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The A. C. Motor at the International Electrical Congress

It is significant that at the International Electrical Congress at St. Louis last week the only subject which was discussed at the joint session of all the sections was that of the application of alternating-current motors to railway work. We say this is significant because it shows this subject to be the one considered of most importance and interest of any in the entire field of electrical activity. The address of President Bion J. Arnold was intended as an introduction to the subject which was taken up at the joint session, and an able introduction it was. It was, in brief, a recapitulation of the conquests of the electric railway motor in different classes of railway work and a forecast of what conquests we may expect electrical traction to make in the immediate future. President Arnold is not one to make predictions about what electrical traction will do in the future without some fairly definite ideas as to how it is going to do it. As he stated in his address, those who are most given to making brilliant prophecies as to the supplanting of steam locomotives with electric motor cars are those who have the least technical knowledge of the difficulties to be overcome. There is perhaps no one prominent in the field of electric railway engineering who appreciates more strongly the advantages that steam locomotives possess for certain classes of traffic than does Mr. Arnold. One can see in his address a disinclination to yield to the electric motor anything more than its legitimate field in steam railroad work. Nevertheless, one cannot read this address without feeling that, great as have been the conquests of electrical traction the past twenty years, and great as have been the investments, we are as yet only at the beginning. Following Mr. Arnold's introduction of the subject was Dr. Steinmetz's clear-cut analysis of the situation as it now appears to him. After giving a history of the reasons which led to the abandonment in this country of attempts to make induction motors with their shunt motor characteristics perform railway work, and an analysis of the characteristics of the direct and alternating-current series-commutator motors, he came to the conclusions that the field of the series, single-phase, alternating-current railway motor would be suburban, interurban and long distance work where rapid acceleration is not of great importance. For rapid transit work in cities where rapid acceleration is of prime importance, he thought the direct-current motor would still hold sway.

In this issue we are able to present a digest of this discussion as well as of all the papers presented in Section F of the International Electrical Congress, and while we considered this subject editorially at some length in our last issue, it is of such importance that a few additional words may not be out of place.

In the first place the discussion brought out that no one advocates the installation of the a. c. system on the score of the superiority of the motor over its direct-current series competitor. The direct-current series motor is still the better of the two as regards efficiency, commutation and power factor. The weight of the d. c. motor and its controlling apparatus is also less than that of the alternating-current apparatus with its attendant step-down transformer. We must, therefore, look elsewhere than in the motor and its control for any reasons warranting its introduction in preference to the direct-current motor fed from rotary converter sub-stations. The generating and high-potential distribution systems are practically the same for both a. c. and d. c. motors, and this narrows the subject down to whether the sub-station and trolley-distributing system furnish sufficient reasons to warrant the introduction of the new system. It may be assumed from the statements of the manufacturing companies that they have brought the single-phase alternating-current motor to a state of development where it is commercially operative, and it has certainly shown itself capable of commutating the large currents required for accelerating our heavy suburban cars and performing the work required without injurious heating.

The general consensus of opinion brought out at the Congress was to the effect that, as the alternating-current motor would owe its success to its ability to use potentials on the trolley higher than those practical with direct-current motors, the a. c. type of motor would be limited to suburban service and the larger electric railway problems that will come up in the future. In other words, the alternating-current motor will not supersede the direct-current motor, but will rather create a field of its own, closed at present, due to the limitations of direct-current motor design, and thus broaden the field of electric traction work beyond its present scope. The dividing line between the a. c. and d. c. motor field will necessarily be indistinct with overlappings on either side, as called for by local considerations, but in general it may be stated that the a. c. motor does not show much advantage in first cost or cost of operation where the units are small and operate at infrequent intervals. For example, many of our suburban roads operate cars equipped with four 50-hp motors and geared for a maximum speed of 40 miles to 45 miles per hour. Sub-stations are placed approximately 12 miles apart, and the copper consists of two No. 000 trolleys, with no auxiliary feeders. The introduction of the alternating-current motor and 2000-volt trolley in such case would result in no copper economy, as a smaller wire than No. 000 is hardly feasible. The decreased cost of the a. c. sub-station would here be balanced against the increased cost of the a. c. car equipments, with the result that the cost of the road would be practically the same in either case. Where equipments are larger and where more frequent sub-stations or heavy auxiliary feeder copper is required, the advantage of the high-tension trolley becomes apparent and may become a controlling factor in deciding upon the system to adopt. In cases of very heavy and frequent traffic there are a number of reasons which favor the d. c. system. The New York Central installation is a case in point.

The sub-station used with the alternating-current motor is being designed to operate without attendance, but it is a question if such a practice will be looked upon with favor by our suburban roads. The duties required of an attendant are so light and infrequent, and such latitude is given in the location of sub-stations, due to the small drop in the high-tension trolley, that it is probable that these sub-stations will be usually located where supervision is available. The item of sub-station labor for the two systems in this case may therefore be practically the same. An automatically operated sub-station has an attractive sound, but the actual operation of an a. c. road may show the desirability of attendance at these points.

A fact not touched upon at the Congress discussion, but one which seems to us worthy of most careful consideration, is the fact that current collection on our suburban systems is a serious problem, especially with their continued development calling for higher speeds and the possibility of using trains of two or more cars. With the present trolley, the limit has practically been reached with a single 40-ton car running at 60 miles per hour, while an unprotected third rail is a menace to continuity of service in our Northern States when the traffic is infrequent. A protected third rail adds at least 50 per cent to the cost of a third-rail installation, and a first cost of some $10,000 per mile is a serious burden to throw upon a double-track suburban system. With an alternating-current trolley operating at 2000 volts or 3000 volts, however, the possibility is offered of using some form of bow trolley which will not come off, and which will permit an increase in both the weight and speed of the train. The alternating-current motor system, therefore, may help solve the current-collecting problem, which has become so serious when considering large railway projects from the direct-current standpoint.

Considerable stress was laid in the Congress speeches upon the fact that alternating-current motors for suburban work possesses much greater advantages if they can run over existing d. c. systems. The relative merits of potential control versus series parallel were not entered into to any extent, and an article of considerable length could be written on this point alone. The three-phase motor was discussed and received stanch support from our foreign friends and scant courteous consideration from American engineers. Its constant-speed characteristics, the necessity of a double trolley, its poor power factor and limited torque all combined, in their opinion, to make it unsatisfactory for general railway work. The motor is well adapted to take care of specific cases, but has not the qualifications demanded in general railway work. The a. c. commutator motor practically duplicates the characteristics of the d. c. series motor, and hence is preferable to its three-phase competitor.

Although the discussions at St. Louis were valuable as bringing together at one place considerable information on this subject, no entirely new light was shed upon it. That the alternating-phase series motor will occupy the places consigned to it by the eminent engineers who are responsible for its design there can be little doubt, provided the commutation of these motors stands the test of time. That is the crucial point which every practical railway man is watching with interest, and which, to judge from their public utterances, is not worrying the designers of these motors to any extent.

Economy in Use of Air

Although the amount of power required to compress air for air brakes is a very small percentage of the total power used on an electric road, there is no reason why waste in this detail should be tolerated more than in any other. We have known of but a small number of informal tests made to determine the amount of power used in compressing air for electric railway cars, and these tests have mainly served to demonstrate what a great difference the adjustment of the brake shoes can make in the total air consumption. The amount of power used varies enormously from no other cause than difference in the amount of slack which must be taken up by the air-brake piston before the brakes are applied. It is not difficult to see the reason for this when one considers that after the slack in the brake rigging has been taken up, the entire cylinder space behind the piston must be filled with air at the full braking pressure in order to apply the brakes. A few inches difference in piston travel will make a great difference in the air required to make a brake application. The point is to keep down the piston travel as much as possible by having as little slack as possible in the brake rigging, so that there is but little lost motion, and but little space between the brake shoes and wheels when the brakes are released. It will not do to carry this close adjustment of brake shoes too far, however, because, as was pointed out in an article in a recent issue of this paper, there is frequently much play between journal boxes and truck frames, so that the car wheels are crowded together more closely immediately after the brakes have been applied than when running with the brakes off. If the brake shoes are adjusted so as to be close to the wheels when the car is standing still immediately after the brakes have been applied, there is danger that brake shoes will bear on the wheels when the car is running, because the wheels are then spread further apart.

Some figures giving the electrical energy consumed by the air-brake compressor on a 25-ton car in city service are given in another column; although, as we have said before, the consumption of air varies greatly, depending on the piston travel. These figures probably represent fair average conditions, as the tests were made by an engineer whose practical knowledge of car equipment would not permit him to be led astray in this respect. In these tests the kw-hours per car-mile used for braking averaged .064, which is probably about 3 per cent of the total power taken by the car, although figures are not given on the total power consumption of the car. Aside from the question of current cost, the amount of air required for braking is a very decided factor in the amount of repairs needed on motors and compressors, as the repairs on motors and compressors should be somewhere near in direct proportion to the amount of air pumped.

The Status of the "Third-Rail System"

It has been an open secret for some time that the old Nantasket third-rail line had been practically abandoned, but now comes the announcement that it has been stripped and definitely given up, which fact has naturally aroused considerable comment. The high-speed trolley line along the beach has not been discontinued, but only the section used by electrics and steam trains in common. An official of the New York, New Haven & Hartford Railroad is quoted as saying that the system was found impracticable, and that if electricity were used further as a motive power it would be in connection with electric locomotives, the state of development of which did not yet warrant their introduction.

For several years the third rail was a fetish among electric railway men, and it was expected to work miracles at short notice. As usually happens in this work-a-day world, the miracles were not forthcoming. There was in fact no good reason to expect them. Nevertheless, we think that our friends of the daily press are making too much of a rather small matter. It is nothing unusual to find a new method of special rather than general applicability, and on the whole, one should be thankful for the success instead of lamenting the fact that success is not universal. As a matter of actual experience, the third-rail method of supply has done and is doing remarkably well in the situations in which success could reasonably be anticipated. On elevated roads and in subways, wherever in fact a third rail could be efficiently insulated, it has done its work admirably. It has even done passably well in special service along private rights of way, although for such service it has seldom had the preference over the overhead trolley system. Converted steam railroad lines have usually adopted the third rail instead of the trolley on account of collection difficulties with the latter, but while the third rail has answered the purposes for which it was installed, and is the only practical conductor for heavy traction under d. c. working, it can hardly be considered as entirely satisfactory on lines having infrequent traffic.

The center third rail as installed at Nantasket was laid very low down, barely clearing the ties, and upon wooden insulators. Using a center rail, this cramped construction was necessary to escape the fire boxes of some of the locomotives, but the wooden insulators were decidedly risky. Even though such a line can be operated where the leakage is severe, bad insulation is bound to make trouble sooner or later. The wonder is that the system lasted as long as it has under the circumstances. Although a third rail placed laterally and suitably insulated is successful from an operative standpoint, when thus placed it is very difficult to arrange for a complicated system of tracks, and is highly dangerous unless in some way protected. Terminal yards present serious and almost forbidding complications, to be overcome only by great skill in planning the conditions of operation, so that steam roads have naturally hesitated to adopt the plan even in its latest forms, which are vastly improved over the abandoned Nantasket system. On the other hand, when large power is required, the third rail with its ample contact surface and simple form of collector is very attractive in spite of the difficulties which beset it. It has long been clear, however, that it constitutes a special device of electric traction rather than a general method.

The Congestion Point in Car Headway

In connection with the handling of St. Louis Day crowds at the Exposition, a point comes up which is not very well understood by the general public, and possibly only by those street railway men who have had to do with operating cars on very short headway in the largest cities. The point is, that increasing the number of cars on a given street or route beyond a certain point, instead of increasing the number of passengers which can be carried per hour, actually decreases the number because of the congestion which it creates and the interference of one car with another. For example, on the Olive Street line in St. Louis, which is the one receiving the heaviest World's Fair travel, it has been found that a headway of about twenty-five seconds between cars is the shortest that is feasible if cars are to maintain their schedule speed of about 9 miles per hour for the round trip between Fourth Street in the downtown district and the loop at the Fair grounds. If more cars are put on the line so that the headway is less than twenty-five seconds, the same schedule speed cannot be maintained because of the interference of one car with another at stopping points. By decreasing the speed, cars can be operated on a shorter headway than twenty-five seconds and, consequently, more passengers can be carried per hour, provided there are no delays, but there comes soon a point where an increase in the number of cars will not result in any shortening of the headway—that is, cars will have to move on such a slow schedule that no more cars can be operated past a given point in a minute than could be operated if fewer cars were on the line and the schedule were made faster to allow them freer movement. The point where an increase in the number of cars on a line ceases to cause an increase in the number of cars operated past a given point in a given time may be called the "congestion point" in car headway, beyond which we cannot go. However, this congestion point is not reached until after schedule speed has been materially reduced from what it ordinarily is on all but the most congested streets. The fact that some streets are so congested that it is impossible to operate except at a very slow speed, fits in very well with the fact that usually it is on such streets that it is desirable to operate the largest number of cars, but on the other hand, it is likely to be the case that the very fact that there are so many cars on the street causes the congestion which necessitates the slow speed.

PASSENGER STATIONS AND ENGINEERING DETAILS OF THE NEW YORK SUBWAY SYSTEM

The approaching completion of the great subway system of the Interborough Rapid Transit Company, New York, is surrounded by the extreme interest that attends the successful accomplishment of an enterprise of so great a magnitude and of so difficult a nature. While the work of construction was only begun something over four years ago, ground having first been broken in March, 1900, work of construction upon the colossal undertaking is now practically completed, experimental trains are running, and within a short time actual operation will be attempted. Articles will be published in an early issue on the power station, signal system and rolling stock, while in this number particulars are given of the passenger stations and general condition of the work.

The construction of the subway rapid transit system in New York is one of the most interesting and wonderful undertakings of an electric nature that have of recent years been made. The engineering difficulties met in the construction work were well nigh appalling. Towering buildings along the streets to be traversed had to be considered, while the streets themselves were already occupied with complicated networks of sub-surface structures, such as sewers, water and gas mains, electric cable conduits, electric surface railway conduits, telegraph and power conduits, and many vaults extending out under the streets, occupied by the abutting property owners. On the surface were surface railway lines carrying the enormously heavy urban traffic of this city both night and day, while all the thoroughfares in the lower part of the city were of course congested with vehicular traffic. All of these conditions added to the difficulties of construction, and it is accordingly greatly to the credit of the contractors that the work has been pushed so rapidly and is approaching completion with such a general harmony of details.

KIOSKS AT COLUMBUS CIRCLE

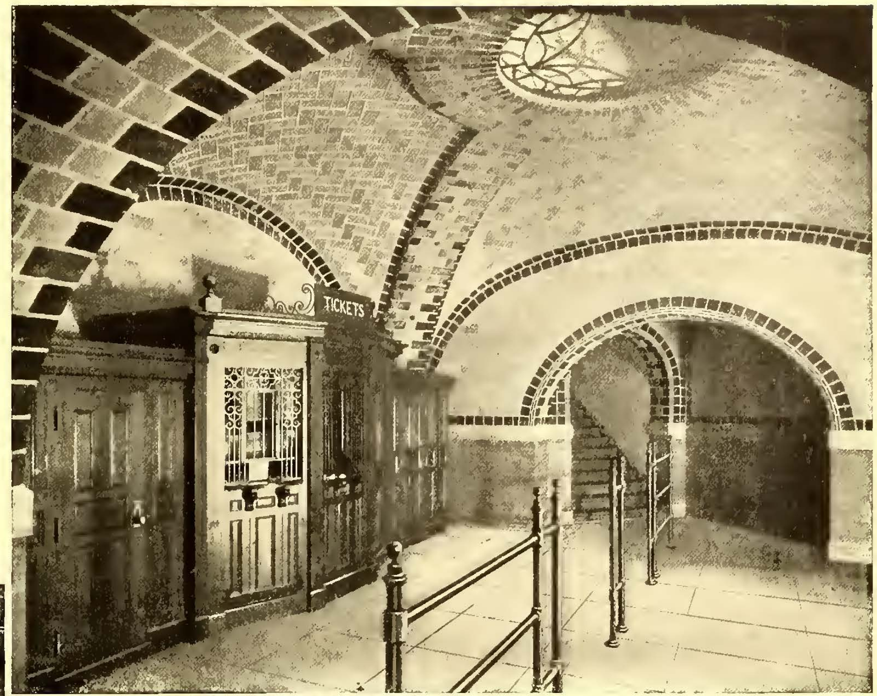
As has been previously noted in the columns of the STREET RAILWAY JOURNAL, the general contract for the construction of the subway system was let by the city to John B. McDonald. In the organization of the construction company, which was known under the title of "Rapid Transit Subway Construction Company," Mr. McDonald was assisted by August Belmont, who, as president and active executive head, perfected the organization, collected the staff of engineers under whose direction the work of building the road was to be done, supervised the letting of sub-contracts, and completed the financial arrangements for carrying on the work.

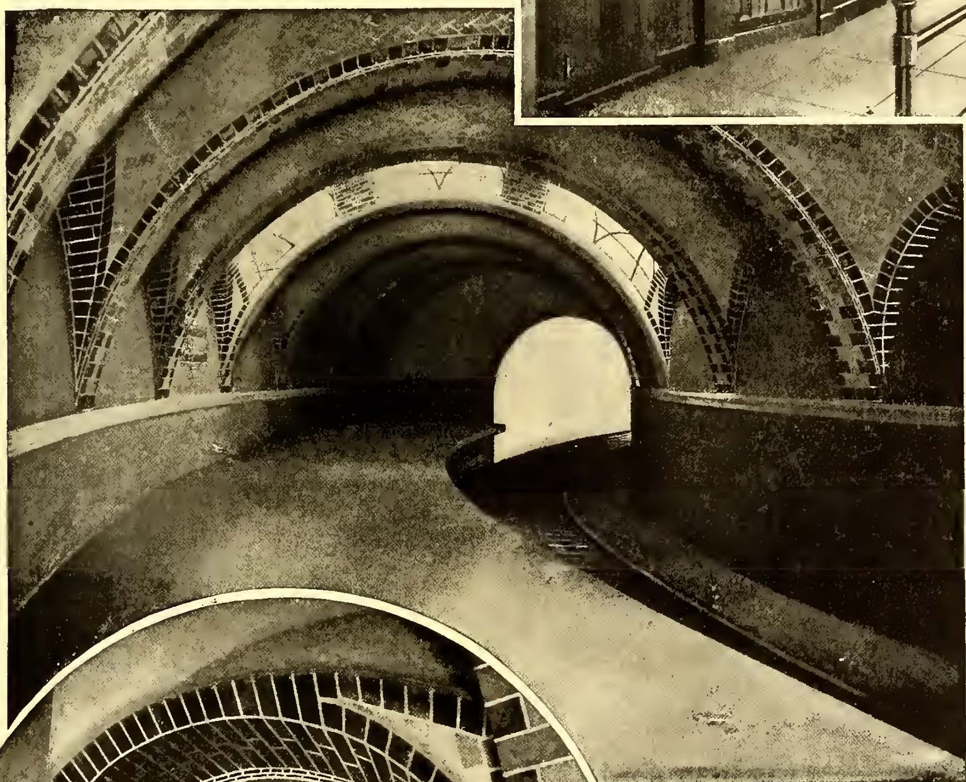
The equipment of the road included, under the terms of the contract, the rolling stock, all machinery and mechanisms for generating electricity for motive power, lighting and signaling, and also the power house, sub-stations and the real estate upon which they were to be erected. The magnitude of the task of providing the equipment was not generally appreciated until Mr. Belmont took the rapid transit problem in hand. He foresaw from the beginning the importance of that branch of the work, and early in 1900, immediately after the signing of the contract, turned his attention to selecting the best engineers and operating experts, and planned the organization of an operating company. As early as May, 1900, he secured the services of E. P. Bryan, who came to New York from St. Louis, resigning as vice-president and general manager of the Terminal Railroad Association, and began a study of the construction work and plans for equipment, to the end that the problems of operation might be anticipated as the building and equipment of the road progressed. Upon the incorporation of the operating company, Mr. Bryan became vice-president.

In the spring of 1902 the Interborough Rapid Transit Company, the operating railroad corporation, was formed by the interests represented by Mr. Belmont, he becoming president and active executive head of this company also, and soon thereafter Mr. McDonald assigned to it the lease or operating part of his contract with the city, that company thereby becoming directly responsible to the city for the equipment and operation of the road. In the summer of the same year, the Board of Rapid Transit Railroad Commissioners having adopted a route and plans for an extension of the subway under the East River to the Borough of Brooklyn, the Rapid Transit Subway Construction Company entered into a contract with the city, similar in form to Mr. McDonald's contract, to build, equip and operate the extension. In January, 1903, the Interborough Rapid Transit Company acquired the elevated railway system by lease for 999 years from the Manhattan Railway Company, thus securing harmonious operation of the elevated roads and the subway system, including the Brooklyn extension.

The incorporators of Interborough Rapid Transit Company were William H. Baldwin, Jr., Charles T. Barney, August Belmont, E. P. Bryan, Andrew Freedman, James Jourdan, Gardiner M. Lane, John B. McDonald, DeLancey Nicoll, Walter G. Oakman, John Peirce, Wm. A. Read, Cornelius Vanderbilt, George W. Wickersham and George W. Young. The incorporators of Rapid Transit Subway Construction Company were Charles T. Barney, August Belmont, John B. McDonald, Walter G. Oakman and William A. Read.

The builders of the road did not underestimate the magnitude of the task before them. They retained the most experienced experts for every part of the work and, perfecting an organization in an incredibly short time, proceded to surmount and sweep aside difficulties. The result is one of which every citizen of New York may feel proud. The stations and approaches are commodious, and the stations themselves furnish conveniences to passengers heretofore not heard of on intra-urban lines. There is a separate express service, with its own tracks, and the stations are so arranged that passengers may pass from local trains to express trains, and vice versa, without delay and without payment of additional fare. Special precautions have been taken and devices adopted to prevent a failure of the electric power and the consequent delays of traffic. An electro-pneumatic block signal system has been devised, which excels any system heretofore used,





VIEWS IN CITY HALL STATION

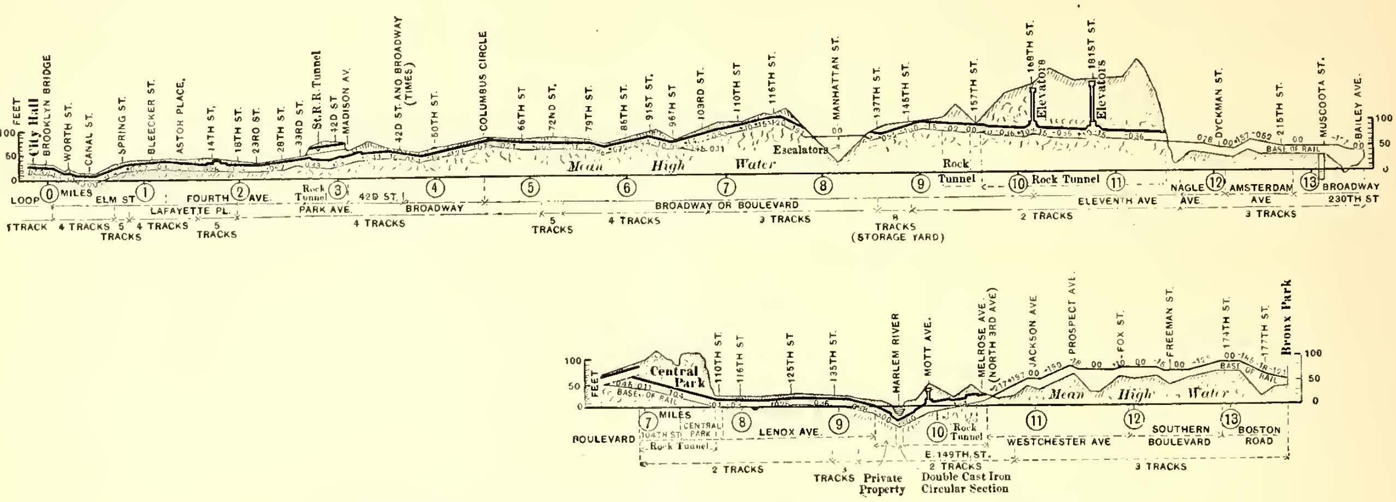
and is unique in its mechanism. Special emergency and fire-alarm signal systems are installed throughout the length of the road. At a few stations, where the road is not near the surface, improved escalators and elevators are provided. The cars have been designed to prevent danger from fire. Strength, utility and convenience have not alone been considered, but all parts of the railroad structures and equipment, stations, power house and electrical sub-stations have been designed and constructed with a view to the beauty of their appearance, as well as to their efficiency.

The routes in detail are as follows: Beginning near the intersection of Broadway and Park Row, one of the routes of the railroad extends under Park Row, Center Street, New Elm Street, Elm Street, Lafayette Place, Fourth Avenue (beginning at Astor Place), Park Avenue, Forty-Second Street, and Broadway to 125th Street, where it passes out and over Broadway by an elevated structure to 133d Street, thence under Broadway again to and under Eleventh Avenue to Fort George, where it comes to the surface again at Dyckman Street and continues by viaduct over Nagle Avenue, Amsterdam Avenue and Broadway to Bailey Avenue, at the Kingsbridge station of the New York & Putnam Railroad, crossing the Harlem Ship Canal on a double-deck drawbridge. The length of this route is 13.50 miles, of which about 1½ miles are on viaduct.

Another route, branching from the above, begins at Broadway near 103d Street and extends under 104th Street and the upper part of Central Park to and under Lenox Avenue, to 142d Street, thence curving to the east to and under the Harlem River at about 145th Street, thence from the river to and under East 149th Street to a point near Third Avenue, thence by viaduct beginning at Brook Avenue over Westchester Avenue, the Southern Boulevard and the Boston Road to Bronx Park. The length of this route is about 6.97 miles, of which about 3 miles are on viaduct.

At the City (Borough) Hall there is a loop under the Park. From 142d Street there is a spur north under Lenox Avenue to 147th Street. There is a spur at Westchester and Third Avenue connecting by viaduct the Manhattan Elevated Railway division of Interborough Rapid Transit Company with the viaduct of the subway at or near St. Ann's Avenue. The route of the Brooklyn extension connects near Broadway and Park Row with the Manhattan-Bronx route, and extends under Broadway, Bowling Green, State Street, Battery Park, Whitehall Street and South Street to and under the East River to Brooklyn at the foot of Joralemon Street, thence under Joralemon Street, Fulton Street and Flatbush Avenue to

There is a storage yard under Broadway between 137th Street and 145th Street on the Fort George branch, another on the surface at the end of the Lenox Avenue spur at Lenox Avenue and 147th Street, and a third on an elevated structure at the Boston Road and 178th Street. There is a repair shop and inspection shed on the surface adjoining the Lenox Avenue spur at the Harlem River and 148th-150th Streets, and an



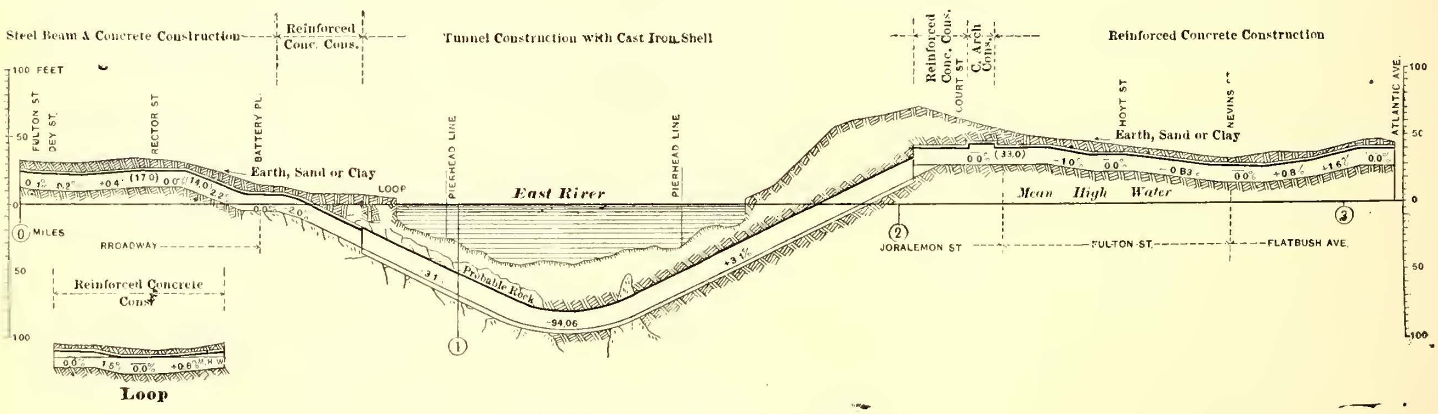
PROFILE OF RAPID TRANSIT RAILROAD, MANHATTAN AND BRONX LINES

Atlantic Avenue, connecting with the Brooklyn tunnel of the Long Island Railroad at that point. There is a loop under Battery Park beginning at Bridge Street. The length of this route is about 3 miles.

The routes in Manhattan and the Bronx, therefore, may be said to roughly resemble the letter Y, with the base at the southern extremity of Manhattan Island, the fork at 103d

inspection shed at the storage yard at Boston Road and 178th Street.

The grades and curvature along the main line may be summarized as follows: The total curvature is equal in length to 23 per cent of the straight line, and the least radius of curvature is 147 ft. The greatest grade is 3 per cent, and occurs on either side of the tunnel under the Harlem River. On the



PROFILE OF BROOKLYN EXTENSION

Street and Broadway, the terminus of the westerly or Fort George branch of the fork just beyond Spuyten Duyvil Creek, the terminus of the easterly or Bronx Park branch at Bronx Park. The total length of the line from the City Hall to the Kingsbridge terminal is 13.50 miles, with 47.11 miles of single track and sidings. The eastern or Bronx Park branch is 6.97 miles long, with 17.50 miles of single track. The total length of the Brooklyn extension is 3.1 miles, with about 8 miles of single track.

From the Borough Hall, Manhattan, to the Ninety-Sixth Street station, the line is four-track. On the Fort George branch (including 103d Street station) there are three tracks to 145th Street, two tracks to Dyckman Street, and then three tracks again to the terminus at Bailey Avenue. On the Bronx Park branch there are two tracks to Brook Avenue, and from that point to Bronx Park there are three tracks. On the Lenox Avenue spur to 147th Street there are two tracks, on the City Hall loop one track, on the Battery Park loop two tracks. The Brooklyn extension is a two-track line.

Brooklyn extension the maximum grade is 3.1 per cent, descending from the ends to the center of the East River tunnel. The minimum radius of curve is 1200 ft. At each station there is a down grade of 2.1 per cent to assist in the acceleration of the cars when they start.

The track is of the usual standard construction with broken stone ballast, timber crossties and 100-lb. rails of the American Society of Civil Engineers' section. The crossties are selected hard pine. All ties are fitted with tie plates. All curves are supplied with steel inside guard rails. The frogs and switches are of the best design and quality to be had, and a special design has been used on all curves. At the Battery loop, at Westchester Avenue, at Ninety-Sixth Street, and at City Hall loop, where it has been necessary for the regular passenger tracks to cross, grade crossings have been avoided; one track or set of tracks passing under the other at the intersecting station points.

