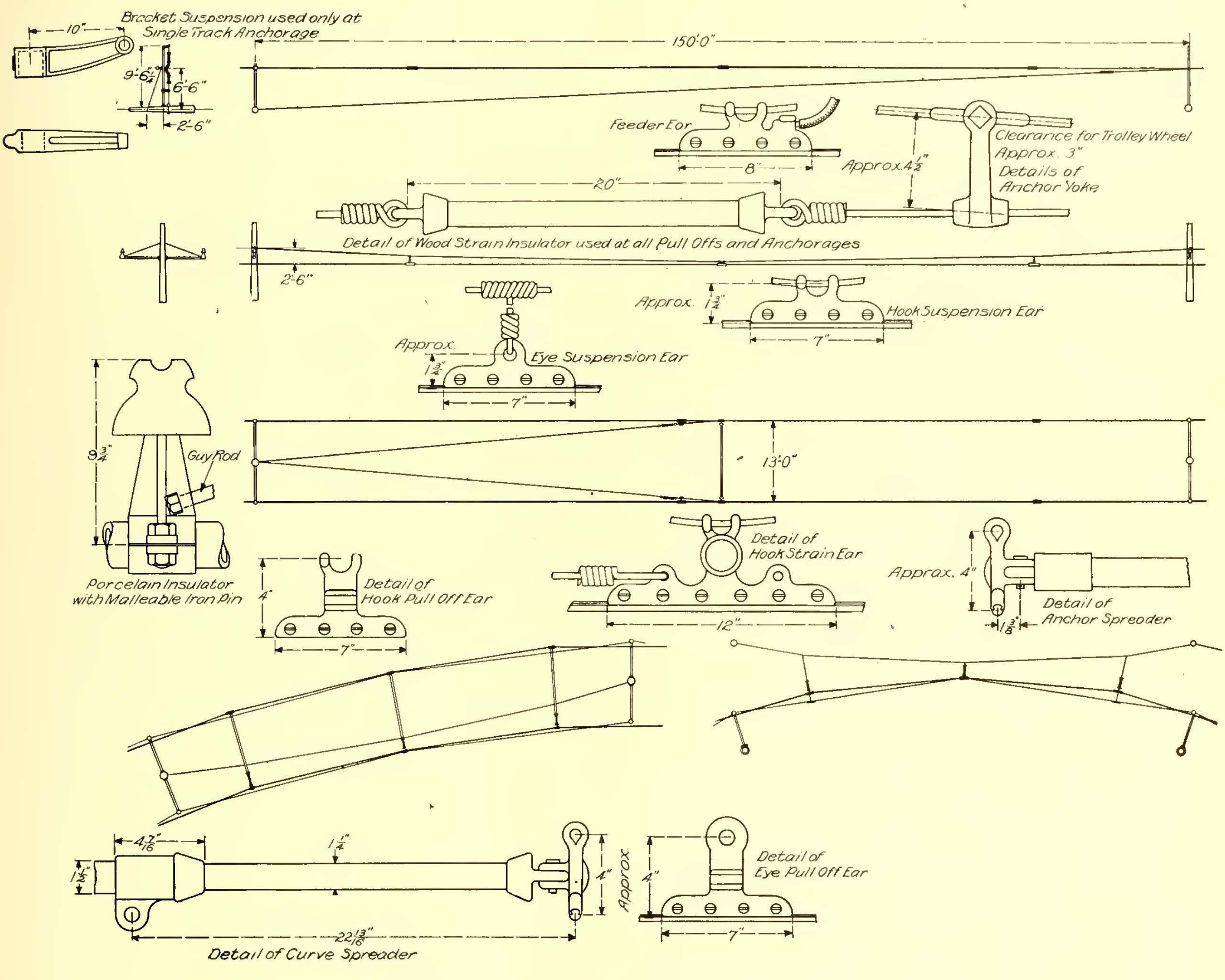


FIG. 4.—DETAILS OF CATENARY CONSTRUCTION

The engine will have a full load output of 200-brake-hp and will run at 600 revolutions. It will be direct connected to a 600-volt generator, the fields of which will be separately excited from an exciter driven by the engine. The controller for the motors will be provided with a series-parallel switch, but no starting resistance, in the usual sense, will be required, as the speed of the motors will be regulated by controlling the voltage of the generator through field resistance points in the controller. The water-cooling system for the engine will be carried through radiators on the top of the car during the summer, and in the winter through the ordinary heater pipes for the purpose of warming the car. An engine of the size proposed will provide for an acceleration sufficient to maintain a schedule speed of 20 m.p.h. to 25 m.p.h. where stops are 3 miles to 4 miles apart and the car can be easily maintained at a running speed of 40 m.p.h. There are no data on which we can accurately base the operating cost of such an equipment, but it seems probable that, including all expenses—of the motorman, conductor, fuel and maintenance—the cost will be between 15 cents to 20 cents per car-mile. This will depend somewhat on the daily mileage made by the conductor and motorman, as their wages amount to a considerable portion of the total expense. Reference has been made to this type of equipment, because considerable interest appears to exist regarding the possibilities in this direction, but what measure of success will be attained can only be determined by a thorough trial. Several different types of engines are under consideration, as is also the use of kerosene as a fuel. The object in view is to produce an equipment comparable in some respects to the all-electric car, and at the same time cheaper to operate than the steam trains, which are usually run over the lines for which an equipment of this type is intended.

Within the limits of this paper, it has been possible to touch only upon a few of the features pertaining to electric traction. The power station and sub-station equipment, the motors and controlling apparatus for the car, and the various automatic protective devices, each bear their due relation to the subject as a whole. The subject of electric traction affords a variety and scope for engineering investigation which makes it exceedingly attractive, and the developments in this direction within the next few years, in connection with the heavier class of service, give promise of being equal in importance to the influence of teh trolley line upon the horse railway.

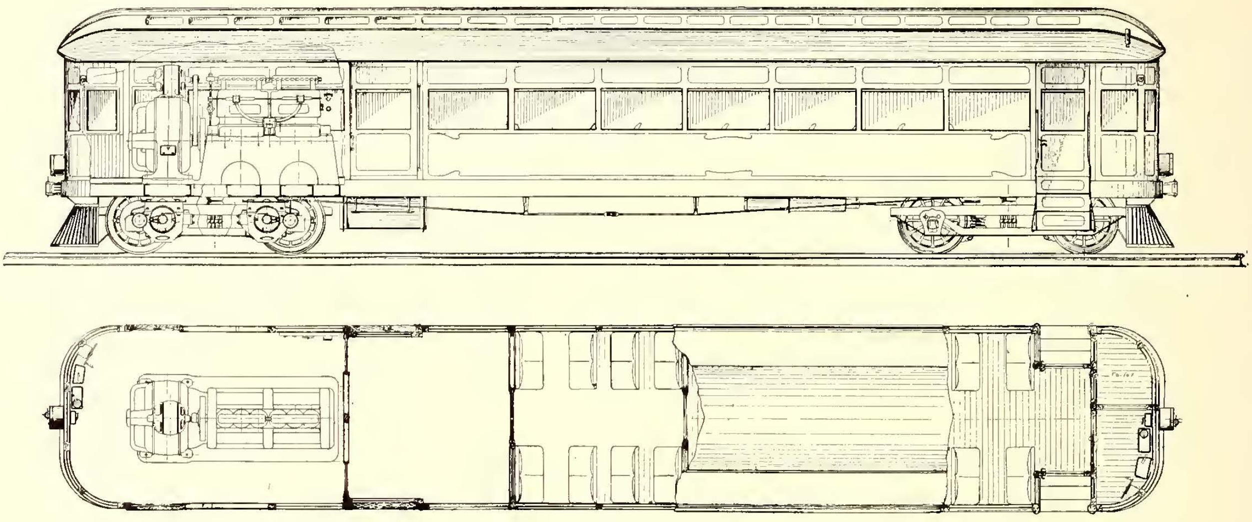


FIG. 6.—GASOLINE-ELECTRIC MOTOR CAR (PROVISIONAL PLAN)

DISCUSSION

After reading his paper, Mr. Potter presented a large number of lantern-slide views, illustrating the principal features of the Schenectady-Ballston single-phase line, described in the Street Railway Journal of Aug. 27, 1904, and gave details of the catenary suspension system, which are shown in Fig. 4. He stated that this system was an ideal one for trolley suspension. The pull-offs and anchorages are second growth hickory which has been subject to a vacuum compound insulating treatment. This consists of introducing into the pores of the wood a mixture of various oils and rosin, which, due to their nature, make it thoroughly impervious to moisture. At the same time they possess the property of not cracking when the wood is subjected to bending strains after the insulation itself has dried. Insulators, after they have been treated in this manner, can withstand practically the same high potential voltage tests as a dry insulator after they have been immersed in water for a period of twenty-four hours. Such insulators are made in 18-in., 20-in. and 30-in. lengths. The 30-in. insulator will stand a high potential test of 50,000 volts. The 20-in. insulator is recommended for 3300-volt trolley wire; these insulators are tested for 5000 volts and will stand a high potential test of 25,000 volts to 35,000 volts. Views were also shown to illustrate the development of the electric freight locomotive, as exemplified in the articulation rigid frame types of the Baltimore & Ohio electric locomotives for tunnel work, Figs. 1 and 2, as was also a large number of views of the New York Central locomotive apparatus and of the Hoffmans, N. Y., section of the New York Central Railroad, on which a large number of elaborate tests have been and are being made. These later views, together with the performance curves presented, will be found in the Street Railway Journal of Nov. 19. The programme of the complete tests to be conducted on the New York Central locomotive was given in detail in the issue of Jan. 21, 1905. Mr. Potter also showed a plan view of the gasoline engine, illustrated in the text of his paper herewith. (See Fig. 6.) This engine is now equipped with a six-cylinder vertical engine, but the company hopes to secure more room in the car by the use of a four-cylinder engine of the same capacity.

After the presentation of the slides, the chairman announced that, owing to the large number of well-known electrical engineers present, he felt that the only thing he could do would be to call them up to participate in the discussion in alphabetical order. For this reason, he requested B. J. Arnold to take the floor. Mr. Arnold, however, retired in favor of W. J. Wilgus, fifth vice-president of the New York Central Railroad.

Mr. Wilgus congratulated the author of the paper of the evening on the very able and comprehensive manner in which he had treated the broad subject of electrification of steam railroads. He felt that there was a growing necessity for making some improvements in steam railroad operation, especially in the suburban service. One point, however, which was often overlooked was that the cost of electrifying a steam railroad was not the principal item of expense. The New York Central had found that the cost of electrifying a suburban division, comprising about 60 miles of four-track line, will be only about one-fourth of the total expenditure necessary to secure the full benefits of electrification. There must be more frequent units; a separation of slow and fast traffic, which means separate express and local tracks, or the increase of two tracks to four and of four tracks to eight in some cases, and the elimination of all grade crossings, as the latter would be absolutely impossible with electric traction. It also means, in the case of the New York Central Railroad, that the platforms of all stations will be raised to the level of the car floor and the reconstruction of many stations, including the Grand Central terminal. The proper way to look at this question is from the standpoint of increase in business, rather than that of decrease in cost of operation. Mr. Wilgus said that in his opinion the value of suburban service had hitherto been ignored by most steam railroads; some have tried to make it so disagreeable to their patrons that it seemed as though they wanted some excuse to give it up entirely. The New York Central felt, however, that this was the wrong principle, for even if it made no money out of its commuter business, electrification would make the territory attractive and bring in a large population, which would result finally in an increased long-haul passenger and freight business. He said that the suburban service of a line like the New York Central was analagous to the wagon delivery service of a department store; each could not be taken by itself, but would have to be studied as to its effect on the other parts of the business.

Another point which Mr. Wilgus said he desired to bring out was the ability of electricity to increase the capacity of the terminals in a way which would be impossible if steam is the motive power. With the latter system in use, only the surface area of the terminal property owned by the company was of value, and extensions in terminal facilities as the railroad traffic grew was almost impossible, owing to the existence of adjoining streets, buildings, etc. The only possible expansion in such cases was either up or down, and this can be accomplished only by electricity. In the case of the New York Central's terminal in New York, electrification meant the reclaiming of about 40 acres of land, allowing the cellar part of the property to be used for railroad purposes, and also giving an enormous increase in the capacity of the terminal. Another great advantage of electricity was the absence of switching. With steam service on suburban lines, locomotives must be cut off and stand idle for hours, flying-switches must be adopted, with a great loss of time standing on sidings, etc. All of this is avoided by the installation of the multiple-unit system in electrical operation, making it possible to handle the traffic on a trunk line to a degree of density approaching that of the New York Subway or Elevated line without the use of twenty to thirty standing tracks. A local advantage would be the increased comfort to passengers when traveling through the Grand Central tunnel. There would also be a great saving in cleaning, as it is necessary at the present time to clean the tunnel about every two weeks. The gases from the steam locomotives are rapidly eating away the iron I-beams overhead, and if steam operation had been continued, this would have meant the early renewal of that feature of the tunnel at an enormous expense. The absence of engine houses in the terminal, with their accompanying scores of smoky locomotives, ash pits, water plugs, etc., will also avoid much annoyance and give valuable space for other purposes.

The president then introduced Frank J. Sprague as the father of the electrical development of railways. Mr. Sprague commended Mr. Potter upon his paper, and especially upon the note of conservatism with regard to the claims made for alternating-current apparatus and operation. He thought that with regard to trunk lines, concerning which he had made numerous statements during the past fifteen years, Mr. Potter was over-optimistic, for in his comparisons he had neglected sundry vital elements, such as capital account and up-keep of the transmission and trolley systems. He had been accused by some of his enthusiastic associates as being over-conservative. They expressed surprise that having—justly or otherwise—been classed in the past as one having confidence, even to the extent of possible rashness, in electric railway development, he should now be found occupying a critical attitude. He saw no reason to change his past views on this subject because of that natural enthusiasm which has greeted every new and important development in electrical science. With regard to the New York Central work—to which, important as it was, some undue significance might be attached—he wished to congratulate the General Electric Company and its engineers on a daring departure in electric motor and locomotive construction, one which promised marked success. This was all the more gratifying in view of the fact that when first proposed, with but limited motor tests, the commission as well as the company had to take something of professional risk. Considering the general subject as practical railroad officials and engineers, he said: "The vital question is not now whether all tramways and suburban or interurban roads be operated electrically, or whether electricity shall be installed for trunk line terminals and for special purposes, as in the cases of the Baltimore & Ohio tunnel and the New York Central and Pennsylvania Railroads, but the broad one—will trunk lines be operated electrically?" This was not a problem alone of high or low potential on the trolley line, or of the use of a. c. or d. c. current in the motors. It was essentially a financial problem affected, of course, largely by these elements.

It has been said that a road of considerable length could not be operated on a moderate rail potential of 650 volts. In answer to this he wished to make two axiomatic statements, as follows: "Any line, so far as physical handling of traffic and reasonable cost were concerned, could be operated on the working potentials common to-day, provided there was sufficient density of traffic, and on the other hand, no matter to what trolley potential one might go, and no matter how perfect the motor, there were conditions which were prohibitive of electric operation." This dependence of successful operation upon the element of density was one which he had frequently emphasized, and its meaning should be fully realized. It had been suggested that a high load factor was important, which was undoubtedly true, but considered alone it was of little moment, as on straight-away running on a long line a single equipment could give a very high load factor and yet electric equipment be out of all serious consideration. The fact was that a number of units between terminals, with a fair distribution of load as well as a good load factor, ordinarily contributed the elements necessary for really successful commercial operation. Every road presented a special problem, and the wisdom of adopting electricity could only be determined by a most careful analysis of all conditions.

He was as keenly alive to the economic advantages of higher potentials as the most ardent advocate of the alternating-current motor, and just as friendly to that piece of apparatus, but it would not materially advance electric railway progress to shut one's eyes to the failure of claims made in the past and certain facts as to present apparatus. This might be illustrated by reference to the attitude once assumed toward the commutator of the d. c. motor and the wonderful predictions made for the commutatorless polyphase motor—all of which was of no present effect when it is realized that in developments as indicated to-day the best designers have gone back to the series motor with a commutator, adapting it by special construction to single-phase a. c. operation, although it is complicated somewhat by the transformer action which takes place in it. The ease with which the alternating current makes possible economical transmission of large amounts of power over long distances, and the marvelous simplicity of transformation from one pressure and volume to another, higher or lower, give this system certain inherent advantages over continuous current transmission which are undisputed, but it is to be remembered that on the initial transmission to and through the static transformers at the sub-stations, which, although varying in number, must be an element in any large railway system, and are, in fact, local stations distributing currents of lower potential to sections of the railroad, this advantage and condition as to initial transmission remains unchanged, no matter what the pressure used on the trolley supply or what the type of motor.

The object then in a. c. development is to eliminate the cost and losses of the moving element—the rotary converter—from sub-stations; to separate the latter by greater distances, thus reducing their number and increasing the average load on each, and to lower the cost of the secondary or trolley system for unit distance and capacity. Elimination of moving parts at the sub-station was, of course, desirable, but that did not necessarily mean doing away with attendance. Moreover, inasmuch as a. c. motor equipments are heavier and more costly than d. c., much of the saving of the cost of rotaries on a large system would be offset. This increased weight of car equipment would also affect the size of the trolley line with any given potential.