The contract for the building of the road contains the following somewhat unusual provision: "The railway and its equipment as contemplated by the contract constitute a great public work. All parts of the structure where exposed to public sight shall therefore be designed, constructed and maintained with a view to the beauty of their appearance, as well as to their efficiency."

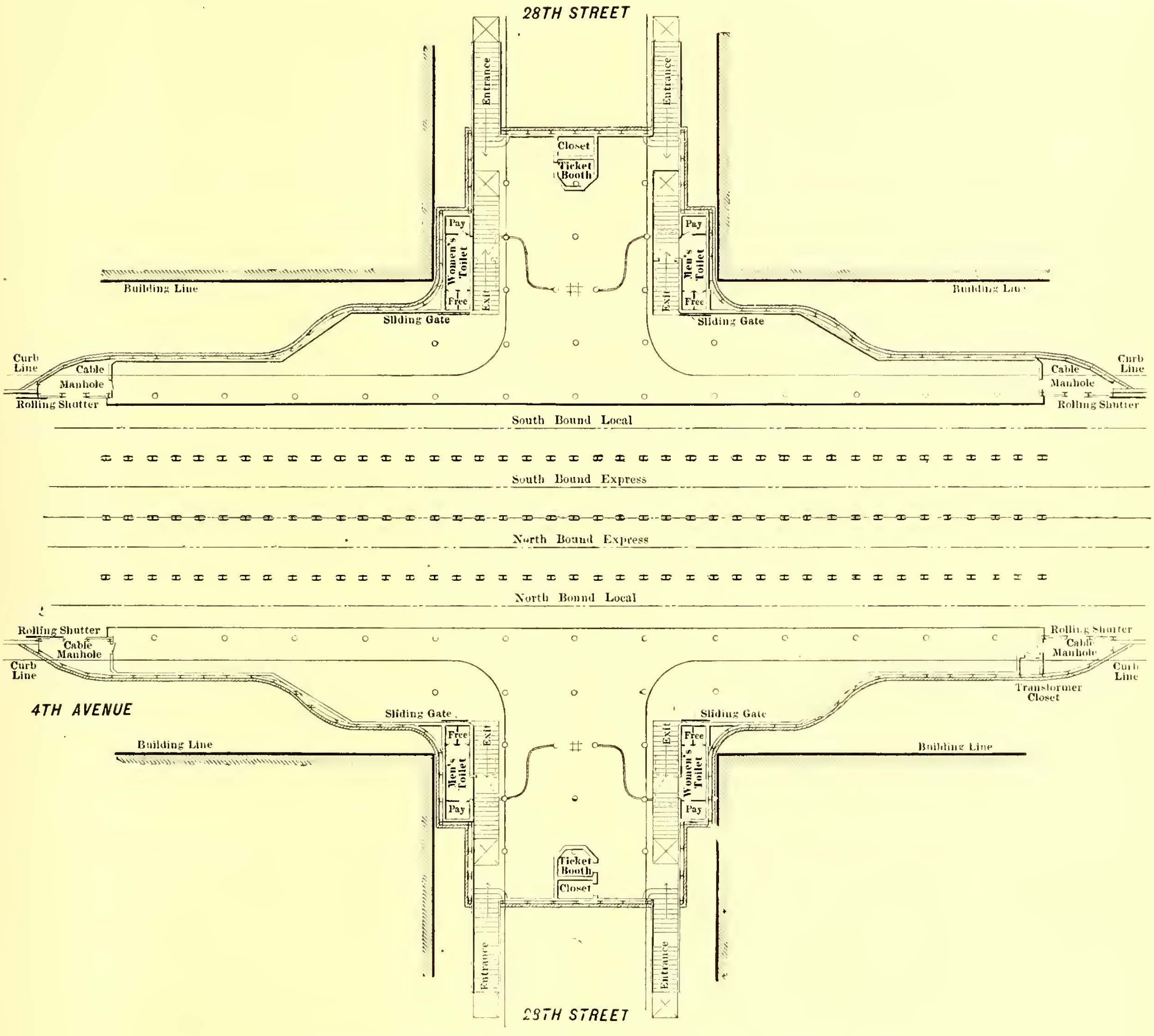
It may be said with exact truthfulness that the builders have spared no effort or expense to live up to the spirit of this provision, and that all parts of the road and equipment display dignified and consistent artistic effects of the highest order. These are noticeable in the power house and the electrical sub-stations, and particularly in the passenger stations. It might readily have been supposed that the limited space and comparative uniformity of the underground stations would afford but little opportunity for architectural and decorative effects. The result has shown the fallacy of such a supposition.

Of the forty-eight stations, thirty-four are underground, eleven are on the viaduct portions of the road, and two are partly on the surface and partly underground, and one is partly on the surface and partly on the viaduct. The underground stations are at the street intersections, and, with the exception of a few instances, occupy space under the cross streets. At all local stations (except at 110th Street and Lenox Avenue) the platforms are outside of the tracks. At Lenox Avenue and 110th Street there is a single island platform for uptown and downtown passengers.

The station plans are necessarily varied to suit the conditions of the different locations, the most important factor in planning them having been the amount of available space. The platforms are from 200 ft. to 350 ft. in length, and about 16 ft. in width, narrowing at the ends, while the center space is larger or smaller, according to local conditions. As a rule, the body of the station extends back about 50 ft. from the edge of the platform.

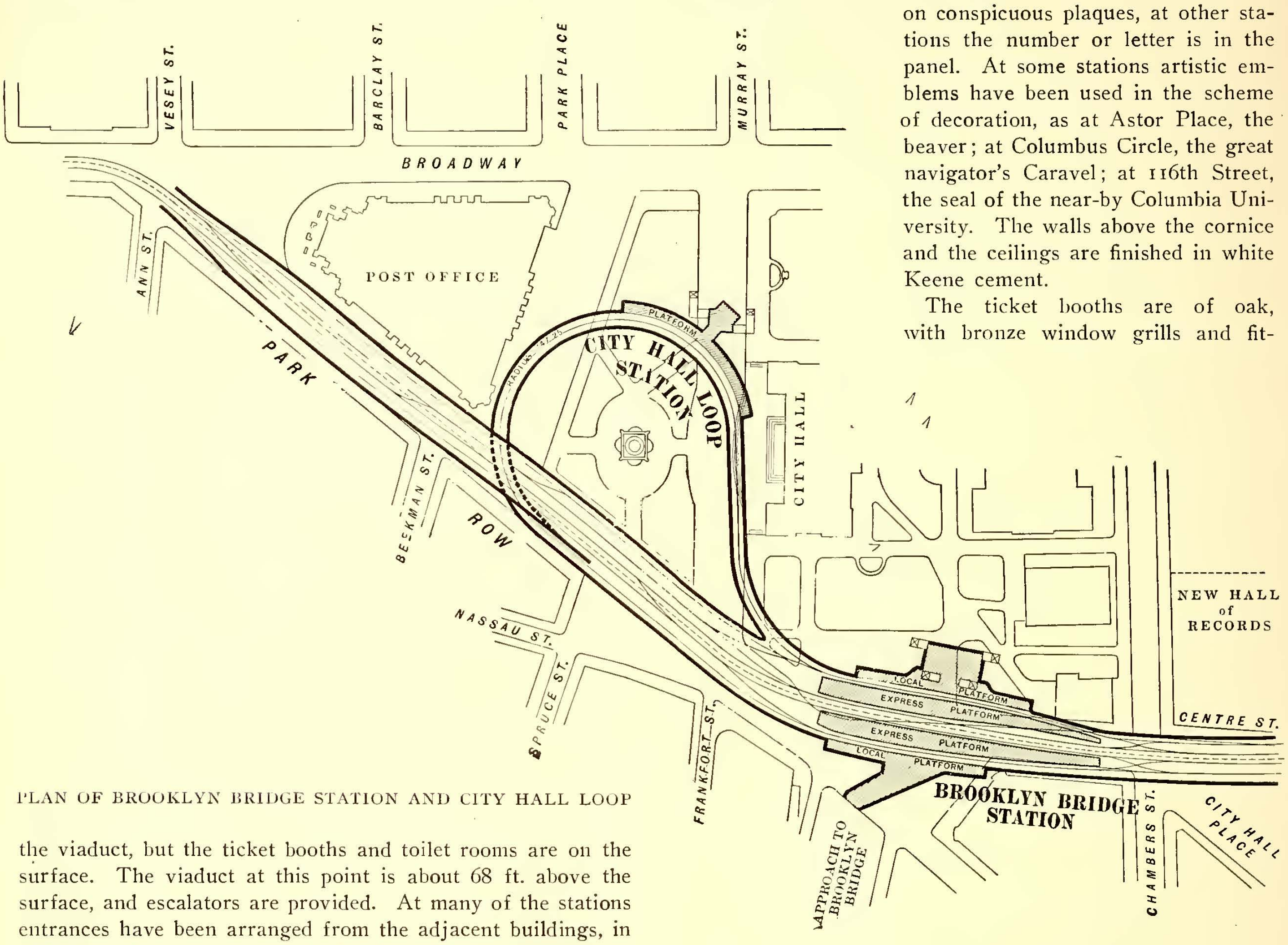
At express stations there are two island platforms between the express and local tracks, one for uptown and one for downtown traffic. In addition, there are the usual local platforms at Brooklyn Bridge, Fourteenth Street and Ninety-Sixth Street, as shown in an accompanying view. At the remaining express stations, namely, at Forty-Second Street and Madison Avenue, and at Seventy-Second Street, there are no local platforms outside of the tracks, both local and through traffic using the island platforms.

The island platforms at the Brooklyn Bridge, Fourteenth Street, and Forty-Second Street and Madison Avenue, express stations are reached by mezzanine footways from the local platforms, it having been impossible to place entrances in the streets immediately over the platforms. At Ninety-Sixth Street there is an underground passage connecting the local and island platforms, and at Seventy-Second Street there are entrances to the island platforms directly from the street, which



PLAN OF TWENTY-EIGHTH STREET AND FOURTH AVENUE STATION is made possible by the park area in the middle of the street, in which is built a commodious ornamental station building upon the surface. Local passengers can transfer from express trains and express passengers from local trains, without payment of additional fare, by merely stepping across the island platforms.

At Seventy-Second Street, at 103d Street and at 116th Street and Broadway the station platforms are below the surface, but the ticket booths and toilet rooms are on the surface, this arrangement being possible also because of the park area available in the streets. At Manhattan Street the platforms are on



PLAN OF BROOKLYN BRIDGE STATION AND CITY HALL LOOP

the viaduct, but the ticket booths and toilet rooms are on the surface. The viaduct at this point is about 68 ft. above the surface, and escalators are provided. At many of the stations entrances have been arranged from the adjacent buildings, in addition to the entrances originally planned from the street.

The entrances to the underground stations are enclosed at the street by "kiosks" of cast iron and wire glass, as shown in the view on page 464, and vary in number from two to eight at a station. The stairways are of concrete, reinforced by twisted steel rods. At 168th Street, at 181st Street, and at Mott Avenue, where the platforms are from 90 ft. to 100 ft. below the surface, elevators are provided.

At twenty of the underground stations it has been possible to use vault lights to such an extent that very little artificial light is needed. Such artificial light as is required is supplied by incandescent lamps sunk in the ceilings. Provision has been made for using the track circuit for lighting in emergency if the regular lighting circuit should temporarily fail.

The station floors are of concrete, marked off in squares. At the junction of the floors and side walls a cement sanitary cove is placed. The floors drain to catch basins, and hose bibs are provided for washing the floors.

Two types of ceiling are used, one flat, which covers the steel and concrete of the roof, and the other arched between the roof beams and girders, the lower flanges of which are exposed. Both types have an air space between ceiling and roof, which, together with the air space behind the inner side walls, permits air to circulate and minimizes condensation on the surface of the ceiling and walls.

The ceilings are separated into panels by wide ornamental moldings, and the panels are decorated with narrow moldings and rosettes. The bases of the walls are buff Norman brick. Above this is glass tile or glazed tile, and above the tile is a faience or terra-cotta cornice. Ceramic mosaic is used for decorative panels, friezes, pilasters and name tablets. A different decorative treatment is used at each station, including a distinctive color scheme. At some stations the number of the intersecting street or initial letter of the street name is shown on conspicuous plaques, at other stations the number or letter is in the panel. At some stations artistic emblems have been used in the scheme of decoration, as at Astor Place, the beaver; at Columbus Circle, the great navigator's Caravel; at 116th Street, the seal of the near-by Columbia University. The walls above the cornice and the ceilings are finished in white Keene cement.

The ticket booths are of oak, with bronze window grills and fittings. There are toilet rooms in every station, except at the City Hall loop. Each toilet room has a free closet or closets, and a pay closet, which is furnished with a basin, mirror, soap dish and towel rack. The fixtures are porcelain, finished in dull nickel. The soil, vent and water pipes are run in wall spaces, so as to be accessible. The rooms are ventilated through the hollow columns of the kiosks, and each is provided with an electric fan. They are heated by electric heaters. The woodwork of the rooms is oak; the walls are red slate wainscot and Keene cement.

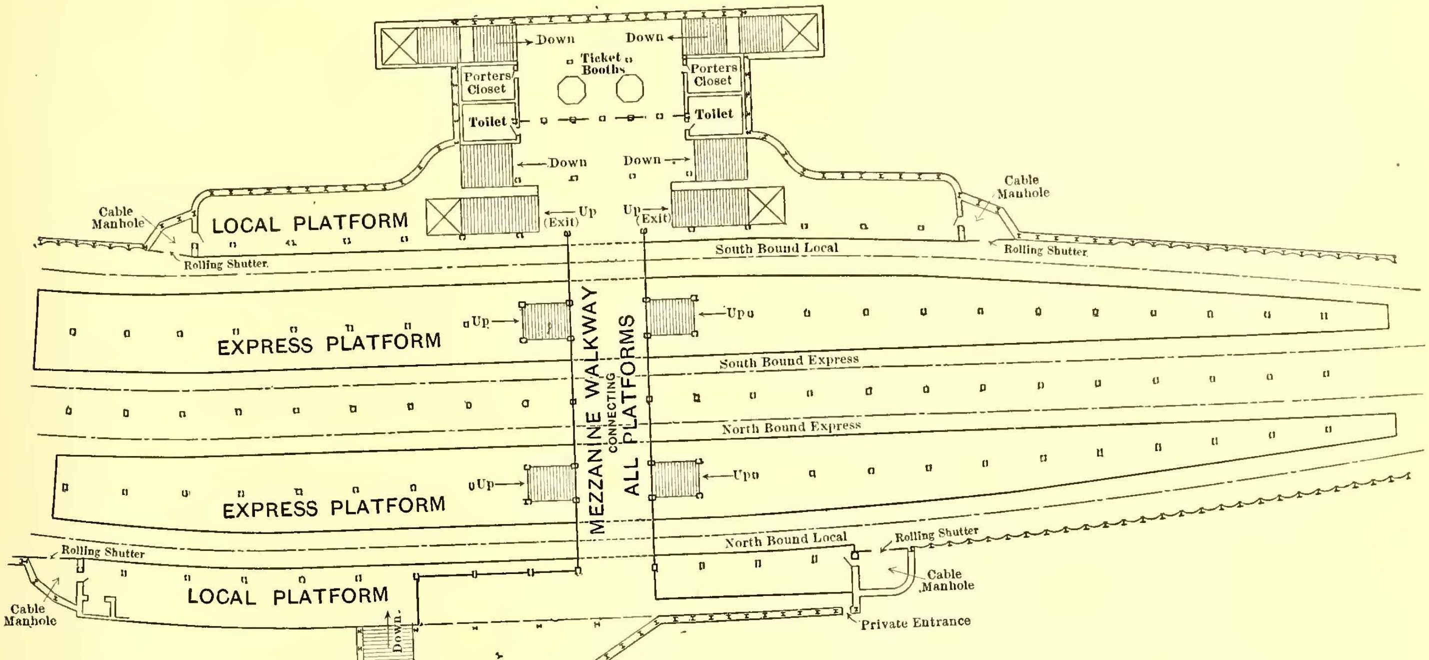
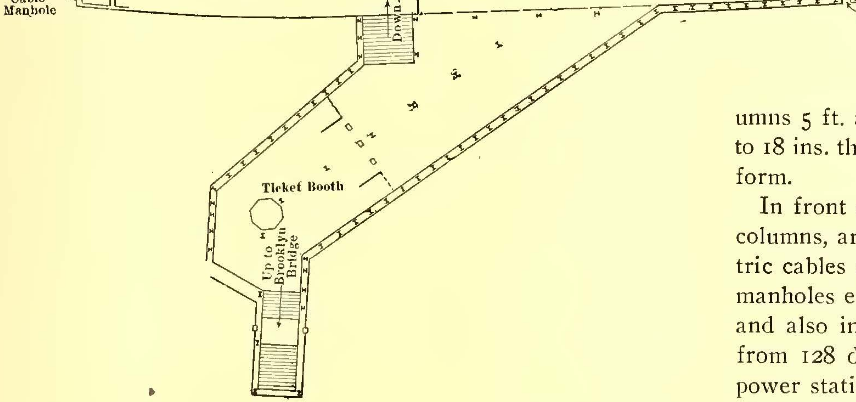
Passengers may enter the body of the station without paying fare. The train platforms are separated from the body of the station by railings. At the more important stations, separate sets of entrances are provided for incoming and outgoing passengers, the stairs at the back of the station being used for entrances and those nearer the track being used for exits.

An example of the care used to obtain artistic effects can be seen in the views of the City Hall station on page 465. The road at this point is through an arched tunnel. In order to secure consistency of treatment, the roof of the station is continued by a larger arch of special design. At 168th Street, at 181st Street and at Mott Avenue stations, where the road is far beneath the surface, it has been possible to build massive arches with spans of 50 ft. over the stations and tracks.

Five types of construction have been employed in building the road: (1) the typical subway near the surface with flat roof and I-beams for the roof and sides, supported between tracks with steel bulb-angle columns used on about 10.6 miles or 52.2 per cent of the road; (2) flat roof typical subway of reinforced concrete construction supported between the tracks by steel bulb-angle columns, used for a short distance on Lenox Avenue and on the Brooklyn portion of the Brooklyn extension, and also on the Battery Park loop; (3) concrete lined tunnel used on about 4.6 miles or 23 per cent of the road, of which 4.2 per cent was concrete lined open cut work, and the remainder was rock tunnel work; (4) elevated road on steel viaduct used on about 5 miles or 24.6 per cent of the road; (5) cast-iron tubes used under the Harlem and East Rivers.

The general character of the flat roof I-beam construction is shown in the view on page 471. The bottom is of concrete. The side walls have I-beam columns 5 ft. apart, between which are vertical concrete arches, the steel acting as a support for the masonry and allowing the thickness of the walls to be materially reduced from that necessary were nothing but concrete used. The tops of the wall columns are connected by roof beams which are supported by rows of steel columns between the tracks, built on concrete and cut stone basis forming part of the floor system. Concrete arches between the roof beams complete the top of the subway. Such a structure is not impervious, and hence, there has been laid behind the side walls, under the floor and over the roof, a course of two to eight thicknesses of felt, each washed with hot asphalt as laid. In addition to this precaution against dampness, in three sections of the subway (viz: on Elm Street between Pearl and Grand Streets, and on the approaches to the Harlem River tunnel, and on the Battery Park loop) the felt water-proofing has been made more effective by one or two courses of hard-burned brick laid in hot asphalt, after the manner sometimes employed in constructing the linings of reservoirs of water-works.

The reinforced concrete construction substitutes for the steel roof beams, steel rods, approximating 1¼ ins. square, laid in varying distances according to the different roof loads, from 6 ins. to 10 ins. apart. Rods 1⅛ ins. in diameter tie the side walls, passing through angle columns in the walls and the bulb-angle columns in the center. Layers of concrete are laid over the roof rods to a thickness of from 18 ins. to 30 ins., and carried 2 ins. below the rods, thus imbedding them. For the sides similar square rods and concrete are used and angle columns 5 ft. apart; the concrete of the side walls is from 15 ins. to 18 ins. thick, and the rods used are of both square and twisted form.

BROOKLYN BRIDGE STATION

In front of the water-proofing, immediately behind the steel columns, are the systems of terra-cotta ducts in which the electric cables are placed. The cables can be reached by means of manholes every 200 ft. to 450 ft., which open into the subway and also into the street. The number of these ducts ranges from 128 down to 32, and they are connected with the main power station at Fifty-Eighth and Fifty-Ninth Streets and the Hudson River by a 128-duct subway under the former street.

The construction of the typical subway has been carried on by a great variety of methods, partly adopted on account of the conditions under which the work had to be prosecuted and partly due to the personal views of the different sub-contractors. The work was all done by open excavation, the so-called "cut and cover" system, but the conditions varied widely along different parts of the line, and different means were adopted to overcome local difficulties. The distance of the rock surface below the street level had a marked influence on the manner in which the excavation of the open trenches could be made. In some places this rock rose nearly to the pavement, as between Fourteenth and Eighteen Streets. At other places the subway is located in water-bearing loam and sand, as in the stretch between Pearl and Grand Streets, where it was necessary to employ a special design for the bottom.

This part of the route includes the former site of the ancient Collect Pond, familiar in the early history of New York, and the excavation was through made ground, the pond having been filled in for building purposes after it was abandoned for supplying water to the city. The excavations through Canal Street, adjacent, were also through made ground, that street having been at one time, as its name implies, a canal.

From the City Hall to Ninth Street was sand, presenting no particular difficulties, except through the territory just mentioned. At Union Square rock was encountered on the west side of Fourth Avenue from the surface down. On the east side of the street, however, at the surface was sand, which extended 15 ft. down to a sloping rock surface. The tendency of the sand to a slide off into the rock excavation required great care. The work was done, however, without interference with the street traffic, which is particularly heavy at that point.

The natural difficulties of the route were increased by the network of sewers, water and gas mains, steam pipes, pneumatic tubes, electric conduits and their accessories, which filled the streets; and by the surface railways and their conduits. In some places the columns of the elevated railway had to be shored up temporarily, and in other places the subway passes close to the foundations of lofty buildings, where the construction needed to insure the safety of both subway and buildings was quite intricate. As the subway is close to the surface along a considerable part of its route, its construction involved the reconstruction of all the underground pipes and ducts in many places, as well as the removal of projecting vaults and buildings, and, in some cases, the underpinning of their walls. The concrete lined tunnel work involved one of the most difficult problems. The tunnel was driven through solid rock between Thirty-Third Street and Forty-Second Street, between 104th Street and Broadway, and 110th Street and Lenox Avenue on the east side branch, and between 157th Street and Fort George on the Fort George branch, the latter being the second longest double-track rock tunnel in the United States, the Hoosac tunnel being somewhat longer.

The elevated viaduct construction extends from 125th Street to 133d Street and from Dyckman Street to Bailey Avenue on the western branch, and from Brook and Westchester Avenues to Bronx Park on the eastern, a total distance of about 5 miles. The three-track viaducts are carried on two-column bents where the rail is not more than 29 ft. above the ground level, and on four-column towers for higher structures. In the latter case, the posts of a tower are 29 ft. apart transversely and 20 ft. or 25 ft. longitudinally, as a rule, and the towers are from 70 ft. to 90 ft. apart on centers. The tops of the towers have X-bracing and the connecting spans have two panels of intermediate vertical sway bracing between the three pairs of longitudinal girders. In the low viaducts, where there are no towers, every fourth panel has zig-zag lateral bracing in the two panels between the pairs of longitudinal girders.

The towers have columns consisting, as a rule, of a 16-in. x 7-16-in. web plate and four 6-in. x ⅝-in. bulb angles. The horizontal struts in their cross-bracing are made of four 4-in. x 3-in. angles, latticed to form an I-shaped cross-section. The X-bracing consists of single 5-in. x 3½-in. angles. The tops of the columns have horizontal cap angles on which are riveted the lower flanges of the transverse girders; the end angles of the girder and the top of the column are also connected by a riveted splice plate. The six longitudinal girders are web-riveted to the transverse girders. The outside longitudinal girder on each side of the viaduct has the same depth across the tower as in the connecting span, but the four intermediate lines are not so deep across the towers. In the single trestle bents the columns are the same as those just described, but the diagonal bracing is replaced by plate knee-braces.

SIDE VIEW OF MANHATTAN VIADUCT

The Manhattan Valley viaduct on the west side line, which spans the ravine-like depression at that point, has a total length of 2174 ft. Its most important feature is a two-hinged arch of 168½-ft. span, which carries platforms shaded by canopies, but no station buildings. The station is on the ground between the surface railway tracks. Access to the platforms is obtained by means of escalators. It has three lattice-girder two-hinge ribs 24½ ft. apart on centers, the center line of each rib being a parabola. Each half rib supports six spandrel posts carrying the roadway, the posts being seated directly over vertical web members of the rib. The chords of the ribs are 6 ft. apart and of an H-section, having four 6-in. x 6-in. angles and six 15-in. flange and web plates for the center rib, and lighter sections for the outside ribs. The arch was erected without false work.

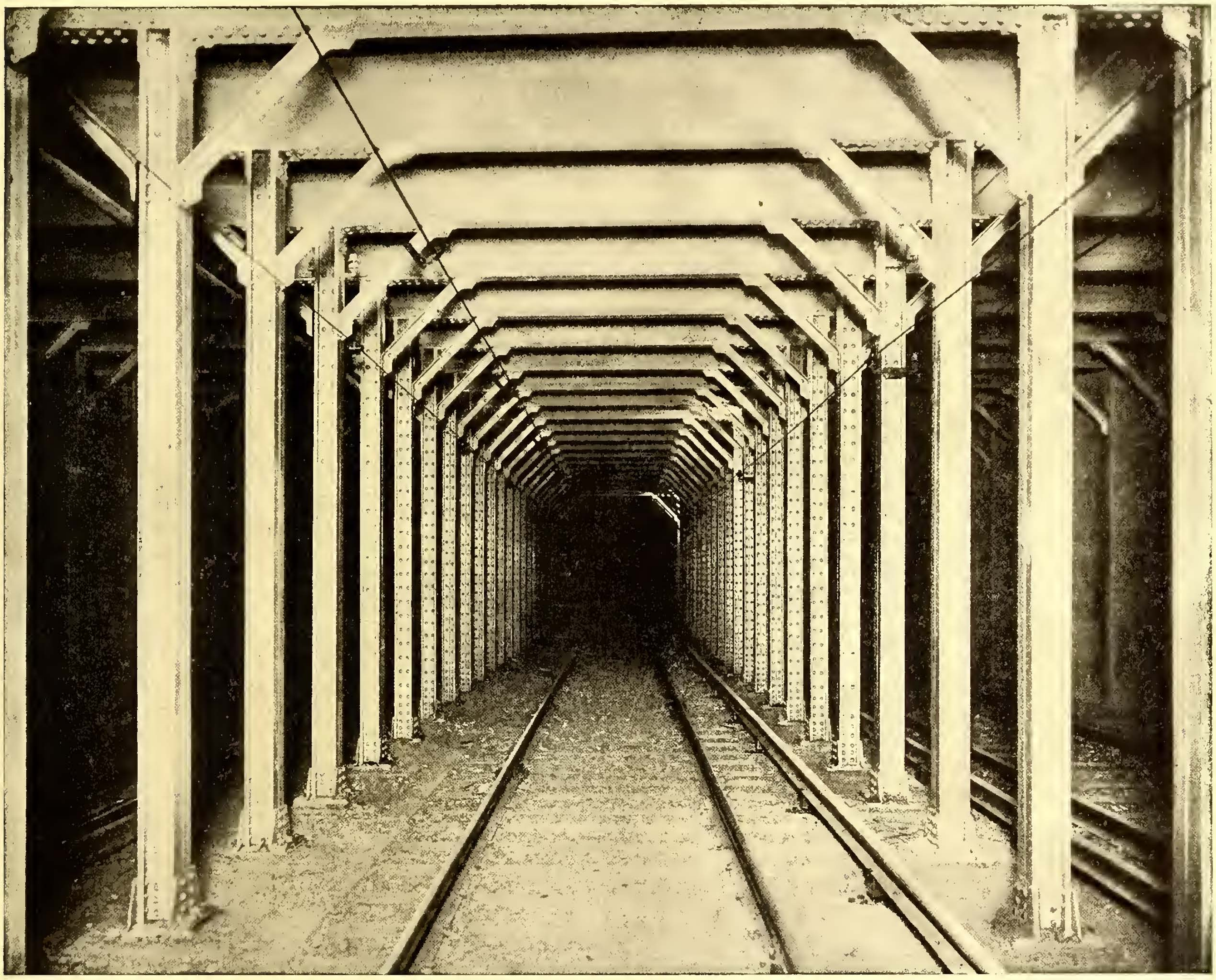
The viaduct spans of either approach to the arch are 46 ft. to 72 ft. long. All transverse girders are 31 ft. 4 ins. long, and have a 70-in. x 3/8-in web plate and four 6-in. x 4-in. angles. The two outside longitudinal girders of deck spans are 72 ins. deep and the other 36 ins. All are 3/8 in. thick, and their four flange angles vary in size from 5 ins. x 3½ ins. to 6 ins. x 6 ins., and on the longest spans there are flange plates. At each end of the viaduct there is a through span with 90-in. web longitudinal girders.

Each track was proportioned for a dead load of 330 lbs. per lineal foot and a live load of 25,000 lbs. per axle. The axle spacing in the truck was 5 ft., and the pairs of axles were alternately 27 ft. and 9 ft. apart. The traction load was taken at 20 per cent of the live load, and a wind pressure of 500 lbs. per lineal foot was assumed over the whole structure.

A movement is now on foot to organize a company for the purpose of building an electric railway at Rosario, a city of about 122,000 inhabitants, in the Province of Santa Fé, Argentina.

ECONOMY IN RAIL CUTTING

Almost every large piece of track construction upon a modern street railway involves the laying down of a certain amount of special work. Even if the job is simply one of double-tracking a city route, it is rare indeed to encounter no cross-overs, switches or Y's to break the smoothness of a straight run over the line, while curves are to be expected on almost all routes. It has grown to be a practice among many companies, therefore, to order their special work directly from the manufacturers, and there is no doubt that a great deal of time and labor during installation is saved in this way.



STANDARD STEEL CONSTRUCTION IN TUNNEL

At the same time it is nearly always necessary in laying track to bend or cut certain rails, and appliances of this character form a part of the tool equipment of every well organized track gang. Formerly the accepted method of cutting off rails was the laborious process of hacksawing, but this slow and tedious operation has been considerably bettered by the introduction of the circular rail saw operated by cranks and adjustable for any desired angle of cutting.

In cases where power is available at the trolley wire, there would seem to be an opportunity for considerable economy to be gained by driving such saws by ½-hp 500-volt motors, thereby doing away with the services of at least one man at the crank. The cost of power for this work would be almost insignificant, and the motor itself should not cost much over $100 complete, with gearing, rheostat and some sort of fish-pole arrangement for making contact with the trolley wire.

GENERAL DESIGN AND FINISH OF THE MODERN INTERURBAN CAR

BY EDWARD C. BOYNTON

The general dimensions of interurban cars have gradually increased until the present standard approximates very closely those of a standard steam passenger coach. The following may be said to be average dimensions:

	Interurban Electric Car	Steam Passenger Coach
Length over corner posts	40 ft.	60 ft.
Length over buffers	50 to 52 ft.	70 ft.
Extreme width outside	8 ft. 6 in.	10 ft.
Height-top of rail to top of roof	13 ft.	14 ft. 3 in.
Weight of car body	30,000 lbs.	40,000 lbs.

Fig. 1 is a side elevation and seating plan of a type of interurban car built but a short time ago, and many such cars are still in service. It will be noticed that the interior of the car is one compartment and there are no vestibules. There are two means of entering the car—at one side of each platform.

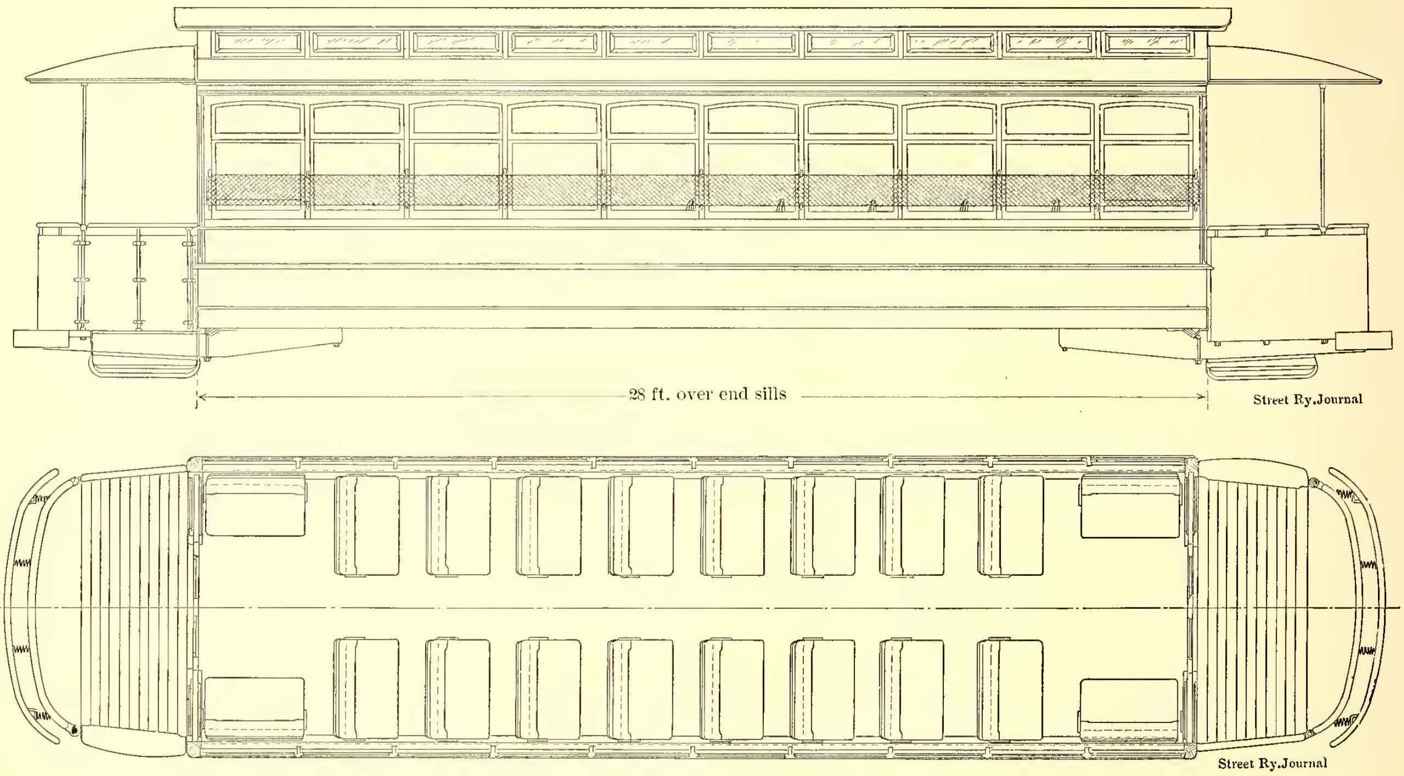


FIG. 1.—PLAN AND SIDE ELEVATION OF INTERURBAN CAR OF SEVERAL YEARS AGO

Fig. 2 is a photo-engraving of the interior of a similar car. The ceiling is three-ply bird's-eye maple in the natural color and varnished. All moldings, panels, doors, etc., are varnished cherry. Register rods, signal cords and strap hangers are just inside the deck sills. The lighting is by electric lamp clusters along the center line of the ceiling. The seats upholstered in rattan. The floor mats are the stationary wooden slats. The heating is by electric heaters under the seats. It is easily seen that the whole interior finish is of a perfectly plain, inexpensive style.

This car is 28 ft. long over end sills, and 38 ft. 6 ins. over all. It is 8 ft. 3 ins. wide, and the body weighs, approximately, 17,000 lbs. The seating capacity is forty. The motor equipment may be of sufficient power, and the gearing such as to drive it at a speed of 40 m. p. h., but the general design is far too light for the high-speed interurban service now demanded in many parts of the country.

In Fig. 3 is shown the side elevation and seating plan of a modern interurban car. The principal dimensions are given on the drawings. The body weighs about 28,000 lbs. The interior is divided, as shown, into a passenger and a smoking compartment, and the total seating capacity is fifty-four.

On a long interurban line the necessity for a smoking compartment is evident. On many roads a baggage compartment is also an absolute necessity, and there are cars in service containing all three compartments, but more often we find the baggage and passenger compartments, where the smokers are allowed to occupy the former, and even seats or benches are provided for them, which can be folded up against the side of the car.

The side and end windows are guarded on the outside by five iron tube guards held by suitable brackets, which are hinged so that they may be dropped down for the proper cleaning of the windows.

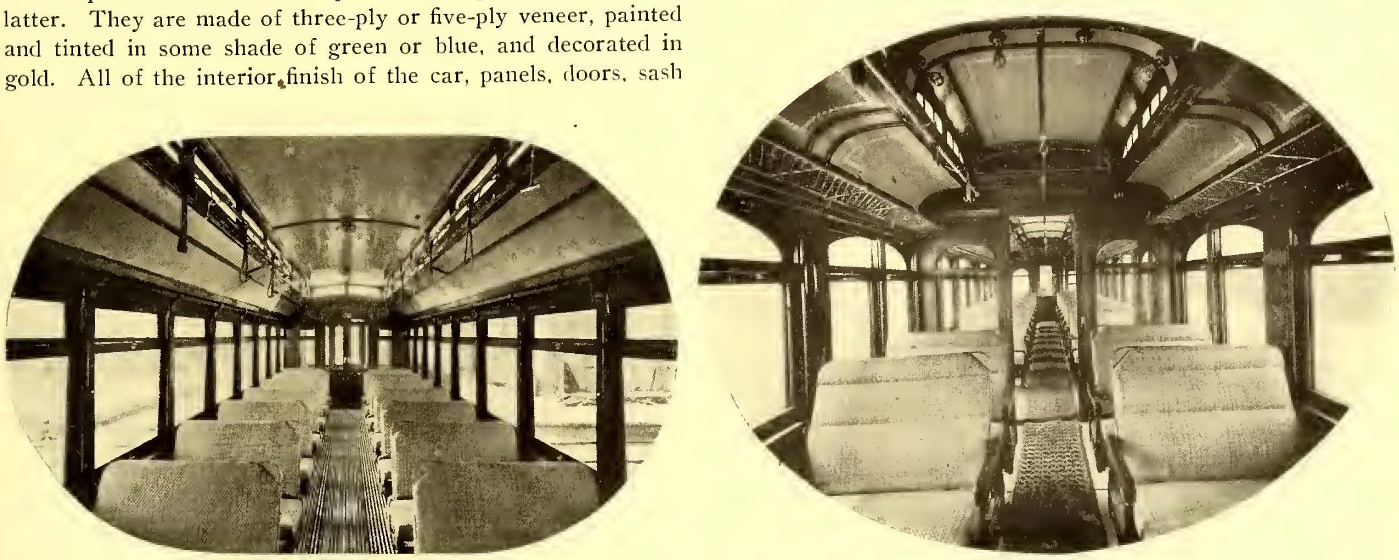
On cars which are to be used where the winters are somewhat severe, extra sashes are provided for the side windows, which are put on in place of these guards in winter, and they serve to keep the temperature of the car much more comfortable. On some of the Northwestern steam roads cars are in use with three window sashes, in the coldest weather.

The system of heating a modern interurban car is usually hot water, the heater being placed at the left of the front platform when the car is single-ended—i. e., runs in one direction only; or sometimes next to the partition separating the smoking or baggage compartment from the passenger.

The principal reason for the use of hot-water heat in preference to electric, in a large car, is undoubtedly economy. In such a car the temperature must be kept between 60 degs. and 70 degs. As it requires from 20 amps. to 30 amps. at 500 volts to maintain that temperature under average conditions, and if we assume the cost of power to be about 1 cent per kw-hour at the car, it is readily seen that 10 to 15 cents per hour for heat is very much above the cost of hot water.

Considerable improvement has been made in the method of lighting the car. Not only have the number of lights been increased, but attention has been given to the proper distribution of light, and, when possible, to its artistic arrangement. The lights are frequently placed along the deck sills, one over each seat, or when the design of the ceiling permits, they are arranged in arches from side to side. Some cars have recently been lighted with small enclosed arc lamps. The finest effect in car lighting can be seen in certain Pullman sleeping or dining cars where the steam train is electric lighted.

The photo-engraving, Fig. 4, shows the interior of the modern interurban car. The two styles of ceilings most used are the Empire and the semi-Empire; the engraving shows the latter. They are made of three-ply or five-ply veneer, painted and tinted in some shade of green or blue, and decorated in gold. All of the interior finish of the car, panels, doors, sash and all moldings are of solid dark mahogany, in natural color, varnished and rubbed down in pumice stone and oil, to a smooth dead finish. All metal trimmings are highly polished bronze. The seats shown in the engraving are the latest type, high back, reversible, with head roll and bronze corner grab handles, the latter making hanging straps unnecessary. The seats are upholstered in white rattan, which many prefer, principally for sanitary reasons. Probably as many cars have the seats upholstered in dark green or blue or crimson plush. The register rod is in the usual position, and the signal cord supported by hangers over the center aisle. Push buttons are placed in each side window panel, connected to electric bells at each end.



FIGS. 2 AND 4.—INTERIOR OF OLD AND NEW TYPES OF INTERURBAN CARS

An improvement long needed and now generally included in the equipment, is the continuous parcel or basket rack, shown along each side above the windows. Other important improvements or additions are toilet room, ice water, fire extinguishers and wrecking tools, consisting of the usual saw, axe, sledge and bar.

Standard railway signal lamps, burning oil, and signal flags, with proper sockets for holding either at the ends of the car; iron cuspidors for the smoking compartment, a manila floor mat for the entire length of center aisle, removable rubber mats for vestibules, a motorman's tool box and switch irons, steel spring clips and floor sockets for the latter being provided in the vestibules. Illuminated destination signs, visible day or night, are now coming into general use. They are usually outside the vestibule below the windows and at one side of the center. Arc headlights and trolley catchers are also provided.

All high-speed interurban cars are now equipped with some form of air brake, as they are far too heavy to be continually braked by hand. The amount of power provided varies from 200 hp to 400 hp, dependent upon the weight and speed. The system of controlling the motors in the higher powered cars is usually the multiple unit, regardless as to whether they are to be run in trains or not. This relieves the platforms of the weight of a heavy controller, places the latter under the car, where it is better able to carry it, and where there is room.

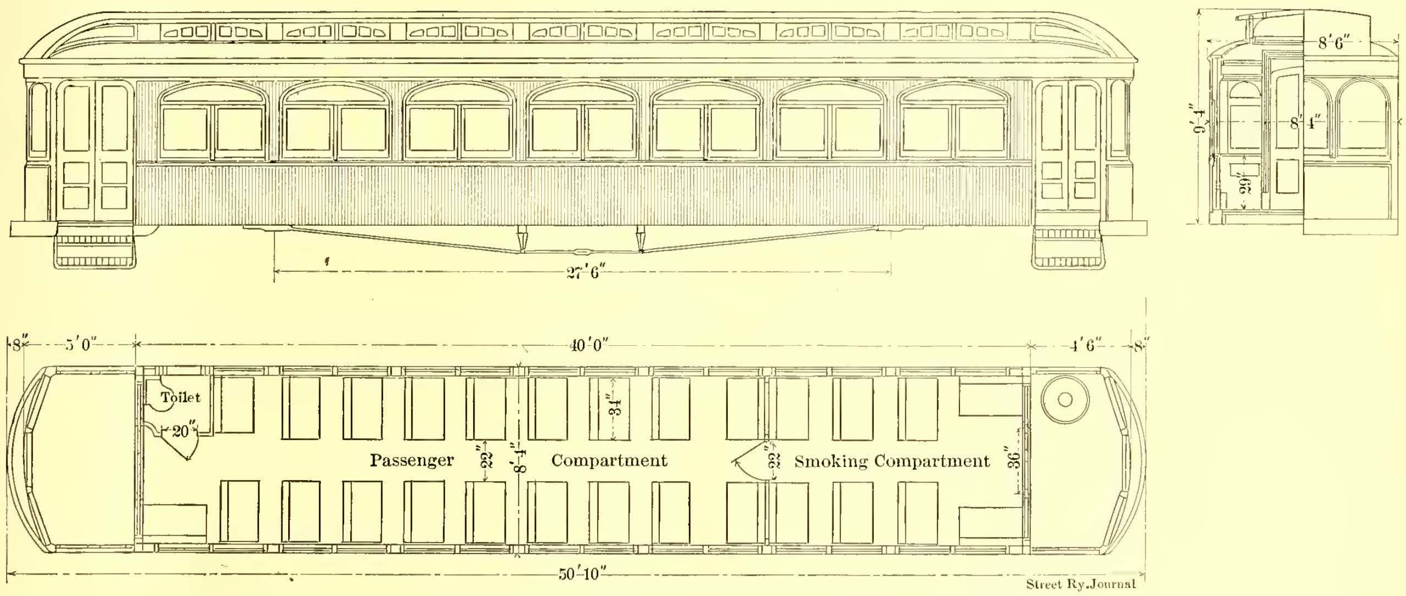


FIG. 3.—SIDE ELEVATION AND PLAN OF MODERN INTERURBAN CAR

Some cars have been recently built with the above system of control and with solid vestibules, allowing no means for passing between cars should they be run in trains.

A marked improvement has been made in car wiring, which consists in separating the power wires instead of placing them in cables, and running each wire in its own fireproofed duct or molding under the car.

The painting of the outside is now according to the M. C. B. specifications, and the colors usually adopted are the same as now used by steam roads.

TRAINING THE NON-COMMISSIONED OFFICERS OF ENGINEERING

Montreal, Canada, Sept. 7, 1904.

Editors Street Railway Journal:

I have been much interested in reading your editorial on the subject of technical education for railway men, and find myself very much in agreement with you. I am the more interested in this because, in Britain, we have a group of men whose ideas of technical education are well set out by your remark:—"There is a tendency to train too many men for the duties of the captain at the expense of good hard drill in the work of the lieutenant and engineers, not to mention the lower grades." To put it in my own way, the theoretical training of the "non-commissioned" officers of engineering is in danger of being overlooked. It is in evening classes that these men usually receive their theoretical instruction, and yet, although excellent work has been done in the past, there is a tendency at the present time to starve technical institutions, polytechnics, mechanics' institutes, etc., where such evening classes are mainly carried on. It is easy to see that this has come about from the fact that the experts on representative bodies controlling educational expenditure are mostly those who get their living entirely by teaching. In Britain technicological teachers and part-time men generally begin to feel that they are not getting fair play, and indeed attempts at some kind of organization are now being made in order to place their views before the educational authorities.

For some five years I have been engaged in lecturing to third-year electrical engineering evening students at the Northampton Institute or City Polytechnic, London, and very much of the success which I have had, has been due to the fact that I have been able to give data of problems and events which have cropped up in my every-day professional work. At the City Polytechnic we are fortunate in having as principal Dr. Mullineux Walmsley (who, by the way, has recently been on an educational tour through the United States). and he is one of those who believes that all technical educational institutions should be partly staffed by men engaged in outside work.

Take the simple case of mechanical drawing and machine construction, surely the best man to teach this is a leading draughtsman in some local manufacturing concern. I remember that when I attended evening classes some seventeen years ago, my teacher was a leading draughtsman with the well-known firm of Smith, Beacock & Tannett, of Leeds. Being a tool-making firm, it followed that the examples we had given to us were largely in connection with the design of machine tools. As it happened I was engaged during the day on locomotive work, and this combination of practical work in engine building and theoretical instruction in design of machine tools was to me a great advantage. In the case of electrical engineering one institution in any particular town might have as its lecturer a man engaged in running an electric lighting and power or traction system, while another institution would probably have as its instructor an expert in dynamo machine design, or they could both be engaged at the same institution. Students or improvers would thus have an opportunity of learning something outside of their regular daily work, for the central station assistant could attend the dynamo design class, and vice versa.

We have in Britain at the present time a strong movement in favor of what is called the "sandwich" system of engineering training, whereby a man goes to college for six months and to the works for the next six months; he again returns to college and then to some other or the same works, and so on, the complete course extending over four or five years. There appears to be a consensus of opinion that this is an excellent method of training, but the difficulty is to get engineering firms who will be troubled with a batch of students coming in and going out of their works every six months. Clearly, if there is anything in this "sandwich" system, then the combination of theory and practice by evening classes is all in the right direction, and instead of the institutions where they are carried on being starved financially, they ought to be helped with a most liberal hand. The very fact that, as I said above, they are largely engaged in training the "non-commissioned" officers of engineering (the backbone of engineering), calls for liberal treatment. It will not do to allow educational matters, at any rate technological education, to be entirely in the hands of the purely academical man, as I fear is the case in my own country, and perhaps may be in yours unless the movement is checked.

With you, the college professor does outside consulting work, and in this way, to some extent, keeps in touch with practical work. We have a little of this, but, generally speaking, it is discouraged, as there is a tendency to disabuse, and the student's interests may suffer. It seems to me that the professors and full-time men should teach principles, and there should be attached to every institution a certain number of outside men to give regular courses of lectures and demonstrations on practical subjects. Given proper encouragement and recognition, and let me also whisper, "adequate remuneration," there is no reason why good men should not be attracted and another important link forged between theory and practice.

It may be said that those engaged in practical work could not be expected to give data of their every-day problems and work, but I do not anticipate any difficulty in this. Scientific men and engineers have no secrets, and, in any case, it is easy to give useful information without going into personal or commercial details. Consulting engineers travel around the country to an unusual degree, and are constantly seeing and inspecting new engineering works. A detailed description of such makes an interesting break in a course of lectures; at any rate, I find this so with my own students.

Another useful feature of this employment of outside professional men is that they are frequently able to advise the students on important points affecting their career. On the question, for example, as to whether it is advisable to move from one branch of engineering work to another, or to go abroad, and so on. E. Kilburn Scott.

The Big Four Railroad (steam) has started a rate war against the encroachments of the Appleyard system of traction lines in Central Ohio. It is directed particularly at the division between Dayton, Springfield, Urbana and Bellefontaine. The steam road recently improved its train service between these points, giving five trains each way a day, and it has cut its rates about 50 per cent to meet those of the traction lines.

Street railway men in the vicinity of Worcester, Mass., are telling an interesting story of an electric car on the Uxbridge & Blackstone Street Railway being held up by a countless number of potato bugs (Colorado beetles) crawling over the tracks. So many bugs were migrating from a potato field near the roadbed that the crew had to get out and shovel them off the track. The progress of the car was interrupted for ten minutes.

NOTES FROM MONTREAL, CANADA

Many interesting innovations are in vogue upon the lines and at the shops of the Montreal Street Railway Company, Montreal, Canada. A general policy of improvement has, during the past year, been in force upon its system, much work of line and track reconstruction having recently been carried out. Considerable attention has also been given to shop work by this company, one of the best equipped street railway shops in Canada having been equipped for the maintenance of its equipment, which at present embraces over 700 cars.

An interesting departure in line construction work upon the system is to be noted in the use of old steel girder rails for poles in span-wire construction in the outlying districts of the city. Permanent way practice was formerly in this city to use grooved girder rails, but these are being replaced by 9-in. 90-lb. T-rails, which have been found more suitable to the prevailing conditions of operation. And in the reconstruction of the overhead line work, the availability of the discarded rails for poles was suggested as a result of the desire for very rigid and permanent construction.

The former girder rails were laid with cast-welded joints, and in sawing the rails to remove them, the weld sections were left one upon the end of each 30-ft. rail section. In adapting the rails for use as poles, these bulky cast-welded joint sections at the one end proved particularly adaptable and were found convenient in making foundations, this end being placed about 3 ft. in the ground and surrounded by a binder of concrete. The holes are often cut in solid rock and, in placing the pole, were lined with loose pieces of stone, into and around which the concrete was tamped solid and allowed to set. The result is that of a very strong construction, the entire contents of the hole uniting into one solid mass.

The rails are all set with their bases toward the sidewalk, this arrangement being adopted for the sake of appearances; in some sections of the city where the streets are extremely narrow, the poles are set within the sidewalk, in which case the head of the rail is brought away from the tracks, while in the usual construction, where the pole is located between the sidewalk and the curb, the head of the rail faces toward the track. The groove in the head of the rail is in all cases filled in with wooden strips, milled to exactly fit the same, and bolted therein by stove bolts. Each rail is surmounted by a capping of more or less ornamental nature, several types of caps having been tried, although one of rather plain outline has the preference. The span wire is carried by an iron-strap connection near the top of the pole, which surrounds the pole and receives the eye of the strain insulator.

In the shops at Hochelaga many interesting innovations are also to be found in the form of improved methods. One of these is in connection with the compressed air piping for the cleaning of armatures and other electrical apparatus when sent to the shop for repairs. This is, of course, in accordance with the latest practice in electric railway shops, the great and important possibilities of removing accumulated dirt, grease, etc., otherwise inaccessible, being very well known.

The novelty in this connection lies in convenient and handy system of service piping from which the hose connections are made. Service delivery pipes from the compressor and storage tank are carried along the back of each bench in the electrical repair department and are provided with an outlet in front of each workman. The hose connections are made through special quick-acting couplings which were designed and built at the shops, and are interesting. They consist of brass sleeves, one fitting within the other, the male connection on the stationary delivery pipe, while the portion on the hose is the female fitting. In coupling, these are arranged to clamp together by projecting pins upon the outside of the male portion, fitting within spiral grooves in the body of the female fitting, by which they may be brought together as tightly as may be desired, and very quickly also, the pin and groove method of clamping thus eliminating the use of screwed connections. A leather washer prevents leakage.

This arrangement makes the air supply so readily accessible in all parts of the shop that there can be no possible excuse for not using it and thus turning out electrical repair work not thoroughly cleaned. The value of this is particularly noticeable in the cleaning of stripped armatures, where it is important that they be perfectly clean before painting, preparatory to winding. On armatures that are not rewound, but need only slight repairs, wonderful results are found possible in removing accumulated dirt and grease by air pressure.

Another interesting device which originated at the shops is a jig for use in straightening armature shafts without removing them from the lathe. It is the practice there to center up in the lathe every armature that comes to the shop and true off its commutator; in doing this any irregularity in alignment of the armature shaft is readily noticeable, and it is arranged to true them without the trouble of removing from the lathe. This is accomplished by a special heating blast torch and straightening clamp by which the slightest irregularity may be removed with ease.

The clamp consists of a block which is laid across the lathe ways to receive the downward pressure of the straightening, and a special yoke which hooks under the outside edges of the bed so as to straddle the work. The yoke is provided with a pressure screw, with swiveling block at its lower end, by which pressure is applied to the shaft. When this yoke is in position the heating torch flame is directed toward the bent portion and the pressure applied as required. A sheet metal enclosure is in this case used to surround the bent portion of the shaft and retain the heat of the torch as much as possible, as a result of which the shaft is always found to heat very quickly, so that a minimum of heat is transmitted to the core. The bending is usually done at black heat, raising to red heat being found unnecessary.

Other innovations are to be found in the use of a convenient little truck of somewhat different design from the usual, for transporting armatures around the shop floor; this permits the rule that they shall not be rolled upon the floor to be rigidly enforced. Another point of interest is the introduction upon their taping machine, by which armature coils are machine-taped, of a universal chuck for guiding the coil, and also to take the pull and thrust of the taping action off of the operator; this action is found, as elsewhere, to greatly tire the taping operators, especially in the elbows and forearm. The guiding chuck has four jaws faced with rubber tips for protection to the insulation of the wires, and is arranged to quickly adjust automatically to different sizes and odd shapes. It has served to greatly increase the output of the machine and has effected an improvement in the quality of the work.

The first electric cars ever built entirely in the city of San Diego are nearing completion at the car houses of the San Diego Electric Railway Company, at the foot of E Street. Three of them will soon be ready to take their places on the various city lines. General Manager Clayton has had a number of the old cars rebuilt since he came here, has lengthened a number of the old Fourth Street electric cars, and remade several of the old cable cars into the handsome double-enders now in service on some of the lines. All of the rebuilt cars have double trucks. Mr. Clayton stated recently that the company has all the single-truck cars that it would ever have use for, meaning that as soon as the traffic warranted it large double-truck cars will be put into service and the smaller cars reserved for emergency use. The three new cars will be supplied with double trucks and double ends, with side seats on the outside capable of carrying twenty passengers.

PENSION SYSTEMS FOR WORKMEN OF GERMANY, WITH SPECIAL REFERENCE TO RAILWAY EMPLOYEES *

BY H. GORELLA
Secretary of the German Street and Light Railway Accident Insurance Guild

It is undeniable that the earnings of the average workingman are so small that even a few weeks absence from employment, caused by sickness or accident, plunges him and those dependent upon his daily wages into poverty, the result frequently being an intense dissatisfaction with existing social conditions which renders him an easy prey to dangerous trades union and political demagogues.

Before 1876, such workmen's funds as existed in Germany were strictly private enterprises, but on April 7 of that year the first law was passed providing certain methods of regulating these funds. On Nov. 17, 1881, the German Emperor recommended the Reichstag to pass further laws giving aid to sick benefit and accidental funds, as well as providing for disability and old-age pensions. This was the first attempt to organize a national pension system, and it was believed that to be successful the payment of dues would have to be compulsory for both employer and employee. The law of June 15, 1883, called for the compulsory insurance against sickness of all employees in trade and commerce earning up to 2,000 marks ($500) a year; that of July 6, 1884, regulated accident insurance; and the law passed May 28, 1895, broadened the scope of previous measures to embrace land, river and sea transportation and the mail, telegraph, railway, marine and military departments.

SICK BENEFIT LEGISLATION

The last measure on this subject went into effect Jan. 1, 1904. It provides that in case of prolonged illness the beneficiary shall be entitled to a benefit period of at least twenty-six weeks; this embracing free medical service and appliances and benefit payments equal to one-half of the regular earnings, if the beneficiary is unable to return to work within three days after falling sick. Such benefit payments may be increased to 75 per cent of the normal earnings. The death payment varies from twenty to forty times the average daily wage. Two-thirds of the dues necessary to make the forthcoming payments are furnished by the workingmen and one-third by their employers. The total dues usually equal about 4½ per cent of the earnings of the laborer in the ordinary callings and rarely reach 6 per cent.

ACCIDENT INSURANCE

The accident insurance law, which has been in force since June 30, 1900, provides for cases where persons are injured or killed in the course of their regular occupation through no fault of their own. Beginning with the fourteenth week after the accident, the injured person receives in connection with the sick benefit fund, free medical attention and appliances, and, during the time of total incapacity for labor, payments equal to two-thirds of his regular income. The payments for the first fourteen weeks are made from the sick benefit fund. If the injured person is capable of earning anything at some lighter work, the benefit payments are reduced in proportion. In extreme cases the payments may equal the ordinary wages of the person injured. In case of death the heirs receive an amount equal to one-fifteenth of the annual wages of the deceased, the minimum being 50 marks ($12.50), and further payments in the form of installments, which vary in amount from 20 per cent to 60 per cent of the annual earnings of the deceased. The cost of the accident insurance must be borne entirely by the various employers' associations.

DISABILITY INSURANCE

The disability insurance law, which has been in operation since Jan. 1, 1900, grants pensions to all insured persons who have reached a certain age or are incapable of continuing their work. Disability pensions are payable to all permanently disabled persons who have paid dues for 200 weeks; also to those temporarily disabled for the period they are unable to do any work. Old-age pensions are granted when the beneficiary is seventy years old and has paid dues for 1200 weeks.

	Annual Wages	Weekly Payments up to Dec. 31, 1910	Annual Old Age Pensions	Annual Disability Pensions
Class I........	$87.50	$ .035	$27.50	$40 to $46.3[illegible]*
Class II.......	137.50	.05	35.00	31.50 " 67.50*
Class III......	212.50	.06	42.50	33.60 " 83.25*
Class IV......	287.50	.075	50.00	33.55 " 97.50*
Class V.......	ov.287.50	.09	57.50	37.50 " 125.00*

* Maximum paid only after the age of fifty years.

Each old-age pension is made up of an annual contribution of $12.50 from the State, besides the amount furnished by the insurance guild. The disability pensions are also made up of an annual contribution of $12.50 and money furnished by the insurance guild. No payments are made to the injured person from either the accident or invalid fund during such time as he may be in jail or live abroad.

Payments for this class of insurance are shared equally by employer and employee.

RESULTS OF THE THREE INSURANCE METHODS

At present 10,500,000 people in Germany are insured against sickness, 19,100,000 against accident, and 14,000,000 against old age and permanent disability. Between 1885 and 1903, $558,250,000 was disbursed for sick benefits, $232,750,000 for accident payments, and $213,500,000 for old age and disability insurance. In this period the working classes received $375,000,000 more than they paid in. The daily cost of all three classes of insurance is now $312,500, and the value of the property owned by the insurance guilds, $375,000,000.

No one who has examined the workings of the system can doubt that its introduction has been of great benefit to the working classes as well as to the country in general. Formerly the sick workingman could not afford to pay for proper medical treatment, and long illness resulted frequently in his pauperization and consequent loss of citizenship. Now his insurance guild secures for him the best medical attendance, offers him a hospital built for his special use, and by paying benefit fees to his family relieves him of all financial worry. The fact that he will not become a public charge in old age also does much to raise his moral tone, especially as all these advantages are largely due to his own efforts and do not bear the stigma of charity. A further good result of the system is the construction of cheap sanitary dwellings for working people, the insurance guilds alone having invested over $100,000,000 for that purpose.