Referring to the question of trolley potentials, comparison between the a. c. and d. c. trolley supply must be carefully made. Mr. Potter had clearly shown that because of the increased losses on any kind of conductor or rail when using a. c. instead of d. c. current of given volume, with like losses at fixed distances and amounts of energy, the relative average potentials of the a. c. and d. c. currents would be about in the proportion of 5 to 3, and when the maximum potentials are considered the proportion would be about 7 to 3. Therefore, to get materially increased distances between sub-stations, the trolley potentials for a. c. operation must be pretty high. In this connection it must also be remembered that, unlike fixed transmissions, the load on a railway must generally be assumed to vary as the unit distance, so that, considering a. c. and d. c. trolley supplies independently, the distance between sub-stations with given unit load and unit investment in trolley lines would only vary directly as the increase of potential, the relation between maximum potentials under like distances and loads being as already indicated, about in the proportion of 7 to 3. It was the speaker's opinion that dealing with larger railway propositions the ordinary practice by no means indicated the limit of operative d. c. potentials, as should be evident from theoretical considerations as well as practical demonstrations already made. But eliminating for the moment the question of danger, the developments possible by the successful use of very high trolley potentials were such that all progress in this direction was to be heartily welcomed, especially on single-phase lines, as the polyphase motor did not, in his opinion, offer any promise of meeting the conditions of general railway operation.

The next speaker was B. G. Lamme, chief engineer of the Westinghouse Electric & Manufacturing Company. He said that while during the last few years there had been a great increase in the size of electrical units and in voltage, the railway motor had gone up in voltage from 500 volts to only about 650 volts. The problem of heavy railway work had hardly been touched. Instead of increasing the voltage of the motor, the development had been in the direction of increasing the current, and the necessity of collecting heavy currents had finally resulted in the adoption of the third rail. But he felt the third rail could not be considered a general solution. In a freight yard, for instance, the third-rail system for many tracks would not be very satisfactory. Any system which would permit a high enough voltage would allow keeping the satisfactory feature of the overhead construction. For general service, with many tracks, it looks as if we must go to higher voltage overhead construction. There is a limit to the direct-current voltage which is allowable, but with alternating current we can use any desired voltage. Assuming the use of alternating current, we must next choose between polyphase and single-phase; as the polyphase system with its two overhead wires would be impracticable for freight yards, our choice narrows down to the single overhead wire of the single-phase system. Single-phase current can be utilized in two ways—by a motor-generator on the car or by transformers and motors. In either system the voltage at the car motors is independent of the voltage of the trolley. The voltage of the trolley is limited only by the insulation used; 10,000 volts transmission has already been used, and 18,000 volts on the trolley is now being planned. At the present time his company is building a 1500-hp freight locomotive, which is to run on 6000 volts single-phase. The equipment is to operate at 10 m.p.h. normal speed, using single-reduction motors. The building of a higher speed passenger service locomotive would be much easier. The catenary form of trolley construction appears to be an ideal one for this service, and could be applied with great advantage to heavy railway service, and also to freight yards. The advantage of this system over that using the motor-generator set is its greater flexibility; the motor-generator set might be all right for heavy service where heavy currents are required, but would not be so suitable on the branch lines requiring less power. The pure single-phase system for locomotives is the best, as the voltage can be adjusted at three places —at the power house, sub-station or on the car. We can use one voltage in the yard, another in the suburban limits and another on the outside lines. The consumption of power is directly proportional to the work done, which is not true with the d. c. system, owing to the rheostatic method of control. The speed may be varied by transformer action without breaking contacts, such as is usual in ordinary direct-current control.

Following Mr. Lamme, Bion J. Arnold took the floor. He said that Mr. Potter had made a very fair statement of the case, and he felt gratified to hear him say that the a. c. motor is now a success, as it was the first time the General Electric Company had gone on record to that effect. He said that, although other single-phase systems might be better than his own, he believed that his early stand in favor of the single-phase system had borne fruit. Mr. Potter, he said, had mentioned only one form of single-phase traction, although that form, he believed, would also take in the Westinghouse type, namely, a series a. c. motor. He then called attention to some features of the motor-generator method advocated by Ward Leonard. He was against the third rail personally, but felt that its use so far had been necessary on account of certain conditions. Ultimately he believed that the steam railroads will all become electrified. He did not claim that electricity was cheaper, and said that not one road in a thousand in the United States could be equipped with the direct current commercially; but there are a great many on which a high-potential alternating-current system could be installed, and the railways eventually will be equipped therewith. He believed that a beginning would be made in a manner somewhat like the following: Some steam road having a sufficient density of traffic between two large cities will be equipped electrically. That road, on account of the liking of the public for electric travel, will get the bulk of the passenger traffic, and consequently the neighboring lines must soon follow. Having their passenger service handled electrically, it will not take long before the freight will be similarly taken care of, especially as fuel becomes dearer.

The next speaker, George Gibbs, consulting engineer of the Interborough Rapid Transit Company and electrical engineer of the Long Island Railroad, stated that he had but one point to emphasize, and this was in connection with third-rail and trolley-contact clearances, especially in reference to the necessity of meeting a great variety of conditions with a continuous electrical conductor located along the railway line. He instanced the case of the Long Island electrification, where trains travel underground, on an elevated road, and on the surface across country; also with through running possibilities with city elevated roads and subways. It would seem, under these conditions, that the overhead contact for low-tension d. c. transmission was almost impracticable; and, under certain conditions, positively dangerous where the roofs of cars ran within from 4 ins. to 6 ins. of the subway roof. Under this latter condition a collision or derailment would almost certainly bring the light roof of the car into contact with the charged overhead conductor. He stated that some three years ago he had written to the executive committee of the Master Car Builders' Association calling their attention to the necessity of establishing some standard clearance lines for car equipment, which would put a limit on the encroachment of steel hopper cars and other special cars on the clearances at and near the track level. He suggested that 27 ins. between the gage line of track rail and middle of the third rail was about the limit for a practical gaging of the third-rail contact. He stated that if car equipment continued to encroach on clearances that this distance for third rail would soon become impracticable. His suggestion to appoint a committee to establish car clearances was evidently misunderstood, as it resulted only in a committee to establish the "standard position of the third rail;" this subject was manifestly not within the province of the Master Car Builders' Association, whereas that of establishing maximum car dimensions was. As a result of this misunderstanding nothing was accomplished and the matter is in the same unsatisfactory condition as heretofore. He said he hoped that the railway members of the club would agitate this question anew in order to bring it to some practical conclusion.

J. G. White being called upon, made a few remarks to the effect that the problem of electrification was largely one of dollars and cents. Incidentally, he said that the ordinary bow trolley, which is so extensively used on the continent of Europe for ordinary city roads, had proved unsuitable in its present form for high-speed work, as shown by the experience of his company in the initial operation of the Amsterdam-Haarlem Tramways, described in the STREET RAILWAY JOURNAL of Jan. 7. It had been found necessary to make some important changes in the construction of the usual type to meet high-speed conditions, principally because the bows had worn out very rapidly.

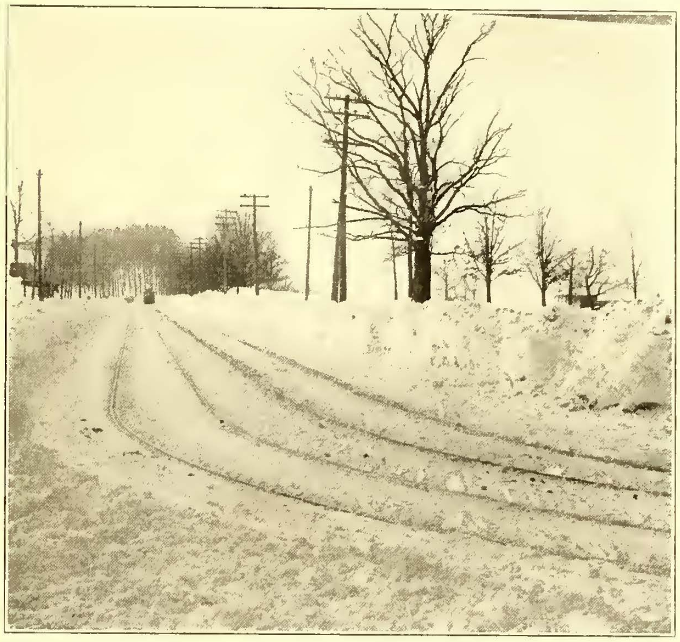
Mr. Potter was asked to make the concluding address, and in referring to the remarks of the preceding speaker said that his reports about the bow trolleys were in confirmation of Mr. White's experience. He thought that the pantagraph trolley, described in his paper, was very suitable for collecting large currents, besides being adjustable for changes in level. He agreed with Mr. Gibbs in the importance of fixing upon a standard clearance for the third rail, and said that if this matter were not attended to soon the problem would become one increasing in difficulty with every additional installation.

SNOW REMOVAL IN SYRACUSE

BY E. G. CONNETTE

The Syracuse Rapid Transit Railway Company has 72.39 miles of track which cover 47.63 miles of streets. The equipment for keeping the tracks clear of snow consists of two snow sweepers, five shear plows, four "A" or nose plows and one plow built in the company's shops, which has a very long wing, and is used particularly to push the snow back a sufficient distance from the rails on paved streets to allow driving on both sides of the tracks without interfering with the movement of the cars.

The removal of snow is under the direct supervision of the superintendent. The system is divided into four divisions, and each division is in charge of an assistant, who receives his instructions from the superintendent. The equipment for the removal of snow is apportioned among the different divisions to the best advantage, and the assistant in charge of each division directs the movement of the plows and sweepers on his respective division. The names of about thirty of the best and most experienced motormen are kept posted in the car houses, and as far as possible they are selected from men who live in the vicinity of the car house so that they can report for duty on short notice. If a snow storm commences during the day, extra men are sent to take the places of the regular men on the cars, who are ordered to report to the car houses as quickly as possible for duty on the plows and sweepers. If a snow storm commences at night the men are called when needed.

WINTER VIEWS IN SYRACUSE, SHOWING METHOD OF PILING SNOW AT SIDE OF STREET

Three men are required to operate the snow sweeper, one man to operate the sweeper and brooms, one man to take care of the trolley, and one to watch horses en route that may be frightened by the action of the brooms. Four men are required to operate the shear plows, and the large type "A" or nose plows require five or six men, on account of the heavy wings, which have to be changed at intervals.

During last winter we were fortunate in securing the service of a large number of outside men, who were not regularly employed by the company, but who would report at the car houses when a snow storm began, or who left their addresses and could be sent for when needed. This saved the necessity of using extra motormen and conductors for this work.

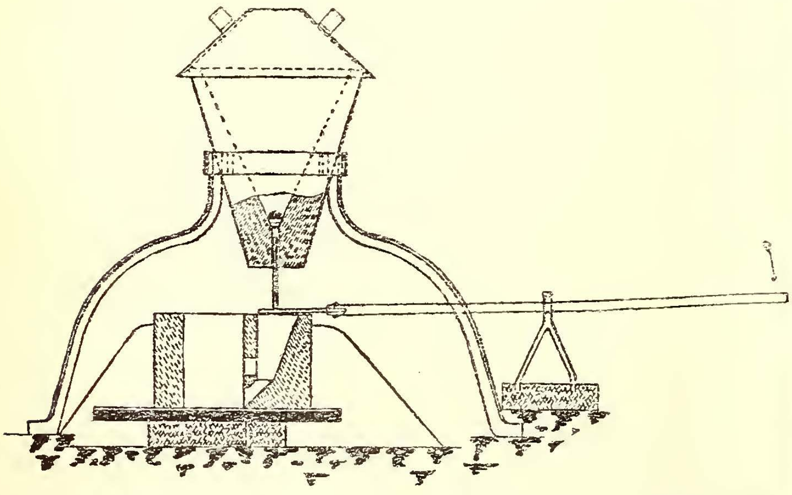
During the last winter some of the snow equipment was in service nearly every day from Nov. 20 up to and including April 20. Total cost for the removal of snow and ice during the past winter was $8,189.60. The total car-miles for fiscal year ending June 30 were 3,869,887, making the cost per car-mile for the removal of snow and ice .0021 cents.

Notwithstanding the heavy fall of snow during the last winter, there was not a single day during the entire time that we did not operate all of our lines. This winter, at points where we have experienced considerable trouble with drifting snow, snow fences of the standard type used by the New York Central & Hudson River Railroad Company have been erected. Fortunately, we have had very little snow and ice to handle during the present winter. The track scrapers on the cars have taken care of the snow so far this winter, and I may add that the track scrapers are capable of keeping the tracks clear in a snowfall of 4 ins. to 5 ins.

THERMIT RAIL-WELDING AT HARTFORD, CONN.

The Hartford Street Railway Company has been doing considerable work with the Goldschmidt thermit rail-welding process, and in view of the general attention that this process is attracting in America, a statement of the results secured in that city will be of interest.

The thermit process has been described in the columns of the STREET RAILWAY JOURNAL. It will be remembered that it is a purely chemical operation, based upon the fact that metallic aluminum, under proper conditions, will reduce many of the other metals from their compounds to their simple form; as, for instance, if aluminum is mixed with oxide of iron and the mixture is ignited, the aluminum will unite with the oxygen of the oxide, forming aluminum oxide (which is commercial corundum), leaving the iron free. As the process of reduction liberates a great amount of heat, the temperature of the mixture during the reaction rises rapidly (to about 5000 degs. F.), changing the iron to a molten low-carbon steel. Expressed in chemical terms, the equation, according to which the reaction takes place, would be $Fe_2O_3 + 2AL = AL_2O_3 + 2Fe$. This is the process utilized in welding rails. The oxide of iron is mixed with powdered aluminum in the right proportion, and introduced into a crucible lined with magnesia, or with material obtained from a previous fusion. Ordinarily, the mixture would be very hard to ignite, as it can be thrown into an ordinary fire, and even upon molten cast iron, without burning. In order to set off the contents of the crucible, a small quantity



CROSS-SECTION THROUGH CRUCIBLE, SHOWING METHOD OF DISLODGING PIN TO MAKE THE POUR

of ignition powder (barium peroxide and pulverized aluminum) is put in a small heap on top of the mixture, and is ignited by means of a match or red-hot iron rod. The reaction propagates itself quickly through the whole mixture, with the result that in a few seconds the whole charge is a mass of white-hot fluid material. The contents of the crucible have separated into two layers, the molten metal reduced by the aluminum being at the bottom and the molten aluminum oxide above it. The reaction takes place very quickly and, although the heat of the mass is intense, there is no explosive effect, as the product is not a gas, and the whole energy of the reaction is preserved as it were in the crucible, the operation being attended only with a violent bubbling or boiling of the mixture.

In the application to rail-welding, the cone-shaped crucible, with its magnesite lining, is mounted on a tripod over the joint to be welded, a properly prepared iron sand clay mold having been previously clamped around the joint. The conical crucible has a hole in the bottom, and, before the operation, a small iron rod or pin is placed in this hole, with its end projecting several inches below the crucible. Above the head of the pin in the bottom of the crucible is first carefully fitted an asbestos washer, and on top of this is placed a solid circular metal washer to hold it in place. About 15 lbs. or 20 lbs. of powdered aluminum and oxide iron are then poured into the crucible. This mixture is known as "Thermit," and is furnished properly mixed and ready for use in small bags by the manufacturers. On top of the mixture is placed a quantity of ignition powder, about enough to cover a 50-cent piece. When all is ready, a match is applied to the powder and a conical cover with a central opening is hastily placed on the crucible. In a few seconds the reaction commences, and within thirty seconds the contents of the crucible become a seething, boiling mass of molten metal. As soon as the reaction has reached its height, a man strikes the pin projecting from the bottom of the crucible with a rod or small shovel, driving the pin upward, thus freeing the hole and

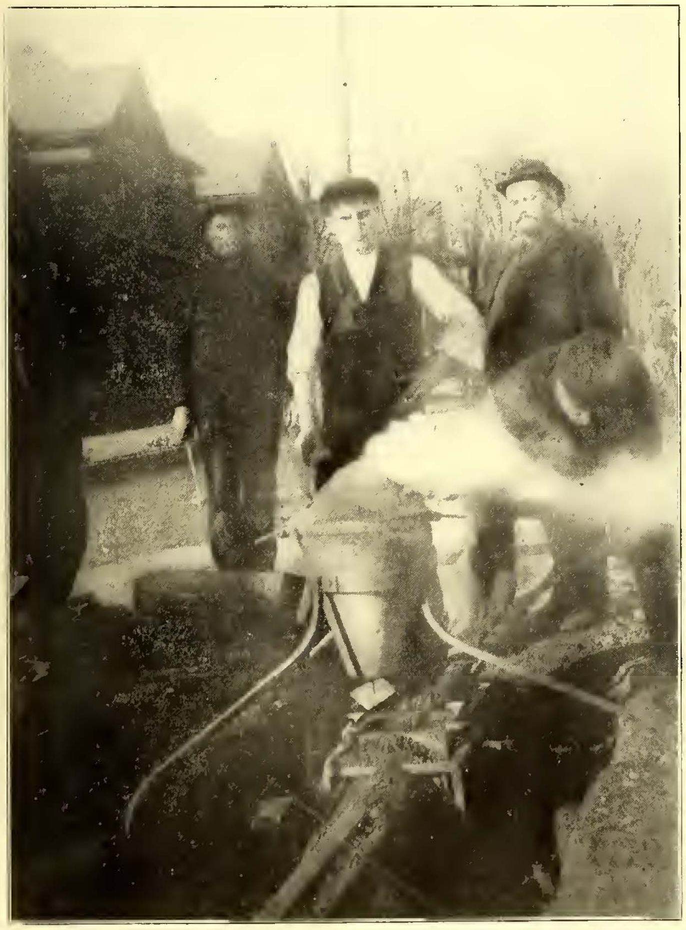
CRUCIBLE AND MOULD IN PLACE READY TO MAKE WELD

allowing the molten metal to flow down into the mold around the joint, depositing a mass of metal around the joint and welding the ends of the rails into a continuous rail.