CLASSIFICATION OF THE INSURANCE

Some kinds of labor are, of course, more dangerous than others, and legislators have endeavored accordingly to group the various funds so that each trade would carry its proper burden. This has been accomplished quite fully in sick benefit and accident insurance, but no attempt has been made along such lines in old-age insurance. In small communities the sick benefit guilds comprise numerous callings, but in the large cities there are separate societies for each trade. These latter form part of organizations known as Berufsgenossenschaften (Insurance Guilds), which are combinations of allied trades extending throughout the Empire. Disability and old-age insurance is grouped according to districts. The direct management of all funds is in the hands of voluntary officers elected by the employers and workingmen.

SUPERVISION

The supervision of sick benefit funds lies with the local authorities and not with the State. Accident and old-age funds, however, are supervised by the State Insurance Bureau, which

* Abstract of report presented at the Vienna, 1904, meeting of the International Street Railway and Light Railways' Association.

has its headquarters in Berlin. The common courts suffice to decide all disputes in sick benefit cases, but for accident and invalid funds there are boards of arbitration, consisting of two employers, two workingmen and a chairman appointed by the State. The State Insurance Bureau is the court of last resort. Whenever possible the decisions are in favor of the injured, as every effort is made to encourage the working classes to take advantage of the system.

STREET RAILWAY INSURANCE SICK BENEFITS

All railway employees earning less than 2,000 marks ($500) a year are compelled to join the communal or local trade insurance guild, unless they are already insured in some other organization operated in compliance with the law. However, a workingman may join a second guild if he so desires; nor is there anything to prevent employees who earn more than 2,000 marks ($500) a year from insuring against sickness. In cases of this kind the employer is not obliged to pay any part of the dues.

As the law requires in most cases that only employers having fifty or more men must establish a sick benefit fund, the larger railway companies alone possess such funds. The employer can be compelled, however, to establish a fund if the local authorities convince the supervising officials that one is necessary. The railway companies must pay one-third of the dues. If there is not enough money in the treasury to pay sick benefit costs after the employees are paying 4 per cent of their average earnings, the deficit must be covered by the employer.

The founding of an individual sick benefit fund is considered advantageous to the employer, as it gives him more influence in the management of the fund than would be the case where the latter is in the hands of the local authorities. As a general thing, such private undertakings are of more benefit to the worker, as they pay higher amounts and, when necessary, for a longer period than the twenty-six weeks required by law. The funds are managed by committees, in which the employees have two representatives to the employer's one.

ACCIDENT INSURANCE

In accordance with the law of June 30, 1900, all railway employees (including mechanics) earning less than 3,000 marks ($750) a year are subject to accident insurance, which covers work in the shops as well as on the lines. The carrier of street and light railway accident insurance is a kind of co-operative organization, founded Oct. 1, 1885, known as the Strassen-und-Kleinbahn Berufsgenossenschaft (Street and Light Railway Accident Insurance Guild), with headquarters in Berlin. One of the by-laws of this organization permits the insurance of operating employees earning up to 5,000 marks ($1,250) per annum, and the voluntary insurance of other employees. All expenses for the insurance required by law are borne by the companies.

DISABILITY INSURANCE

All employees over sixteen years old and earning less than 2,000 marks ($500) a year are subject to disability insurance. As previously stated, money for this purpose goes into general funds, over which the railway companies have little control. The cost of this insurance is equally divided between the company and its employees. The former receives coupons upon making payments, and these in turn are given to the employees every pay day as receipts to be pasted in a special book issued for that purpose.

The figures for 1903 of the Strassen-und-Kleinbahn Berufsgenossenschaft show that the average wages of the employees of the railways forming the association were $300 a year, and that the employers' annual contribution per worker was about 3.3 per cent of that amount. The railway companies are not permitted, of course, to take this money from the wages of their employees, and that they do not do so is shown by the fact that since 1890 the average annual wages have increased from $200 to $300.

ORGANIZATION AND METHODS OF THE STRASSEN-UND-KLEINBAHN BERUFSGENOSSENSCHAFT

This society, when founded in 1886, numbered only sixty-nine street railways, employing 18,500 persons, and paying total wages of about $2,225,000. It now numbers 380 railways, insuring 69,318 employees, who earn annually about $15,000,000. Up to Dec. 31, 1903, the society had paid out $7,750,000 to satisfy accident claims, paying on an average $56 to each claimant. The affairs of the society are managed by a committee of nine, who are elected by delegates from the companies, and serve without pay, but are granted traveling expenses. All members are allowed one vote for every $5,000 up to $50,000 paid in wages annually, and an additional vote for every $25,000 above the last-named amount.

As some lines are operated by electricity or steam and others by animal traction, the liability of accident varies with the conditions, and the rules of the association therefore call for a readjustment in rates every five years. If a member is dissatisfied with the new rate a protest must be filed with the committee within fourteen days. If the claim is not granted the case may be appealed to the State Insurance Bureau for final adjudication.

The State Insurance Bureau has caused a number of regulations to be passed designed to prevent accidents, and the association acts as a sort of guardian over its members to see that such regulations are obeyed. If an offending company does not comply with the orders of the government inspector or the association, it is given a rating of greater hazard and its accident dues increased in proportion. If it is already in the most hazardous class, its dues may be increased up to 100 per cent. Employees who fail to comply with the regulations may be fined up to $1.50 upon notice of the association to the employee's sick benefit organization.

All fatal accidents and those requiring more than three days' absence from work must be reported to the association and the local police. The latter make a detailed investigation and send a copy of their report to the association, which appoints a committee of three to decide what assistance is necessary after the fourteen weeks' period, during which the injured person is cared for by the sick and death benefit fund. The association, however, may take complete charge of the patient at once if deemed advisable, and the sick benefit fund gives the payments due the injured man to the association, which in turn makes to the patient's family whatever payments are required by law. These payments vary according to the patient's condition, of which the association is kept informed by the local authorities. Should the injured person be dissatisfied with the amounts allowed, an appeal may be taken before a board of arbitration, and finally before the State Insurance Bureau. That the decisions of the association are made in all fairness is shown by the fact that not more than 10 per cent of its rulings are reversed.

During the last five years the expenses of the association were as given in the following table:

YEAR	Total Expenses	Percentage Cost for Each Form of Outlay					
		Accidents	Accident Investigations	Arbitration	Accident Prevention	Management	Reserve Fund
1899.......	$74,574	83.4	3.3	1.7	1.	10.6	..
1900.......	88,594	83.	3.5	2.2	.6	10.7	..
1901.......	122,800	81.4	2.8	1.7	.4	9.2	4.4
1902.	146,011	82.7	3.1	1.4	.1	9.	3.6
1903.......	164,812	80.7	3.	1.5	.1	8.	6.7

The annual premiums for every $1,000 insurance were as follows: 1899, $7.22; 1900, $7.31; 1901, $8.93; 1902, $10.89; 1903, 10.95. The cost per person insured was almost $2.50 in 1903, but the regulations provide that no increases are to be made in this per capita tax after it reaches $4.50, the intention being to call upon the reserve fund if necessary to cover any deficit. Upon reaching this maximum, the total sick and accident cost to the members of the association would equal about 3.5 per cent of the wages paid to their employees.

The scope of the association was enlarged by the law of June 30, 1900, granting it the right to insure railway officials against criminal prosecutions and to pay pensions to those dependent upon them. While this insurance is purely voluntary, many railway officials are ready to take advantage of it, as insuring in the association is expected to prove cheaper than in the private companies, and larger pensions can be paid than are provided by the workingmen's pension laws. The association is now preparing estimates for this class of insurance.

THE PRESENT STATUS OF WORKMEN'S INSURANCE IN OTHER EUROPEAN COUNTRIES

The insurance laws passed in Germany during recent years have not failed to attract the attention of neighboring countries, and an international workingmen's insurance congress was organized for the purpose of introducing similar laws throughout Europe. The last session of this congress was held in 1902, at Düsseldorf. The reports and proceedings of that meeting show plainly that Germany is very far ahead of other countries in the development of pension systems for the working classes. Where such systems have been introduced, particularly where the organizations are voluntary, the benefits have been far less than is granted by the compulsory insurance in Germany. In other countries there is much protest against compulsory insurance, but it is a fact that in Germany, where the good consequences of such laws are being experienced, very little is heard to-day about compulsion or criticism of the government for interfering in matters of this nature. On the contrary, the results have been so good that the system is being broadened from year to year, and bids fair to meet with constantly increasing success.

In conclusion, Mr. Gorella presented statistics on the status of different classes of insurance in Continental countries.

TWO OTHER PAPERS AT THE VIENNA CONVENTION

Among the other papers presented a few weeks ago at the Vienna meeting of the International Tramways and Light Railway Association was one by Mr. Björkegren, of the Grosse Berliner Strassenbahn, on measures for neutralizing the influence of stray railway currents on electrical instruments, and another by R. H. Scotter, of London, on street and light railway law in different countries.

Mr. Björkegren divided the disturbances by railway currents into two classes—those caused by the inductance of transmission lines and leakage of motor fields, the effects of which may be considered negligible beyond a few hundred feet, and the far more serious variations in the earth's magnetic field due to return circuits. Included under the last cause are the currents set up between adjacent railway lines supplied from the same power station owing to difference of potential in the return circuits. Mr. Björkegren then described a number of instruments devised to reduce the variations caused by such stray currents, and also described the changes his company had made in the construction of several lines to avoid influencing the precision instruments in nearby physical laboratories.

Mr. Scotter's paper presented some interesting points for discussion. Attention is called to the public's desire for high speed in city transit, this often resulting in the extensive building of elevated and subway lines, for which franchises are readily granted by the municipal authorities without pausing to consider how ruinous the new lines may prove to the longer established surface railway. The members of the association should make it their duty to collect all available data on this subject for the education of franchise-giving bodies, so that street railways will run less risk of losing business they are entitled to handle. The question of municipal operation is also worthy of careful consideration. Mr. Scotter said that not all of the municipal lines in England had proved successful. Many of the municipalities are heavily in debt, and the frequent political changes make responsible and economical management impossible. Another unpleasant feature is the unwillingness of municipalities to grant running rights to adjoining railways. On the subject of freight handling, Mr. Scotter said that such traffic was permitted on street railways only by special permission of Parliament. Light railways may carry freight, but very few running on public roads have found any advantage in doing so. Mr. Scotter thinks that freight transportation should be taken up wherever possible, basing his belief on the experience of companies who have given particular attention to the development of this business.

POWER USED BY BRAKES

The amount of power required by air brakes in every-day service has been investigated but little. The power required is small, to be sure, as compared with the total power required by a car. Nevertheless, it is interesting to know the value of these small items. Through the courtesy of James D. Tanner, of the Tanner Electric Brake Company, of Cleveland, it is possible to give here the results of some tests on power required for operating brakes on cars in commercial service. These tests were made by H. M. Wheeler, instructor in Lewis Institute, Chicago, formerly in charge of tests in the engineering department of the Chicago Union Traction Company. These tests were made with the object of determining the energy consumption of an independent air-brake compressor in ordinary service, and from this to learn how much saving in electrical energy could be gained by the use of a new type of electric brake which was being developed by Mr. Tanner. Leaving aside any question of possible economies that might be brought about by a radically new type of brake, these tests are of value to the electric railway engineer as regards the air brake, because they afford definite information on a subject regarding which there is little or no published data. The car upon which the air-brake tests were made was a double-truck city car, equipped with four G. E.-70 motors, and weighing, approximately, 25 tons. The air brakes were supplied with the latest type of Christensen motor-driven compressor. To measure the amount of electrical energy supplied to the compressor motor an ammeter and voltmeter were connected in the motor circuit. The time the motor operated in seconds was measured by a stop watch. The summary of the two tests is as follows:

	Test No. 1	Test No. 2
Round trip, miles	11.88	11.88
Running time, minutes	92	85
Number of stops	130	107
Stops per mile	11	9
Total time pumping	18′ 22″	26′ 30″
Per cent of time pumping	20	31
Total kw-hours at car	.5293	.7584
Total kw-hours at power-house	.6229	.9034
Number of times pump operated	27	33
Average voltage at car	467	461
Average voltage at power station	550	550
Kilowatts at car during pumping	1.73	1.72
Kilowatts at power-house during pumping	2.03	2.05
Average kw-hours at car for each pumping	.0196	.023
Aver. kw-hours for each pumping at power-house	.0231	.0274
Average amperes during pumping	3.70	3.70
Average time for each pumping, seconds	41	48
Kw-hours per car mile for braking	.0525	.076
Kw-hours per car hour for braking	.406	.637

The automatic governors started to pump at 45 lbs. gage pressure and cut out at 60 lbs.

A glance over the test sheet, which it is not necessary to reproduce here in full, shows that the pump operated from a maximum of fifty-seven seconds to a minimum of thirty seconds each time, the average being forty-one, as given in the summary. The number of stops to each time of pumping was from ten to three; in the majority of cases it ran four, five and six stops. The car was comparatively new in service, having been in operation twenty-four days. From the number of stops per mile it will be seen the test was made in city service on crowded streets. Figuring it on a basis of kw-hours per stop, test No. 1 required .0478 kw-hours, and test No. 2, 0084 kw-hours per stop.

A test of a double-truck 22½-ton car in suburban service, with two-motor equipment and the new type of electric brake referred to, was made about the same time. The brake was of a type taking electrical energy from the storage battery of the car, which was charged from the trolley. With this brake kw-hours per stop were .0009 under extreme conditions.

A. L. Neereamer, traffic manager of the Columbus, Delaware & Marion Electric Railroad Company, of Columbus, is responsible for a very handsome little book entitled "Through the Heart of Ohio." The book contains a description of the construction work on this line, also numerous illustrations of important points of interest, including views in the several attractive summer resorts which are touched by the system. The road is now in full operation between Columbus and Marion, and occupies a strong position in the very center of the great system of Ohio interurban roads, providing the logical entrance to Columbus for lines building to both Cleveland and Toledo. The system was thoroughly described in a recent issue of the Street Railway Journal.

The executive committee of the Ohio Interurban Railway Association was entertained a few evenings ago at the Dayton Country Club, West Milton, by Edward Spring, superintendent of the Dayton, Covington & Piqua Traction Company.

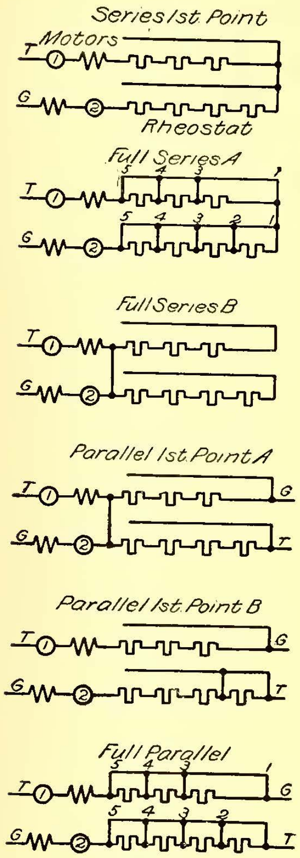
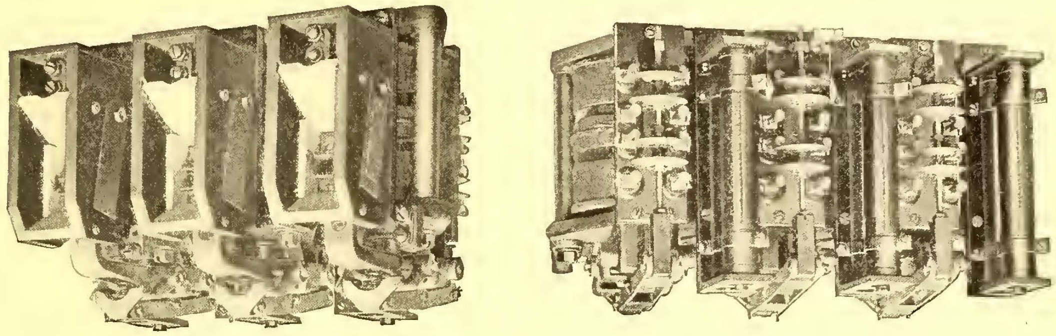


FIG. 1.—CIRCUIT COMBINATIONS OF MOTORS

NEW FORM OF SPRAGUE-GENERAL ELECTRIC AUTOMATIC RELAY TRAIN CONTROL FOR BOSTON ELEVATED RAILWAY

The form of train control recently installed on twenty-four new cars of the Boston Elevated Railway embodies some novel and interesting features.

This control employs magnetic switches or contactors of the standard General Electric type, controlled from the master controller, but are also governed automatically by a current relay or "throttle" connected in the motor circuit so that the accelerating current of the motors is substantially constant. This is accomplished by having small auxiliary interlocking contacts on certain of the contactors (see Figs. 4 and 5), so arranged and connected that the contactors will be always energized in a definite succession. Starting with the motors in series with all resistance in circuit, the resistance is cut out step by step, then the motors are connected in parallel with all resistance in, and the resistance again cut out step by step. This succession is always followed whether the master controller is turned on slowly or thrown directly to the full "on" position. The progression, however, never goes beyond the point indicated by the position of the master controller handle, and its rate is absolutely governed by the throttle relay (Fig. 7, upper part), so that the advance is not made faster than will keep the current in the motors within the prescribed limit.


FIGS. 2 AND 3.—CONTACTOR UNITS WITH INTERLOCKING CONTACTS

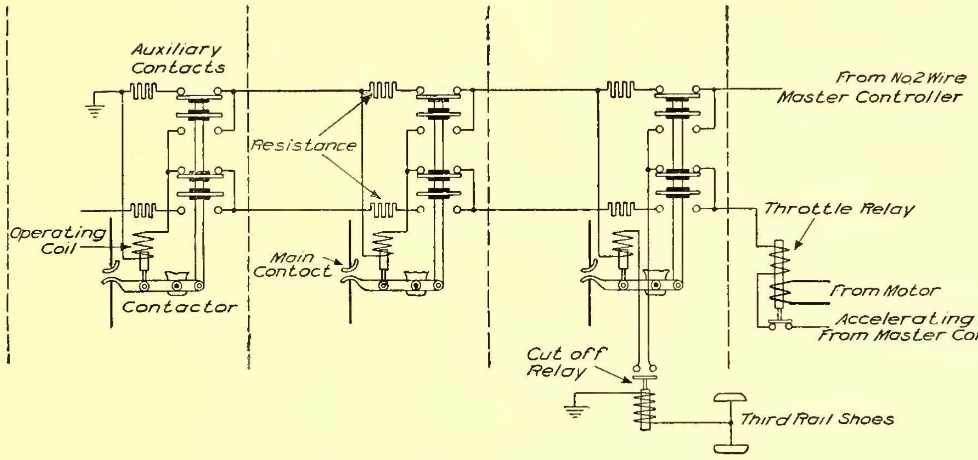


FIG. 4.—WIRING DIAGRAM, SHOWING CONTACTS AND RELAYS

One of these throttle relays is provided with each car equipment, so that while the contactors on all cars of a train are controlled from the master controller at the head of the train as to the application and removal of power, the rate of progression through the successive steps is limited by the relays on each car independently, according to the adjustment and current requirements of that particular car.

A particularly noteworthy feature of the control is the method of accomplishing the series-parallel connection of the motors. This is by the so-called "Bridge" method of connections, which are arranged so that the circuit through the motors is not opened during the transition from series to parallel, and so that the full torque of both motors is preserved at all times from the series to the full parallel connection. The result is a perfectly smooth acceleration and absence of the jerk noticeable in ordinary series-parallel controls when passing from series to parallel, especially with as large motors as are used on modern elevated cars.

The circuit combinations of the motors are shown in Fig. 1. The connections are the same as usual, with separate resistances for each motor, up to the position "Full Series A." The next combination places a bridge connection between the motors, inside of the resistances, and opens the shunts around the resistances, as in "Full Series B." The next step ("Parallel 1st Point A") makes a ground connection on No. 1 motor and trolley connection on No. 2 motor resistances, which places each motor across line potential with resistance in each circuit, giving parallel connection—the bridge connection becoming an equalizer between points of substantially equal potential. This bridge connection is then opened ("Parallel 1st Point B") and resistance cut out as usual ("Full Parallel").

The wiring diagram, Fig. 5, gives the complete car connections, showing in detail the method of producing the automatic action of the contactors.

The master controller, Fig. 6, consists of a single cylinder with handle directly connected thereto. The handle is moved in one direction to give forward movement of the car, and has four positions in this direction, corresponding to: (1), switching position in series, giving a slow movement; (2), accelerating position series; (3), lap position in parallel; and (4), accelerating position parallel. There are but two positions in the reverse direction corresponding to the two first mentioned for forward. The handle is returned to the central or "off" position by a spring so that the power is cut off whenever the motorman releases the handle.

There are five circuits leading from the master controller and five corresponding train wires for this control proper. There is also a sixth circuit in the train line which is used for an emergency cut-off (Fig. 7, lower part), to be described later. The five circuits comprise one for forward direction, one for reverse, one each for series and parallel, and the fifth for controlling the acceleration.

When the master controller is moved to its first position (say forward), the forward direction wire is energized, which throws the reverser to its forward position, and when so thrown energizes contactors in the main or trolley leads to the motors. At the same time the series contactor is energized and the circuit through the motors is completed in series, with all resistance in circuit, giving a slow speed forward. In this position no further action is produced. When the master controller is moved to its second position, a circuit is completed through the accelerating wire (No. 1), see Figs. 4 and 5, in addition to the above circuits, which energizes the contactor shunting the first resistance step, the current also passing through the fine wire coil and the contacts of the throttle relay. The plunger of this relay has a lost motion, so that an appreciable time is required to move it, and this time is adjusted to be the same as that required by the contactor in closing its contact. These two devices thus operate simultaneously. The contactor, being lifted, shifts its operating coil, by means of the auxiliary contacts carried on its stem, into the circuit through the series contactor above mentioned, which maintains it in the closed position independent of the circuit that has lifted it. At the same time the throttle relay has opened the lifting or accelerating circuit. The shunting of the resistance step by the contactor causes an increased current to flow through the motor circuit and through the heavy coil of the throttle relay, which is sufficient to hold the relay plunger in its raised position, and so keeps the accelerating circuit open until the motors

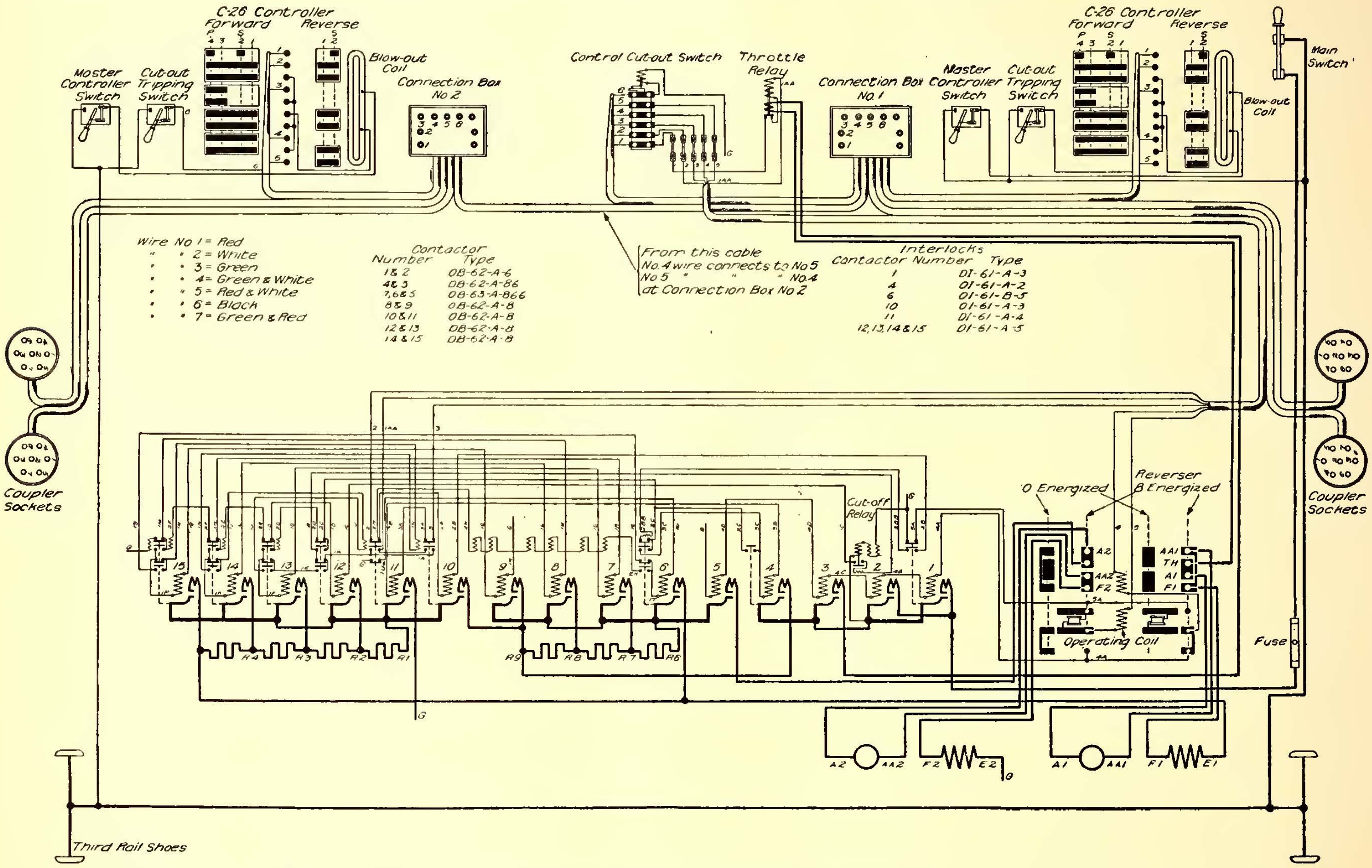


FIG. 5.—WIRING DIAGRAM OF COMPLETE CAR CONNECTIONS, SHOWING IN DETAIL THE METHOD OF PRODUCING THE AUTOMATIC ACTION OF THE CONTACTORS

by speeding up cause the current to diminish enough to allow the relay plunger to drop. Circuit is then established through the contactors shunting the second resistance step (the first contactor having shifted this circuit also), and these contactors are energized and the relay again lifted and held up by the increased current, and so on until all the resistance is cut out.

When the master controller is moved to the third position, the parallel circuit is established, and the bridge contactor and then the parallel contactors closed and the motors connected in the multiple arrangement. When the master controller is moved to its fourth or "full-on" position, the resistance is cut

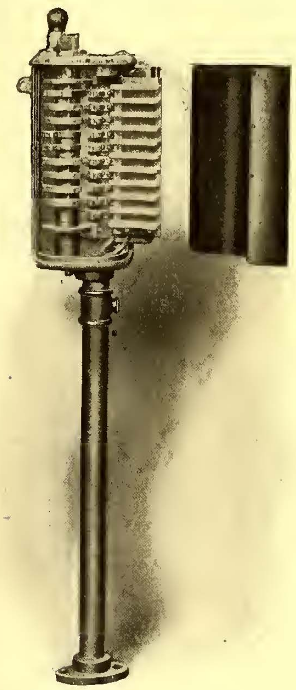


FIG. 6.—MASTER CONTROLLER

FIG. 7.—TRIP MAGNETS ON TOP OF CUT-OUT SWITCHES

out step by step as in series. These same successive actions are produced if the master controller is thrown to the full-on position directly, as the interlocking contacts prevent an advance circuit being established before the proper preliminary action has taken place.

If at any point during the acceleration, the master controller is moved to its "lap" position, the existing positions of the contactors are maintained, but the further progression is arrested so that the motorman can limit the acceleration to as slow a rate as desired, but he cannot exceed the predetermined rate for which the relay is adjusted.

The sixth wire in the train line above referred to, providing an emergency cut-off, is connected to a switch in the motorman's cab and to trip magnets on the top of the cut-out switches (Fig. 7, lower part) provided on each car of the train. All of the control circuits for each car pass through its individual cut-out switch, and when the motorman operates the emergency switch in his cab all of the cut-out switches on the train are opened, thus cutting off power on all of the cars.

A further automatic protection is provided by the cut-off relay shown in Figs. 2 and 6. This relay has its coil connected to the lead from the collecting shoes of the respective car, and its contacts are so connected in the contactor circuits that in case of failure of power to the car, such as would be caused by passing over a dead section of rail, this relay is de-energized and causes the control circuits on that car to be thrown back to series position with resistance in, and when power is restored the control progresses automatically step by step to its former advanced position. This prevents any surging or overloading on such occasions.

The master controller, illustrated in Fig. 6, is of small dimensions and occupies but very little space in the cab. One of the contactor units with interlocking contacts is shown in Figs. 2 and 3. The cars weigh approximately 35 tons each and are equipped with two GE 68 motors geared to a maximum speed of about 40 miles per hour. The acceleration is adjusted to approximately 1½ miles per hour per second.

RAILWAY GUIDE BOOK AND PASSENGER REGULATIONS IN SYDNEY, AUSTRALIA

It is unfortunate that so many urban and interurban railway companies fail to realize how much additional traffic could be gained both from the local public and strangers by distributing a booklet giving the intending traveler a clear idea of the different routes and connections of the system, the headway on each route at various parts of the day, and the time and cost required to reach a given point.

An excellent example of such a booklet is the publication issued monthly by the New South Wales Government Tramways, of Sydney, Australia. Here the tramways cater for a population of about 500,000, carrying last year over 137,000,000 passengers. The time table is sought for principally by visitors to the city; regular travelers being familiar with them do not look for them to the same extent. In this book, 96 pages, 2¾ ins. x 4 ins., particulars are given of all the tramway services, and, where necessary, the steamer or train connections. In addition, there is included a small map, showing the railway system, with the names of the important places. Cars run strictly in accordance with the schedule, and when alterations are made on holidays or other special occasions, brief particulars are advertised of the changes in service. At a number of places throughout the system larger maps, 3 ft. 3 ins. x 2 ft. 6 ins., are exhibited, together with sheet time tables in bold type.

Some of the tramway by-laws given in this booklet should make interesting reading for strenuous advocates of government ownership. The Sydney system is owned by the government of New South Wales, and is controlled by a Railroad Commission, which has authorized the enforcement of some strict by-laws, a few of which are quoted herewith:

Smoking is strictly prohibited in or upon any carriage, or platform thereof, not set apart for the purpose; and any person who persists in smoking after being requested by a passenger or warned by any officer employed on the tramway to desist, shall be liable to a penalty not exceeding £2, and may be removed from the carriage by any such officer.

Any person, unless authorized by the Commissioners, who shall post or stick any placard or bill within or on any of the tramway property or premises, shall be liable to a penalty not exceeding £2.

Any person who shall assault or wilfully impede any officer or servant of the Commissioners in the execution of his duty, shall be liable to a fine not exceeding £5.

No person except a passenger or intending passenger shall be allowed to enter or mount upon any carriage; and any person holding or hanging by any part of a carriage, or getting into or upon or quitting any carriage while in motion, or attempting to do so, shall be liable to a penalty not exceeding £2.

Any person who shall prevent a passenger from getting in or out of any carriage, except when in motion, or obstruct any passenger in such ingress or egress, shall be liable to a penalty not exceeding £5.

Any person entering a tram car after being informed by the conductor that the same is full, or having entered, refusing to leave at the request of the conductor, may be removed from such tram car by any employee of the Commissioners, and will be liable to a penalty not exceeding £2.

Any passenger who shall remain upon the front platform of any electric motor car after having been requested to leave the same by the driver, conductor or other authorized officer of the Commissioners, shall be liable to a penalty not exceeding £2.

Any passenger who shall place his or her foot or feet upon any seat or part of a seat in any railway or tramway carriage, shall be liable to a penalty not exceeding £2.

Several pages are devoted to rates of fare for adults, children, school pupils between twelve and eighteen years of age, technical college and university students, workmen's and military fares, owl cars, special excursions and the like.

WOOD-WORKING TOOLS FOR STREET RAILWAY REPAIR SHOPS

With the growing importance of the repair shop for street railways, the selection of machine and wood-working tools has become one of more than ordinary importance. Not only is it found necessary to maintain carefully equipped shops, but the exigencies of modern repair-shop conditions also demand results far beyond the standards provided in the older types of tools. In this direction a representative of this paper, during a recent visit to the shops of the S. A. Woods Machine Company, Boston, Mass., was impressed with the high standard of excellence attained by that company in the manufacture of wood-working machinery. Various classes of wood tools, especially adapted to street railway work and car-body repairs, as well as for the production of stock for various other uses, were examined, and the development of labor-saving equipment was everywhere apparent.

Lack of space forbids the mention in detail of each machine shown, but particularly prominent were the Woods drop-table variety moulder and No. 302 vertical hollow-chisel mortiser.

The former is a characteristic machine for the production of irregular moldings and variety woodworking. The table is in two sections, the front section lowering 7½ ins. below the back or fixed table, permitting stock of greater curve or sweep to be worked than it would be possible to handle otherwise and retaining the cutters close to the boxes, thus eliminating vibration and insuring superior results.

The latter is probably one of the best known of the company's new hollow-chisel mortisers, of which several types are built for varying classes of work. This machine is successfully cutting square mortises as small as ¼ in., a new departure in machine work, but one of great importance. The lack of success in this direction with earlier machines has been a serious limitation, since sash and similar work requiring ¼-in. cuts have necessarily been worked on a lighter machine than that suited to the heavier mortising of the sills or general car-body work. This is in marked contrast to the mortiser referred to, which, by its special design and construction, is adapted to small work, with provision to handle the heavy material. It uses chisels up to 1½ in. square without the least inconvenience or effort, owing to the transverse travel or movement of the chisel carriage across the timber or sill, while the latter remains in position.

In addition to its stability, in which respect this machine resembles a metal-working tool, it has the same provisions for taking up of wear, etc., as are to be found in the latest types of iron-working tools. This is a very commendable innovation for machinery of this class, as recent conditions of rapid production have brought upon the wood-working tool often more severe conditions of operation than are elsewhere experienced, even upon iron-working tools using the high-speed tool steels. It is a well-known fact that a wood-working tool, with the blades or knives slightly dulled, will require many times more power to operate than when the knives are sharp, while the use of green or knotty timber produces even greater strains upon the mechanism, which must manifestly be taken care of, if satisfactory operation is to be expected.

In the minor features of the machine, the arrangements provide for easy adjustments, attract attention. It is probable that no tools are more adequately provided in this respect; reduction of time of handling is thereby reduced to a minimum, an important factor in this work. The wide range of adjustments also makes possible the cutting of gains and end tenons upon car sills and other heavy timber work that would be very difficult otherwise.

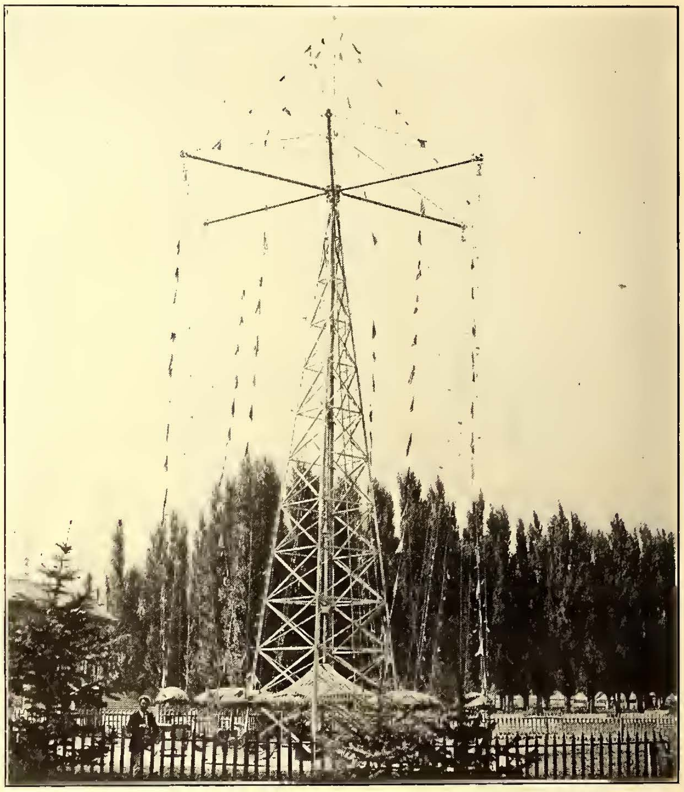
The Woods fast-feed planers and matchers, timber sizers and straight molding machines are also favorably known in many of the latest equipped shops.

The finish given to all of these tools is worthy of remark; all castings are carefully rubbed down and done in an egg-shell finish, which produces a most attractive result and also greatly facilitates the keeping clean of the various parts.

THE CIRCLE SWING AND AIR SHIP

A popular novelty in the line of amusement apparatus is the circle swing and air-ship shown in the accompanying illustration. This device, which is made by the Traver Circle Swing Company, of New York, was first operated during the summer of 1903 in Electric Park, Kansas City, Mo., where it met with immediate success. At present there are installations in service in Revinia Park, controlled by the Chicago & Milwaukee Electric Railway Company; Elitch Gardens, Denver, Col.; Salt Palace, Salt Lake City; the Chutes, Los Angeles, Cal.; Luna Park, Coney Island, N. Y.; Coney Island, Cincinnati, and many other places.

One of the most attractive features of the ride in the circle



THE CIRCLE SWING AT SALT LAKE CITY

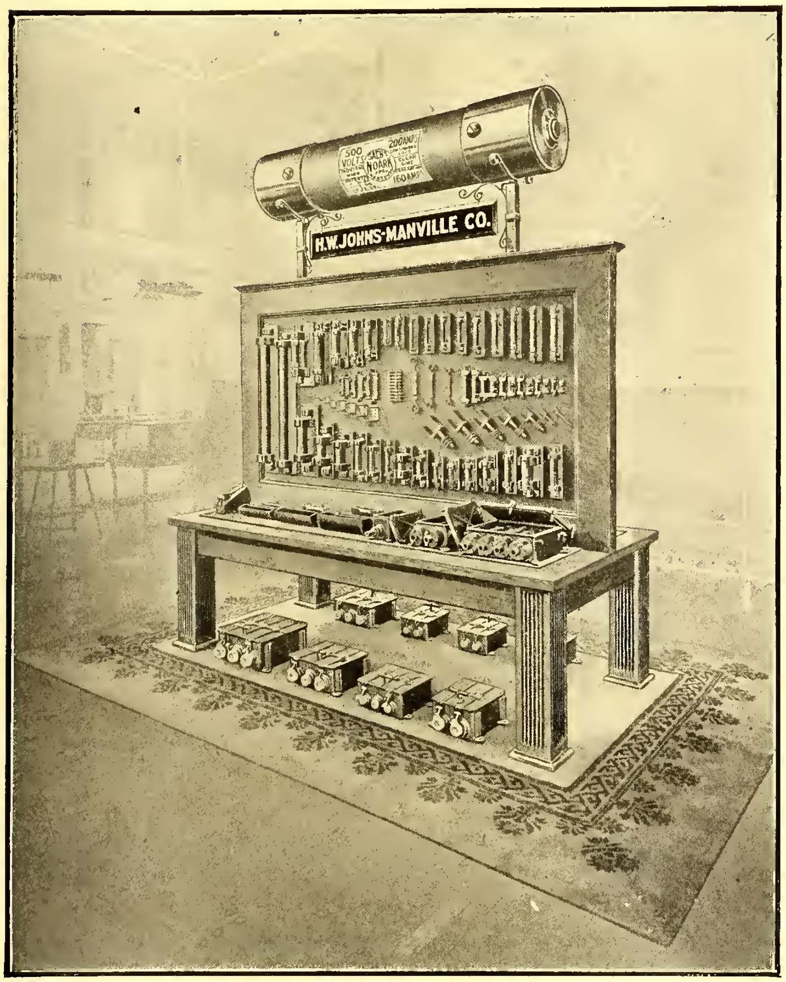
swing is the ease with which the cars move, there being absolutely no noise or vibration. Another feature is the pleasing, cooling effect produced by the rapid flight through the summer air. The passengers are seated in narrow, pointed cars, which are lifted slowly and gracefully into the circle. Gradually, however, the machine moves faster, the cars gain momentum and the passengers are rapidly swung forward. When the cars have been lifted to their utmost height and the limit of speed attained, the power is slowly reduced and the speed lessened to permit the cars to return gently to the ground.

All parts of the circle swing, including the tower, shaft, trusses and cables, are made of steel. All exposed parts are galvanized to prevent rust. The car seats are made of rattan, stiffened with iron and upholstered in fine red leather. The machine is built with a factor of safety of twenty to one, and speed regulation is secured by an electric controller, which gives absolute control under all conditions. The cars are swung by ½-in. steel cables capable of holding 16 tons in each car, and are loaded from a circular platform built of concrete. Every circle swing is designed, built and erected under the supervision of the company's engineers, complete for operation.

FUSE EXHIBIT OF THE H. W. JOHNS-MANVILLE COMPANY AT THE LOUISIANA PURCHASE EXPOSITION

An inspection of the exhibition of Sachs "Noark" enclosed fuses and fuse devices, made by the H. W. Johns-Manville Company, in the Electrical Building at St. Louis Exposition, impresses the observer at once that the enclosed fuse, as an electrical accessory, has obtained a permanent position in the electrical field.

While the exhibit is not large, it is thoroughly representative, and shows to excellent advantage the various enclosed fuse devices of different types and styles manufactured by this company. It is mounted on a large display board, rising from the center of a handsome oak table. Over all is suspended an enormous enclosed fuse, duplicating the actual device in every particular, and attracts the eye of even the casual visitor, as it can be seen long before the exhibit is reached. Mounted on both sides of the display board are the different styles of fuse blocks equipped with their respective fuses; one side of the board being covered with 220-volt devices, while the other presents the higher potential appliances. The display of blocks and fuses is very comprehensive, including every standard block and fuse manufactured by the company.



FUSE EXHIBIT AT THE LOUISIANA PURCHASE EXPOSITION

Placed upon the table on each side of the display board and also on the floor underneath the table, is a complete line of fuse and service boxes, with the now well-known lobster-claw fuse-clamping arrangement; and also a line of car equipment fuse boxes, subway boxes, etc. A feature which is by no means the least attractive, both to the layman and others, is the actual demonstration which is given from time to time of the operation of open and enclosed fuses. The exhibit includes a testing box containing an open fuse block and a Sachs "Noark" enclosed fuse block. The open fuse is first blown with the usual terrific explosion, while the enclosed fuse—in that quiet manner which has won for it the approval of discerning engineers—opens the circuit, so that unless one looked at the indicator, with which all Sachs "Noark" fuses are equipped, it would be impossible to know whether the fuse had blown or not.

The exhibit certainly stands with the very best of the exhibits of electrical accessories at the Fair, and is unquestionably worthy of close inspection. Much credit for the attractive appearance of this display is due to the efforts of G. D. Pogue, of the electrical department of the St. Louis branch of the H. W. Johns-Manville Company, who has full charge of the exhibit.

ELECTRIC-HYDRAULIC BLOCK-SIGNAL FOR ELECTRIC RAILWAYS

S. H. Harrington, of New York, has recently brought out a block-signal system for electric railways, the operation of which is based upon the combined use of electric and hydraulic power, the latter being employed for storing any desired number of signal movements to insure operation even if the electric current is cut off. The pump of the hydraulic accumulator is situated in the base of the signal post, and its plunger is connected with a small motor supplied by the line current. Should the signal ever become inoperative, the blade is automatically pulled to an angle of 30 degs. and a green light displayed. This is a cautionary signal, and allows the car to proceed under reduced speed to the next signal.

The means for setting and clearing this signal when a car enters or leaves a block consist of a short rail similar to a guard-rail placed at a suitable distance in front of the signal, which is normally set at danger. This short rail is movable on a pivot, and when a car-wheel flange passes between it and the traffic rail the circuit is closed, thereby energizing the magnets of an electrically operated double valve. This operation lifts the valve and admits fluid from the accumulator to the plunger chamber, causing the plunger to operate and set the signal to 60 degs., indicating safety.

After the car has passed the block and entered the protected section, the valve is released and the signal consequently returns to danger position and is locked until the car has passed out of the protected section. At the end of the section is located a second pivoted-rail arrangement, so that the passing of the car flange between it and the traffic rail releases the electrical locking device, which permits the next car arriving in front of the signal to restore it to safety on entering the block.

The blade of the signal contains five incandescent lamps, which show white lights when the signal-arm is at an angle of 60 degs., or safety, and red lights when the blade is horizontal, or at danger. As an additional source of light and as a precaution in the event of the extinguishing of the blade lights, the signal contains an oil lamp which is capable of burning seven consecutive days without refilling. All the operating mechanism is contained inside the post, thus reducing the chances of the signal becoming inoperative. It is also sealed to prevent tampering.

The St. Louis & Suburban Railway has submitted a report of its business for the quarter ending June 30, which shows good increases on account of the World's Fair. Passengers for the quarter numbered 5,889,746, against 4,451,164 last year. The number of trips last quarter exceeded the corresponding quarter of last year by more than 3000, 77,743 trips having been made, against 74,563. The gain over the previous three months of the present year also shows a great increase of traffic.

PROPOSED ASSOCIATION OF CLAIM AGENTS

One of the steps which will undoubtedly be taken at the St. Louis convention will be the organization of claim agents of different street railway companies. The movement has been discussed for several years, but took tangible form some time ago when William A. Dibbs, claim agent of the New York City Railway Company, sent to a number of street railway companies a circular, of which the following is a copy:

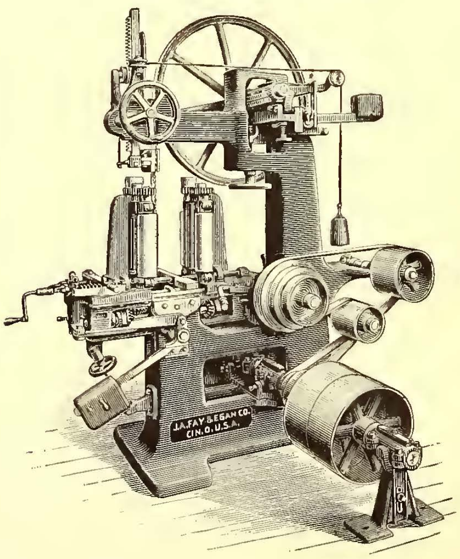
Several of the claim agents in this vicinity have for a number of years past been corresponding with one another relative to claimants and their methods. It has been found to be of mutual benefit, not only to the agents but to the roads. A system of the magnitude of yours no doubt meets with a number of maligners and repeaters. Information, of course, regarding them will help your defense. Why not start an association of street railway claim agents under the same auspices as the steam railway claim agents; have semi-annual conventions, discuss the different topics of business, and advance ideas for the betterment of the office work and its branches? If you are interested, I would be glad to get an expression of your views.

A large number of favorable replies have already been received, and a meeting of those interested will be held in St. Louis to consider the organization of a permanent body. All street railway claim agents are eligible to the new association. As some companies may not have received the original circular, this paper has been requested to state that all who are interested in the proposed movement are invited to participate in proposed meeting at St. Louis, looking to the organization of an association of claim agents. An announcement will be made on Wednesday, Oct. 12, the first day of the American Street Railway Association meeting, of the place and time of the proposed meeting of the claim agents.

BAND RESAWING MACHINE

The accompanying illustration shows a band resawing machine of medium capacity brought out by the J. A. Fay & Egan Company, of Cincinnati, Ohio. It is intended for general resawing in fine lumber.

Some of its most salient points are worth careful considera-



BAND RE-SAW OF MEDIUM CAPACITY

tion. The upper wheel is mounted on a heavy column, reducing all tendency to vibration and insuring great speed. The improved tension on the blade is very sensitive and reliable, and uniform on all occasions. The lower wheel is solid, thus lessening circulation of dust, increasing momentum and preventing the upper wheel from overrunning it. The upper wheel has a lateral adjustment to keep the saw on its proper path without stopping the machine.

The feed is variable, and rolls will open to receive stock 24 ins. wide and 8 ins. thick. The inside rolls can be locked in position and the outside ones instantly moved to or from the saw by a lever, and are gaged by an accurate quadrant. The rolls can be tilted 12 degs. and clamped for any angle work. The machine has other mechanical features that recommend it very highly to all having resawing to do.

WEED-CUTTING BRUSH FOR RAILWAYS

Charles D. Smith, who is connected with the Wisconsin Rapid Transit Company, Fond du Lac, Wis., has invented a metallic wire brush that may be readily adjusted to either end of a car to keep the space between the rails clear of plant growth. When in use the brush is dropped so that wires will just scrape the ground, and when the car is in motion the brush will effectively cut the weeds. The apparatus is very flexible and can be adjusted to any desired position.

A REAR GUARD FOR STREET CARS

C. A. Willard, of St. Louis, has devised an apparatus which is intended to prevent some of the accidents caused by passengers attempting to cross the street behind a car when another car is approaching on the opposite track. This apparatus consists of a safety guard operated by compressed air, which extends out in the rear of the rear platform so as to prevent persons from crossing the street immediately behind a car when another car is approaching in the opposite direction. A signal is displayed on the dashboard of the car which indicates whether the guard is out at the rear, the idea being that if the motorman of a car approaching in the opposite direction does not see this signal he must proceed with great caution. Both the guard in the rear and the target or signal on the dashboard are illuminated when the car is lighted, thus rendering them of value at night as well as by day. Mr. Willard expects to have an exhibit of this device in the Transportation Building, Aisle E, No. 5455, during the street railway convention at the Louisiana Purchase Exposition.

ST. LOUIS TRANSIT COMPANY'S CAR LUNCH ROOMS FOR EMPLOYEES

The St. Louis Transit Company, through General Manager McCulloch, has established street car lunch rooms at the Olive Street loop at the World's Fair for the convenience of its employees. Capt. McCulloch has inaugurated the lunch rooms as an experiment, and should they prove successful, he will place cars on all of the through lines. The motormen and conductors think highly of it and are steady patrons. Two negro waiters, faultlessly clad in white, serve the sandwiches and coffee to the men, who stand on the outside. The plan is a great time-saver, for it does away with the necessity of the men making arrangement for securing their luncheon while on regular runs. In many cases it was found they would leave their cars to go into a restaurant to get a prepared lunch or meet some member of the family who would be in waiting for them at a designated spot. Thus they were often called from their cars.

Some of the photographs taken at the recent Utica meeting of the New York State Street Railway Association and delivered during the convention have faded out. The photographer, A. P. Zintsmaster, of Herkimer, N. Y., states, however, that he will replace any of these faded photographs by a perfect one if the purchasers of the photographs will return the faded ones to him. Mr. Zintsmaster is a photographer with an excellent reputation, which he is desirous to maintain.

PROCEEDINGS OF THE INTERNATIONAL ELECTRICAL CONGRESS—SECTION F

MONDAY, SEPT. 12.

The first meeting of Section F, that on electric transportation, of the International Electrical Congress, was held on Monday, Sept. 12. Dr. Louis Duncan, chairman of the section, announced that the first paper to be presented was that by Philip Dawson on electric traction on British railways. This is presented in abstract below:

DAWSON, ON "ELECTRIC TRACTION ON BRITISH RAILWAYS"

Owing to the stringent regulations imposed by the Government and the very densely populated districts which railways traverse, the capitalization of English lines is an exceedingly heavy one, amounting to about £1,184,000 for 22,078 miles of railway, both single and double track. The percentage of net receipts to total paid-up capital is decreasing, owing to increased taxation and competition of electric tramways. The author's opinion as to the remedy is the judicious adoption of electric traction. He classifies railway traffic as follows: Short-distance suburban and interurban; long-distance main line, and goods traffic. The first class is extremely favorable for the adoption of electricity, and the others may furnish some instances where it would be feasible. The Mersey Railway is cited as an example of the beneficial effect of electrification of a steam line. While only installed last year, in six months the train mileage was increased from 155,000 to 401,000, and the number of passengers from 2,844,708 to 4,153,777. Even better results have been secured on the Milan-Varese railroad.

The author shows that electricity is the only hope of suburban and short-distance interurban systems. Their introduction has resulted in an increase of schedule speeds, and he does not doubt that from 12 miles to 15 miles per hour will be allowed at no distant date. The accelerating ability of the electric cars contributes to good schedule speed. The steam lines benefit by electrification in that they have advantages over tramways in not having to operate in congested districts, and they have a greater distance between stops. The small number of journeys per head of population in London is an evidence of poor facilities for travel. These were 129 in 1901, as compared with 223 in Berlin, and 320 in New York.

There are certain conditions which must be fulfilled by a system of electric traction.

1. Sub-stations with moving machinery should be few in number, and these should require little attendance.

2. The number of conductors supplying current to trains should be few and capable of unlimited extension, hence the use of a third rail is not possible.

3. It must be possible to take from a single conductor sufficient current to haul one or more fast trains between feeding points.

4. It is very desirable that the system should be applicable to main line as well as to suburban systems.

5. It should be possible to operate trains at any speed so as to make up lost time.

6. Controlling apparatus must be simple and high-pressure conductors must not be in dangerous positions.

7. If a. c. motors are used the power factor must be high and the motors must permit of high rates of acceleration.

8. In some cases the motors might be used to return current to the line, but in any case they must be reversible and applicable for braking purposes.

The paper enlarges upon these points, giving the reasons for the conclusions and the requirements of a satisfactory overhead conductor, which is strongly advocated as the only practicable means of conveying current to the trains. A considerable amount of attention is given to the current collector, and a sliding bow arrangement is preferable, as it is simple and does not need excessive pressure against the conductor.

A number of advantages are claimed for electric traction over steam, an important feature being that much greater traction is secured for less weight upon the drivers. Among other important advantages are the decreased wear upon the permanent way, the possibility of multiple-unit control, the reduced number and required skill of operatives and the possible high rates of acceleration. Up to the present time comparatively little has been done in the direction of introducing electric traction upon steam lines in Great Britain, but progress is being made and with satisfactory results.

DISCUSSION ON DAWSON'S PAPER

In the discussion which followed Mr. Dawson's paper it was brought out by Mr. Ward Leonard that high capitalization is not necessarily an indication of poor earning ability, as some American roads have even higher capitalization per mile than the amount reported for England. The important point in operating a road is to utilize to the highest degree the investment in the road, that is to operate so as to produce the maximum ton-miles per mile of track. In this country, by the increase of power employed relative to the investment the cost of transporting a ton for 1 mile has been reduced to about one-quarter what it was fifteen years ago. Here is where the electric power has its great advantage in that unlimited power is possible for a given investment in track. Mr. Leonard also stated that it was fortunate that where there are many grades, water power is prevalent, and that a locomotive of 50,000 lbs. drawbar pull was required. This at about 30 miles an hour would mean about 4000 hp.

Another feature of the discussion was the distinction made by Mr. Sprague between the fields of application of steam and electric traction. Concentration of traffic and multiplicity of units justify the adoption of electricity. Long runs with infrequent stops are not suited to electric traction. The application of electricity is simply a power distribution proposition, and nothing new is created by its use. As illustration of these points, Mr. Sprague cited the case of the New York Central Railroad, which will use electricity for all trains within 35 miles of the center of the city. This will be used for all trains, because two systems are not possible on the same track, and electricity is best adapted to all but the through trains. It was shown that England will adapt electricity when compelled to, because on account of the expense it will be impossible to duplicate existing lines. Electricity offers the only solution of the problem of increasing present facilities.

Mr. Leonard called attention to the fact that in England mail and express matter are classed as freight, while in America they are charged to the passenger service, and these facts must be borne in mind when comparing conditions in the two countries.

The paper of J. B. Entz, on the storage battery in electric railway service, was then read in abstract:

ENTZ, ON "STORAGE BATTERIES"

The principal application of batteries to electric railway systems is made at the generating stations, at distribution sub-stations and directly connected to points on a direct-current distributing line. The objects of such installations are to store electrical energy at efficient and convenient periods and to return it when most useful, generally at periods of increasing or heavy load. The author shows how a battery results in increased economy and reliability of operation and classifies the reasons for installing batteries as follows:

1. Reasons affecting investment.

2. Reasons affecting economy of operation.

3. Reasons affecting reliability and public convenience and safety.

The point is made that there is usually some part of a station load which can be carried by a battery without increasing the total cost of the installation and that sometimes it is good engineering to go to greater expense to insure economy and reliability of operation.

The economies resulting from the use of batteries in power stations and sub-stations are due to the improved load factors in the various pieces of generating and transforming apparatus. The efficiency of a battery for "peak work," which will have an output between 15 per cent and 20 per cent of the total output of the station, amounts to about 85 per cent as a minimum, which is but 3 per cent of the output of the station. This amount should be more than offset by the increased efficiency of boilers, engines, lines and rotaries. The author estimates the total gain due to the use of the battery to be from 15 per cent to 20 per cent. He also makes the point that as the plates of the storage battery are constantly renewed the battery is in as good form at the end of a period of years as at the beginning.

The most important argument made by the author for the use of the storage battery is that it is entirely reliable as a reserve. Its uses in this connection are tabulated as follows:

1. The entire load of a power house may be carried for from three-quarters of an hour to several times that period even during the time of heaviest load.

2. At a sub-station the rotaries can be shut down for an indefinite period of time, the battery floating on the line.

3. The batteries can take care of sudden excessive loads due to unusual congestion of traffic.

4. They will take care of short circuits on the line.

5. At night the entire machinery of a station can be shut down and current cut off the a. c. lines for inspection and repair.

6. The batteries make it possible to buy power from another line

at times when it may be spared and at constant and controllable rate.

The author discusses the matter of boosters for forcing the battery to charge and discharge as desired. Such boosters may be either hand or automatically controlled. The former are employed where a constant voltage is not necessary, but if the battery is to be used in parallel with generating machinery of a constant or rising characteristic, some automatic device is necessary. The automatic excitation of the booster field is accomplished by including an exciting coil in the working circuit. The exciting coil must be neutralized by another, so that with any predetermined average output of the station the booster shall neither add nor oppose its voltage to that of the battery. In order to make such a combination as stable as possible, another main-current coil has been included in the generator circuit so that an increase of current falling upon the generator following an increase of outside load would further affect the battery and cause it to discharge.

The paper also describes the methods used for magnifying the effects of variations in the generator load upon the booster excitation. One of these is a counter electro-motive force generator which derives its field excitation from a field coil placed in the generator circuit, said coil being so adjusted that the average generator load produces an e. m. f. equal to and opposed to that of the station voltage, so that under such conditions the battery is neither charging or discharging. An increase in the generator output increases the voltage of the counter e. m. f. generator, which in turn increases the booster excitation. The reverse effect results from a lowering of the generator load.

The other method of regulation is by means of an electro-mechanical device which varies the pressure upon groups of carbon discs connected in the manner of a Wheatstone bridge, with the exciting field coil of the booster connected in the position of the galvanometer. By the compression of one or the other groups of disc current is passed through the booster field coil in such a direction as to produce the desired effect.

The author concludes by discussing the proper construction of a battery for railway service. He states that the positive plates should be of the "Plante" type, while the negative plates are preferably of the "paster" type. The development of the active lead should be made in such an amount that it will provide secure receptacles for the retaining of the active material, and the necessary further corrosion of the active lead for the purpose of replacing active material carried away should not interfere with the mechanical strength nor the conductivity of the plate.

DISCUSSION ON ENTZ'S PAPER

The paper was discussed by Messrs. Sprague and Edstrom.

In the discussion upon Mr. Entz's paper great stress was laid upon the fields of application of this class of device. It was shown that in stations of small capacity, and therefore with fluctuating load, the battery is almost a necessity. Sub-stations come under this class, as they are virtually small stations, regardless of the original source of the power. In this country it is a debatable matter as to whether storage batteries shall be used or not in large stations. In Europe there no question about this as a rule, for the stations are small and hence furnish the proper conditions for an efficient application of batteries. In very large stations abroad the storage battery is not used as much as formerly.

TUESDAY'S SESSION.

On Tuesday morning a joint meeting of Section B (general applications) and Section F (electric transportation) was held for the purpose of discussing the question of alternating-current motors as applied to electric traction, particularly with reference to the use of a single-phase current on the trolley system and the adaptability of various types of motors to this condition.

Mr. C. P. Steinmetz, chairman of Section B, called the meeting to order and announced the general object of the joint meeting, stating that the papers would all be presented before commencing the general discussion. Mr. B. J. Arnold was then introduced and read his paper entitled "Some Early Work in Polyphase and Single Phase Electric Traction." He reviewed the general development of the application of polyphase currents to electric traction and told how, as early as in 1896, shortly after the appearance of the rotary converter commercially, he first proposed to use this type of apparatus in railway work on a projected line called the Wisconsin Inland Lakes & Chicago Electric Railway. This road was not built, but a few months later he made use of the idea in connection with the Chicago & Milwaukee Electric Railway and installed in 1898 the first rotary converter system used in connection with electric railway work. In 1899 he commenced the development of the present Arnold system, which was discussed in detail in his paper. His general scheme is to make use of single-phase motors and to employ an air storage system to be used in starting and stopping the car, the motor running continuously at maximum load and efficiency. The speed of the car is controlled by accelerating or retarding the parts usually known as rotor and stator, by means of compressed air, in such a manner as not only to regulate the speed of the car, but also to restore the kinetic energy of the car when stopping and to utilize this stored energy in starting again.

In June, 1903, the first experimental machine was ready and a successful trial trip was made. As the apparatus used on this occasion was more or less of a makeshift, it was considered desirable to defer further tests until a complete equipment could be constructed. This was ready in December, 1903, but was destroyed by fire a few days before the date set for public tests. A new equipment was built and on Aug. 3, 1904, a successful trial run was made.

STEINMETZ, ON "ALTERNATING-CURRENT MOTORS"

After the presentation of Mr. Arnold's paper, Dr. Louis Duncan (chairman of Section F) announced that the next paper would be that of Mr. C. P. Steinmetz, entitled "Alternating-Current Motors." Mr. Steinmetz then read one of his characteristic papers. As it contained much mathematical development of the general theory of the various types of alternating-current motors, it was read in part only, the general equations being shown and then the application to the various types developed, together with the corresponding speed and torque curves. The motors considered were the following:

POLYPHASE MOTORS AND MOTORS OF SIMILAR TYPE

(1) Polyphase induction motor.
(2) Single-phase induction motor.
(3) Single-phase condenser motor.
(4) Polyphase shunt motor.
(5) Polyphase series motor.