The Hartford Street Railway Company has just completed the welding of 162 joints by the thermit process. The work was done on the Wethersfield Avenue line, which is laid with 6-in. girder rail in 30-ft. lengths on standard wooden ties placed 2 ft. c. to c. The street along this stretch of track is paved with macadam. The track has been in use for several years, and the joints were low in many places.

In preparing for the welding work, the paving was first dug up around each joint. The end of the tie immediately under the joint was then cut off for about 2 ft., leaving the joint entirely free. The rails for a short distance from the ends were next cleaned with a wire brush. It is not necessary to thoroughly scour the rails, as the presence of oxide or rust on the surface of the rails does not interfere in any way with the making of the weld. The idea is merely to remove the loose dirt in order to get good contact with the metal. The welding work was carried on during very cold weather, so, of course, the rails were found very open at the joints. Where the space between rail ends was more than 1/8 in., a steel shim was driven down between the ends of the rail to give close fit.

The molds were then clamped on around the joints. As furnished by the manufacturers, these molds were made of sheet iron and angle iron, and cost in the neighborhood of $2.50 each. Mr. Tregoning, engineer for the Hartford Street Railway Company, to whom the work of overseeing the welding was entrusted, conceived the idea, however, that these mold boxes could just as well be made of cast iron. He conferred with the engineers of the Thermit Company, and it was finally decided to try cast iron. The results were entirely satisfactory, and the work was carried on with the use of cast-iron boxes, which were made at a local foundry at a cost of $1.05 each, as against $2.50 for the sheet iron. Another interesting departure was made in the grade of filling used in the molds. The company first tried a mixture of half clay and half sand, or practically a brick clay. This was expensive, and it was hard to prepare, as the clay had to be broken up, tempered with water and then screened while damp. Mr. Tregoning finally came to the conclusion that this filling was an unnecessary expense, and he made experiments with ordinary foundry dry sand as filling for the molds. This was easily obtained from local foundries at insignificant expense and gave perfect results. Straight dry sand was used without blacking or other ingredients.



THE FIRST STEP IN THE REACTION, GETTING READY TO DRIVE PIN UP AND MAKE POUR

The molds used are open sand molds, made up, of course, to fit the section of rail to be welded. They were prepared at a local foundry at a cost of 50 cents for each pouring. The molten metal flows from the bottom of the crucible into a cup or lip on the mold, and then flows down one side of the rail, under the foot of the rail, and up the other side. It was found that better results were secured if the ends of the rails were heated by means of a blow-torch just before the weld was made. If the rails are cold, the molten metal, when it strikes the cold surface of the rail, will sputter badly and the weld is apt to be porous. The warmer the rails the quieter will be the flow of the metal.

DURING THE POUR, SHOWING THE MOLTED METAL FLOWING INTO MOULD

In other American cities where experiments have been made with the thermit process, it has been reported that some trouble was experienced, due to the fact that the molten metal spattered and burned the rail. It is therefore of interest to know how this trouble was overcome at Hartford. By thoroughly heating the rail before the pour, much of this trouble was avoided, and it was also found that if the crucible was placed on the ball side of the rail, as far away from the rail as possible, the danger of the hot metal splashing on the rail was greatly reduced.

Another difficulty reported from other cities was the occasional premature pouring of the contents of the crucible before the reaction had reached the proper stage. A little trouble was experienced from this source at Hartford in the first work done, but it was soon overcome. Mr. Tregoning discovered that the premature pour was usually due to the fact that the washers covering the hole at the bottom of the crucible did not fit properly and were apt to slip and let the metal through before the pin was struck. He found that the magnesite lining in the crucible, after successive pourings, wore away at the bottom and did not provide a good seat for the washers. One lining will give from twelve to fifteen reactions or pourings, and must then be renewed, but after the third or fourth pouring, the lining, which at the bottom should be funnel-shape, wears away from the continuous cone contour and a ridge develops where the asbestos washer rests. This gives a square seat for the washer, whereas it must have a jam fit in order to hold back the mass of molten metal as it should. The trouble was easily remedied by cleaning out the lining with an iron rod after each pour, and by taking care to see that the asbestos washer had a tight jam fit before the new charge was put in the crucible. The best results were secured when the washer was carefully tamped all the way around with the fingers and pushed down tightly into the tapering opening through the lining, so that the weight of metal from above only served to drive it tighter. There is no danger of getting the washer too tightly placed, as it can always be dislodged easily by driving the pin upward with a sharp blow.

The mold can be removed from the joint after about ten minutes. As soon as the weld was cold, the end of the tie that had been cut off was replaced under the joint and the paving put back and tamped around the rail. After a short time it was almost impossible to find where the joints were, so thoroughly were the ends of the rail welded together.

In doing the work at Hartford, a slip joint was left in the rail about every thousand feet to take care of expansion and contraction. The slip joint consists of a joint left unwelded, with the fish-plates hot riveted to the rail, and the ends of each plate bonded to the rail.

Briefly summarized, the results secured at Hartford were as follows:

Of the 162 joints welded, six, or 3.7 per cent, were spoiled in the pouring, due largely to the breaking in of laborers who were not familiar with the work. Of the six defective joints, five were repoured, the sixth being left as a slip joint.

Of the total number, only two joints pulled apart by contraction after having been in the ground several days, during a particularly severe cold snap. In both cases the rail broke through a bolt hole. These were the only instances of broken joints. They were left as slip joints, with fish-plates hot riveted on, and No. 0000 bonds at each end of the plates.

A force of fourteen men, including the engineer in charge, was engaged in the work of welding. It was found this force could weld about twenty joints a day, including all the preparatory work of opening street at the joints, attaching the molds, etc. The work was done in very cold weather when the days were short. It is believed in summer, with a gang of thirteen men, twenty-five joints could be welded in a day.

The cost of labor, including stripping, fastening the molds, pouring, etc., can be stated at $1, roughly, per joint. The charge of thermit for pouring one joint under the conditions as found at Hartford was $2.77. To this must be added the pro rata cost of the molds and preparing the molds for each pour (about 50 cents per joint), and the pro rata cost of the crucible (crucibles cost $7.25 each and will last indefinitely), and the cost of renewing the crucible linings (one lining will last for from twelve to fifteen pourings, and it costs $2.50 to renew a lining).

It may be stated that the total cost per joint, including cost of excavation, preparing joint, making weld and repaving, at Hartford, was about $5.

The thermit process of welding rails has been used very extensively in Europe for several years. It is now being introduced in America by the Goldschmidt Thermit Company, of New York City, under patents owned by Dr. H. Goldschmidt, of Berlin.

A NEW HYDRO-ELECTRIC BRAKING SYSTEM

Many attempts have been made to design braking systems for electrical traction to use either the source of power that starts the train or the kinetic energy of the train changed into electrical energy by using the motors as generators. A system utilizing this idea has recently been developed by the Allgemeine Elektricitäts Gesellschaft, of Berlin, after the designs of Charles A. Mudge, of New York, who also controls the American patent rights. It has been installed successfully in

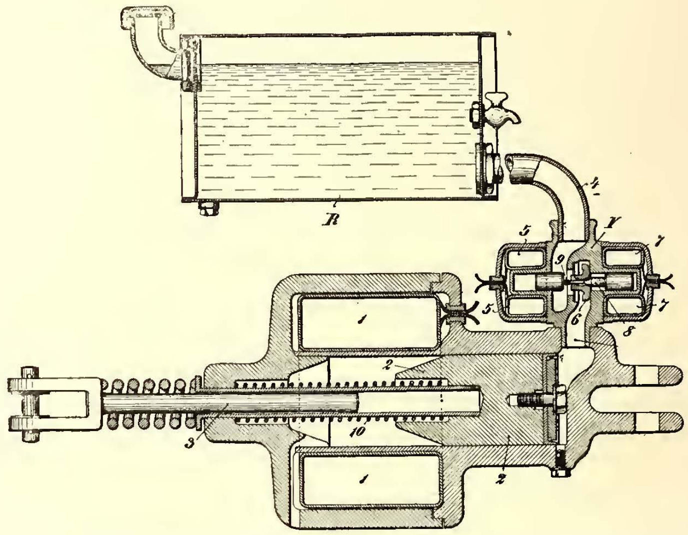


FIG. 1.—SECTION OF THE HYDRO-ELECTRIC BRAKING SYSTEM

several European cities, among them Stuttgart, Strassburg and Lodz.

A sectional drawing of this braking system is shown in the accompanying figure, representing a form of solenoid brake operated in the usual manner by admitting current to the main coil (1), which sets the piston (2) in motion, producing pressure on the brake rod (3), the magnitude of which varies directly with the amount of current flowing in the coil. The magnetic circuit of the brake is so formed that for approximately three-quarters of the stroke of the piston a pressure is exerted, which is practically constant when a constant current is flowing. At the beginning and end of the stroke the pressure falls off according to a predetermined value. *R* is a reservoir holding a liquid, either a thin oil or a mixture of water and glycerine. Between this reservoir and the brake is an electrically operated valve (*V*), whose function is to control the flow of liquid between the brake and reservoir.

The operation is as follows: The controller handle is turned

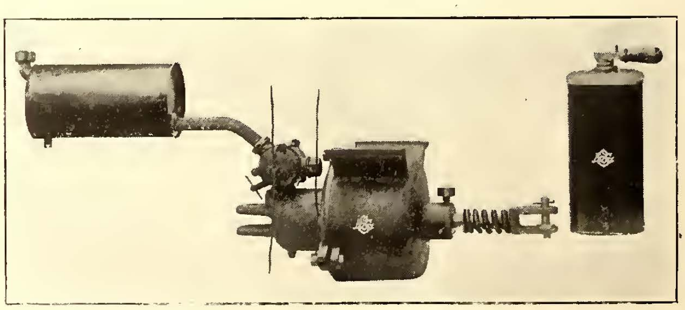


FIG. 2.—ASSEMBLY OF BRAKING SYSTEM; ALSO SHOWING PLATFORM CONTROLLER

from the off position through successive notches, admitting different current values to the brake coil (1) until the proper braking effect is obtained, when the handle is pressed downward, thus admitting current to the valve coil (5) and closing the valve (6), the space at the rear of the piston (2) in the meantime having filled up with the liquid from the reservoir.

The controller handle is then returned to the off position, which interrupts all current, the brake pressure being retained as the piston, cannot return to its original position, being held in place by the liquid between it and the valve.

This pressure may be retained for any length of time without the expenditure of electrical energy. To release the brake gradually, the controller handle is pressed downward in the off position, which admits current to valve coil (7), opening the small valve (8), allowing the liquid to slowly escape through the small hole shown in the large valve (6), which allows the

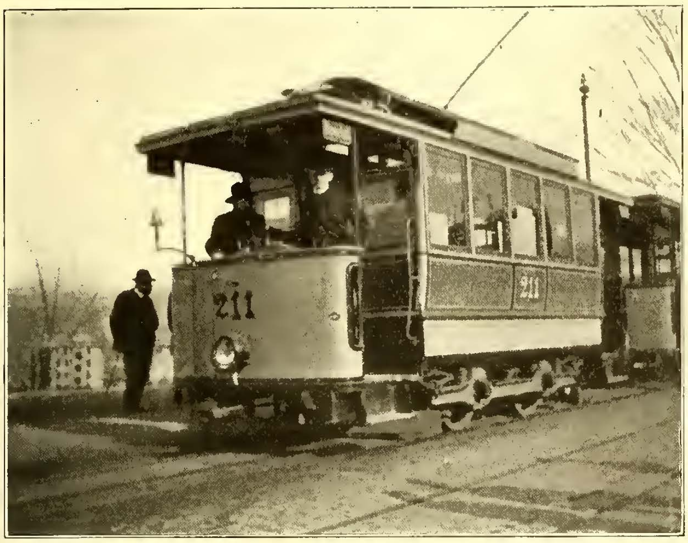


FIG. 3.—STUTTGART MOTOR CAR AND TRAILER EQUIPPED WITH HYDRO-ELECTRIC BRAKE

main piston to gradually return to its original position, thus releasing the brake gradually. As soon as the current is cut off from the coil (7), the small valve (8) is closed by the spring (9) and the brake piston ceases to move. In this manner any brake pressure desired from that at which the brake was originally set to zero may be obtained. This feature is most valuable in making proper stops, due to the fact that the coefficient of friction increases as the speed decreases, thus necessitating a decrease of the brake pressure in proportion to the

FIG. 4.—ANOTHER VIEW OF THE STUTTGART EQUIPMENT

speed, so that no uncomfortable shock will be felt as the train is brought to a stop. It is valuable also for use on cars when coasting down long hills with varying grades.

To release the brake instantaneously, the controller handle is turned in the opposite direction to that used in applying the brakes. This admits a greater amount of current to the valve coil (7) than that used for the gradual release, which opens the large valve (6), allowing the liquid to escape rapidly from the rear of the piston, which is immediately returned to the position shown by the spring 10. An emergency stop is made by turning the controller handle through 80 degs. to the last braking position which allows the maximum current to flow, giving a total pressure on the brake-shoes nearly equal to that of the weight of the car.

Any number of these brakes may be connected together on a train so that all can be operated through a single controller located any place on the train, or through emergency switches in different parts of the train. All brakes work simultaneously, no matter how long the train may be, the braking effect being applied to each car at the same instant, so that no part of the train receives its retarding effect before other parts. The couplers between the cars contain three wires, and are so ar-

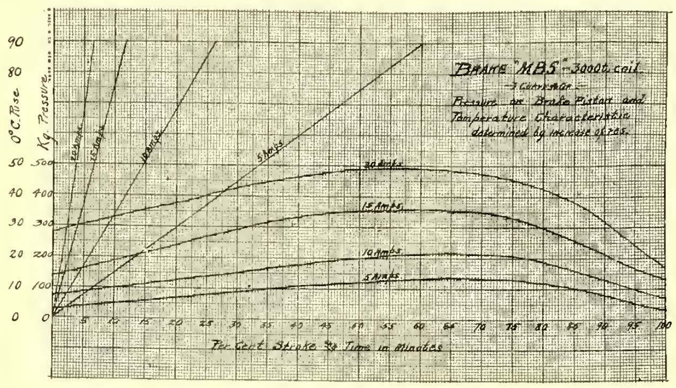


FIG. 5.—PRESSURE AND TEMPERATURE CURVES OF BRAKE USED ON CARS WEIGHING UP TO 10 TONS

ranged that if the train should pull apart, a switch will be opened, setting the brakes.

The energy consumption is very low, an idea of which may be obtained from the amount necessary to operate the brake shown, which is the size used on ordinary street cars up to 10 tons weight. Current is never kept on over two seconds, at the end of which time the desired pressure has been found for the speed at which the car is running, when the brake is locked and current cut off. The maximum for this brake is 20 amps., which gives a pressure of 1100 lbs. at the brake cylinder. To release the brake requires 10 amps. for the same length of time. This equipment, including one brake, two controllers, resistances and cables complete, weighs 405 lbs.

That there may be a source of power always at hand for stopping the train, the controller is so arranged that if for any reason the trolley current fails, the controller may be turned to an emergency position, throwing the motors in short-circuit through suitable resistance, which brings the train quickly to a standstill. By suitable interlocking devices, this feature can only be used in case the trolley current is interrupted, and as this is seldom the case, this extra service upon the motors does not necessitate an increase in their capacity.

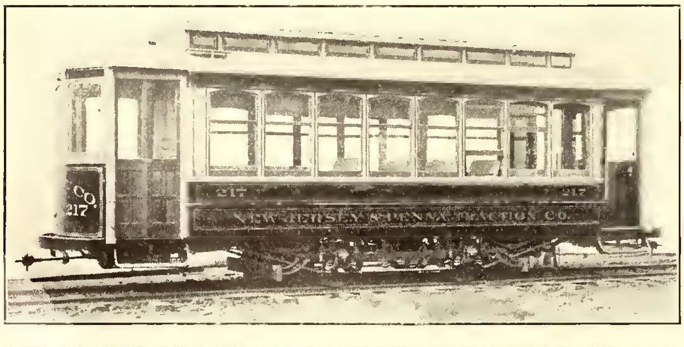
Figs. 3 and 4 are views of a Stuttgart motor car and trailer equipped with this braking system. The brakes were first tested on a train weighing 20 tons. The grades on parts of this line run as high as 6 per cent and 8 per cent for long distances; the low energy consumption was the determining factor in the selection of the braking apparatus. The curves reproduced in Fig. 5 were obtained from the type of this brake used on cars up to 10 tons weight, and show the effect of the shape of the magnetic circuit in this brake as compared with the ordinary type of solenoid, which has a curve similar to the speed curve of a series motor, its pressure increasing as the piston moves toward the end of its stroke.

The diameter of the wheels on the Stuttgart cars is 800 mm ($31\frac{1}{2}$ ins.), and the height of the car floor is 710 mm (28 ins.) above the track, under which run 130-mm (5-in.) stringers, making 580 mm (23 ins.) actual clearance above the rail for mounting the brake and its rigging. This space, however, is never filled by the brake or its rigging, no matter what type of this brake is used. The one used at Stuttgart is 315 mm (12½ ins.) high—that is, there is a clearance of 265 mm (10½ ins.) from the lowest part of the brake to the top of the rail. The reservoir in this particular installation is placed in the car under the seats, which is the usual practice on cars of this type. The valve is located directly under the reservoir on the under side of the car floor, where it is easily accessible for inspection. The three parts—brake, reservoir and valve—being independent parts of the equipment, may be mounted as desired. The reservoir, of course, is kept higher than the brake, to allow the liquid to run into the brake cylinder at all times. The reservoir holds about six times as much fluid as is necessary to lock the brake, hence it does not need to be mounted much higher than the brake itself. In case the valve, reservoir and brake are all screwed together, making the total distance from the bottom of the brake to the top of the reservoir 470 mm (18½ ins), the brake will operate on a 25 per cent grade. In special cases, as for cranes, elevators, etc., the reservoir is turned around 180 degs. from the position shown in Fig. 2, allowing the brake to be used vertically. Again, both reservoir and valve have been mounted with flexible connections (1-in. hose), this method having been found advisable in cases of severe vibration.

For cranes, hoists, elevators, etc., this system adapts itself most admirably, as any degree of brake regulation can be instantaneously obtained, no matter at what distance the operator is located from the brake itself, without the expensive and complicated systems of mechanical or air transmission of power at present so commonly in use. The current values used for large braking powers being so small, and the time during which it operates so insignificant, the cost of the installation, including the consumption of the electrical energy needed, is a very low figure, as the cables are few in number and the mounting of the brakes so simple.

VESTIBULE CARS FOR TRENTON, N. J.

The J. G. Brill Company has recently completed for the New Jersey & Pennsylvania Traction Company an order for five of its semi-convertible cars, some of which have 30-ft. 8-in. bodies, and are for use on the 14-mile division between Trenton and Lambertville. The type shown in the illustration is for use at Trenton. The railway company is constructing extensions to



ONE OF THE NEW JERSEY & PENNSYLVANIA TRACTION COMPANY'S LATEST SEMI-CONVERTIBLE CARS

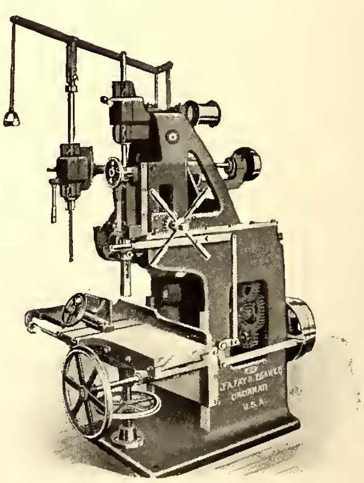
its system, which, when completed, will connect the principal cities and towns north, east and west of Trenton. The company is familiar with this type of car, having operated with it for a considerable time, and evidently it has proved satisfactory.

The car illustrated is 20 ft. 8 ins. over the end panels and 30 ft. 1 in. over the vestibules. The platforms are 4 ft. 8½ ins. The width over the sills, including the panels, is 7 ft. 11½ ins., and over the posts at the belt, 8 ft. 2 ins. The sweep of the posts is 1¾ ins. The side sills are 3⅜ ins. x 5 ins., and the end sills, 3½ ins. x 6⅝ ins. The sill plates are 12 ins. x ⅜ in. The thickness of the corner posts is 3¾ ins., and of the side posts, 2¾ ins. The distance from center to center of the side posts is 2 ft. 8 ins. Longitudinal seats for four passengers each are placed at the corners, a somewhat unusual arrangement for a car of this length, but which has the advantage of providing more aisle space at the ends, thereby facilitating the movement of passengers in and out. The transverse seats are 36 ins. long and the aisle between, 22 ins. wide. These seats have step-over backs, and both side and cross seats are upholstered in spring cane. The seating capacity of the car is thirty-two. Cherry in natural color constitutes the interior finish, and the ceilings are of three-ply birch veneer, neatly decorated. A simple device recently patented by the builder controls the movement of the folding vestibule doors. It consists of a guide rail, beyond which moves a roller situated at the top of the door. Other specialties of the same make are radial draw-bars, angle-iron bumpers, "Dedenda" gongs, ratchet brake handles, Retriever conductors' bells and window sill arm rests. The car is mounted on the 21-E type of truck, having 33-in. wheels and 4¼-in. axles. The weight of the car and trucks without the motors is 16,840 lbs.

A NEW MORTISER

One of the latest tools which has been designed for the woodworking department of railway shops is the hollow-chisel mortiser made by the J. A. Fay & Egan Company, of Cincinnati, Ohio. This machine is said to be easily adjustable and operated, besides being of strong and compact construction. It is designed for chisels up to ½ in. square, and it is recommended by its makers wherever clean cutting and accurate mortising are required.

The main column is cast in one piece, with broad floor base, making it steady and free from vibration or jar. The upper part is carried on friction rollers, making it easy of adjustment for mortises out of line. The pilot wheel for moving the upper column travels back and forth with it, always retaining it in a convenient position for the operator. Stops are provided for the transverse movement of the upper column, the extent of which is 11 ins. The chisel ram is mounted in a dovetail slide and has a stroke of 6 ins. It is counterweighted for easy adjustment, and can be quickly set to the different depths of mortise desired or compensate for thickness of material. The boring spindle in the chisel is driven by miter gears. This arrangement permits belting it from above or directly below the center of the machine.



HOLLOW-CHISEL MORTISER

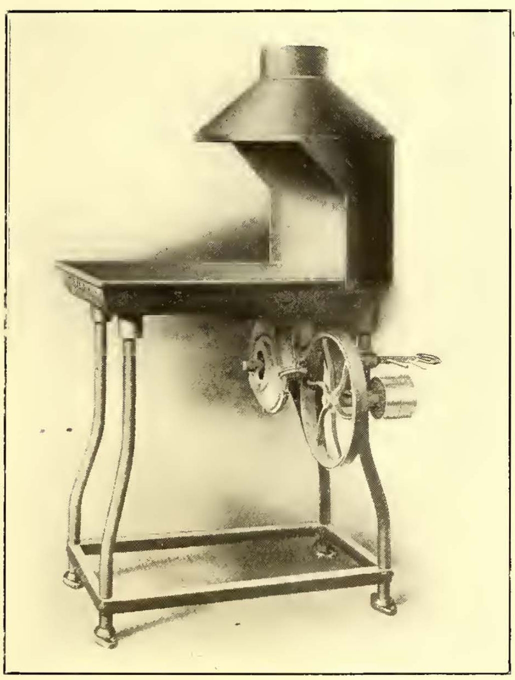
The feed mechanism is contained in the lower column and gives two speeds to the chisel. The chisel has a return stroke of "three to one," accomplished by means of elliptical gears. The feed is controlled by a lever within convenient reach of the operator, and is so arranged as to stop the chisel instantly at any point of its stroke. The table is mounted on the lower column, forms a take-up for all wear, and is 1 ft. x 4 ft. It is raised and lowered 12 ins. by screws, and has a lateral movement of 18 ins. by means of rack and pinions, and has stops for gaging the length of mortise. It will accommodate material

17 ins. high and 12 ins. thick. An adjustable lamp is provided for holding any thickness of mortise, and goes clear to the fence. The auxiliary boring attachments are placed on one or each side of the frame at such a distance from the chisel as will permit of adjusting them to an angle of 30 degs. in either direction. These are convenient for joint-bolt boring and save much handling of material. The depth of stroke of these boring attachments is 12 ins. and the transverse movement 11 ins.

PORTABLE FORGES

The adaptability of the Sturtevant portable forges to all light forge work, their endurance and ease of running, has given them wide popularity wherever small and medium sized forges are needed for heating, tempering and small repairs. From time to time new sizes have been added to the list to meet new applications, there being now no less than thirty-one sizes. The designs also have been perfected in every detail. The sheet metal work is of heavy steel plate, the running gear strong and easily operated. The tuyeres are made extra strong to resist the action of the fire, and the fire pan is of a double metal plate with asbestos between to prevent the heat from cracking the main pan or affecting the running gear. The blower is of the Sturtevant steel pressure type, has babbitted journal boxes and has been redesigned to give increased capacity.

There are seven distinct types. Types A, B and C are alike, except in the means of producing the blast. The blast for type A forges is provided by an attached blower driven by hand-power. The B forges are arranged for pipe connection, and receive blast from an independent blower, which may also supply a number of forges. Forges of the C type are fitted with a blower driven by a pulley on the forge, belt-connected to a line shaft or other drive.



PORTABLE FORGE NO. C-5

The A forge is built in five sizes, adaptable to all light work. The B type is made in eight sizes, particularly adaptable to mechanical laboratories of technical schools. The C forges are made in four sizes, and are fitted with a tight and loose pulley for belt connection; a continuous blast may be thus provided which can readily be regulated by means of a blast gate underneath the fire pan.

With some of the lighter forges a strong wooden box is furnished sufficiently large to hold a complement of tools, together with the forge itself. The equipment is therefore extensively used by repair and set-up men on account of its ease and convenience of transportation.

THE "INTER-POLE" VARIABLE-SPEED MOTOR

The Electro-Dynamic Company, Bayonne, N. J., has placed on the market a new motor, which is essentially a variable-speed motor, but which can also be used on constant-speed work. It was designed especially to drive machine tools, pumps, blowers, woodworking machinery and all other classes of machines, either driving the same directly or in groups. The motor operates on any two-wire, direct-current circuit from 110 volts to 500 volts. A striking feature of this machine is the introduction of four auxiliary poles in the field between the main poles of the motor. The main poles are in shunt with the armature, while the inter-poles, which are considerably smaller than the others, are in series with each other and with the armature.

In any direct-current, shunt-wound motor having a variable speed, the strength of the main field poles must be decreased if the speed of rotation is to be increased. Sparking at the brushes will then result, and if an attempt is made to fit the motor to run in either direction by shifting the brushes to positions equidistant between the poles, the sparking will be still further increased. In this motor, however, the brushes are placed equidistant between the poles, and it is capable of reversing its direction of rotation without sparking, with variable load as well as with variable speed. This is accomplished by means of the inter-poles, which may be seen in Fig. 1.

The coils in the auxiliary poles are so proportioned and arranged as to give the proper field for commutation, and as these coils are connected in series with the armature, weakening the field of commutation by increased load is prevented, and the inter-poles produce a compensatory field of commutation independently of the main field, which is weakened with an increased number of revolutions of the armature. The function or effect of the inter-poles is independent of the direction of rotation of the armature, for if the latter be reversed, the current in the auxiliary field is also reversed. The motor as applied to a Hendey lathe is shown in Fig. 2.

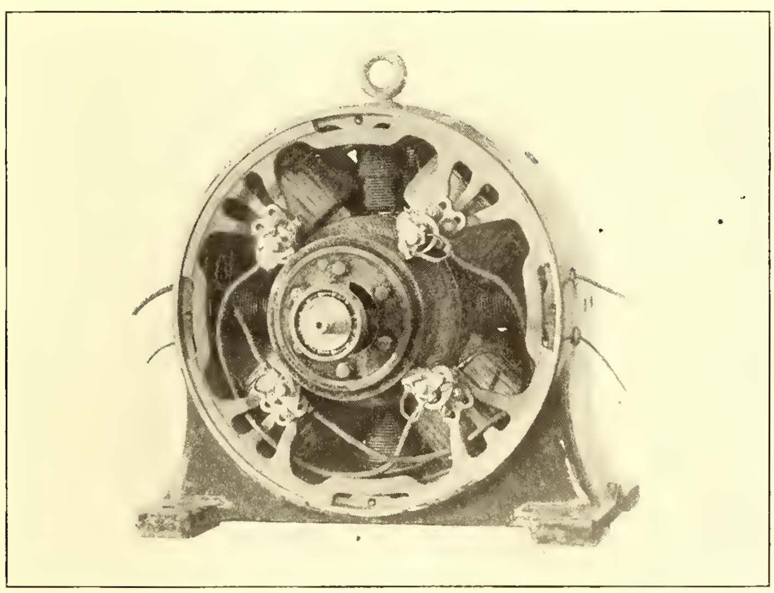


FIG. 1.—MOTOR WITH FRONT BEARING REMOVED, DEPICTING SIMPLICITY OF CONSTRUCTION AND COMPACTNESS

Another novel feature of this motor is the use of ball-bearings in place of the ordinary journal bearings. This bearing consists of two races, one of which is fastened to the armature shaft and the other to the bearing housing. Between the balls are placed spring separators, which are packed with mineral wool. This mineral wool takes up the lubricant and feeds it

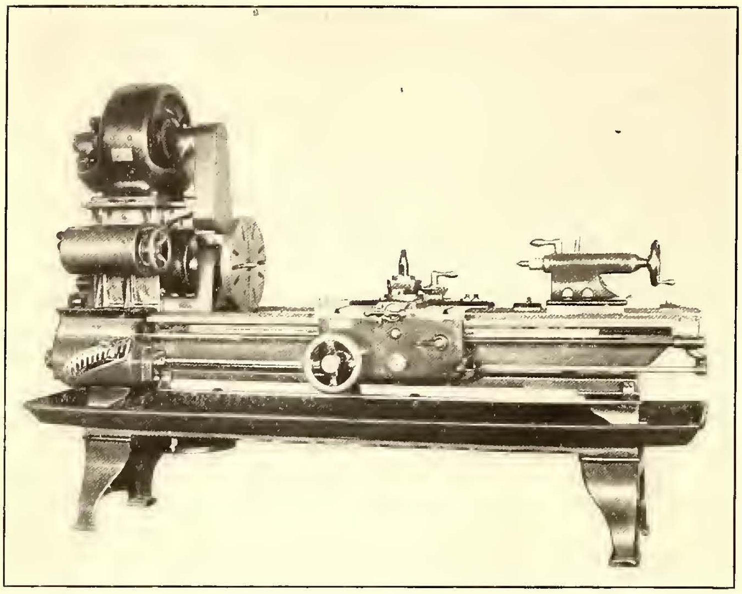


FIG. 2.—INTER-POLE MOTOR DRIVING 16-IN. HENDEY LATHE, THROUGH SILENT CHAIN. ANY DESIRED SPEED CAN BE QUICKLY OBTAINED

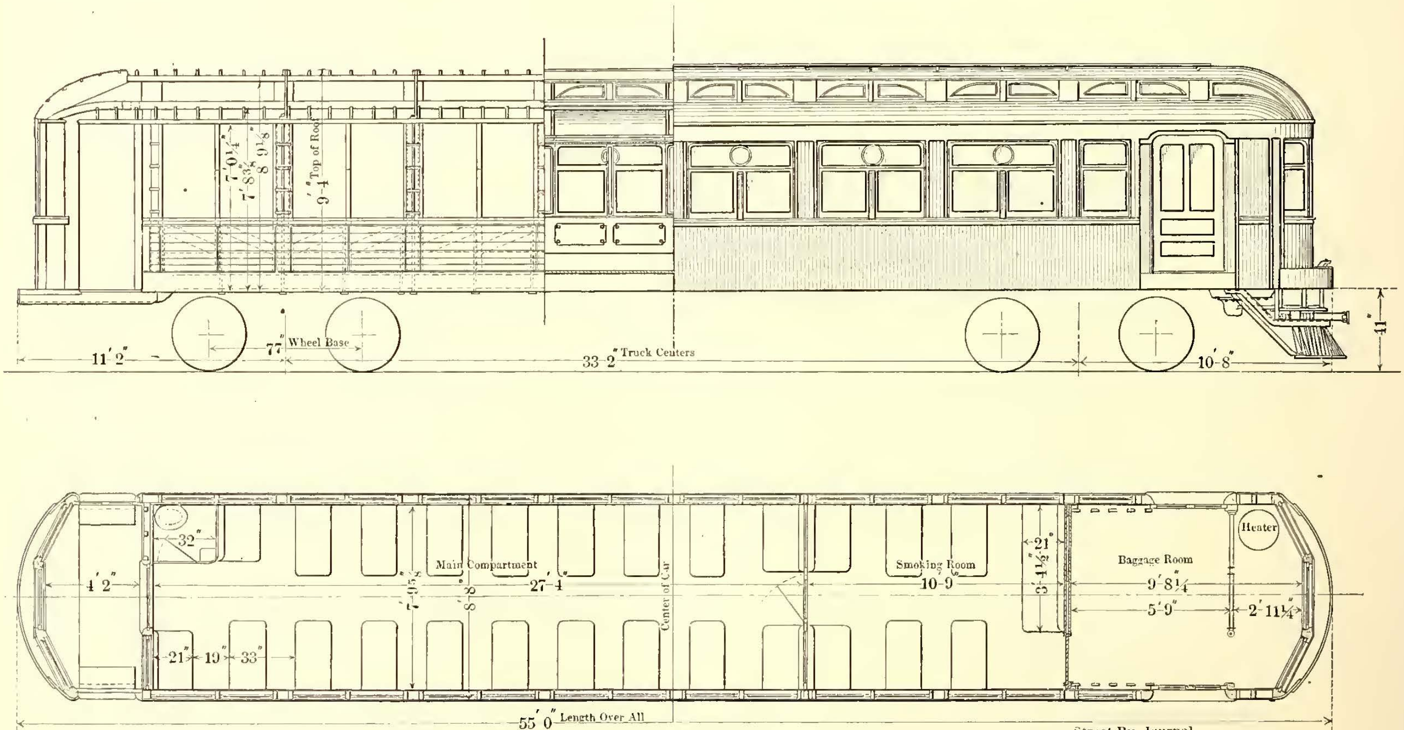
gradually to the bearing. The only attention required for the bearing is to have the lubricant renewed once about every six months. This bearing is shown in position on the end of the armature shaft in Fig. 1.

CARS FOR THE INDIANAPOLIS & CINCINNATI TRACTION COMPANY'S SINGLE-PHASE LINE

The framing and dimensions of the ten cars which the St. Louis Car Company is completing for the new single-phase alternating-current railway of the Indianapolis & Cincinnati Traction Company are shown in the accompanying drawings. These cars are among the heaviest ever built for interurban service, the weight complete, including motors and electrical equipment, being 96,760 lbs. Part of this weight is due to a very heavy construction of the car body and trucks, and part to the fact that the car is equipped with alternating-current motors, which are somewhat heavier than d. c. motors of the same capacity, and which also require transforming apparatus on the car. The motor equipment consists of four 75-hp Westinghouse single-phase motors. The Westinghouse electro-pneumatic train-control system is used.