SINGLE-PHASE COMMUTATOR MOTORS

(1) Single-phase series motors.
(2) Compensated series motor. (Eickemeyer motor.)
(3) Repulsion motor. (Thomson motor.)

It was shown that the maximum power factors of the commutating motors are decidedly higher than those of corresponding induction motors, and that, therefore, the same power factor as in the induction motor can be secured in the commutating motor with a much larger air gap. This is a decided advantage in electric railway work. The compensated motor is intermediate between the repulsion and the series motors, but rather nearer the former for low speeds and to the latter at high speeds; that is, its torque is high in starting and at low speeds, but does not fall off as rapidly at high speeds as that of the repulsion motor. Induction motors are essentially constant speed motors. The repulsion motor is a low speed motor, the series motor a high speed motor, while the compensated or Eickemeyer motor is intermediate between the repulsion and series motors, approaching the former at low speeds and the latter at high speeds.

DERI, ON "SINGLE-PHASE MOTORS"

The next paper presented was that by Mr. Max Deri, entitled "Single-Phase Motors." This paper was read in abstract by Mr. W. I. Slichter. The author reviewed the essential functions and relations of modern single-phase motors (of the commutator type) with the idea of facilitating a comparison of the working conditions and commutating requirements of the different systems. Some new points of view were presented and some new methods of construction were shown.

LATOUR, ON "COMMUTATION"

Mr. Deri's paper was followed by that of Mr. Marius Latour, which was entitled "Commutation of Direct and Alternating-Current Machines." Mr. Latour read his paper in person and discussed in general the essential features of similarity and difference in the commutation of motors on direct and alternating-current circuits.

BRAGSTAD, ON "REPULSION MOTORS"

Mr. Steinmetz then read in abstract from the original manuscript the paper of Dr. O. S. Bragstad, entitled "Theory and Operation of Repulsion Motors." This paper was largely mathematical and cannot be briefly reviewed. Dr. Bragstad stated that commutator motors for alternating currents have become of great interest within recent years, mainly because of the demand for a single-phase railway motor, but that a broad field would also be found for other purposes where speed regulation is required. The repulsion motor is of special interest, not only in itself, but also in that it marks a transition stage to the different forms of compensated motors. The general theory of the repulsion motor was developed in considerable detail under the usual assumption that the magnetic resistance is constant for all magnetic circuits and that the iron losses are proportional to the square of the magnetic induction. The results of the mathematical development were represented graphically by a series of diagrams.

DANIELSON, ON "COMPENSATED REPULSION MOTORS"

The next paper, also read by Mr. Steinmetz, in abstract from the original manuscript, was that of Mr. Ernst Danielson, entitled "Theory of the Compensated Repulsion Motor." Like that of Dr. Bragstad, this paper is very mathematical and the matter contained can not be very well presented in a condensed form. The general analytical theory of the repulsion motor was developed. Leakage was considered and the formulas for the calculation of current, torque, and lag with known voltage, brush position and speed were given. The formulas developed were those used by the Allmanna Svenska Elektriska Aktielolaget, of Westeras, Sweden, for figuring repulsion motors.

LINCOLN, ON "SINGLE-PHASE RAILWAY PROBLEMS"

Mr. Paul M. Lincoln then read his paper on "Transmission and Distribution Problems Peculiar to the Single-Phase Railway." Among other things, Mr. Lincoln pointed out the fact that, as far as the transmission line is concerned, the true criterion of voltage strain is that which exists between any conductor and ground, and not that between any two conductors. If the terminal voltage be so adjusted that the insulation strains to ground be made the same, then to transmit a given amount of power a given distance at a given loss will require no more copper by the single-phase line than that required by the three-phase line.

NIETHAMMER, ON "A. C. AND D. C. TRACTION"

Upon the conclusion of Mr. Lincoln's paper that of Dr. F. Niethammer entitled "Alternating versus Direct-Current Traction" was presented in printed form without being read.

In this paper Prof. Niethammer described all of the different electric railway systems, viz.: direct-current, three-phase, single-phase, with commutator motors; current changers, such as the Ward-Leonard and Heilman; single-phase induction motors, such as those of C. E. L. Brown and Arnold; constant direct-current systems and storage batteries. Tables were then given of maximum speed, acceleration, horse-power of motors, etc., for different classes of service, and examples taken from roads representative of each class of service. He then discussed the design of the different types of motors for each of the different systems, especially for the different alternating-current systems, and gave a second table showing weight, dimensions, gear ratios, etc., for the standard direct-current, single-phase and three-phase motors of the different European manufacturers. He then discussed starting torque, speed variation and braking for the different types of motors, also different methods of gearing and controlling, the latter accompanied by a table showing the weights of various controllers. Different forms of current-collectors were also described and compared

DISCUSSION

The discussion was opened by Mr. E. K. Scott, who advocated the three-phase as against the single-phase system. Every three-phase generator is a three-crank engine, and with transformers connected in delta, if one breaks down the system can still be operated, while if the transformer breaks down in the single-phase system the system is shut down. With the single-phase system you have a pulsating torque, while in the three-phase system and in the direct-current system you have a constant torque.

Mr. Lamme stated that the problem of single phase electric traction is considerably affected by the opinion of the electrical public, which opinion is based largely upon experience with alternating-current motors of various kinds. One point of confusion is that many engineers fail to understand why the single-phase commutating motor can have a large air gap and also a high power factor. In the commutating type of motor the current represents torque regardless of the power factor, whereas in the induction motor a low power factor means a low torque. He advocated the use of the straight series motor.

Mr. Steinmetz, in referring to the relative advantages of single-phase and polyphase motors, said the single phase tends to synchronize much more strongly than the polyphase induction motor, so that while the polyphase induction motor might be used in electric railway work, the single phase induction motor is not directly applicable. The single phase commutating motor is advantageous. In this motor the limit of torque is the magnetic saturation. In action this motor approaches the direct-current series motor; that is, the torque is proportional to the square of the current, while in the polyphase motor it is more directly as the current. As regards systems of distribution, the polyphase system is generally used here but is not so common abroad. The polyphase system has the advantage in stationary motor work and the generators are somewhat smaller and more efficient. In answer to the argument by Mr. E. K. Scott regarding running on a delta-connected three-phase system with one transformer burned out, Mr. Steinmetz brought out the point that equal safety could be secured in the single-phase system by employing two transformers instead of one. In electric railway work the single-phase system is simpler and must be employed. A two-phase system might be used by connecting one phase on each track of a two-track road, but it would be a difficult and a complicated system. With modern engineering methods the single-phase railway system will improve.

Mr. A. H. Armstrong, in referring to the question of a three-phase versus a single-phase system, said that it is necessary to consider the commercial aspect. At present there are one-half a billion kilowatts of rotary converters and three-phase railway apparatus installed. This must be used as far as possible, and it is therefore necessary to use 25-cycle motors at present. The great amount of lighting at the present time supplied by railway power houses, and also the power supplied to stationary motors, must be also taken into consideration. For the present it appears that the three-phase generating apparatus will be used with a transformation to two-phase at the sub-stations and the railway load divided on the two phases.

Mr. Steinmetz also said that it is necessary to consider the present state of the art and the conditions now existing. It will probably be necessary for some time to come to operate cars on 500-volt direct-current circuits within city limits, and therefore the new alternating-current motors for electric railway work must be so constructed that they will operate equally well on the direct current city systems and on the alternating-current system used beyond the city limits. The alternating current commutator motor may be made to meet these conditions.

Mr. Lamme said that in the original single-phase railway built recently by the Westinghouse Company, the frequency was 16 2-3, but the standard frequency of to-day is 25 cycles, in order to meet the requirements of machinery already installed. Four motors are used on a car, operating in series on a direct-current circuit in the city, and either in series or in parallel on an alternating-current circuit beyond the city limits.

Mr. A. H. Armstrong stated as regards frequency, that a 15-cycle equipment has been already installed and placed in operation. Another point is that of the standardization of line voltages on the trolley circuit. Both 2200 and 3300 volts have been used and both will probably be standard voltages for the present.

Mr. P. M. Lincoln, in referring to the trolley line voltage, said that with present installations, 1100 volts would generally be as high as would be advisable, but with the new types of line material 2200 and 3300 volts will be found perfectly satisfactory.

Sections B and F then adjourned to meet at 10 a. m. on Wednesday, Sept. 14, in Festival Hall at the World's Fair.

WEDNESDAY'S SESSION

This was a combination meeting of the American Institute of Electrical Engineers and the Institution of Electrical Engineers of Great Britain, with sections B and F, and constituted the annual meeting of the Institute. President B. J. Arnold, of the A. I. E. E., called the meeting to order. The meeting was not a part of the congress, but President Arnold extended an invitation to all members of the congress to take part in the discussion. He called attention to the session as a joint meeting of the A. I. E. E. and the I. E. E., of Great Britain, and expressed the hope that this would not be the last of such meetings, but that there might be many of them in the future. President R. Kaye Grey, of the Institution of Electrical Engineers, of Great Britain, then took the chair, and President Arnold delivered his annual address as president of the A. I. E. E., abstracted below:

Eleven years ago we met in Chicago under the auspices of a great exposition. To-day we are gathered again at a greater exposition. At the time of the Chicago meeting engineers were strenuously advocating the use of electricity on street railways and elevated work. The Chicago Exposition Intermural road was the first instance of the application of electricity to large traffic. The interval between these two expositions has been one of extensive activity in interurban and suburban work. The traffic on these lines has enormously increased over the steam road figures. We now aspire to enter the steam road field. The question is whether the advantages are greater than the difficulties to be overcome. It has been proven that suburban traffic of a steam road is a legitimate field for the introduction of electricity, as for instance, the New York Central and Pennsylvania terminals, in New York City. The best conditions for electrical operation are many units at even intervals. The power now required by a car is small compared to that taken by a steam train. A more economical method of producing power is required before electricity will become fully applicable to steam lines. In some cases, with water power available, the power is cheap enough for electrical operation at the present time.

When the traffic is dense enough the ideal equipment for electrical operation would be six tracks arranged in pairs for different classes of traffic moving at the same speed on each pair of tracks. This condition only exists in a few cases. In most places the traffic is too light. No general law can be laid down on account of varying conditions. In all cases the relative cost of operation must be carefully analyzed.

Electricity will be the power ultimately. At first terminals will be equipped, due to lessened operating expense or the demands of the public for better service. Then electric feeders for trunk lines will follow and finally the trunk lines operating between electrically equipped terminals will be changed over to the new power. Many advantages will accrue, such as increased passenger revenue, a high class freight service not possible now, and lower cost of power as time goes on.

The principal problem is the transmission of power and voltage on the trolley and the solution seems near. Heretofore the necessity of rotaries has precluded the equipment of trunk lines, but the alternating-current motor has made it more probable due to the decrease of first cost and the improved transmission.

It is only seventeen years since the first electric road was equipped and yet the horse and cable have practically disappeared, the suburban railway has become a great factor in our daily life, and the total investment in electric industries reaches $4,000,000,000. Steam will hold its own on trunk lines for some years, but at present, trunk lines in the United States, Switzerland, Sweden and Italy are figuring on electric operation, and the future looks promising.

President R. Kaye Grey, of the Institution of Electrical Engineers, of Great Britain, moved that a vote of thanks be tendered President Arnold for his able address. The motion was seconded by Col. R. E. Crompton, senior vice-president of the Institution of Electrical Engineers, of Great Britain, and carried by acclamation.

The subject for discussion at this meeting, "Different Methods and Systems of Using Alternating-Current in Electric Railway Motors," was taken up, Dr. Charles P. Steinmetz opening the discussion. Mr. Steinmetz reviewed at some length the development of the alternating-current railway motor, starting with the early work of Messrs. Rudolph Eickemeyer and Charles Van Depoele, and leading up to the latest type—the compensated commutator motor. He discussed the characteristics of the direct-current series railway motor, the polyphase induction motor and the commutator alternating-current motor, and their adaptability to different classes of railway work, these classes being ordinary city street service, rapid transit service, as on elevated and underground tracks; suburban and interurban service, trunk line passenger service and long distance freight service.

For city service the characteristics of the direct-current series motor are best, on account of its enormous torque at starting, its rapid acceleration and maintenance of torque from the limit of acceleration to the free running speed. These features were absent in the induction motor. This latter type of machine cannot combine very high acceleration with high efficiency at free running, or with the ability to run efficiently at low speeds. The alternating-current commutator motor, however, while having not quite such good characteristics as the direct-current series motor, is well adapted for city service. The problem and conditions in rapid transit service are the same as those in city service, except that the units are larger, the speeds higher and stops are not so frequent

In interurban and suburban work there are fewer stops, so that rapidity of acceleration is of less importance and a lower torque of acceleration will do, but the same surplus torque is required as in city service, because the voltage cannot be maintained so nearly constant in interurban lines as in the city. The induction motor being most sensitive to voltage variation (the torque varying as the square of the voltage) is not at all adapted to interurban and suburban service, the maximum torque which the motor can give cannot much exceed the acceleration torque without spoiling the characteristics of the motor, and while the motor will run at constant speed regardless of voltage fluctuations, an excessive drop in voltage will cause it to "break down" and refuse to carry the load. The alternating-current commutator motor, however, appears to be pre-eminently constituted for this class of work.

In trunk line passenger service, the rate of acceleration at present obtained by means of steam locomotives is much lower than that obtained in everyday practice for electric railways, and as excessive acceleration torque does not need to be sustained up to high speeds in this class of service, it is a field where alternating-current commutator motors should be employed and possibly induction motors if the question of voltage maintenance does not interfere.

In trunk line freight service the same considerations come in, except that the speeds are relatively low and the train weights are enormous, so that here more than in any other class of work it is essential to have a very large surplus torque available in order to start the train or to hold it on an up grade. For this service, therefore, as in interurban service, the motor must run efficiently at light loads and be able to give a very high torque, although it need not carry this torque up to high speeds.

Mr. Steinmetz then pointed out that on account of the enormous mileage of direct-current railways already existing in cities, this type of equipment would always remain; consequently, long distance motors, that is to say motors running over connecting links between different city systems, must be able to operate on the direct-current-systems. The alternating-current commutator motor is highly advantageous, since it possesses this peculiar characteristic. He also expressed the opinion that since 25 cycles had been adopted as the lowest alternating-current frequency, and there is a great deal of 25-cycle generating apparatus now in use, alternating-current railway motors must be built for that frequency. Dr. Steinmetz expressed the belief that the alternating-current motor would not make any very serious inroads into the field occupied by the direct-current motor. He thought the alternating-current machine will develop a field of its own, just as alternating-current transmission and distribution have supplemented rather than displaced direct-current distribution.

Mr. B. G. Lamme continued the discussion. In the development of the direct-current motor for traction work a process of elimination brought out the series motor as the best type. Its torque increases faster than the current and it gave a cushion action to the car. The next bothersome problem in railway work was transmission of power to the car. Motor generators were tried in substations with some success, but the rotary converter was out of the question on 125 to 133 cycles. Even at 60 cycles the design was difficult and the machine cumbersome. At Niagara a compromise between 4000 and 2000 alternations per minute gave us the 25 cycles now so common. In 1894 the converter was adopted as an emergency necessity. In 1895 the Westinghouse Company tried two 75-hp motors, single-phase, with rheostatic control, but they were abandoned. Next, motors of 100 hp wound for several speeds, were tried, both being of the induction type. The next experiments were with a single-phase commutator motor of 10 hp, and 16 2-3 cycles frequency. Two of these were run on a car for a while with 400 volts on the trolley, but the results were unsatisfactory and the work was dropped. The work was again taken up in 1897, when several motors of 30 to 40 hp were tried. Finally in 1900 and 1901 a motor of 100 hp was operated successfully on 16 2-3 cycles, and in September, 1902, the first public announcement of a single-phase system was made before the A. I. E. E., in a paper describing the proposed Baltimore & Washington Electric Railway. Many objections were raised, principally directed at the commutator. It is of interest that one of these motors ran continuously, day and night, under full load for nine months on 60 frequency, without showing the slightest sign of trouble at the commutator.

The Indianapolis and Cincinnati line has adopted the alternating-current. In the terminal cities direct-current is used with rheostatic control with four motors in series outside of this, the four motors are in parallel and control is accomplished by means of transformer taps.

Now looking at the problem in general, several points are in favor of single-phase motors. Only one overhead conductor is required. The motors are mostly of series type, which gives good operating characteristics and permits of the operation on direct-current. The single-phase motor can also utilize potential control, doing away with rheostatic losses. In trunk line operation the question of frequencies does not enter, as a system of this kind can afford to adopt its own frequency irrespective of others in use at points on its lines.

Dr. E. V. Drysdale was of the opinion that the main advantage of the single-phase commutator motor was the ability to operate on direct and alternating-current equally well. In starting a car from rest, not power, but force, is required. In the steam locomotive the force is applied direct, and with electricity we must install a line to furnish force in starting, and power in running. The Ward-Leonard system is ideal in this respect, furnishing force for starting, with large current and low voltage by variation of the excitation on the generator.

Mr. B. J. Arnold at this point said that although he must give the credit to Mr. Lamme for the first announcement of a purely single-phase system, yet he must take credit for the first construction of an electric railway using single-phase motors.

Mr. F. J. Sprague continued the discussion. The future of the adoption of electricity on trunk lines appears hopeful. It will not be because of more efficient or economical operation or esthetic considerations, but only by financial necessity. The best finance will dictate the purchase and control of competing electric roads.

President Elihu Thomson gave some historical points on repulsion motors. The discussion was carried over to Friday morning before Section F.

THURSDAY'S SESSION

At the meeting on Thursday, there was no discussion and four papers were read by title: "The Mono-Railway," by F. P. Bahr; "The Railway Booster," by Dr. Rasch; "The History of the Electric Railway," by F. J. Sprague, and "The Wilkesbarre & Hazelton Railway," by L. B. Stillwell.

STILLWELL, ON "THE WILKESBARRE & HAZLETON RAILWAY"

Mr. Stillwell's paper stated that the Wilkesbarre & Hazelton Railway is the first railway of any considerable length in America to be equipped for commercial use with the protected third rail. The most noteworthy features in the railroad and its equipment are:

(1.) The use of a contact rail covered by plank guard to protect it against snow and sleet, and to prevent accidental contact by people crossing the track or walking near it.

(2.) The elimination of all grade crossings.

(3.) The fact that it traverses a rugged and mountainous country, level stretches of roadbed being practically insignificant, while there are several stretches of 3 per cent grade not less than 4 miles in length.

(4.) The use of cars weighing 42 tons, net, without passenger load, and equipped with four motors of 125 hp (one hour rating) each.

(5.) Brake equipment so designed that no one accident to any part of the rigging can render all brakes inoperative.

(6.) The use of a portable converter station in the form of a car carrying transformers, converters and necessary switch gears.

(7.) The use of a soldered, not riveted, rail bond.

The composition of the contact rail is as follows: Carbon, not to exceed 10 per cent; manganese, 55 per cent; phosphorus, 8 per cent; sulphur, 10 per cent; silicon, 3 per cent. Its conductivity is equivalent to pure copper having about one-eighth its cross-section. The construction of this road was described in March 7, 1903, of the STREET RAILWAY JOURNAL, so that only a brief abstract of the operation will be given.

During the winter of 1903-1904 cars were operated from 6 a. m. until after midnight, upon headway which at no time was less than one hour. Notwithstanding this infrequent service, there were but two instances in which any serious delay occurred by reason of formation of sleet on the contact rail. Upon one occasion a car was delayed one hour and fifty minutes. Another time, a car lost on round trip twenty-eight minutes. Partial formation of sleet on the contact rail which occurred in these cases would have been greatly reduced, if not eliminated, had the guard been even 2 ins. wider. The addition of a vertical plank attached to the posts which carry the top guard would secure effective protection against sleet from that side of the track, but on the other hand it would tend to cause an accumulation of snow around and upon the contact rail. The success of the guard used was in a large measure due to its open front and back permitting the wind to drive snow through the space between the contact rail and guard.

The shoe has been very satisfactory, although some trouble was experienced in shoes breaking, due to failure to maintain an accurate alignment of the third rail. The shoe has been somewhat modified since its original design, so as to make a weak point at which it will break in case it strikes any of the supporting posts instead of tearing away the entire support. At high speed, the shoe has less tendency to jump than the link type shoe. The current per motor cars has frequently exceeded 400 amps. per shoe, and there has been no appreciable sparking.

RASCH, ON "BOOSTERS"

The paper by Dr. Rasch was largely mathematical in its character, and was a discussion of the best method of regulating a booster.

SPRAGUE, ON "ELECTRIC RAILWAY HISTORY"

"The History of the Electric Railway," by Mr. Sprague, was a very valuable contribution to street railway literature, and described the salient points in the history from the time of Davenport to the present. The early part of this paper will be reproduced in the next issue of this paper.

FRIDAY'S SESSION

On Friday morning Section F held a joint session with Section G for the discussion of Prof. G. F. Sever's paper on "Electrolysis of Underground Conductors." Prof. Sever presented an abstract of his paper, giving a brief summary of the situation in the United States.

SEVER, ON "ELECTROLYSIS"

Experts in this country are greatly divided as to the cure and modification of the trouble. The data of the paper were collected by Messrs. Waterman, Stilwell and Sever, and tables were made from replies received from 102 street railway companies from 29 cities and from the opinions of 22 experts. The information from the street railways comprised the date of commencing operation, miles of track operated, weight of rails, style of bonds, size and number per joint, return feeders, attachment of pipes to bus, rails or both, electrical drainage, number of power stations, minimum line volts, nature of pipe joints and soil, parts corroded, extent and nature of damage, remedy applied and effects produced.

The most interesting replies are to the question of remedy applied and results attained. A few answers are given below:

1. Some electrolysis, no remedy. 2. Larger bonds. 3. Analysis showed rust and not electrolysis as cause of decay. 4. Proved decay due to earth corrosion. 5. Return feeders. 6. Some electrolysis; installed return feeders; less trouble. 7. Ignored. 8. Better bonds. 9. Renewed bonds; At Madison, Wis., the pipes were tapped to the station and no more trouble was experienced.

In the table of replies from the twenty-nine cities the following points were asked:

Was electrolysis encountered? What was the effect upon pipes? Was blame placed on railway company? (This question was always answered in the affirmative.) What remedy was suggested and applied? Was legal action taken?

Among remedies suggested and applied, five cities called for double trolley, but in no case was it applied. Others suggested better return, more bonds and return feeders.

Peoria, Ill., Dayton., Ohio, and Richmond, Va., reported legal action taken. In Peoria the decision was against the railway company, but the case is still open. In Dayton, Judge Brown told both parties to get together and adjust the trouble between them.

The third table concerns various points in municipal ordinances regarding electrolysis. The questions asked were the following: 1. What system is required?. 2. Are taps from pipe to rail and negative bus allowed? 3. Is electrical drainage in positive area allowed? 4. Are railway companies liable for corrosion? 5. What maximum positive or negative potential difference between rail and adjacent pipes is allowed? 6. What drop per mile is allowed in return, and what total drop is allowed?

In Battle Creek and Atlantic City no taps from the rail to pipes or the negative bus are allowed. The positive difference of potential allowed in various places is from a quarter of a volt to a volt, the negative difference being the same.

The leakage current allowed in various places varies from 0 to 1 amp. per pipe. In Chicago 8.8 volts drop is allowed per mile of return circuit, other cities specifying from 3.3 to 6.6 volts. Most of the cities require a return circuit of not less current carrying capacity than the positive feeders. Of fifty cities with which Prof. Sever corresponded, only ten report any trouble from electrolysis.

The opinions of twenty-two experts are also tabulated mainly from testimony in Peoria, Dayton and other places. Most of them are of the opinion that electrolysis can be stopped with the rail return still in use. Among the remedies suggested are the double trolley, a return booster, more efficient return and insulating pipe joints.

DISCUSSION ON SEVER'S PAPER

Dr. Louis Duncan opened the discussion, and thought Judge Brown, of Dayton, had the best idea of a remedy, that is joint action by both parties concerned.

John Hesketh, Esq., was of the opinion that mutual action was necessary for the abatement of the evil, and it was as much the duty of the company liable to damage to protect itself as it was of the tramway company to provide protection. One water company to his knowledge had laid service pipes within 3 ins. of the rail, thus directly inviting electrolysis. All efforts to prevent damage by specifying return drops must take account of length of line. It is not only the difference of potential that causes damage, but also the ampere carrying capacity of leakage path, and hence some definite form of test should be prescribed.

In Germany the method specified is that the drop shall be taken between the rail and the earth nearest to it. An expression on this subject, as to remedies, should be called for from scientific bodies throughout the world.

Professor F. D. Caldwell said that in Columbus, Ohio, two questions arose: first, whether or not to guard against trouble where current leaves the pipes or to keep the current away from them altogether; and second, how much current can be permitted to flow without serious damage? The entire problem varies with the soil encountered, regarding its electrical resistance.

This closed the discussion and Section F adjourned to its own meeting room, where the discussion on the methods of applying alternating current to traction was continued from Wednesday's session in Festival Hall at the Fair grounds.

DISCUSSION ON "ALTERNATING CURRENT MOTORS"

The discussion was opened by Dr. Louis Duncan, chairman. The speaker noted three quite distinct traction fields now successfully operating by electricity; namely, tramway service, city train service and interurban service. In all of these fields the electric operation gives better and more economical service than steam, cable or any other system heretofore employed.

In the tramway system a large number of small units are constantly in operation, and consequently, notwithstanding the numerous stops and great variations in speed due both to this frequent stopping and to the curvature and gradients of the track, the load factor remains quite constant and high. With this good load factor the copper is economically used. The success of the cable car was due to just such conditions as give rise to a high load factor in a district of limited extent. With the introduction of the multiple unit control, city train operation became possible. Here again a good load factor obtains. In both of these classes of traction, it is of utmost importance to be able to rapidly accelerate up to the desired speed. Interurban systems require frequent, good and economical service. Here the load factor is good in the generating station, but is often poor in both the sub-station and the lines. In this last field the necessity for the use of alternating-current is most strongly felt. Transmission of power by alternating-current and the use of rotary converter sub-stations has made it possible for the direct-current railway motor to be successfully used in this service. But the next logical step is the use of alternating-current direct on the car, thus doing a way with the constant attendance required at sub-stations and greatly simplifying the apparatus as a whole.

A good load factor may be maintained, yet a poor cost factor may result, cost factor being defined as the ratio of the cost of operation, under the actual conditions of operation, to the cost of operation under full load for continuous running. It is very obvious that this factor must vary greatly with the character of the load moved. For example, if it is uncertain just when excessive power will be required, more boilers and other equipment must constantly be held in readiness to furnish power, while if it were known that at a certain time and for a definite period a given additional amount of power would be required, then this extra power would only have to be used at this time. For all of the remaining time the extra machinery would require no attendance or fuel.

For trunk line service, displacing the steam locomotive, little can at present be expected. Here neither the expense can be decreased nor the facilities increased, while with present systems a great deal of trouble would be introduced. In special cases when the traffic is so heavy and frequent that the steam locomotive cannot well take care of it, as in the case of the Baltimore & Ohio tunnel, in Baltimore, the electric operation of trains is very advantageous. Again in the case of the Pennsylvania Railroad and the New York Central Railroad, not only is electrical operation much better, but absolutely necessary both because of underground service and of legal requirements. Yet these examples do not in any way point to the early adoption of electric train operation on trunk lines.

Mr. F. J. Sprague continued the discussion and expressed himself as decidedly of the opinion that one overhead wire was all that was possible on account of the necessity for simplicity. The direct-current series motor is, and always will remain superior to the alternating-current motor from the considerations of weight, efficiency, reliability and torque, and considered by itself alone, while the alternating-current is liable to cause more trouble in insulating conductors. The sub-stations are not as much farther apart with alternating-current as would appear. The distance cannot increase even in direct proportion to voltage. With the higher voltages used with alternating-current the liability of shocks to passengers on account of leakage is greater, especially in stormy weather. On trunk lines the money available should be used on feeders rather on main line work, but electrical operation of terminals is becoming a necessity irrespective of cost.

Mr. B. G. Lamme spoke next. He stated that one of the advantages of alternating-current is that it permits the use of low voltage motors, using even as low as 125 volts, without difficulty. The alternating-current motor comes in when railway motors design is well understood, and thus one can avoid many troubles which arose in direct-current work. The liability to shocks is less instead of more as the higher voltage will arc through ice and sleet on a track much more quickly. There is only about 1 per cent as much electrolysis with alternating-current as with direct-current, and this is liable to be an important factor in many cases. The starting and acceleration with alternating-current is largely inductive, and this with the abolishment of rheostatic losses, considerably improves the load factor.

Mr. E. Kilburn Scott advocated the polyphase induction motor. In England, simplicity of apparatus is of prime importance, and polyphase induction motors without commutators are the simplest form. Single-phase commutator motors are necessarily heavier than polyphase motors for like service. Thus if one has a certain service that requires a 50-ton locomotive equipped with polyphase induction motors, to operate with single-phase commutator motors would require a locomotive weighing about 85 tons. With single-phase commutator motors, in case the torque is insufficient to start the motor, a bad short-circuit will result in the commutated coils due to the transformer action of the fields. In trunk line service the multiplicity of conductors is not so great a disadvantage as most think, as it is necessary to eliminate all complicated overhead work anyhow, no matter whether one or two trolleys are used. In polyphase working if one transformer in a sub-station breaks down the other two will carry the load, while in single-phase it is necessary to provide duplicate equipment for this purpose.

Mr. H. Ward Leonard continued the discussion by briefly stating the requisites necessary in the successful and economical handling of trains. The plant must embody: (a) A single-phase generating and conducting system; (b) means on the train for converting this single-phase current of transmission into suitable form for using in the train motor; (c) means on the train for varying the voltage, as applied to the train motors, from zero to maximum value without the use of rheostats or other wasteful devices. As is well known, the Ward-Leonard system embraces the above points, and consists of a single-phase synchronous motor driven continuously direct from the single-phase current on the trolley, and driving a shunt generator which supplies direct-current to the train motors. The train motors are controlled by varying the field excitation of the direct-current generator. By such means a uniform and gradual application of current may be given to the motors without entailing any rheostatic losses other than that of the direct-current generator's field circuit. Now for light service the direct application of the single-phase alternating-current to the car motors is advantageous. For heavy traffic, however, the above described system is far superior. Besides the great advantage in control by means of this system, there is a further advantage of no little importance in the ability to return power to the line during retardation in speed, all the way from maximum speed down to zero. This is probably the only system successfully embodying such features.

The Swedish Government, a couple of years ago, investigated the feasibility of changing the power of its roads from steam to electricity. As the investigation of the expert engineers proceeded, they first eliminated direct-currents entirely, and later all but single-phase alternating-currents. In their report it was shown that a saving of $2,000,000 per annum would be secured by the adoption of the Ward-Leonard system over any other practical system then developed. The expert engineers who investigated the direct use of single-phase alternating-current motors for train service, reported unfavorably each for different reasons, viz.: too high voltage, too severe sparking and too complicated mechanism.

Both the United States and Great Britain use almost exclusively the Ward-Leonard system in the control of turrets on ships in the navy. Here, if any place, sure and precise working must be had. The moving platform at Paris, in 1900, weighing 3000 tons, was operated and controlled by this system. A single-phase current at 14,000 volts has been used successfully directly on the trolley, and further, the complete control, including braking, was secured by only one lever on a locomotive operated from such trolley. In comparing this system with that of one using sub-stations, it is obvious that a large saving in both attendance and apparatus is possible.

In America a combination of policy, patents and business seems to carry an inertia sufficient to make it almost impossible for a weak company or an individual to develop his particular system, however meritorious his device may be, while in England and on the Continent the situation is much more favorable to individual developments. In conclusion, it is quite clear that whatever system becomes universal, it will be one using only one trolley wire.

Mr. B. J. Arnold, remarked that the alternating currents of high voltage can be used direct without the use of a transformer, and he did not see any advantage in the possibility of using low voltage motors as pointed out by Mr. Lamme. The problem demands some type of single-phase variable speed motor. Polyphase current is out of the question, due to the two trolleys. Simplicity, first cost of installation and maintenance will finally determine the solution of the problem.

Mr. Henry Dikler took exception to Mr. Steinmetz's statement in Wednesday's session, that the polyphase system was unsuccessful. The Italian three-phase railways were giving eminent satisfaction, and in fact were accepted by the government two months before the expiration of the specified trial-operating period. No one would think of polyphase current for street railways, but for high speeds it is very satisfactory. For heavy railway work two speeds are amply sufficient for all service.

Mr. A. H. Armstrong said that the chief objections to polyphase induction motors are their constant speed, limited output and poor power factor. On most roads there are more or less steep grades and variable speed is absolutely necessary.

Mr. Alexander Zelewsky, of Buda Pest, Hungary, took up the discussion, speaking in German. It is generally stated that a series motor is most suitable for railway purposes, because of the inherent relation between torque and speed. The polyphase induction motor whose behavior is similar to that of the direct-current motor does not meet railway service requirements. In discussing the induction motor for heavy locomotives and still heavier trains, a somewhat different phase is presented than in the cases of street car or similar service. For heavy trunk service accurate time schedule must be kept. A motor whose speed depends upon the voltage and torque is sensible to grade and load, and in order to maintain the schedule, recourse must continually be had to the controller, to regulate the speed. If the control for single-phase motors is inductive and is much used, it is at the expense of a lowered power factor, while if ohmic resistance is used, energy is again lost. If the polyphase motor is used the speed will not vary with the voltage or load, provided the capacity of the motor is not exceeded. In high speed service the air resistance rises rapidly, so that the ratio between operating torque and accelerating torque requirements is not so unfavorable as with street railways. Therefore an induction motor with sufficient starting torque can be designed.

Polyphase induction motors operate at full torque at almost synchronous speed, and are thus capable of accelerating in a shorter time than the series motor with a torque falling as the speed rises. In through service stops are less frequent and the losses of electrical power occasioned by controllers is quite small. One great advantage of the polyphase induction motor is its ability to restore power to the line. The space and weight of a railway motor is quite limited. The polyphase induction motor has constant torque and no commutator, so has these great advantages over single-phase motors. If a transformer is used, conditions are worse from both the added weight and low efficiency caused by the variable torque.

The Valtellina railway in northern Italy has been operated for two years, using polyphase induction locomotives of 1200 normal hp, with the utmost satisfaction. In Canada a combined polyphase and direct-current system is to be built by Ganz & Company, for local and interurban service. All present were invited to inspect the Valtellina road.

Mr. B. G. Lamme called attention to the Swedish State railways as spoken of by Mr. H. Ward-Leonard. Very recently the Swedish Government has ordered Lamme motors for use with 18,000 volts on the trolley. One thing that should not be lost sight of in alternating-current work is the rail loss. This usually runs from four to seven times the loss with direct-current with equal currents in the rail, and at 25 cycles per second.

Mr. P. M. Lincoln added to this last, that with 1000 volts alternating-current the rail loss is less than with direct-current at 500 volts due to less current flowing and the possibility of locating substations closer together.

Mr. C. P. Steinmetz replied to Mr. Dikler in regard to polyphase motors. Polyphase motors are inherently good machines, but the single-phase commutator motor is far superior. The polyphase induction motor is only good at one particular speed. At other speeds its efficiency and power factor are low. The large air gap required by railway men gives poor power factor in the induction motor, and on half speed (in concatenation) the current consumption is greater than at full speed, thus giving only one efficient speed. The Ward-Leonard system offers excellent control, but the problem is not one of control merely, but rather the ability to start quickly and run efficiently. With the rheostatic control on alternating-current the rheostat is on only from one-quarter to one-sixth of the time, and the extra power consumption as compared with the voltage contral is insignificant. Thus one is not losing as much advantags as might seem to be lost by the use of rheostatic control with the single-phase commutator motor.

Mr. F. J. Sprague corrected M. H. Ward-Leonard in his definition of multiple unit control. The multiple unit control is not a control of motors on different cars from one controller with full current in the train line, but is a control by controllers on each car from any point in the train. The direct-current motor considered as a motor only, is superior, and will remain superior to the alternating-current motor.

Messrs Sprague, Zekwsky, Steinmetz and Scott made a few remarks on minor points, and the discussion was brought to a close by Mr. B. J. Arnold in a few words in which he expressed himself gratified to see the tendency toward the use of single-phase motors.

The paper by Mr. R. A. Parke on "Braking High Speed Trains," was read by title, and the meeting adjourned.

PARKE, ON "BRAKING HIGH-SPEED TRAINS"

In this paper Mr. Parke referred to the testimony given by him at the New York & Portchester Railway hearing, about three years ago, that electric trains might be stopped in regular service from a speed of 60 miles an hour by what is commonly known as the "emergency application" of the quick-action air brake. It is obvious that if increased expense is justified in increasing the rate of acceleration, as has been the experience during the past few years, expense in increasing the stopping efficiency is also warranted. Experiments show a declining ratio of friction to the pressure of the shoes at increased speeds. For the same brake-shoe pressure the friction at 60 miles an hour is about one-half that when the speed is 20 miles an hour. Other causes result in a reduction of the brake-shoe friction during a continued application of the brakes, so that in train braking to secure the same rate of retardation there should be an increased pressure of the brake-shoes upon the wheels to correspond with the reduced rate of friction occurring at the higher speeds. Moreover, an application of the brakes which will produce a given rate of retardation at one speed, without danger to the rolling stock or discomfort to the passengers, may also be applied at any other speed with no more danger or discomfort. The high-speed brake was designed more particularly for use upon high-speed trains, and it employs a considerably greater brake-shoe pressure in emergency applications than that of the ordinary quick-action brake, to more nearly realize the rate of retardation obtained in the emergency application of the quick-action brake upon trains of lower speeds. At such a high speed as 60 miles an hour, however, even the emergency application does not develop greater brake-shoe friction than does a full service application of the quick-action brake at a speed of 20 miles an hour. It is true that the service application is attended by a comparatively gradual application of the brake-shoe pressure, while the emergency application develops the greater brake-shoe pressure very quickly; but experience and observation seemed fully to justify the conclusion that the reduced rate of friction at the higher speeds would permit the use of even the high-speed brake without noticeable shock or disagreeable sensation.

Experiments in the use of the high-speed brake upon passenger trains have amply confirmed the writer's views upon this subject and demonstrated the absence of disagreeable effect as well as the highly increased rate of retardation in employing the emergency application of the high-speed brake for stops in high-speed train service. The time and distance saved in such stops permit the employment of the maximum speed up to a comparatively short distance from the stopping point and cause the train to be brought to a quick, smooth stop in much less than half the time and distance required for an ordinary service stop.

That the shortened running time and increased efficiency of high-speed train service—particularly local express-train service—by the employment of such higher rate of retardation, may be attained at a small fraction of the expense at which a lesser improvement in such efficiency can be obtained through the increased acceleration resulting from extending the multiple-control system from the use of motors upon one-half the cars in the train to their application to all of them, seems hardly open to doubt. The neglect to take advantage of this higher rate of retardation would seem to be attributable chiefly to the long-established doctrine that emergency applications must not be employed for service stops, under far different conditions. It is to be understood that such a doctrine still applies, with all its force, to the operation of passenger trains at moderate speed, as well as to freight-train service. It is only under the special conditions of uniform operation at high speeds—not less than 50 miles an hour—that the recommendation of a most powerful application of a most powerful brake, in all stops, properly applies.

In addition to the advantage of effecting a reduction of from 50 to 75 per cent in the time and distance required by a service application of the brakes, a collateral advantage of material importance is the much greater accuracy of the stop.

Electric train service furnishes exceptional conditions for attaining the maximum retardation, as well as the maximum rate of acceleration—though for different reasons. Where trains are drawn by steam locomotives the conditions existing at the locomotive and the variable load carried in the tender involve limiting the braking power so that the retarding force is considerably inferior to that realized upon the cars. Where electricity is employed, the motive power is applied directly to the cars themselves in such a manner that the maximum braking efficiency may be obtained as well upon motor as upon other cars, and the whole train is thus subject to the maximum rate of retardation.

An exceedingly important element of braking efficiency is the character of the brake-shoes applied to the wheels. Extensive experiments have demonstrated a very wide variation in the frictional quality of brake-shoes of different materials, and, further, a marked difference in the friction of the same brake-shoe upon wheels of different materials. It is, in general, found that the maximum frictional resistance occurs in the application of soft cast-iron shoes to chilled cast-iron wheels, and the friction-producing quality generally declines as harder brake-shoe materials are employed. It should not be concluded, however, from this general relation of the hardness of the brake-shoe materials to the frictional quality, that soft material only should be employed in brake-shoes. The question is, to a large extent, a commercial one. Increased pressure upon the harder shoes involves, of course, somewhat increased wear; but when, in each case, the brake-shoe pressure is so adapted to its frictional quality that the maximum retarding friction is acquired, the practical question resolves itself into the relative cost of initial installation and of subsequent maintenance—to which must be added due consideration of trouble and annoyance arising from the necessity of frequent attention.

Within the past two or three years, two different series of experiments with the high-speed brake have furnished most interesting and important information bearing upon this subject. In one series, soft cast-iron brake-shoes were employed with chilled cast-iron wheels. In the other the "Diamond S" form of brake-shoe (of hard cast-iron, with steel inserts) was used with steel-tired wheels. Otherwise, the conditions were fairly comparable, the tests being conducted in the same general locality. In the case where soft cast-iron shoes were employed, the initial air-pressure in the brake-cylinder was about 85½ lbs., which became reduced, toward the end of the stop, to 60 lbs. In the tests with the Diamond S brake-shoe, the initial air-pressure on the brake-cylinder was also about 85½ lbs., which, by the use of special high-speed reducing valves, became reduced to a final minimum of from about 69 lbs., from a speed of 80 miles an hour, to about 78 lbs., in stopping a six-car train from a speed of 50 miles an hour. Moreover, in some instances, a brake-cylinder pressure of 75 lbs. or more occurred in applications of the brakes at speeds of 20 miles per hour (and even less), without producing wheel-sliding of an injurious character or exceeding that which occurred with the use of the soft cast-iron brake-shoe, when the final minimum air-pressure in the brake-cylinder was but 60 lbs. The stopping distances were phenomenally short in the tests with the Diamond S brake-shoe, averaging 602 ft. from a speed of 50 miles an hour, 982 ft. at 60 miles an hour, and 1334 ft. at 70 miles an hour—the shortest authenticated stops on record.

In the case of a service employing single cars, the advantage of an automatic brake practically disappears and more simple forms of apparatus may be employed to advantage; but, where two or more cars are assembled in trains, and particularly in high-speed trains, the necessity of providing for the contingency of train partings permits but the one prudent and safe course of employing an automatic brake, and, thus far, the automatic air brake alone has become safely established as meeting all the requirements of service. The necessity of the most efficient high-speed train service requires, in addition, the most forcible application of the most efficient form of automatic air brake—the emergency application of the "high-speed" brake.

LONDON LETTER

(From Our Regular Correspondent.)

For some time past there have been somewhat lugubrious tales going about as to the mishaps to the Lancashire and Yorkshire electrification scheme, and it seemed to the writer only proper that a report of a personal inspection of the whole system would do much to set aside these rumors. The writer can now therefore confidently state that it is quite true that the contractors have been, for reasons over which they had no control whatever, somewhat unfortunate in their power house experiences. These, however, have been confined solely to the engines, two of them having unfortunately been accidentally damaged. Soon after commencing to operate, the crank shaft of one of the engines gave way, and on removing it, it was seen that a complete fracture had taken place, the reason being easily traceable to a flaw in the steel which must have been there from the moment the bloom was made in Sheffield, although completely out of sight during the whole process of manufacture. The Sheffield firm that supplied the forging at once supplied the engine maker with another forging which has now been manufactured, and the engine is to-day running and doing good service. Another of the engines through some unknown cause—probably from starting with water in the cylinders—broke down, one of the cylinders being completely fractured. This necessitated another long delay while a complete new cylinder was being supplied, but this engine is also now entirely repaired and in daily service. The electrical equipment of the station and of the line, and the trains themselves, have given absolutely no trouble of any seriousness from the first, but owing to two of the generating units being put out of action it was, of course, absolutely impossible for the Lancashire & Yorkshire Railway Company to operate the whole system. During this time, therefore, that only two units out of the four were available, a service of only six trains has been used, but for the past month or so nine trains have been put in service and are in daily successful operation, and the complete service of twelve trains will very soon be adopted. It will thus be seen that no trouble at all has arisen out of the system which has been adopted, and everyone on the line speaks in the highest terms of the success which has been achieved, which has only been militated against by the unfortunate and totally unforeseen accidents to the engine units. While figures are as yet unavailable, it is confidently stated that extremely good results have been achieved and that the traffic on the line from Liverpool to Southport and Crossens has been largely augmented and already receipts in that branch show that the adoption of electricity was a wise step and will lead to great economies in operation, and to much larger traffic receipts without any increase in terminal facilities. There is no doubt, therefore, that for the time being the Lancashire & Yorksire Railway has saved vast future expense in not being required to increase its terminal facilities in Liverpool, which with the increasing traffic on this branch of the line would have been absolutely necessary in the near future.

The Wakefield and district tramcars have commenced running, and everything appears to be in thorough working order. The center from which the routes from Wakefield radiate is the Bull Ring or market place, and there will be a regular service from that place to Belle Vue and Sandal, Horbury and Ossett and Outwood, Lofthouse, and Leeds. A branch to Rothwell will shortly be opened, and within a short time the system will couple up with Normanton, Casleford, Pontefract and Knottingley.

The site of the old General Hospital, in Summer-lane, Birmingham, is being utilized for the erection of the new electrical supply station to furnish the power for the comprehensive system of municipal trams. The task is a heavy one, for the general level was a high one, and excavation has had to be carried to a depth of 40 ft. The estimated cost of the new power station and installing the cables will reach £400,000. When completed the system will help to bring about a revolution, not only in the tramway traffic, but also in the lighting of the city.

Commencing on Oct. 3, the Edinburgh & District Tramways Company, Limited, is to inaugurate a quick parcel express delivery, and for this purpose central premises have been secured at 5 and 7 West Register Street, and altered to suit the requirements of a central parcel receiving office. This latest enterprise of the company will no doubt be largely taken advantage of, not only by merchants of the city, but by the general public. It will also enable small merchants to meet the demands of their customers more readily.

Accrington is promoting a bill in Parliament to work its tramways, the Corporation's own system, which will shortly revert to it on the expiration of the lease to the company which has been working it. The trams will be driven by electricity, the power being supplied by the Corporation's own installation. Considerable extensions are intended to be through Church and Oswaldwistle and along the main thoroughfares towards Burnley. The Corporation lines are at present between 6 and 7 miles, which, with the Haslingden and Rawtenstall sections owned by the company at present working the system, make a total length of over 11 miles. This, with the extension, will be increased to about 13 miles.

The financial difficulties connected with the tramways track which is to cross the Ribble estuary near Lytham, and thus connect Southport, Lytham, St. Annes, Blackpool and Fleetwood by tram, have been satisfactorily arranged. Sir Hiram Maxim is the chief supporter of the scheme, and the firm of Vickers, Maxim & Co. are to construct the transport bridge over the channel to the land on each side of the Ribble. Tenders have been invited, and there is every prospect of an early start being made on the work.

The tramways sub-committee of the Dewsbury Town Council has recommended the purchase of the electric tramways worked by the Yorkshire (Woollen District) Tramways Company, Limited, at a price of £52,500, the concern to be leased to the company for a term of thirty years, at the expiration of which time it will belong to the corporation. The recommendation was adopted, and borrowing powers were ordered to be sought.

At the half yearly meeting of the North-Eastern Railway Company, the chairman, Viscount Ridey, said that from the point of view of traffic the newly electrified lines had been very satisfactory, but of course the novelty of the system had caused them to be beset with a great many difficulties, which, though being surmounted gradually, were real difficulties both as to the safety of their workmen and the public and the passengers, and the convenience of patrons on the line. They had been fortunate in their expert advisers, and altogether they had no reason to be dissatisfied with the progress which they had made, and he did not know but that the feeling generally was that under difficult circumstances they had given an improved service on that part of the system. They worked an enormous number of passengers to Whitley Bay and down to the coast, and the reports he had made of the numbers carried and the hours people had to wait to return to Newcastle, showed that the traffic they had to deal with was almost beyond their means. So far as profit and loss was concerned it was too early to speak. It was impossible to have accurate figures; 53,402 miles were run in the half year up to June 30, and the expenditure was £4,911, but they must remember that a good deal of that expenditure included the experimental running both for the satisfaction of their own officers and for the education of those who were to be in charge of trains. The capital for the conversion of the line was £186,000. If he came to the passengers carried he would take the two weeks ending July 11, 1903, and July 9, 1904, for comparison, making all allowances for the fact that one week might have been fine and the other wet. The number of bookings between all stations had increased by 25 per cent, and the money 22 per cent. With reference to the difficulties which had beset them, they were considering most carefully all the plans that could be thought of by their experts for the purpose of averting the danger of the live rail, as well as promoting the convenience of their passengers.

A special meeting of the tramways committee of Newcastle Corporation was held recently to consider the resignation of A. E. le Rossignol, engineer and general manager of the tramways. The committee having heard that Mr. le Rossignol had received the offer of an important and lucrative appointment abroad, regretfully agreed to accept his resignation. Mr. le Rossignol superintended the construction of the Newcastle Corporation tramways on behalf of the engineer, Mr. Hopkinson, and was recommended by him to be the manager and engineer of the new system. Mr. le Rossignol was accordingly appointed, and has performed the duties since the opening of the tramways.

Douglas, Isle of Man, is following its great rival, Blackpool, in a novel social experiment. Children of school age are to be provided with tramway coupons at greatly reduced fares, so that those who dwell at a distance from school may take farthing rides to and fro. Probably this will not be all loss in a place like Douglas, which has its very slack, out-of-season times, when electric trams had better take farthing passengers than none at all; but the proposal was mooted, not in the interests of the corporation, but for the sake of the school children.

A little over two months ago the Alvaston Osmaston and Midland Station routes of the new Derby electric tramways were opened to the public, and recently the remainder of the routes included in the contract let to J. G. White & Company, of London, was formally inaugurated, viz.: Burton Road, Normanton Road and Dairy House Road. Early in the afternoon the Mayor, accompanied by many members of the Corporation, and a number of ladies, travelled over the routes in special cars, returning to the new offices in Victoria Street, which were opened with some ceremony, Alderman F. Duesbury, the chairman of the tramways committee, unlocking the door. Afternoon tea was served in this commodious building, and the members of the committee availed themselves of the opportunity of presenting to Alderman Duesbury a Derby Crown china vase to commemorate the event and as a mark of appreciation of the valuable services rendered by him in the transformation of the tramway system of the borough.

A further meeting of the tramway reconstruction committee, of Perth Town Council, has been held. Mr. Dawson, of Kincaid, Manville, Waller & Dawson, was present. The report by the firm on the offers received for the reconstruction of the Perth tramways was submitted, from which it appeared that the cost of reconstruction would amount to a sum close on £44,000. It is estimated that, allowing for engineers' fees, the purchase of the old tramway concern from the company and the Parliamentary expenses, that the cost of the reconstructed tramway in Perth will amount to £68,000. The committee is also considering the use of petrol 'buses.

The tramways committee of the Manchester City Council has resolved to provide a number of covered cars to run on routes where their use is or may be made practicable. One or two routes are crossed by bridges, which are too low for these vehicles. In other cases it is possible to lower the roads under certain bridges, so as to allow the passage of covered cars. It is not to be understood that open-topped cars are in future to be covered in. What is intended is that by a gradual introduction of the sheltered vehicles there shall be a reasonable proportion of them, giving much better provision than at present exists for protecting passengers from inclement weather. The covers for the cars will all be made in the new workshops of the Tramways Department at the Hyde Road shed, where they will be fitted to existing cars.

It will be of interest to know that the Electric Railway & Tramway Carriage Works are now manufacturing a Brill type of truck. As is well known, this enterprising firm, which was one of the first to build electric cars in Great Britain, have never gone in for the manufacture of trucks, being content to put on the thousands of cars which they have already supplied, such trucks as were specified. They chiefly used the Brill trucks, all of which were imported from America. It has gradually been forced upon them, however, that to be able to compete with the lower prices, and also to meet the requirements of certain engineers who desire a completely British product, that it would be absolutely necessary for them to build a truck of their own. Arrangements have therefore been made at their extensive Preston works, and a department inaugurated by which an absolutely British made truck of the Brill type is being manufactured by them. Already a large number have been made and delivered.

There has been of late some little talk of a project for providing the Kentish coast with an electric railway. Parliamentary powers will, of course, have to be sought and obtained, in the usual way, and probably there will be a sharp tussle in the committe room when the scheme gets there. The proposed line is to be constructed on the overhead system, and will have a length of about 70 miles, commencing at Ramsgate and ending at Hastings, so that a portion of Sussex is taken into the plan. The places to be served include Sandwich, Deal, Walmer, Dover, Folkestone, Shorncliffe Camp, Hythe and Winchelsea, with a few others.

It is claimed that the scheme should receive the support of the military authorities, inasmuch as, if carried to a successful issue, it will facilitate the rapid movement of troops, artillery, etc., along a portion of the south coast. The financial part of the project has been elaborately worked out, but its consideration may be postponed for the present. From the outline here given it will be seen that the scheme is a somewhat ambitious one, possessing features, or, at all events, a feature, interesting to others than those who reside in, or occasionally visit, the districts proposed to be traversed by the Cinque Ports Electric Railway.

After prolonged negotiations, an agreement has been drawn up between the Salford and the Bury Corporations for the interchange of tramway traffic, and this will be formally signed in the course of the next few days. The Salford Corporation under existing agreements has control of the tramways in Prestwich and Whitefield. The Whitefield tramways were opened eighteen months ago, or rather that part of them lying between the Prestwich boundary and the Whitefield railway station. There has been considerable delay in the completion of the lines to the Bury boundary owing to trouble between the Whitefield Urban District Council and the company running the steam trams from Whitefield to Bury. The differences, however, have now been settled, and the Salford Corporation has prepared the track and erected the overhead equipment, and the route will be opened very shortly.

The Devonport & District Tramway Company has now completed the system of tramways for which the company and the Corporation have obtained powers, the last section to be completed having been examined by Major Druitt, a Board of Trade inspector. The line runs from Milehouse to Ford, being a continuation of the St. Levan Road section. The road has been made by the Corporation, and has been laid with a single line with loops by the company. At the official inspection Major Druitt was accompanied by J. C. Tozer and Alderman J. Goodman, chairman and vice-chairman of the Corporation tramways committee; R. J Fittall, town clerk; J. F. Burns, borough surveyor, and J. W. Endean, general manager Devonport & District Tramways Company. Although the powers of the company and Corporation are now exhausted, it is proposed to apply for permission to extend the St. Budeaux section to the parish church, which will be a great convenience to the rate payers in that part of the town.

The London County Council is introducing the double-deck electric tram cars, the necessary change having been ordered for sixty cars at a cost of £80 each. It is computed that the double-deck car will earn from £130 to £150 more per annum than the vehicles with open tops. Unfortunately, however, on two or three of the South London routes the available height under railway bridges precludes the adoption of a roof over the tops of cars.

Recently at Bruce, Castle Park, a section of tramway line constructed on the overhead trolley system along 2 miles of main road, from Lordship Lane, Tottenham, to Woodgreen, was opened by Sir Francis Cory-Wright, chairman of the tramway and light railways committee, of the Middlesex County Council. The undertaking thus inaugurated represents only a very small portion of a plan promoted by the Middlesex County Council, which when completed will provide a cheap and easy means of transit over 50 miles of trunk roads under its jurisdiction. The routes chosen comprise the four radial highways from Willesden to Wembley, Cricklewood to Edgeware, Highgate to High Barnet, and Woodgreen to Enfield, together with cross-routes linking the main lines together at various points. Three of the routes extend into the neighboring county of Hertford, where the County Council has also promoted light railways. Running powers have been granted over the Walthamstow Light Railways, so that the area of the whole electric tramway enterprise north of the metropolis extends from Willesden in the west to Woodford in the east, the London County boundary practically serving as the southern frontier, while towards the north the benefits of electric traction will be carried as far as Watford on the one hand and Chestnut on the other.

The Middlesex County Council, having constructed the line, resolved to lease it for a term of years, until 1930, to the Metropolitan Electric Tramways (Limited), which furnish the rolling stock and the entire electric equipment of the undertaking, an arrangement which relieves the Middlesex County authorities from the costly necessity of constructing power stations. An average of 4½ per cent on the council's expenditure is paid by way of rent; out of the gross receipts the company receives an average of 4½ per cent on its capital expenditure, and the net revenue is divided between the Council and the company in the proportion of 45 per cent to the Council and 55 per cent to the company.

The Huddersfield Corporation has put on trial for the first time an electric coal wagon for the haulage of coal from the Hillhouse coal chutes, Huddersfield, to a distant part of the borough. The suggestion that the Corporation should become coal carriers is not a new one, though as far as can be ascertained, no other Corporation has up to the present undertaken work of that nature for private individuals. In 1880 the Corporation obtained powers in its Act of Parliament to convey coal over the tramways. The lines were laid of a sufficient width, and with a proper depth of groove to receive the railway trucks, but owing to the numerous sharp curves on the tram routes the original idea was abandoned. The idea lay dormant until a year or two ago, when it was revived by the present chairman of the tramways committee. Though operations are at present designed to serve only one firm— Martin, Sons & Co., Limited, the well-known cloth manufacturers, of Wellington Mills, Lindley—they must be extended, and it is quite probable that the coal required at the gas and electricity (light and power) stations will be conveyed from the coal chutes by the same means at no distant date. Messrs. Martin's works are situated nearly 3½ miles from the Hillhouse coal sidings, at Huddersfield, the gradient rising all the way. Their average consumption of coal the year through is about 40 tons a day. The haulage hitherto has been done solely by team labor, ten or a dozen horses and carts being almost continuously in use in the service, causing great wear and tear of the roads, and occasionally congestion of traffic over important tram routes. Negotiations between the tramways committee and Messrs. Martin were set on foot with a view to the conveyance of the coal by tram. The difficulty lay in getting electric coal trucks up to the coal chutes, which occupy ground belonging to the railway companies. The companies, however, readily consented to the laying of the necessary track, and a length of about 400 yds. of line was laid from the Bradford Road Section of the Corporation tramways by way of Whitestone Lane to the coal depot at Hillhouse for the purpose of the coal traffic. The whole of the Huddersfield tramways is thus opened out for such traffic if necessary. At the Lindley end Messrs. Martin have at their own expense laid the requisite line from the Salendine Nook Section of the Corporation tramways, that the coal may be delivered at their works. The two trucks which are to be used for the carriage of the coal are in appearance very much like an ordinary railway coal truck, and of a similar carrying capacity, about 10 tons each. The wagons have been built by Milnes, Voss & Company, of Birkenhead, and are mounted upon radial trucks, of the Brush Electrical Engineering Company. These give a longer wheel base, and serve the purpose of a single truck for hill-climbing properties, while giving the qualities of the bogie, in being able to get easily round curves without undue strain upon any part of the mechanism. Each vehicle is equipped with two No. 80 Westinghouse motors, approximately of 45 hp each, with four Westinghouse-Newall magnetic brakes, powerful hand brakes and sanding gear. The coal is delivered into the wagons direct from the chute and discharged direct into the coal store of the mills with the minimum of labor, and thence carried to automatic stokers.

A. C. S.

The Toledo, Urban & Interurban Company, of Findlay, Ohio, has had plans and specifications prepared for a new power house and has already broken ground for the building, which is to be located at Findlay. The plans were prepared by E. Darrow, the company's consulting engineer. The company, through C. F. Smith, general manager, is asking for proposals on three 1500-hp, cross-compound condensing engines, to run at 94 r. p. m., to be operated with an initial steam pressure of 175 lbs. In connection with these engines are three 1000-kw 25-cycle generators and sub-station apparatus for 33,000-volt transmission.

PARIS LETTER

A definite start has been made on the new electric railway up the slopes of Mont Blanc. The line commences at the terminal station of the Le Fayet Road, and following the southern slopes of the mountain will have its present proposed terminus at the Col de l'Aguille du Gouter, 12,140 ft. above sea level. The continuation of the line to the summit of the mountain, some 3000 ft. higher, is reserved for a later project. The total length of the line is 18½ km, of which some 3 km will be in tunnel. Meter gage will be used, and the rails, weighing 40 lbs. per yard, will be laid on metal ties. The maximum speed is 23.2 per cent, and rack construction will be employed. The speed up the steeper grades will be 3⅛ miles per hour, and on lighter grades about 8 miles per hour. A three-phase locomotive of 14 tons will be used with two 4-ton trailers. The summer traffic will be handled by ten trains daily, each accommodating eighty-four passengers. The cost of the line is estimated to be about $2,200,000.

The discussion at the Vienna convention of the International Congress on the subject of trail cars possesses a particular interest in Paris, owing to the general use in that city of double deck cars. These cars are being abandoned in Paris, however, and outside the city it is not unusual to see two or more trailers coupled at rush hours.

The engineer specially charged with the supervision of street railway affairs by the French Government has just left Paris together with a municipal commission on a trip to New York, St. Louis, Chicago and other principal cities of the United States in order to inquire closely into the conditions affecting the tramway interests in America. As your readers will remember, the whole of the tramway and omnibus situation in Paris is coming again to the front, the reason being the ruinous competition afforded by the new Metropolitan lines. There are very few tramway lines in the Paris district which are doing at all well, and some are in an extremely critical condition. One of these is the Compagnie de l'Est Parisien, which is being permitted for the moment to run a trolley service on the Rue du Quatre Septembre, in place of the Diatto contact system first laid down. The city authorities are endeavoring to force the company to replace the contacts which were taken up when work on the new No. 3 Metropolitan line was commenced, and the company wishes to throw the onus of the change on to the city. There is a strong feeling against the replacing of the contacts, because of their danger to traffic. Altogether things are at a deadlock on this point. The franchises of certain of the traction companies expire in a few years and their end, under the present régime, is only being hastened by the Metropolitan lines, with their two to three minute service.