The cars are 55 ft. over all, with a rear platform extending 5 ft. There is no front platform. The motorman occupies the front end of the baggage compartment, with merely a pipe rail to separate his space from the baggage room. The wheel base is 77 ins., the distance between truck centers, 73 ft. 2 ins. The bottom frame is made very heavy. The side sills consist of two 10-in. steel channels, having between them a 20-in. steel plate which extends up into the wall of the car. The side sills are further reinforced with timbers. The other longitudinal sills are wood, reinforced with steel, as shown in the drawings. The cars are plainly but handsomely finished inside in mahogony, with simple inlay lines. Further details of the construction and arrangement can be seen from the drawings.

These cars are to be equipped with the usual form of trolley pole and wheel for use inside the city of Indianapolis, and with

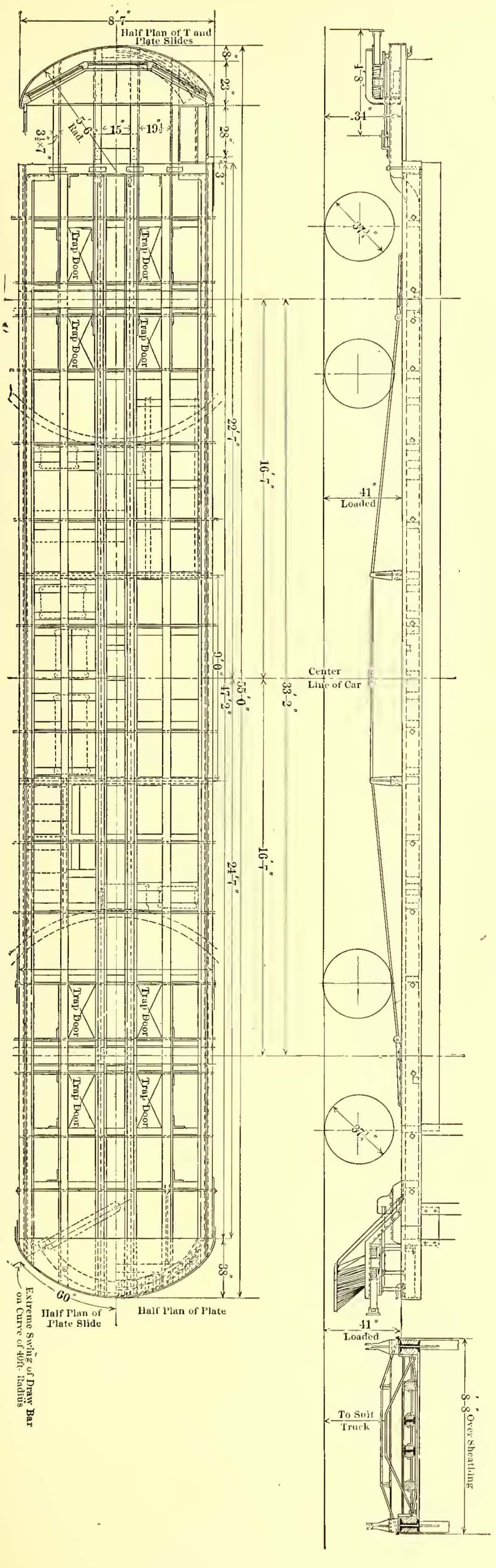


COMBINATION CAR FOR INDIANAPOLIS & CINCINNATI TRACTION COMPANY

The motor has been designed so that it will operate in any position, even with the shaft vertical, without any change being made in the machine. It is readily adaptable for use open, semi-enclosed or enclosed. The average speed variation is 5 per cent from full load to no load, at any set speed of the controller. This is a particularly important point to be considered when machine tools are equipped with motors for variable-speed duty.

a bow, sliding contact trolley for use in the country. The contact surface of the bow is 3 ins. wide, so as to make contact on about 3 lineal ins. of trolley wire.

The Schenectady Railway Company will hereafter instruct all new motormen on a skeleton car which was at the St. Louis Exposition as a part of the General Electric exhibit.

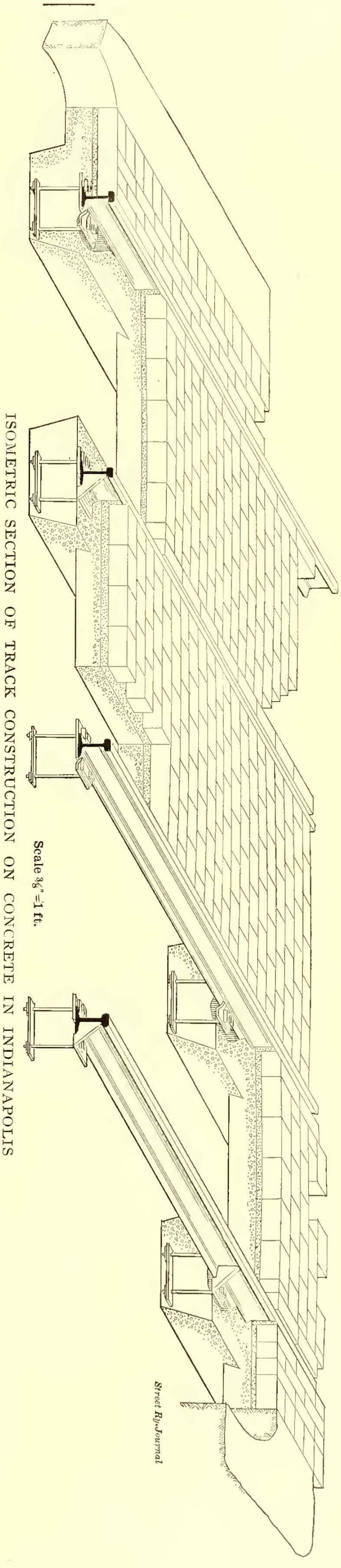


BOTTOM FRAMING OF 55-FT. CAR TO BE USED ON INDIANAPOLIS & CINCINNATI SINGLE-PHASE RAILWAY

THE LATEST CONCRETE BEAM TRACK CONSTRUCTION IN INDIANAPOLIS

The accompanying drawing shows the latest track construction on concrete beams laid by the Indianapolis Traction & Terminal Company. This construction was described in the paper of Thomas B. McMath, civil engineer of that company, which was read before the Indiana Electric Railway Association convention at Indianapolis, Jan. 12, and published in the STREET RAILWAY JOURNAL of Jan. 21. The accompanying drawing was also presented to the convention at that time. This construction is employed on the streets approaching the new interurban terminal station.

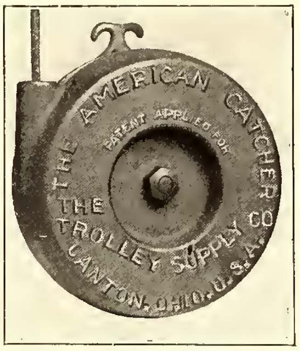
Wooden ties to hold the track to gage are placed every 12 ft. Concrete beams are laid under each rail to support the rail. The peculiarity of this construction lies in the anchor bolts holding the tie plates, which were inserted by Mr. McMath for the purpose of preventing the rails from kicking up under the traffic. This was apparently one of the weak points of previous concrete beam construction. The concrete beams extend about 11 ins. below the base of the rail and are 18 ins. wide at the base. The upper part of each beam is continuous with the paving foundation. The rail used is a 7-in. Shanghai T-rail with an extra wide head.



ISOMETRIC SECTION OF TRACK CONSTRUCTION ON CONCRETE IN INDIANAPOLIS

TROLLEY CATCHER FOR CITY SERVICE

The success of the Knutson trolley catcher and retriever for high-speed railways has led its manufacturers, the Trolley Supply Company, of Canton, Ohio, to bring forward a modified design known as the "American," for city work, which is simpler and lighter than the original type, owing to the absence of the retriever feature. The latter has been removed purposely, as it is not considered a necessity in ordinary city work, because the cars usually can be stopped before much damage is done. The new catcher has but seven parts, which are so disposed that repairs can be quickly made by any employee. It is made entirely of malleable iron, weighs 14 lbs., is 7 ins. wide and 4½ ins. deep. It is fastened upon the car dasher by a bracket, and can be easily interchanged in transferring from one end of the car to the other. Ample reel space has been provided to take care of the slack of the rope. Another good feature is the outlet provided in the bottom of the machine for drainage, which prevents the action of the reel from being stopped by rain, snow or sleet.



TROLLEY CATCHER ADAPTED FOR CITY WORK

CORRUGATED TROLLEY POLE

The trolley pole is so simple a piece of apparatus that the selection of a type best suited for the requirements would appear to be an easy matter compared with making a decision with reference to the adoption of some particular design of motor. Nevertheless, the subject is an important one, for the breaking of a trolley pole frequently results in as serious interruptions to traffic as would be caused by the failure of the more expensive apparatus.

CORRUGATED TROLLEY POLE

The essential qualifications of a good trolley pole, namely, lightness, strength and elasticity, are claimed to be well embodied in the seamless steel, taper drawn, corrugated pole made by Swazey & Smith, of Boston. This pole is made to fit the standard harp and base, and is manufactured in all lengths. It is said to be lighter and stronger than the ordinary weldless tubing, requires less tension in the base spring and will withstand the most severe strains likely to arise. In claiming the superiority of this corrugated tubing over the weldless tubing, the manufacturers of the former refer to a government test on tubes of these materials of the same length, weight, gage and diameter, the testing conditions being exactly the same. It was found that the weldless tubing stood a transverse test of 850 lbs. before giving way, while the corrugated tubing successfully resisted a strain up to 1300 lbs.

In a statement before the railroad committee of the Common Council of Milwaukee, President John I. Beggs, of the Milwaukee Electric Railway & Light Company, said that at present 110,000 commutation tickets are daily given in payment of fare, and that the company has to issue daily from 50,000 to 60,000 transfer tickets.

A TYPICAL HIGH-CLASS CAR USED FOR INTERURBAN SERVICE IN OHIO

As interurban electric railways have grown in importance, their rolling stock has been correspondingly improved, and today there are electrically-operated cars in service whose general construction and finish successfully rival the best coaches that are running on steam lines. This is especially true in Ohio, Indiana and other States of the Central West, where electric railways have reached a high state of development. An excellent type of the cars used in this section of the country is the one shown in the accompanying illustration, which represents a car used on the Akron-Bedford-Cleveland division of the Northern Ohio Traction & Light Company. This car is a product of the Niles Car & Manufacturing Company, of Niles, Ohio, which is now completing five of this type, the cars having been sold to the traction company through J. A. Hanna & Company, of Cleveland, who are the general sales agents for this car building company.

Of course, the illustration gives little conception of the beauty of the interior arrangement of the car, but the view of the exterior alone is sufficient to show its handsome outlines and substantial construction, and without doubt it is one of the finest interurban coaches entering Cleveland. This car is of the single-ender style, is 34 ft. long over the corner posts and has an extreme length of about 44 ft. 10 ins. The width across the sills is 8 ft. 6 ins. It is necessary to carry the cars 3 ins. off center toward the curb in order that they may pass each other on city streets.

The bottom frame is principally of steel, having two 6-in. I-beams in the center sills, 5-in. I-beams in the two intermediate sills and ¾-in. x 7¾-in. steel plates in the side sills. All these sills extend from the rear end sill under the front vestibule to the front buffer. The needle beams are of 7-in. steel I-beams. The cars have beveled edge plate glass throughout and silk-lined "Pantasote" curtains; are finished in solid mahogany with neat inlaid work. The ceilings are full Empire style, covered with green tinted burlap, and are lighted by clusters of electric lights in Holophane globes.

The seats in both compartments are Hale & Kilburn No. 99-EE, high-head roll back, with grip handle and mahogany seat ends, and are upholstered in dark green horse-hide leather. The toilet rooms are fitted with water flush closets, and the deck sash are glazed with leaded cathedral glass.

ONE OF THE HANDSOME INTERURBAN CARS NOW RUNNING ON THE AKRON-BEDFORD-CLEVELAND DIVISION OF THE NORTHERN OHIO TRACTION & LIGHT COMPANY

The cars are mounted on Peckham No. 40 A. M. C. B. style trucks, fitted with rolled-steel wheels 34½ ins. diameter, and equipped with General Electric No. 57 motors. The cars are extremely easy riding and comfortable.

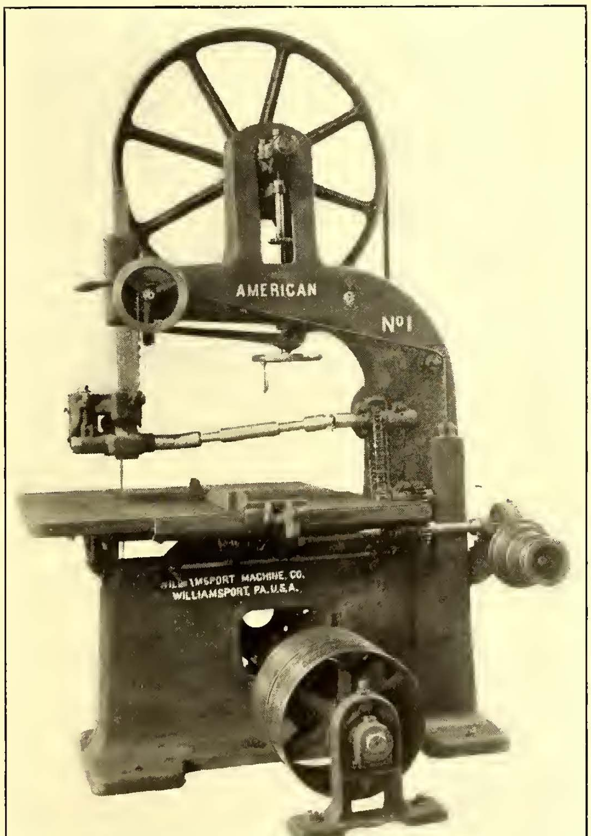
Officials of the Lima Electric Railway, Light & Power Company, of Lima, Ohio, a few evenings ago tendered a banquet to the company's employees in recognition of faithful service.

GERMAN STREET AND INTERURBAN RAILWAY ASSOCIATION TO HOLD ITS ANNUAL MEETING NEXT SEPTEMBER

The Verein Deutscher Strassenbahn und Kleinbahn Verwaltungen (Association of German Street and Interurban Railway Managers) has arranged to hold its tenth annual meeting on Sept. 6, 7 and 8, at Frankfort-on-Main. While some of the subjects to be discussed are of purely continental interest, others no doubt will bring out a great deal of information that will prove of equal value to both European and American railways. Last year the Verein decided to have a secretary who would devote all of his time to its interests. This action has greatly extended the usefulness of the Verein, and hence its coming meeting should prove productive of more good than those held under the old method.

After considering the general work of the association during the preceding year, several reports will be presented on matters of general interest to the members. These will include "The Liability of Street Railways," by Dr. Wussow, of Berlin, in connection with which a petition for remedial legislation is to be prepared by the Verein; "Special Rates of Fare on Street Railways" (a continuation of the former report on "The Latest Fundamental Principles for Rates of Fare on Street Railways"), by General Secretary Vellguth, of Berlin; "Finding the Cost of Operating Trail Cars," by the Grosse Berliner Strassenbahn; two reports on the "Reliability, First Cost and Maintenance of Mechanical Brakes for Electric Railways," one (in favor) by Director Scholtes, of Nürnberg, and the other (against) by the Grosse Berliner Strassenbahn; "The Present Knowledge of the Use of Rail-Joints on Electric Railways," by the Grosse Berliner Strassenbahn; "The Acceptance of Railroad Traffic Regulations as a Basis for the Promulgation of Rules for Interurban Railways," by Committee D.

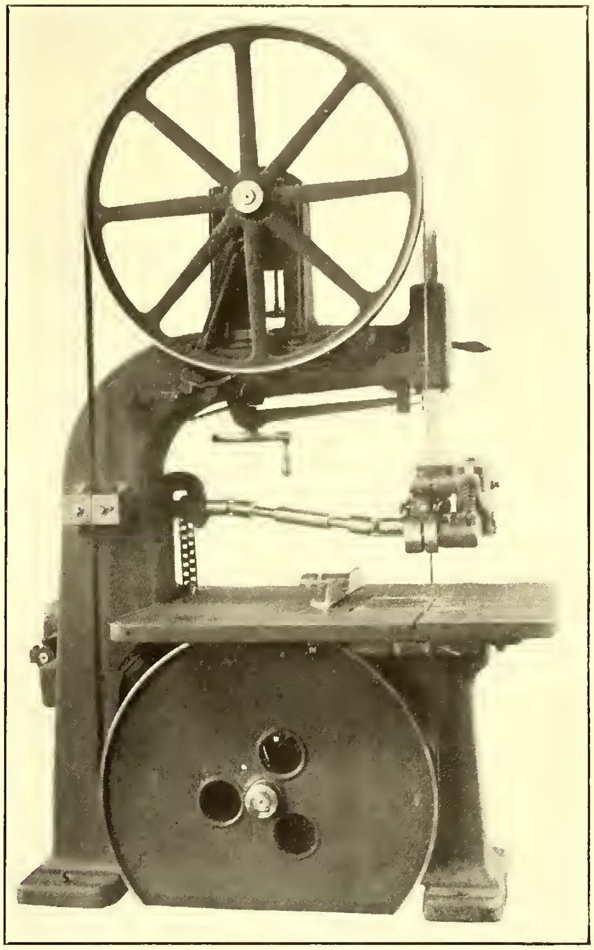
The Verein will also consider the adoption of uniform disciplinary rules and examination systems for inspectors, trainmen, etc., based upon a report to be furnished by Committee D.



FRONT VIEW OF BAND RIP SAW

A NEW BAND RIP SAW

The No. 1 American band ripper is a new machine recently developed by the American Woodworking Machinery Company, of New York, for general ripping of lumber in all woodworking shops. The main frame is cast hollow with cross struts and heavy foot flanges. The shafts are all steel, extra heavy, and run in long boxes lined with babbitt metal. The table is of iron, and is 46 ins. wide x 44 ins. long, is fitted with the company's improved self-locking gage.



REAR VIEW OF BAND RIP SAW

The feed is strong and reliable, and consists of three driven rolls, 5 ins. in diameter, and one press roll. The top in-feeding roll and press roll are hung in separate frames so they will yield for variation in thickness of lumber. They are attached to the heavy guide bar, which is indexed to show the height from the table to the bottom of the rolls. The two lower feed rolls in the table are also driven rolls, 5 ins. in diameter. The upper feed rolls are adjusted up and down by a large hand wheel, and these parts are counterbalanced with weight, as shown. The rates of feed are 60 ft., 105 ft. and 150 ft. per minute.

The wheels are 40 ins. in diameter. The lower one is very heavy, with solid center web; the upper one is as light as possible consistent with strength.

The capacity of the saw is 15 ins. vertically and 28 ins. horizontally. The blade is 2½ ins. wide.

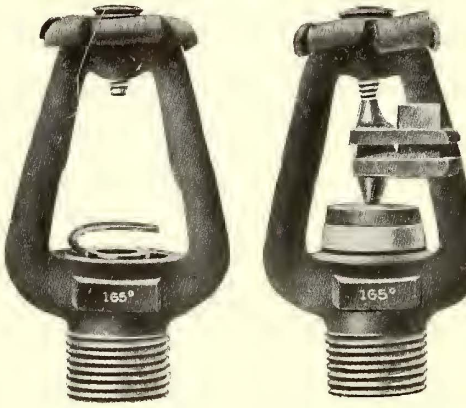
L. B. Stillwell, electrical director of the Interborough Rapid Transit Company, controlling the subway and the elevated lines of New York, lectured before the Franklin Institute of Philadelphia on Jan. 18. His subject was "The New York Subway."

THE APPLICATION OF AUTOMATIC SPRINKLERS

The great interest which street railway companies are now taking in automatic sprinkler protection makes opportune a description of the sprinkler system made by the Manufacturers' Automatic Sprinkler Company, of New York City. This system has been installed in a large number of manufacturing establishments, warehouses and other places where valuable material is stored. It was also one of the two systems used during the car house test at Newark, described in the STREET RAILWAY JOURNAL for Jan. 14, and in this test these sprinklers made an excellent showing.

While practically all automatic sprinklers depend for their operation upon the melting of the solder in the sprinkler head by the heat of the fire itself, it does not follow that all are equally reliable in service. Moreover, the efficiency of even the best sprinklers is largely dependent upon the proper design and installation of the piping, dry valve and other features.

The car house equipment advocated by this company consists of the use of a low line of automatic sprinkler heads, level with the tops of the car windows, as described in the Newark car house test, and supplemented by ceiling sprinklers. The principal features of the heads are their non-corrosive



FIGS. 1 AND 2.—SHOWING DETAILS OF SPRINKLER HEADS

quality, duck-bill form of strut and rotary deflector. Figs. 1 and 2, which show the heads five-eighths size, illustrate these three points.

The non-corrosive quality is secured by making all points of contact of either German silver or porcelain. The manufacturer claims that in the use of the duck-bill strut less solder is employed than in any other type, thereby insuring greater sensitiveness. A small coil spring is employed under the porcelain disc, as shown, to unseat the head quickly under small or no pressure, but it has no influence on the solder or sensitiveness of the head. This head is so constructed that it must open even without water pressure as soon as the fusible link is released. The melting point of the link can be made to depend upon the local conditions. When the valve is released the water is distributed to cover approximately 80 sq. ft. of floor space. The deflector is of the rotating type, so as to give good distribution. The set screw cannot be readjusted after the head is in place, thus preventing injury to the fusible joint and loss by water.

The dry-pipe valve is shown in Fig. 3, and is known as Manufacturers' dry-pipe valve. This valve intervening between the outside water supply and inside air system in the sprinkler pipes, makes practical the use of dry-pipe sprinkler systems in property not protected in winter against freezing. The record of this valve in the past ten years and more has been instrumental in convincing all interests that dry-pipe systems controlled by this valve are as reliable as wet-pipe systems.

This valve is purely mechanical in operation, and is not dependent upon springs, diaphragms or weights. The ratio of the air to the water is sufficient to hold the valve closed against any water pressure with only 15 lbs. of air. The levers cannot remain in position unless air is on the system, and the valve can be quickly tested by turning the wheel on the drain valve. An important feature, said to be embodied only in this dry-pipe valve, is the anti-water column, which makes it impossible to column the valve, as the air line from the air cup in the valve is carried to a point above the first floor and into the riser pipe.

By the use of this device the air, to release the leverage system, is drained through the anti-water column fixtures, and

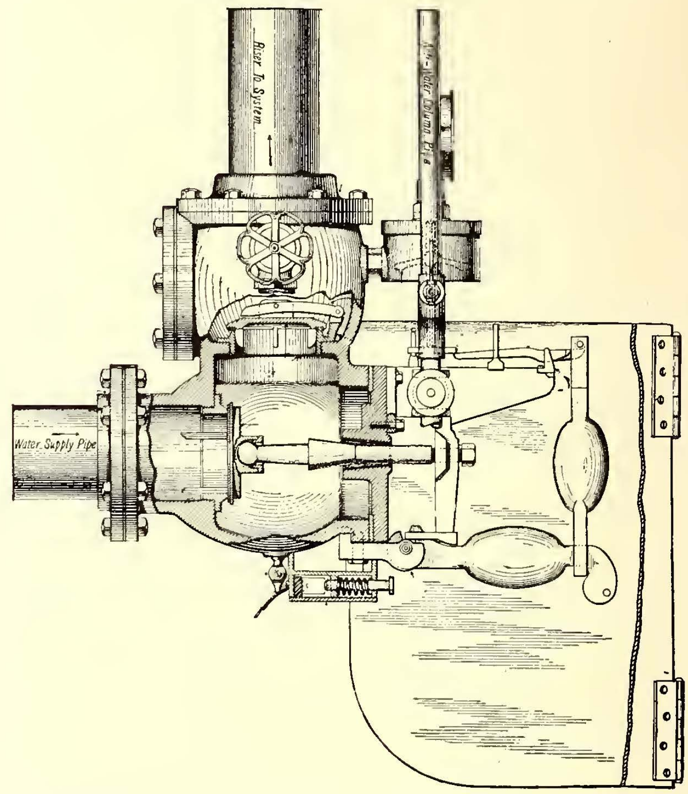


FIG. 3.—DRY-PIPE VALVE PLACED BETWEEN OUTSIDE WATER SUPPLY AND INSIDE AIR SYSTEM OF THE SPRINKLER PIPES

not through the lower riser pipe or air-valve chamber, where drainings from the system used as wet pipe in summer, as is often the case, might accumulate a water supply above the check valve into the system that would seriously interfere with or retard the opening of the valve.

The simplicity of construction allows of the quick resetting of valve after it has been tripped or opened, and no parts require any systematic renewing. A valve shield incases all exterior working parts or levers.

NEW TRACKLESS TROLLEY LINE IN ITALY

The Societa Italiana per Trazione Elettrica Ing., Meriggi, Diaz & Company, of Milan, has been given a contract for the construction of a trackless trolley 'bus line, 16 km (10 miles) in length, between Spezia and Portovenere. Three 'buses will be run. The overhead material is being supplied by the Ohio Brass Company.

A representative of the Post-Office Department in Washington has been investigating the electric railways in Northern and Eastern Indiana, with a view to bringing them into competition with the steam railroads as carriers of the mails. The frequency of the service on the electric lines gives them an advantage over the steam railroads that is not compensated for by anything that the steam roads have to offer.

FINANCIAL INTELLIGENCE

WALL STREET, Jan. 25, 1905.

The Money Market

The extraordinary ease which has characterized the money market for some weeks past, continues, and at the present time there is nothing in the situation to warrant the belief that rates will improve appreciably in the near future. About the only factor that is likely to result in the stiffening of interest charges is the existing labor troubles throughout the Russian Empire; but as yet the local market has not in any way reflected the unsettled condition prevailing in that country. Gold exports to France continue on a moderate scale, but as yet the movement has been confined to gold bars, the entire output of the Assay Office having been engaged up to the middle of March. The strength of foreign exchange, however, continues, and indicates an increased demand for gold by Paris bankers, with a view of protecting themselves against any contingency that may arise from the present unsettled state of affairs in Russia. During the week there has been tentative inquiries at the Sub-Treasury for gold coin for export, but according to local bankers, the belief prevails that even should the outward movement of gold assume large proportions, it would be some time before they would be reflected in any material advance in money rates. The receipt of funds from the interior continues on an extremely large scale, which, together with the considerable amounts of funds received from Western institutions, to be placed in the local market, has resulted in a pressure of funds in this market, and which has forced rates to the lowest point attained in several months. Money on call opened at 2½ per cent, but subsequently, on heavy offerings by the large national banks, the rate ran off to 1¾ to 2 per cent, and at the close lenders experienced considerable difficulty in obtaining over 2 per cent. In the time loan department business was practically at a standstill. The demand from stock commission and mercantile sources was extremely light, and borrowers were able to do business on practically their own terms. Sixty-day funds were obtainable at 2½ per cent, while three and four months maturities were offered at 2¾. Five and six months' contracts were made at 3 per cent, the funds being supplied largely by out-of-town institutions. Specialists in mercantile paper reported an increasing demand for prime material, but the supply was light, merchants not being obliged to make much paper in view of the good collections making throughout the country. There was no national change in the discount rates at the principal European centers. At London the rate is 2½ for three months' bills, at Berlin the rate is 2½ per cent, and at Paris 2½ per cent is quoted.

The statement of the associated banks, published last Saturday, was in the main favorable. The feature was the increase in loans of $34,474,700, which was attributed to syndicate operations. The increase in cash of $10,438,300 was larger than generally expected. Deposits increased $44,655,100, while the reserve was $11,163,775 greater than the previous week. The surplus decreased $725,475 to $23,733,800, as compared with $26,072,675 in the corresponding week of last year, $26,414,975 in 1903, $25,332,400 in 1902, $36,799,450 in 1901, and $29,277,975 in 1900.

The Stock Market

Increased activity developed in the stock market this week, but the price movements continued to show considerable irregularity. During the early part of the week the dealings were on a rising scale of activity, and prices generally displayed an advancing tendency. The strength was pronounced in Reading, Union Pacific and the Erie, while in the less active issues New York Central, Omaha, Chicago & Northwestern, Pullman, and many other issues ruled decidedly strong. On Saturday the bank statement failed to impress traders favorably, on account of the enormous figures of loans and deposits, and the selling by them ended in a severe reaction in prices in all quarters of the market. The developments at St. Petersburg over Sunday was a matter of great concern, and the market ruled weak under its influence. At the close there was a decided improvement in the foreign markets, London being liberal buyers of American securities, but the local market continued weak and unsettled. A feature of the week was the activity and strength in the bond department, which was attributed directly to the extraordinary ease in the local money market. The absorption of high-class stocks and bonds, by investors, has continued throughout the week, and at the close an urgent demand exists for all high-grade issues. Trading in the local traction issues were fairly active, but prices moved in sympathy with the rest of the market. Brooklyn Rapid Transit was decidedly weak, the price declining 3¼ points net, to 60¼, and closing at the lowest. The weakness in this stock was attributed to reports that the road was in a poor condition, which would necessitate the expenditure of large sums, and to the rumors of another issue of bonds. The latter report was, however, denied. Manhattan was strong and ended the week with a small gain, while the net changes in Metropolitan Street Railway and Metropolitan Securities were limited to ½ and ¾, respectively.

Philadelphia

Considerable activity developed in the local traction stocks this week, and prices generally displayed decided strength. Interest centered largely in Philadelphia Rapid Transit, which established a new high record price on extremely heavy transactions. Initial transactions were made at an advance of ¾ at 19½, from which the price advanced steadily to 25¾, with a subsequent reaction on profit-taking to 24⅞. There was no need to explain the sharp rise in this stock. It was said, however, that New York interests continue to accumulate the stock, in view of the listing of the stock upon the New York Stock Exchange. It is understood that as soon as the engraved certificates of stock are completed the application to list the same will be accepted. About 20,000 shares of the stock were dealt in. Another noteworthy feature was Consolidated Traction of New Jersey, which also established a new high record. From 81½, at the opening, the price advanced to 83½, and closed at the highest, or 3 points above the closing figure of a week ago. Philadelphia Traction was strong at 100, but the amount of stock traded in was very small. Union Traction was firm at 58⅞ to 59. Philadelphia Company declined ⅞ to 41⅛ on limited dealings, but the preferred remained unchanged at 47. United Gas & Improvement opened strong at 109¼, but subsequently the price ran off to 108⅛, where it closed.

Chicago

There have been no important developments in the traction situation this week. The franchise question is still a matter of much discussion in the council, and the prospect of a satisfactory settlement is remote. At the last meeting of the Council over forty amendments to the tentative ordinance were offered, and were finally sent back to the local transportation committee for revision. The representatives of the syndicate now seeking control of the Chicago City Company are to be asked to participate in the reconstruction of the ordinance so as to make it apply to the entire city. Public hearings will be given on the amendments, which include an extension of the transfer system, remove tracks from Michigan Avenue, and a revision of ambiguous provisions.

Although no official announcement has yet been made, it is understood that the syndicate has secured sufficient City Railroad stock at $200 a share to carry control. It is said that service of the largest individual holders of the company's stock have already deposited their stock under the syndicate's agreement.

Trading in the traction stocks has been devoid of feature during the week. Dealings have been extremely small, and price fluctuations have been confined to a narrow range. Chicago City Railway sold at 196, or 1¾ points below last week's closing, but the amount of stock involved was only 125 shares. Chicago Union Traction was steady at 11, West Chicago lost a point to 60, while North Chicago held steady around 83. The elevated railway stocks were extremely quiet. Metropolitan sold at 20, and the preferred at 61 and 60. Northwestern brought 24½ for a small amount, while the preferred changed hands at 64. The bond market was also quiet and without noteworthy feature. The week's transactions included $20,000 North Chicago 5s at 100. West Chicago Consols at 88, $1,000 Northwestern Elevated 4s at 94½, and $2,000 Metropolitan Elevated extension 4s at 86.

Other Traction Securities

In the Baltimore market the dealings in traction stocks were confined almost exclusively to the United Railway issues, all of which were strong. The stock changed hands to the extent of several hundred shares at 13¼ to 13¾, an advance of ⅝. The 4 per cent bonds sold from 93 to 93¼, a gain of ½, while the incomes brought 50⅝ and 51. Norfolk Railway & Light 5s were in good demand, $24,000 selling at 95, an advance of 1⅞ points.

Macon Railway & Light 5s advanced from 94½ to 96. At Boston the traction stocks were practically neglected, but such transactions as were made were at somewhat higher prices. Boston Elevated fluctuated between 157 and 158, the final sale being made at the higher price. Massachusetts Electric advanced 1½ points to 15½, but subsequently reacted to 15, while the preferred rose from 59½ to 61, the closing transaction taking place at 60. West End common held firm at 96, while the preferred stock changed hands at 114¼ to 114, a gain of a full point. Interborough Rapid Transit has been the principal feature on the New York curb, both on account of activity and erratic price movements. During the early part of the week trading in it was extremely quiet, but toward the close the transaction assumed enormous proportions, while the price fluctuated wildly. From 186, at the opening, the price advanced rapidly to 202⅜, from which there was a reaction to 194. Subsequently, there was another upward movement which carried the stock back to 200, but at the close there was a decline to 187¾, on account of reports of dissatisfaction on the part of the company's employees. New Orleans Railway was fairly active and weak, about 1000 shares changing hands at from 4⅝ down to 3¾.

Cincinnati, Dayton & Toledo stock continues in strong demand at Cincinnati. About 2000 shares changed hands at the uniform price of 24. Ten thousand dollars' worth of the 5s of this company sold at 86 to 87. Several lots of the old Southern Ohio 5 per cent bonds sold at 96½. Cincinnati Street Railway was inactive at 144½. Cincinnati, Newport & Covington preferred advanced to 91½ on several sales, and the common sold at 31½ to 32. Several large blocks of Indianapolis Street Railway 4s sold at 87, while thirty thousand dollars' worth of Columbus Railway 4s sold at 92; the preferred stock of this company sold at 108¾.

Cincinnati, Dayton & Toledo stock also featured in Cleveland selling at 23½ to 23⅞, a shade lower than in Cincinnati. Cleveland Electric sold at 79½ and 80 on moderate sellings; it dropped back slightly, the first of the week, on indications that the 3-cent fare test would not solve the franchise problem in Cleveland. Muncie, Hartford & Fort Wayne made a new high mark of 41½. Northern Texas continues strong at 45. Northern Ohio declined slightly to 19. There is a steady demand for Western Ohio receipts at 12½, with but little coming out. Several blocks of Northern Texas 5 per cent bonds at 90 to 90½. The underlying issues of the Cincinnati, Dayton & Toledo bonds were in strong demand.