While traction engineers in the United States are installing Curtis and Westinghouse turbine plants, in France attention is being attracted to the Swiss firm of Brown, Boveri & Company, which is supplying the 18,000 hp for the St. Ouen power station of the Metropolitan Railway. In addition this firm is also supplying quite a few alternating current units of several hundred kilowatts' output to various plants in France. The Curtis turbine has not yet made its appearance here, but two groups will shortly be installed at Nice, of 800 kw each.

Notwithstanding the continual increase in traffic on the Metropolitan lines, the General Omnibus Company, which is the one company most seriously affected by the competition, reports receipts this year, up to Sept. 10, of 31,227,308 frs, which is an increase over the same period of 1903 of 106,208 frs.

The Orleans Railway Company, whose electric extension was described in your Aug. 6 issue, contemplates the handling of its freight traffic as well as the passenger traffic by electric means, as far as the limits of the third rail at Juvisy. To do this the Orleans Company will require a much larger number of locomotives than is at present in use. It is stated that an attempt will be made to use the gearless locomotives of the Central London Railway, which machines have been laying practically idle since the adoption of train control cars by this company.

Owing to the very great increase in the numbers of passengers carried by the Belgian State lines in and around Brussels, there is a great congestion of traffic, especially in the departure and arrival of trains in the Belgian capital. A paper scheme for an underground railway company has existed for some time, and attempts are now being made to bring the project to a head. The density of traffic at Brussels requires the establishment of an underground or elevated electric system.

Ganz & Company, who equipped the Valtellina line in northern Italy with the three-phase system of traction, have just delivered three new locomotives for this line. The locomotives have three motor axles and a free axle at either end. Ready for service they weigh 62 tons each, and have a length of 11.54 meters between buffers. The wheel base is 9.5 meters. The motors are double, that is, they comprise a high and a low tension motor on the same axle and in a common frame. The commercial speeds are 64 and 32 km per hour, according to whether the high-tension motor alone is in circuit or whether the low-tension motor is connected in cascade with it. The tractive efforts respectively at the above speeds are 3500 kg and 6000 kg. Each locomotive develops about 1600 effective hp. The current is 3000 volts three-phase, at 15 cycles per second.

The problem of electric traction applied to long distance steam railroads is attracting just now a great deal of attention in Italy, where it is thought that a large reserve of energy in the form of abundant waterfalls could be turned to excellent account at comparatively slight cost. The Swedish Government is also taking up this subject very seriously in view of the vast reserve of hydraulic force in the country. Experiments are to be made in electric traction on the State line between Stockholm and Jarfra. A temporary power station is to be installed at Tomteboda. Estimates for the transformation have been requested, and four important firms, viz., Siemens-Schukert, Allgemeine, Oerlikon and the British Westinghouse Company have already presented bids for the work.

SINGLE-PHASE SYSTEM FOR BLOOMINGTON, PONTIAC & JOLIET ELECTRIC RAILWAY

A contract has just been made by the Bloomington, Pontiac & Joliet Electric Railway Company for two cars to be equipped with the new General Electric Company's single-phase, alternating-current motors. These are to be used on the 20 miles of line which this company expects to have completed by the end of the year between Pontiac, Ill., and Dwight. The cars will be supplied by the American Car Company, of St. Louis, one of the cars being that on exhibition in the Transportation Building at the Louisiana Purchase Exposition. As it is not expected that the cars on this road will be required to operate over direct-current trolley lines, the series parallel method of control will not be used, potential control being used instead. The manager of the company is F. L. Lucas, who is also manager of the Pontiac Light & Water Company. The road is being constructed, and the engineering work is being done by the Arnold Electric Power Station Company, of Chicago. Cars will be supplied at 2300 volts, 25 cycles, from a generator in the plant of the Pontiac Light & Water Company, the generator feeding direct to the trolley line. A considerable saving over any other method of construction has been made possible by the use of alternating-current motors on this particular road, this being a case where it was desirable to keep down the investment to the lowest point possible.

NEW HAVEN ABANDONS THIRD RAIL

The New York, New Haven & Hartford Railroad Company is dismantling its third-rail line between Nantasket Junction and Braintree, and the announcement is made that the electrical equipment and operation of its suburban lines will not be undertaken until the invention of new appliances or the perfection of those now existing makes such a step more feasible. An assertion by President Mellen, of the New York, New Haven & Hartford road, has discouraged the hopes of residents of Boston that electricity would soon be adopted as the motive power of lines into the new South Station.

"We have not yet been able to make definite plans for electrical equipment, and it is not likely that we shall be able to do so right away," said Mr. Mellen.

"The trolley and the third-rail," another official is quoted as saying, "have been found impracticable for our system, and if electricity is further used by our road for motive power it will probably be in the form of an electric locomotive, although the electric locomotive has not yet reached an efficiency warranting its present adoption."

The Nantasket branch of the New York, New Haven & Hartford road was equipped with the third-rail several years ago as an experiment. It is now stated that while the third-rail system has proved satisfactory on that section of the line between Nantasket Junction and Pemberton, where only the electrically equipped cars are operated, on the other section of the line, between Nantasket Junction and Braintree, where steam trains also have been run, the step has proved a failure. For this reason the Braintree-Nantasket Junction equipment is now being abolished.

President Mellen, when pressed to be specific, said:

"Whatever experiments are decided upon will take place at the New York end, where the problem is being worked out in connection with the subway. Whatever is decided upon with reference to this and to the Pennsylvania tunnel will govern the electrical plans not only of our road, but of all the other large roads in the country."

ANNOUNCEMENT FOR SUPERINTENDENTS AND ENGINEERS OF WAY

In the Street Railway Journal of Sept. 17, announcement was made of the proposed changes in the constitution of the American Railway, Mechanical & Electrical Association, so that this association could include superintendents and engineers of way. F. G. Simmons, of the Milwaukee Electric Railway & Light Company, who has been heading the movement to secure some kind of an organization of way men, has just issued a circular which explains the present situation as follows:

"The efforts expended to date in the attempt to organize the superintendents and engineers of way have resulted in three propositions looking to this end.

"The first, which appears to be the most popular, would require the reorganization of the American Street Railway Association and its division into sub-organizations covering the different departments of the work.

"The second proposition contemplates an amalgamation with the present 'American Railway, Mechanical & Electrical Association,' and the necessary expansion of the work of that organization.

"The third, and the original intention, was an independent organization, but the concensus of opinion is very much against this idea as multiplying to too great an extent the various expenses incident to the annual meeting of the street railway interests, also as tending to strip the parent organization of all its functions.

"There is little hope of very much being accomplished at the coming meeting in October, by the main association, although it is more than probable the matter will receive careful consideration, and in order that something may be accomplished during the ensuing year it is proposed to extend the scope of the American Railway, Mechanical & Electrical Association, so as to take in the 'way' men, and thereby provide for the preparation of two or three articles concerning the work of this important branch of the electrical railway business.

"Future action of the parent association would be in no wise affected by this step, and a year's preparatory work in the organization of the 'way' men provided for."

A UNIQUE POWER PLANT SALE

Probably there has never before been such an opportunity to purchase equipment for a power plant as is open now in connection with the disposal of the service station of the Louisiana Purchase Exposition. This plant was described in "The Engineering Record" of Jan. 23, Feb. 27, and June 4 of the current year, and also in the Street Railway Journal. It has a capacity of about 14,000 hp, and was designed and built to illustrate the best practice in plants of such size. The equipment must be removed at the close of the exposition and will be sold in whole or in part for immediate delivery when the Fair is over. It was designed and installed by Westinghouse, Church, Kerr & Company, of New York, who will dispose of it, and has demonstrated its efficiency by continuing in steady operation for twenty-four hours a day since the opening of the Exposition.

The equipment was all new and has been used just enough to insure the good condition of all parts. The present purpose of calling attention to this sale is to make known the great variety of equipment which central stations will be able to secure. There are four vertical cross-compound engines, with 38-in. and 76-in. cylinders, 54-in. stroke, fitted with Monarch safety stops. Two of these engines are direct connected to General Electric 2000-kw generators, and two of them to Westinghouse generators of the same capacity. These are three-phase, 25-cycle, 6600-volt machines of the revolving field pattern. Steam is furnished by sixteen 400-hp Babcock & Wilcox boilers equipped with Roney stokers.

The auxiliary apparatus will probably be particularly attractive to a large number of central station managers. It includes a Worthington Admiralty pattern boiler feed pump, two Worthington compound feed pumps, two Cochrane feed-water heaters and purifiers, four 14- ft. mechanical draft fans, each driven by a Chandler & Taylor automatic engine, two Worthington elevated jet condensers, a Worthington vertical dry vacuum pump and two Worthington horizontal fly-wheel vacuum pumps, sixteen Seymour fans driven by a Westinghouse compound engine, three Worthington volute centrifugal pumps, three Westinghouse 80-kw exciter units, a switchboard and all the appurtenances, and a 40-ton, 80-ft., 3-motor Niles-Bement-Pond crane. In addition there is a large amount of steam and water piping, valves, gages, traps and apparatus used in the Holly system for returning condensed water to the boilers.

ANNUAL REPORT OF RAILWAYS COMPANY GENERAL

The report of the Railways Company General for the year ended June 30, 1904, has just been made public. It shows earnings as follows:

	1904	1903
Income for year	$45,901	$75,532
Expenses, rent, taxes, etc	7,482	7,445
Net profit	$38,419	$68,087
Previous surplus	85,957	17,870
Total surplus	$124,376	$85,957

The general balance sheet as of June 30, 1904, compares as follows:

ASSETS	1904	1903
Cash	$84,639	$30,076
Due from sub. companies	60,990	108,419
Bonds sub. companies	787,300	593,132
Capital stock sub. companies	242,723	256,090
Other securities owned	284,459	120,825
Sundry underwritings	24,500	183,865
Furniture, fixtures, etc	1,910	4,366
Capital stock R. Co. Gen. in hands of trust	34,000	34,000
Unpaid stock sub	28,000	28,000
Total	$1,548,522	$1,358,677
LIABILITIES		
Capital stock	$1,200,000	$1,200,000
Notes due	224,145	72,917
Surplus	124,377	85,957
Total	$1,548,522	$1,358,677

President E. R. Dick, in his annual report, says:

"The net operations of the various trolley lines owned and controlled by this company have been unsatisfactory. The unprecedented severity of the last winter, especially in Michigan, caused a loss in receipts accompanied by heavy increased expense for operation. The necessity of improvements to the Michigan Traction Company, added to expenditures forced upon that company by the cities of Kalamazoo and Battle Creek, required the expenditure of $164,191. The Michigan Traction Company has been compelled to build various extensions in Michigan, and, in order to secure a first mortgage bond that would be collateral, the Michigan Traction Extension Company was organized and all new mileage constructed under its charter. The entire capital stock of the Michigan Traction Extension Company was delivered to the Michigan Traction Company in consideration of the Traction Company leasing the Extension Company under a lease, the terms of which guarantee interest on the Extension Company's bonds. As the entire capital stock of the Extension Company is owned by the Traction Company, all earnings would go into the treasury of the Michigan Traction Company. As additional security for the Traction Extension loan, the second mortgage bonds of the Michigan Traction Company have been deposited with the trustee of the Extension mortgage.

"For the various sums advanced for improvements, extensions and equipment, there have been delivered to the Michigan Traction Company first mortgage collateral trust bonds of the Michigan Traction Extension Company amounting to $326,000, which are held in the treasury of the Railways Company General. The new mileage built during the last year has resulted in considerable increase of gross earnings, while the additional equipment and improvements to the property have resulted in a considerable decrease in the ratio of operating expenses, so that, in case no ill luck such as the severity of last winter takes place, it is probable that the Michigan Traction Company will not only be self-supporting, but will begin to pay back to the Railways Company General the money which the latter has been compelled to advance in past years.

"In answer to inquiries from various directions as to the unsatisfactory showing made by the Railways Company General, the management can only state that the operation of small independent trolley lines would seem to be as difficult and as unsuccessful as the operation of the small independent steam lines as they existed thirty years ago, and that practical results will not be realized until consolidations are forced upon them either by bankruptcy proceedings or by amicable agreement between the various connecting lines, and further, the absolute impossibility of selling to the investing public the bonds of these small trolley lines, makes it necessary for any surplus over and above their bonds to be put back into the property in order to make improvements and extensions required by the normal growth of the companies.

"The policy of your management is, if possible, to arrange for the consolidation of the various controlled trolley lines in order that net returns shall improve and the present unsalable securities in the treasury of the company be replaced by those that can be negotiated."

AMERICAN LIGHT & TRACTION REPORT

The American Light & Traction Company reports for the period extending from July 1, 1901, to July 31, 1904, as follows: Earnings on stock owned, $2,735,105; interest on loans, etc., $249,891; gross earnings, $2,984,996; expenses, $72,282; net earnings, $2,912,714; dividends paid on preferred stock (6 per cent), $1,549,167; undivided profits, $1,363,547.

The statement of assets and liabilities as of Aug. 1, 1904, shows: Assets—Stocks of subsidiary companies owned (cost) $12,244,595; bonds, $100,345; bills receivable, $1,651,977; earnings (due A. L. & T. Co.), $961,197; interest, $20,441; miscellaneous stocks owned (cost), $99,104; office furniture and fixtures, $1,025; cash on hand, $362,562; total, $15,441,247. Liabilities—Preferred stock, $9,396,900; common stock outstanding, $4,680,800; undivided profits to date, $1,363,547; total, $15,441,247.

The company has not yet published separately its statement of earnings for the fiscal year ended July 31, last, but by adding the results of operations for the two last preceding years and deducting the totals from those contained in the current statement for three years the following results are arrived at for 1904:

	1904.	1903.	Increase.
Gross earnings	$1,099,600	$1,092,063	$7,537
Operating expenses	27,135	25,078	2,057
Net earnings	$1,072,465	$1,066,985	$5,480
Preferred dividends	563,815	528,337	35,478
Surplus	$508,650	$538,648	*$29,998

*Decrease.

The surplus for the year is equal to approximately 11 per cent on the $4,680,800 outstanding common stock.

THE GREAT FALLS & OLD DOMINION ELECTRIC RAILWAY

The grading of the Great Falls & Old Dominion Electric Railroad is completed for half the distance between Washington and Great Falls. The distance covered by the graded roadbed is 7¼ miles, reaching to a point between Lewinsville and Langley. The rails have been laid across the Aqueduct bridge and the reconstruction of the bridge accomplished at a cost of $60,000. Many additional supports had to be put in, and over the canal, on the west side, a complete truss was built to insure the safety of the structure. At the southern end of the bridge a large fill has been made, widening the approach to the bridge, so that there will be plenty of room for the new tracks without interfering with traffic on the roadway. A large excavation has been made in the hillside at the Virginia end of the bridge, wherein a car shed or freight station will be erected. The power house will be constructed at the base of the hill east of Rosslyn, near the Potomac, where the Baltimore & Ohio Railroad will run in a siding to supply coal direct at the plant. The scope of many of the details of the work depends entirely upon the decision of the question whether the company will be permitted to run its proposed crosstown line in the district. If the franchise is granted the trackage arrangements will be different from those contemplated for the road without city connections. If the line is to be suburban solely, the trains from Virginia will be run across the bridge to the base of the wall at the foot of Thirty-Seventh Street, from which they will have to be backed out again. But if the crosstown line becomes a reality, the city cars will run across the bridge and around a loop on the Virginia side, and the suburban cars will stop at a passenger station which will be erected there. Incoming and outgoing passengers would be transferred from one line to the other under the shelter of this station. On the portion of the grading yet to be accomplished there will be four bridges, besides a viaduct 400 ft. long at Difficult Run. This viaduct will reach an altitude of 60 ft. at the highest point. Bids have been received for the completion of the balance of this work, and the contract will probably be awarded this month.

CONTRACT AWARDED FOR NEW PENNSYLVANIA LINE

The Scranton, Factoryville & Tunkhannock Electric Railway Company has given the contract for the building and equipping of 30 miles of line from North Main Avenue, Scranton, to Tunkhannock, via. Factoryville, Clark's Green, Glenburn, Dalton and La Plume, with a spur to Lake Minola, to the American Limestone & Cement Company, a Pennsylvania corporation, for the sum of $950,000. The line will be built over private right of way, all of which has been secured, and will carry freight as well as passengers. Construction work will not be commenced before next spring. A station will be built on North Main Avenue, Scranton, within 50 ft. of the line of the Scranton Railway Company. Eventually the line is to be extended to Williamsport. Among those interested in the new company are Deputy Attorney-General Fleitz, James P. Dickson, J. P. Suisher and L. P. Carter, of Scranton. The officers of the American Limestone & Cement Company, whose plant is at Turbotsville, Pa., are: C. D. Eaton, of Berwick, president; J. H. Catterall, of Berwick, vice-president and secretary; Harry E. Long, treasurer; L. D. Dodge, general manager; W. C. Farrington, general superintendent.

EXHIBIT OF THERMIT RAIL WELDING IN ST. LOUIS

The Goldschmidt Thermit Company has arranged to give daily exhibitions of its system of rail-joint welding during the conventions at St. Louis, Oct. 10 to 15. These demonstrations will be given in a space adjoining the exhibit of the company, which is in the Metals Pavilion, opposite the south corner of the Mines and Metallurgy Building, and, if necessary, more than one exhibition will be given each day. The company wishes to demonstrate in this way to those delegates who have not seen a thermit reaction, the simplicity and quickness of the process.

TERRIBLE ACCIDENT TO AN ELECTRIC CAR NEAR BOSTON

An outward bound electric car from Boston to Melrose, Mass., containing thirty-two passengers, was blown to pieces at 8 o'clock Wednesday evening, Sept. 21, near the corner of Wyoming Avenue and Main Street, Melrose, by striking a 50-lb. box of dynamite that had fallen off an express wagon.

Six persons were killed, three more died of their injuries within an hour, and nineteen others on the car were taken to the two hospitals suffering from all sorts of wounds. At least a score of people in the immediate vicinity of the explosion were treated for cuts from flying glass and splinters.

The driver of the express wagon, when he discovered that the box had dropped off, rushed back to get it, but before he got within a hundred yards of the box the car came along and was blown up.

CHICAGO TUNNELS AND LOCAL TRANSPORTATION

The Chicago tunnels having been ordered lowered by an Act of Congress because of the obstruction they offer to navigation, the city of Chicago is now taking steps to accomplish this. This is a matter in which the street railway companies are vitally interested, as they occupy all the tunnels with tracks. Two of these tunnels are owned by the city, and the third by one of the companies. The idea is to have the tunnels vacant so that they can be removed or altered by Jan., 1905. The local transportation committee has been submitted two reports by experts on problems connected with tunnel lowering. One of these, by George W. Jackson, one of the prominent engineers of Chicago, relates especially to the tunnel lowering proposition, and the other report, by George A. Yuille, with whom street railway men are familiar, relates to the routes for cars and methods of operating after tunnels shall have been abandoned. The report of George W. Jackson recommends the abandonment of the La Salle and Washington Street tunnels and their destruction. He takes the position that it would cost more to lower the tunnels and widen them than to destroy the old tunnels altogether and build new tunnels either in the present locations or on other streets. He favors the construction of new double roadway tunnels having grades not to exceed 4 per cent to take the place of the present tunnels. A new subway could be constructed at either Clark or Dearborn or at La Salle Street, if necessary, though extra precautions would have to be taken at La Salle Street properly to protect the city's present water tunnel. In other respects the construction at La Salle Street would be easier owing to the unobstructed condition of the river as compared with either Clark or Dearborn Streets. The cost of destroying the La Salle and Washington Street tunnels, filling the approaches with clean sand, and constructing bulkheads inside of the established dock lines in the tunnels, he estimates at $155,000. The cost of a subway 2800 feet in length at either Dearborn, Clark or La Salle Streets is estimated at $1,170,000, and the cost of a similar subway at Washington, Madison or Monroe Streets, $1,090,000. He submits plans for subway loops connecting the north and west sides of the down-town district. These plans, however, are somewhat tentative, as the exact routes across the river, he states, can be altered He concludes with the following recommendations:

"1st. That the La Salle and Washington Street tunnels be destroyed immediately, and that bascule bridges be constructed as soon as practical at these points.

"2d. My opinion is that there is a necessity for a comprehensive subway system, as well as modern double roadway bascule bridges located about St. Clair Street for boulevard purposes; at La Salle Street, Franklin Street, Washington Street and Monroe Street. The rapid opening and closing of the modern lift bridges reduces to a minimum the delay of traffic crossing the river, and navigation in the river as compared to the old style draw-bridge. Five new bridges can be built for an amount not exceeding two million dollars ($2,000,000), including about forty-five hundred (4500) ft. of viaduct."

He says: "In conclusion, I beg leave to suggest that plans be drawn for a comprehensive traction subway of terminal loops to provide for the handling of all traffic between Michigan Avenue, Halsted Street, Twelfth Street and Chicago Avenue, my opinion being that if a traction subway is to be built, it should be planned on a scale sufficient to meet the city's future needs. The construction of two new tunnels to take the place of the present tunnels will afford no additional advantages in the matter of relieving the congestion in the down-town district, unless bascule bridges are built at various points and a number of surface car lines rerouted. The La Salle and Washington Street tunnels were constructed about thirty-five years ago, when the city had less than a fourth of its present population. If the tunnels were necessary then to meet the needs of transportation, it seems evident that they must be supplanted with new bridges or a comprehensive traction subway system of loops in the territory described.

The report submitted by George A. Yuille gave a plan for operating cars from the north and west sides into the down-town district after the down-town cable loops are abandoned because of the removal of the tunnels. This plan is to haul the cable trailers behind short electric motor cars from points short distances north and west of the river. The receivers of the Chicago Union Traction Company object to this plan because of the difficulty of operating electric motor cars with trailers in the down-town district and up the grades approaching the bridges, and wish to string trolley over the cable lines and handle all traffic with regular electric cars.

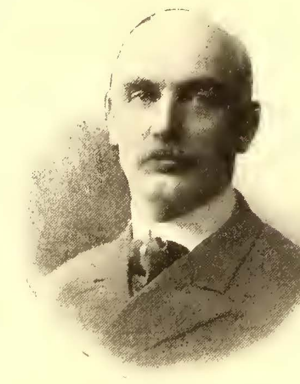
NEW YORK, NEW HAVEN & HARTFORD BUYS ANOTHER ELECTRIC ROAD—NEGOTIATING FOR STILL MORE

The New York, New Haven & Hartford Railroad, pursuing its policy of buying street railway lines which parallel its existing tracks, and which are becoming dangerous competitors for passenger traffic, bought, Sept. 22, the Worcester & Blackstone Valley Street Railway, a road 17 miles long running between Worcester and Whitinsville. The purchase price has not been made public. The road was started in 1895, and before cars were put in operation it went into the hands of receivers. Four years ago it came under the control of Matthew J. Whittall, of Worcester, Mass., and since that time it has been extended and conducted successfully. When the property was sold, the old officers all resigned and were replaced by men whose names have not been announced.

The New York, New Haven & Hartford Railroad is said to be negotiating for the purchase of the Middletown Street Railway, of Middletown, Conn. It is said that the company will, if it secures control of the Middletown Company, extend the Portland line to connect with the line from South Glastonbury into Hartford, and thus lay the foundation for a belt line on both sides of the river. It is said they will also get possession of the charter now held for a line from the end of the Wethersfield line to Middletown by way of Cromwell and that the cars will cross on the Air line, instead of on the highway bridge, where an extra toll of 3 cents is now charged, so that travel is greatly restricted. It is also said that a line is planned for East Hampton. It is desirable to have the Middletown Street Railway Company's lines in order to carry out the plan to build from Hartford to Middletown.

ELECTRIC RAILWAY IMPROVEMENTS IN TACOMA

An interesting example of several different types of railways which are successfully operated under one management is that of Tacoma, Wash., where the Tacoma Railway & Power Company and the Puget Sound Electric Railway Company have the same managing officials. These properties combine cable, trolley, third-rail and steam lines, operating passenger and freight business over city, suburban and interurban roads. The general management is vested in Stone & Webster, of Boston, the owners, but the active and detailed control of the systems is in the capable hands of W. S. Dimmock, who occupies the position of manager in both companies. The diversity of the lines and the variety of equipment and service call for a careful consideration of details and a broad and liberal policy with employees and the public, and Mr. Dimmock's wide experience has specially fitted him for the work. He was formerly connected with steam road operation and entered the electric railway field in 1892, in Omaha, where he was general manager of the Omaha & Council Bluffs and the Omaha & Southern Railways for about six years.



W. S. DIMMOCK

In 1900 he left Omaha and assumed the general management of the Richmond Passenger & Power Company, of Richmond, Va., controlling lines in Richmond and Petersburg and an interurban road between the two cities. He left this position in July, 1901, to go with Stone & Webster, of Boston, and a month later was appointed manager of the Tacoma Railway & Power Company, at Tacoma, Wash. In January of the following year, in addition to the duties with the Tacoma system, he was made manager of the third-rail Seattle & Tacoma Interurban Railway, which had commenced operation in Sept., 1901, and is now known as the Puget Sound Electric Railway.

The growth of a heavy freight traffic between the two companies demanded a change of the gage of the Tacoma lines from 3 ft. 6 ins. to standard gage, and this work, involving 87 miles of track, has been successfully and economically carried out during the past year. The alterations involved changing all the trucks and splicing the axles, and this work has been done in the shops of the Tacoma Railway & Power Company. The widening of the gage has given the company an opportunity to improve its roadbed, and there is hardly a rail in use that was in place two years ago. Double-truck modern cars have replaced the single-truck cars formerly in use, and in many cases two old 16-ft. cars have been spliced to form a large and serviceable double-truck car.

On the suburban lines of the Tacoma Railway a large freight business has been developed, lumber, cord wood and coal being hauled in car load lots. The freight business on the Puget Sound Electric Railway between Tacoma and Seattle is handled in exact accordance with steam road methods and has reached good proportions. All the freight equipment is of standard steam road construction. In connection with the main third-rail line is a logging road branch which is operated by steam locomotives.

A novel feature of the freight business of the interurban is a refrigerator line, which has recently been established for a meat packing company in Tacoma. Exceedingly large cars are used, they being of sufficient height to allow the beef, which is dressed in halves, to be run in on tracks and suspended vertically. Two of these cars are now in use, and eight more are being built. This service is an unusual one for an electric railway, but it is being carried on very successfully.

Mr. Dimmock is now on a tour of the Eastern cities.

STREET RAILWAY PATENTS

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

UNITED STATES PATENTS ISSUED SEPT. 20, 1904

770,464. Convertible Car; Walter H. Hoven, Salt Lake City, Utah. App. filed June 29, 1904. Consists of windows filling the spaces between the side posts, and each consisting of an upper and a lower sash, the lower sash being adapted to be pushed upward beside the upper sash, and both sashes adapted to be swung upon a hinge inward and upward and attached to the ceiling of the car. The cross-seats have a removable section in the middle to provide an aisle extending throughout the length of the car.

770,698. Railway Car; Isaac W. Phelps, New Bedford, Mass. App. filed Nov. 21, 1903. Hangers pivoted to one side of the car and to a longitudinally-extending guard rail, are so located as to normally support the rails between the side standards of the car and the grab handles, and a lug and catch for securing the rail in either raised or lowered position.

PERSONAL MENTION

MR. HOWARD FRAVEL, superintendent, and Claude Conelo, master mechanic of the Dayton & Western Traction Company, of Dayton, Ohio, have resigned from the company.

MR. JACOB HILL BYRNE, secretary of the Lancaster & York Furnace Electric Railway Company, of Lancaster, Pa., was married last week in Lancaster to Miss M. Deborah Allwein, of that city.

MR. GEORGE G. MULHERN, formerly general superintendent of the Cleveland Electric Railway Company, has resigned as a director of the company, and, it is stated, has sold his stock in the company. His resignation as director has been accepted, but his place has not been filled. Mr. Mulhern is candidate for Sheriff of Cuyahoga County on the Republican ticket.

MR. A. W. BRADY has been elected president of the Indiana Union Traction Company and the Indianapolis Northern Traction Company to succeed Mr. George F. McCulloch, who tendered his resignation at a meeting of the directors held in Philadelphia last week. Mr. Brady has been general counsel as well as vice-president of both companies, and is thoroughly familiar with the properties and the duties of his new office. Mr. McCulloch has been elected president of the boards of directors of the companies, and will continue to be identified with their management. Mr. Brady will reside in Anderson. Mr. W. Kelsey Schoepf, of Cincinnati, was elected vice-president and Mr. W. C. Sampson re-elected secretary-treasurer.

MR. THOS. FARMER, for the past year superintendent of the G. C. Kuhlman Car Company, and previously superintendent of motive power of the Detroit United Railway Company, has opened an engineering office in the Electric Building, Cleveland. It is Mr. Farmer's intention to make a specialty of inspecting cars in process of construction at the various car manufacturing plants, and if desired, to furnish specifications under which they are to be built. This is a branch of engineering that has never been specialized by any individual or firm, but is one for which Mr. Farmer is especially trained. In addition to his connection with the Kuhlman Company, he held the position of superintendent of motive power and car shops of the Detroit United Railways for a period of nine years, and the experience gained in that time in practical operation of rolling stock, coupled with previous experience in car building, makes him exceptionally well fitted to prepare the work which he has undertaken. Mr. Farmer already has the clientage of a number of the large roads, some of which have abandoned their old manner of inspection in favor of the methods he presents, which cover among other good points a daily report to the purchaser as to the progress of the work. Mr. Farmer was the founder and first president of the American Railway Mechanical and Electrical Association, and is also a member of the Detroit Engineering Society.

MR. OLIVER SHIRAS, one of the best known and most popular of the representatives of the British Westinghouse Company in England, has resigned his position with that company and has returned to New York to take up an important new position as electrical superintendent of parent and subsiduary companies of the International Nickel Company, of New York. Mr. Shiras has been in England for about four years, having occupied the position as manager of one of the branch offices of the British Westinghouse Company, during which time he has become extremely well known and popular with electrical engineers and managers of tramway companies in that country. Mr. Shiras was graduated from Cornell University in June, 1897, taking the degree of mechanical and electrical engineer, afterwards, up to the year 1900, acting as assistant to the chief engineer of the New York Telephone Company. Mr. Shiras, when in England, acted as president of the Cornell Club, of London, and was recently given a dinner by that association, at which were present about seventy-five of his most intimate associates and friends, who gave him a most hearty send off, and indulged to their hearts' content in the Cornell yell, a proceeding which seemed to take his English friends by storm. The meeting was presided over by Mr. J. G. White, of New York and London, and many speeches were made expressing great regret at Mr. Shiras' departure for New York. Mr. Shiras will hereafter have his headquarters at 3 Exchange Place, New York.