Security Quotations

The following table shows the present bid quotations for the leading traction stocks, and the active bonds, as compared with last week:

	Jan. 18	Jan. 25
American Railways	48	48
Aurora, Elgin & Chicago (preferred)	—	—
Boston Elevated	157½	157
Brooklyn Rapid Transit	63¾	60⅛
Chicago City	193	195
Chicago Union Traction (common)	11	a12
Chicago Union Traction (preferred)	45	a48
Cleveland Electric	a79	—
Consolidated Traction of New Jersey	80½	83¼
Consolidated Traction of New Jersey 5s	108½	109
Detroit United	77½	75½
Interborough Rapid Transit	187	197
Lake Street Elevated	—	—
Manhattan Railway	169¼	169½
Massachusetts Electric Cos. (common)	13⅝	15
Massachusetts Electric Cos. (preferred)	59½	60
Metropolitan Elevated, Chicago (common)	20½	20¼
Metropolitan Elevated, Chicago (preferred)	60	60
Metropolitan Street	116⅞	116½
Metropolitan Securities	76¾	76¼
New Orleans Railways (common)	4	3¼
New Orleans Railways (preferred)	14	14
New Orleans Railways, 4½s	76	74
North American	100½	98
Northern Ohio Traction & Light	—	—
Philadelphia Company (common)	41¾	41
Philadelphia Rapid Transit	19½	25
Philadelphia Traction	99¾	99¾
South Side Elevated (Chicago)	—	94½
Third Avenue	127	125
Twin City, Minneapolis (common)	106¼	105
Union Traction (Philadelphia)	58¾	58¾
West End (common)	95½	96
West End (preferred)	113	114

a Asked.

Iron and Steel

The "Iron Age" says that the purchase by Cambria Steel of 40,000 tons of basic Bessemer pig at $15.50 is regarded as significant, and was followed by further purchases from other sources of 20,000 to 25,000 tons. In the Pittsburg market, most sellers are now asking $16.

In the steel markets there is a good deal of pressure for material, and it is only lately that a leading interest declined to consider altogether one contract for 25,000 tons.

New England was the principal buyer of rails during the past week. In the East the Baltimore & Ohio and in the West the Rock Island are in the market.

Ninety thousand tons of railroad bridge work is imminent, of which one-half will be placed in the next three months, and 500,000 to 600,000 tons of building work are on architects' boards. Reports from the whole line of lighter finished material continue exceedingly encouraging.

A REPORT ON THE PHILADELPHIA RAPID TRANSIT

Chandler Bros. & Company, bankers and brokers, of Philadelphia, have recently issued in pamphlet form an extended report and statistical analysis of the financial condition of the Philadelphia Rapid Transit Company, of that city. Figures are given of the earnings of the street railway systems in Philadelphia for a number of years back, with passengers carried, gross and net earnings, underlying properties, etc. There is also a table of quotations of the high and low for the last five years of all of the principal Philadelphia securities.

INDIANA SINGLE-PHASE LINE OPENED

The Indiana & Cincinnati Traction Company's single-phase line was opened for traffic between Rushville and Morristown, 16 miles distant, on Saturday, Jan. 21, on a regular 2-hour schedule. The line from Morristown to Indianapolis is expected to be completed in a few weeks. Cars will then be run to the interurban terminal station in Indianapolis.

ANNUAL REPORT OF THE BRITISH THOMSON-HOUSTON COMPANY

The annual meeting of the British Thomson-Houston Company was held in London, Dec. 15. The profit and loss account for the year ending March 31, 1904, showed net earnings, after charging off selling charges, etc., of £182,570. From this amount £20,000 was written off for suspense account and £23,810 for depreciation, good will and patents, leaving a balance of £11,903, which was carried forward to next year. The report states that the works at Rugby have been completed, and mentions the condition of several recent contracts taken by the company.

A. I. E. E. ANNUAL DINNER

The preparations for the Annual Dinner of the American Institute of Electrical Engineers are being pushed actively, and the affair promises to be a great success. It will be devoted, as already announced, to signalizing the triumphs of electric traction. President Lieb has appointed the following committee, which is already at work: Messrs. T. C. Martin, chairman; W. C. Gotshall, L. B. Stillwell, H. G. Stott, Calvin W. Rice, F. C. Bates, H. W. Blake, P. G. Gossler, E. B. Katte, C. W. Price, W. A. Pearson and W. L. Conwell. This committee has organized, and subcommittees are at work on different features of the banquet. Some original and novel features will be included, and it is believed that the oratory will be unusually interesting. Frank J. Sprague and Leo Daft are to speak for the Institute pioneers in this great field of electrical development. The banquet will be held in the grand ball-room of the Waldorf-Astoria, on Feb. 8, and it is expected that between 400 and 500 will be present, including many ladies. Tickets are $5 each, exclusive of wine. It may be mentioned that in addition to the features connected with the dinner itself, there will be exhibited, for the first time, the beautiful oil painting just presented by the British Institution of Electrical Engineers, as a souvenir of last year's visit, to the Institute, representing Dr. Gilbert making magnetic experiments before Queen Elizabeth. The bust of Prof. Ferraris, also presented to the Institution last year, will be exhibited in the Astor Gallery reception room.

A NEW LINE OUT OF CHICAGO

Cornelius J. Ton, secretary of the South Side Suburban Railway Company, of Chicago, says the construction of the company's proposed line from Chicago to Chicago Heights and Hammond, Ind., will be begun about April 1. The system will call for the construction of 41 miles of standard-gage track; part to be equipped with the overhead trolley, and part with the third-rail system. About twenty-two cars will be used. The power station will be built at Calumet River and Wentworth Avenue. Here, also, will be located the repair shops. At Hammond, the terminus of the road, connection will be made with a proposed line building in Indiana. At Thornton Park, through which the new line will pass, an amusement resort will be laid out. The officers of the company are: C. C. Heisen, president; S. A. Foster, vice-president; Cornelius J. Ton, secretary and general manager; C. L. Taylor, auditor; W. D. Ball, electrical engineer; S. B. Spencer, engineer of power station. The office of the company is at 1325 First National Bank Building, Chicago.

RECOMMENDATIONS FOR IMPROVEMENTS IN BROOKLYN—WHAT HAS BEEN DONE THERE

Recommendations to be made to the Brooklyn Rapid Transit Company by the Railroad Commissioners for the improvement of its service will call for the expenditure by the company within the next three years of $20,000,000. This has been decided upon by the commisioners as a result of a report to be made by Commissioner Baker of the board. He will recommend that the sum of $8,500,000 be spent within a year; that $5,000,000 be spent within the following year, and that the balance be spent within the third year. Among the things that it is known will be specifically recommended are the purchase of 200 surface cars, 100 elevated coaches, and the investment of $2,300,000 in increasing power facilities.

Of what the company has done in the way of betterments since the preent management assumed charge of the property, readers of the STREET RAILWAY JOURNAL are familiar through the many articles that have been printed about work that has been of general interest. To some of the plans of the company for the future, detail reference has also been made in these columns. The statement that $4,800,000 was spent in betterments last year conveys better than any generalities the magnitude of the work done in a twelve-month. Of this sum, $4,000,000 came from bond issues and $800,000 from earnings, which was divided among the following improvements: For new tracks and terminals, $800,000; for the central power station on Third Avenue, $740,000; for the Williamsburg power house, $235,000; for new cars, both surface and elevated, $1,500,000; for rebuilding cars, both surface and elevated, $1,500,000; for new sub-stations, $160,000; for building underground conduits for carrying the feeder wires, $420,000; for rebuilding old track, $80,000, and for track improvements, such as bonding of rails by electrically welding the joints, $332,000.

Best of all, perhaps, the effort of the management to mitigate abnormal conditions is generally recognized. There is kindly toleration by the public of a service that in some cases will not permit of improvement until a number of municipal betterments shall have been made, and a tendency is shown by the public willingly to co-operate with the company in adjusting itself to changes that are made for the benefit of the majority. The efforts of the company have also met with fitting acknowledgement by the daily press. "The Brooklyn Daily Eagle," in a recent laudatory editorial on what has been done for the improvement of the service, says:

"The company has made large expenditures for improvements, as Mr. Baker shows, and other large projects are under way, but the traffic grows faster than the company is able to keep up, just as the school population grows faster than the board of education is able to build school houses. During this last November, 150,000 more passengers were carried than in the November previous, and the heaviest day's traffic last year, 1,167,000 passengers, was 67,000 larger than on the heaviest day of the year before. * * * But the figures explain the difficulty of the problem. They show that these conditions are not the choice of the Rapid Transit Company, but its misfortune, and they show that an expenditure and an energy which would make the service of a city like Boston or Baltimore palatial in its comfort is simply swamped by the increasing crowds of Brooklyn. * * * If President Winter could draw unlimited checks on the treasury of the United States he could not alter a good many of the conditions which hamper the service here. He could not make the Brooklyn Bridge carry more surface riders than it is carrying, and he could increase the capacity of the elevated trains which cross the bridge but slightly. Neither could he get more cars between Flatbush Avenue and the bridge, at least until Livingston Street has been widened."

NEW YORK CENTRAL AND NEW HAVEN BUY MORE ELECTRICS

Reports are confirmed of the purchase by the New York Central Railroad interests of the Schenectady Railway, and of the purchase by the Consolidated Railway Company, acting for the New York, New Haven & Hartford Railroad, of the Berkshire Street Railway in Massachusetts.

The purchase of the Schenectady system by the New York Central adds another to the already formidable properties in New York State controlled by that company, and in fact seems to be the welding of another link in what is fast assuming the shape of a chain of lines between Albany and Buffalo. The property was controlled by the General Electric Company. It comprises the city lines in Schenectady; a double-track line between Schenectady and Albany, a distance of 12 miles; a double-track line to Troy, about 12 miles, and a suburban line to Ballston, which it is planned to extend to Syracuse. The local system in Syracuse is owned by the Central, and as the company plans to operate by electricity to the west of Syracuse on its Auburn branch, the line is complete to Rochester. The financial consideration is not even intimated.

By its purchase of the Berkshire Street Railway the New Haven has come into the possession of 42 miles of line operated in and between Pittsfield and Great Barrington, Mass. Control of the property was secured through the purchase of a majority of Berkshire stock, for which, so an unofficial source says, payment will be made in bonds bearing 3 per cent. per annum for a number of years, and later 3½ per cent. It is also said that negotiations are being conducted by the Consolidated Company for the purchase of the principal street railways in the Connecticut River Valley including the Springfield, Holyoke, Northampton, the Hartford & Springfield Companies, and possibly the Greenfield, Deerfield & Northampton Street Railway.

AUGUST BELMONT ON TRANSPORTATION PROBLEMS IN CHICAGO

August Belmont was the principal speaker at the annual banquet of the Chicago Real Estate Board at the Auditorium Hotel on Thursday, Jan. 19. Mr. Belmont's subject was on "Subways: What to Do and How to Get Them." Mr. Belmont's remarks were, of course, more particularly on municipal transportation facilities in their relation to a subway system. After calling attention to the New York subway, which was constructed by the city of New York and leased to an operating company for fifty years, with a renewal period of twenty-five years, he said:

"In my opinion, under right conditions, not only are there no fundamental objections, but, on the contrary, there are distinct advantages to a city in going beyond what are considered to be strictly its governmental functions and acquiring and continuing to hold the title to a transportation system, whether by land or water; perhaps even to other quasi public enterprises. Yet if associated with municipal ownership there is municipal operation of these properties, then I think the justifiable line of municipal activity has been overstepped.

"The great danger in the present situation in Chicago is that in seeking relief from present conditions, something permanent and enduring, and yet absolutely undesirable, may be determined upon. On such occasions, it is well for us all to be on our guard against the adoption or even the serious consideration of many inchoate ill-digested schemes which bring about merely change, but not improvement. The change should be as desirable as it is to be enduring.

"The results which foreign cities have accomplished in the matter of operation of so-called public utility corporations are not of such character as to stimulate their duplication in this country. Municipal operation has, in the main, according to the view of Robert P. Porter, the economist, been an unsuccessful municipal speculation, whether the experiment has taken place in England or Australia, or even in the United States."

Mr. Belmont suggested that all litigation and controversy over the street railway franchises in Chicago be suspended and the companies be permitted to develop and rehabilitate their properties so as to meet the public need; that if the operation was not up to the prescribed standard, the city have the right to take the properties at a figure fixed by arbitration, and after the payment of the money be permitted to enter upon the operation itself or to select a new private occupant. If this 'compromise' did not work out favorable results, Mr. Belmont said Chicago would be free to undertake the venture of municipal ownership, with its financial and civic responsibility.

POWER IMPROVEMENTS IN MONTREAL

The Montreal Street Railway has arranged for the expenditure of $500,000 during 1905 in securing and distributing additional power and making improvements over the system.

An important project which will greatly improve the company's power facilities calls for the erection of three sub-power stations at different terminals of the system. The capacity of each sub-station will be 1000 hp. One of the stations will be located on Glen Avenue near Notre Dame Street, opposite the St. Henri car houses and will supply the western sections of the system; a second station will be located at the corner of St. Denis and Comte Avenue, immediately north of the company car house above the C. P. R. Railway track on St. Denis Street, and will supply lines in the northern sections of the city, and the third station will adjoin the large power station of the Shawinigan Water Power Company at Hochelaga, and will supply the lines in the east end of the city. The central station will then be used only for the lines in the center of the city.

The sub-power stations in the west and north ends of the city will be supplied by a direct line from the Shawinigan power station at Hochelaga.

The company, it is announced, has concluded arrangements for the purchase of twenty acres of land north of the car houses on St. Denis Street. The land would enable the company to extend its system of houses when the requirements demand it.

RIGHT OF WAY RULING IN PENNSYLVANIA

The Supreme Court has sustained the decision of the Potter County Court in an important ruling affecting railway options and rights of way; the case being that of J. D. Newton vs. the Goodyear Construction Company, of Buffalo, N. Y. About 15 years ago George Dillinger and J. D. Newton surveyed and located a line in Potter County under an old charter, Mr. Newton having taken options on the lands along the line in his own name. About three years ago Mr. Dillinger sold his maps, surveys, etc., to the Goodyears. Mr. Newton also agreed to sell his options, but failed to turn them over, subsequently attempting to sell them to an electric railway syndicate. The Goodyears began grading, when Mr. Newton enjoined them, and the court sustained the old survey and decided that "the options without the survey, on which the land ownars agreed and did assign the right to use, were worthless, and there was an implied understanding that the land to be used was that land which the survey located, and no other. It follows, therefore, that to take right of way options without locating a survey cannot be used subsequently, and are worthless, as the survey and location is the only thing to hold the right of way therein described. The Supreme Court held to the same view, deciding that "all options for lands must be confined to the location and survey made at the time, and to no others."

CHICAGO TRACTION MATTERS

The most important development in Chicago traction affairs the past week was the drafting of an ordinance by the local transportation committee of the Chicago City Council to cover an extension of the franchises of the Chicago Union Traction Company. This measure is drawn up along the same lines as the ordinance proposed for the Chicago City Railway Company. The principal features of this proposed ordinance are summed up by the "Chicago Tribune" as follows:

City grants Traction Company a franchise to operate for twenty years for compensation of 5 per cent of gross receipts for first thirteen years and 10 per cent for remainder of the period, reserving the right to commute either percentage into a reduction of fares at any time.

Company is to reconstruct at once the antiquated portion of its equipment and establish a first-class service.

Motive power on all lines shall be electricity—underground trolley within territory bounded by Chicago Avenue, Halsted and Twelfth Streets, and overhead trolley outside of that area.

Company is required to give continuous passage for a 5-cent fare from any point on its lines to any other point within present or future boundaries of city, and is to exchange transfers with City Railway and any other line in city limits.

City may purchase property of company at any time after expiration of thirteenth year of the grant at fair cash value, to be appraised by stated authorities.

Company is to pave certain streets of its right of way and keep in repair all such pavements and remove snow and refuse, sprinkle and otherwise care for streets in which it operates.

Company may be required to operate its cars through proposed downtown subway.

It is reported that Chicago City Railway stockholders are responding well to the offer of the recently formed consolidation syndicate to buy City Railroad stock at $200 per share.

TERRE HAUTE POWER HOUSE BURNED

The power plant of the Terre Haute Traction & Power Company, of Terre Haute, Ind., was partially destroyed by fire on Friday, Jan. 20. The conflagration started in the boiler room, and swept through the plant with great rapidity, doing serious damage to the engines and dynamos before the flames were gotten under control. The lighting service of the city is temporarily crippled, and horse cars had to be resorted to for transportation. The company has a new plant under construction in the city, and the part of this equipment now ready for use will be pressed into service at once to afford relief. The property loss to the burned plant is variously estimated from $100,000 to $150,000. This loss, however, is inconsiderable when compared with the loss that must necessarily result from the partial paralysis of the company's service that the fire has caused.

INTERBOROUGH EMPLOYEES HAVE GRIEVANCE

Committees representing the Brotherhood of Locomotive Engineers, the Brotherhood of Locomotive Firemen and the Amalgamated Association of Street Electric Railway Employees of the Interborough Rapid Transit Company, including the elevated and subway divisions, declaring that the terms of agreement made last summer and entered into between them and the Interborough officials had been absolutely violated in every particular, held a meeting Tuesday, Jan. 24, as a result of which a communication will be presented to the Interborough officials, demanding redress for what the men claim are violations of the working agreement between the company and the men. They ask that the automatic stop now in use to safeguard express trains from collision be installed on the local tracks. They also contend that the men are compelled to work overtime in violation of the term of the contract governing hours of service.

BOSTON Y. M. C. A. ESTABLISHES EVENING CLASSES IN APPLIED ELECTRICITY

For several years the Boston Young Men's Christian Association has conducted one of the most extensive and highly developed evening schools in the United States. It has now established a school to teach the theoretical and practical application of electricity in such a comprehensive, yet thoroughly educational manner, as to be within the grasp of the average man, to eliminate non-essentials, and both in the lectures and laboratory work to use simple and intelligible language, to avoid extreme technicalities and mathematics, and to illustrate the points presented with the actual object under discussion.

The association has secured accommodations in the Park Square Automobile Station on Columbus Avenue. Here a lecture hall has been constructed with accommodations for over one hundred students, office of the superintendent, coat room and large laboratory. The laboratory has been furnished with an equipment illustrating the various subjects included in the school programme.

The association has been most fortunate in securing as the head of this school Professor William L. Puffer, of the Massachusetts Institute of Technology. Professor Puffer is a man of broad technical training and experience, a member of the American Institute of Electrical Engineers since 1893, consulting electrical engineer for the Associated Factory Mutual Fire Insurance Companies since 1893, electrical adviser at the annual meeting of the Underwriters' National Electric Association, lecturer in the course of practical electricity under the auspices of the Lowell Institute for the past sixteen years. Professor Puffer brings to this work every quality essential to the successful conduct of such an enterprise, and students may go to him for advice with assurance of careful personal attention. The instructing staff has been selected with great care from men who are eminently qualified to instruct in the special branches of electricity which have been assigned to them.

The first term of the school was opened on Jan. 10, 1905. The work of this year will consist of a lecture course of eight weeks, on Tuesday and Thursday evenings from 7:30 to 9, a recitation on Friday evenings from 7:30 to 9, and laboratory course as outlined below. The laboratory course will open upon the conclusion of the lecture course, and will extend well into the spring months, requiring two evenings per week, Monday and Thursday or Tuesday and Friday, from 7:30 to 9:30. The instruction will be planned to supplement the work of the lecture course and to familiarize the student with methods of using various kinds of instruments in the making of tests.

MIAMI & ERIE CANAL SENSATION

Sensational charges have been made against the promoters of the Miami & Erie Canal Transportation Company in a suit and answer in cross petition filed last week by T. H. Johnson, of Cleveland, who asked that the court compel the original canal syndicate to pay back to the company the original securities amounting to approximately $3,000,000 par value. Mr. Johnson alleges that he is the holder of stock and bonds of the company, and his answer is in reply to a suit brought by the Cleveland Construction Company to enforce the stockholders liability. Mr. Johnson also alleges that the original distribution of the securities was illegal. His suit amounts to an effort to compel the original syndicate of bankers who floated the company and made the allotment to the subscribers of the underwriting to return the securities to the company. The specific allegation upon which his suit is based is his statement that certain of these securities were given to subscribers without due cash consideration therefore. The defendants named in the Johnson suit are among the best known bankers and traction promoters in Cleveland. The result of this petition, if granted, would be to reopen the entire Miami & Erie case, which was thought to have been settled when the reorganization committee recently announced that it had acquired all the outstanding claims against the company.

STEPHENSON PLANT CHANGES HANDS

As announced in the last issue, the large car and truck plant of the John Stephenson Company, at Elizabeth, N. J., was purchased last week by parties connected with the J. G. Brill Company, of Philadelphia, who have organized a new company under the old name with the following officers: W. H. Heulings, Jr., president; Samuel M. Curwen, vice-president; James Rawle, treasurer, and J. G. Root, secretary and assistant treasurer. Peter M. Kling, who was general manager of the old company, is retained in the same capacity. The sale of the Stephenson Company is one of the most important transactions which has occurred for a long time in street railway manufacturing circles. The recent taking over of the American Car Company and the G. C. Kuhlman Car Company by people interested in the Philadelphia concern, has given rise to a report that a consolidation of all the car building interests is about to take place, and that there will be an alliance with British manufacturers. Acccording to the best authorities, however, there is no foundation for such a report; the purpose of purchasing these plants is simply to reduce freight rates and afford facilities for an ever-increasing business. The American Car Company, the G. C. Kuhlman Car Company, and the Stephenson Company each has a distinct organization, and aside from being licensee of the patented cars and trucks and specialties of the J. G. Brill Company has no other connection therewith, and does not confine its business to any especial territory.

The Stephenson plant at Elizabeth is of a comparatively recent date, having been completed about five years ago. It is situated on 90 acres of ground in the southern outskirts of the city, and has excellent shipping facilities on account of the proximity of two trunk railroads with which the plant is connected. The shops are large and well lighted, and the arrangements for handling cars are of the best. A fine power house supplies the current for the machinery, which is all electrically-driven, and the electric cables between the power house and the various buildings extend through tunnels. The plant is well stocked with material, and the work on the orders in hand is being continued without interruption.

The John Stephenson Company is the oldest concern in the car business. Its founder was the designer and builder of the first street car, which had the appearance of three stage coaches joined together, and was mounted on a pair of wheels at either end and drawn by a pair of horses. This car was built in 1831, and operated in New York City. Before his death, in 1893, John Stephenson had developed an immense business in all parts of the world. The plant was formerly located in New York City at Twenty-Sixth Street, between Fourth and Fifth Avenues, and the business had reached such a magnitude a few years after the death of Mr. Stephenson that it became necessary to seek larger quarters. The company has been very successful in its new plant, and among important orders recently executed were cars for the New York Subway, and cars of a convertible type put in use last season on the Brooklyn Elevated Railroad. It has a reputation for building fine interurban cars, and a notable exhibit at the St. Louis Exposition was one by the company, of the largest electric car ever built, which was mounted on the first six-wheeled trucks made for electric service. The officers of the new company are all men who are widely known in the railway world.

THE BROOKLYN TUNNEL HEARING

The hearing by the New York Rapid Transit Commission on the recommendations of Engineer Parsons for the construction of subway lines to Brooklyn was continued last week. The session was given over entirely to the consideration of the claims advanced by interests in the eastern district of Brooklyn, which territory would not benefit by the building of the tunnels along the lines recommended by Mr. Parsons. In building to Brooklyn there is much more to be considered than the building of lines north and south. Interests in several sections will have to be pacified by the route that is finally decided upon. The claim of the eastern district interests is unquestionably sincere, but it seems to fall equally as far from being ideal as some of the other proposals made to the commission. The route proposed by the eastern district interests would be a part of the East Side subway, in New York, making a continuous route from the Bronx to Jamaica. It would run from Union Square, under Fourteenth Street, across the East River to North Seventh Street, Brooklyn; through Union Avenue to Broadway, through Broadway to Jamaica Avenue, and on to Jamaica. It would be about thirteen and a half miles long. The contention that this line would relieve congestion on both the Brooklyn Bridge and the Williamsburg Bridge is well taken, but the part of the city now suffering most from congestion—that near the City Hall—is entirely ignored in the recommendations. A hearing is being held as the STREET RAILWAY JOURNAL goes to press on an alternative subway proposal advanced by still another faction in Brooklyn.

WATSON MACHINE COMPANY TO BUILD CONOVER CONDENSING APPARATUS

The Watson Machine Company, of Paterson, N. J., announces that it has secured the full line of patterns, working drawings, templets, tools, good-will, etc., of the Conover Manufacturing Company to manufacture the full line of condensing apparatus originated by E. K. Conover, who will be retained as manager of the condenser department of the Watson Machine Company.

The Watson Company's object is to manufacture a complete line of first-class condenser outfits, from the smallest units to the largest. These manufactures will comprise the following: independent steam driver and belt-driven jet condensers, surface condensers, centrifugal pump, independent air pumps, combined air and circulating pumps, cooling towers adapted for fan or natural draft, and dry vacuum pumps.

The company's new erecting shop will have a 25-ton crane, with a 40-ft. span, a runway of 150 ft., and a clearance of 30 ft. under the hook, and as the equipment embraces modern machine shops, foundry, smith and pattern shops, the company is in a position to manufacture all parts of the above condensing outfits under its own supervision, and can therefore guarantee the highest grade of workmanship and materials.

STREET RAILWAY PATENTS

[This department is conducted by Rosenbaum & Stockbridge, patent attorneys, 140 Nassau Street, New York.]

UNITED STATES PATENTS ISSUED JAN. 17, 1905

780,040. Brake Shoe; Harry Jones, Bloomfield, N. J. App. filed Dec. 16, 1903. Comprises a cast body portion and a pair of attaching lugs composed of malleable strap.

780,055. Electrical Controlling Apparatus; Frank C. Newell, Wilkinsburg, Pa. App. filed May 5, 1902. The object of this invention is to place all the apparatus required for the control of the motors on a moving car, outside of the car, so that no current will have to go into or through the car.

780,058. Controller for Electric Motors; Thomas S. Perkins, Wilkinsburg, Pa. App. filed June 24, 1902. Relates to details of a controller in which movement of the handle in reverse direction operates a reversing switch to connect the motors in a local braking circuit and varies the resistance of such circuit.

780,066. Brake Block; Firt W. Sargent, Mahwah, N. J. App. filed April 6, 1904. A combined brake head and shoe consisting of a cast wearing sole and supporting means for the brake beam anchored therein.

780,072. Brake Shoe; Alfred L. Streeter, Chicago, Ill. App. filed March 23, 1903. The shoe is provided in its wearing face with a metal insert consisting of a plurality of longitudinally extending parallel bars across the central portion of the face of the shoe.

780,117. Register; John O. Morris, Richmond, Va. App. filed Dec. 9, 1903. Relates to details of construction of that class of register in which an alarm is sounded after a certain number of fares has been "rung-up," indicating that the person paying the fare at the time of the alarm, is entitled to a rebate or a free ride.

780,194. Sheath for Trolley Wheels; Santos Jurado, New York, N. Y. App. filed March 25, 1904. Provides a sheath for trolley wheels and a pivotal support on the sheath through which support the bearings for the trolley wheel extend.

780,211. Axle for Railway or Other Vehicles; Augustus C. Massey, Los Angeles, Cal. App. filed Sept. 2, 1902. The car axle is constructed in two portions connected by ball bearings, the object being to prevent torsional strain when rounding sharp curves.

780,239. Switch Operating Device; Wilber K. Smith, Denver, Col. App. filed April 28, 1904. Mechanism for throwing the switch from a moving car comprising a vertically-swinging frame, rollers arranged in the frame at opposite sides of its pivot, the rollers being arranged at opposite sides of a lengthwise center line through the frame, and an operating lever extended through the platform of the car and having connection with said frame.

780,268. Rapid Transportation System; Edward W. Curtiss, New York, N. Y. App. filed March 30, 1904. A circular-moving platform to facilitate mounting to an endless train of cars, the circumference of the platform adjacent the cars being adapted to travel at substantially the same speed as the train, while the center travels slowly.

780,276. Brake Mechanism for Six-Wheeled Trucks; George L. Fowler, New York, N. Y. App. filed April 20, 1904. The braking mechanism is confined to each side of the truck, so as to permit greater space within the same for the mounting of electric motors, or for other purposes.

780,316. Third Rail Insulator; Paul Winsor, Weston, Mass., June 10, 1904. Comprises a metallic cap and base and an interposed body of insulating material firmly joining cap and base together, and having an outer covering or shell of non-metallic material provided with a glazed surface.

780,388. Trolley; Guthie H. Tuttle, Shorter, Ala. App. filed Oct. 26, 1904. Comprises two sections separated transversely of the axis, and a support for the sections whereby the sections may move into parallelism and also into oblique relation with each other.

780,410. Automatic Railroad Switch; Goff Currier, St. Paul, Minn. App. filed June 17, 1904 A cam in the road-bed shifted from side to side by a projection on the car, thereby throwing the switch.

PERSONAL MENTION

MR. E. H. MULLIN, of the General Electric Company, died at his home in Millburn, N. J., on Jan. 25. The cause was heart failure.

MR. R. A. WHITE has resigned as engineer of Ford, Bacon & Davis, Birmingham, Ala., office to accept the position of engineer and assistant manager of the Mobile Light & Railroad Company, of Mobile, Ala.

MR. THERON W. ATWOOD has been reappointed Commissioner of Railroads for the State of Michigan, and has announced the reappointment of Mr. D. Healy Clark as deputy commissioner, and of Mr. James Bice as mechanical engineer.

MR. WILLIAM R. KING, M. E., consulting engineer, of New York, is now associated with Sanderson & Porter, of New York, in their general practice as consulting engineers and contractors for the development of railway, light, hydraulic and power propositions.

MR. MARTIN SCHOENHALLS has been appointed master mechanic of the Cincinnati, Dayton & Toledo Traction Company, with headquarters at Trenton, Ohio, to succeed Mr. L. M. Sheldon, resigned. Mr. Isaac Smith has been appointed chief engineer of the company, with headquarters at Trenton.

MR. C. O. LENTZ has resigned as assistant mechanical engineer of J. G. White & Company, of New York, to become connected with Sanderson & Porter, of New York. Mr. Lentz has been with Messrs. White & Company for three years, and formerly was connected with Sargeant & Lundy, of Chicago.

MR. WILLIAM N. STEVENS, assistant mechanical engineer of the Interborough Rapid Transit Company, of New York, has resigned from the company to become connected with J. G. White & Company, of New York. Mr. Stevens formerly was with the Manhattan Elevated Railway Company, of New York.

GEN. WILLIAM A. BANCROFT, president of the Boston Elevated Railway Company, delivered an address on Jan. 19 before the Commercial Club, of Boston, on "Local Transportation in American and European Cities." The salient differences between street railway practice in this country and that noted abroad in the speaker's recent trip were discussed, and the lecture was illustrated by lantern slides. Speaking of the East Boston Tunnel, Gen. Bancroft said that his company is considering the operation of cars therein, which, according to present plans, are to be nearly 46 ft. long, with large vestibules and exits about 3 ft. 6 ins. wide. Prof. Elihu Thomson presided at the meeting, which was attended by about 50 members, all of whom are prominent in business and professional circles in Boston.

MR. WILLIAM SELLERS, head of Wiliam Sellers & Company, of Philadelphia, manufacturers of machine tools, died Tuesday, Jan. 24, at the University Hospital, that city, after an operation. He was 80 years old. Mr. Sellers was a member of the American Philosophical Society, and was at one time president of the Franklin Institute.

MR. J. M. COX has been appointed electrical engineer of the Atlantic City Railroad Company, of Atlantic City, N. J., to succeed Mr. Ellis E. Brown, resigned. Mr. Cox has been the electrical engineer of the Philadelphia & Reading Company at its power house at the Reading Terminal station. He will be succeeded at the power house by Mr. D. T. Williams, assistant engineer of the station.

DR. S. S. WHEELER, of the Crocker-Wheeler Company, is being prominently mentioned for the presidency of the American Institute of Electrical Engineers at the coming election. The name of Mr. J. G. White, of New York, is also being very favorably received as a candidate for vice-president. The usual blanks for nominations under the rules of the Institute are to be mailed to members at an early date.

MR. LOUIS H. HAYNES has become connected with the engineering staff of the New York Central & Hudson River Railroad, and not with the New York, New Haven & Hartford Railroad as previously mentioned in these columns. Mr. Haynes formerly was electrical engineer of the Boston Suburban Electric Companies, from which corporation he resigned to become connected with the New York Central Company.

MR. ARTHUR L. LINN, JR., assistant secretary and treasurer of the Utica & Mohawk Valley Railway Company, of Utica, N. Y., has resigned from the company to become general manager of the Fairmont & Clarksburg Traction Company of West Virginia, and will assume the duties of his new position about Feb. 1. Mr. Linn has been associated with Mr. John J. Stanley, of Cleveland, the general manager of the Cleveland Electric Railway and the first vice-president of the Utica & Mohawk Valley Company, for some twelve years, and for the past four years he has filled acceptably the position of assistant secretary and treasurer of the Utica Company. Prior to that time, he held a responsible position with the Cleveland Electric Railway. The road of which Mr. Linn is to become manager is 20 miles long, and connects Fairmont with Clarksburg. It runs through a rich coal country, and it is the intention of the company to develop the mines and find a Northern market for the coal. Some of the men who are interested with Mr. Andrews and Mr. Stanley have money invested in the company, and Mr. Linn's new position is in the nature of a promotion. When Mr. Linn reaches Fairmont, which place will be his headquarters, plans will be made to build an extension of 20 miles to the road. Mr. Linn is a member of the executive committee of the Street Railway Accountants' Association of America.

PROF. W. ELWELL GOLDSBOROUGH, director of the School of Electrical Engineering, Purdue University, and who, for the past three years, has held the position of chief of the department of electricity at the Louisiana Purchase Exposition, has become associated with J. G. White & Company, of New York City. Mr. Goldsborough will ultimately be permanently located in New York. For the present, however, his time will be divided between Lafayette, Indiana, and New York City. Incidentally, he is still giving attention to the matter of closing up the affairs of the electrical department of the exposition, which will necessitate his being in St. Louis at times during the next month or so. Prof. Goldsborough was graduated from Cornell University in 1892, with the degree of M. E. After graduation he accepted the position of electrical engineer for the Colliery Engineering Company, of Scranton, Pa , and the following year took charge of the Department of Electrical Engineering of Arkansas University, Fayetteville, Ark. In 1894 he was appointed associate professor of electrical engineering at Purdue University, and two years later was advanced to its full professorship. Prof. Goldsborough is most widely known, however, through his papers before the American Institute of Electrical Engineers, and as chief of the department of electricity of the Louisiana Purchase Exposition. His contributions to the Institute have included papers on extensive tests carried on by him in the power station at the Edison Company at Baltimore, Maryland, and on the system of the Union Traction Company, of Indiana. He was also chairman of the executive committee of the Electric Railway Test Commission, under the direction of which an elaborate series of wind resistance tests is now being conducted at Anderson, Indiana.