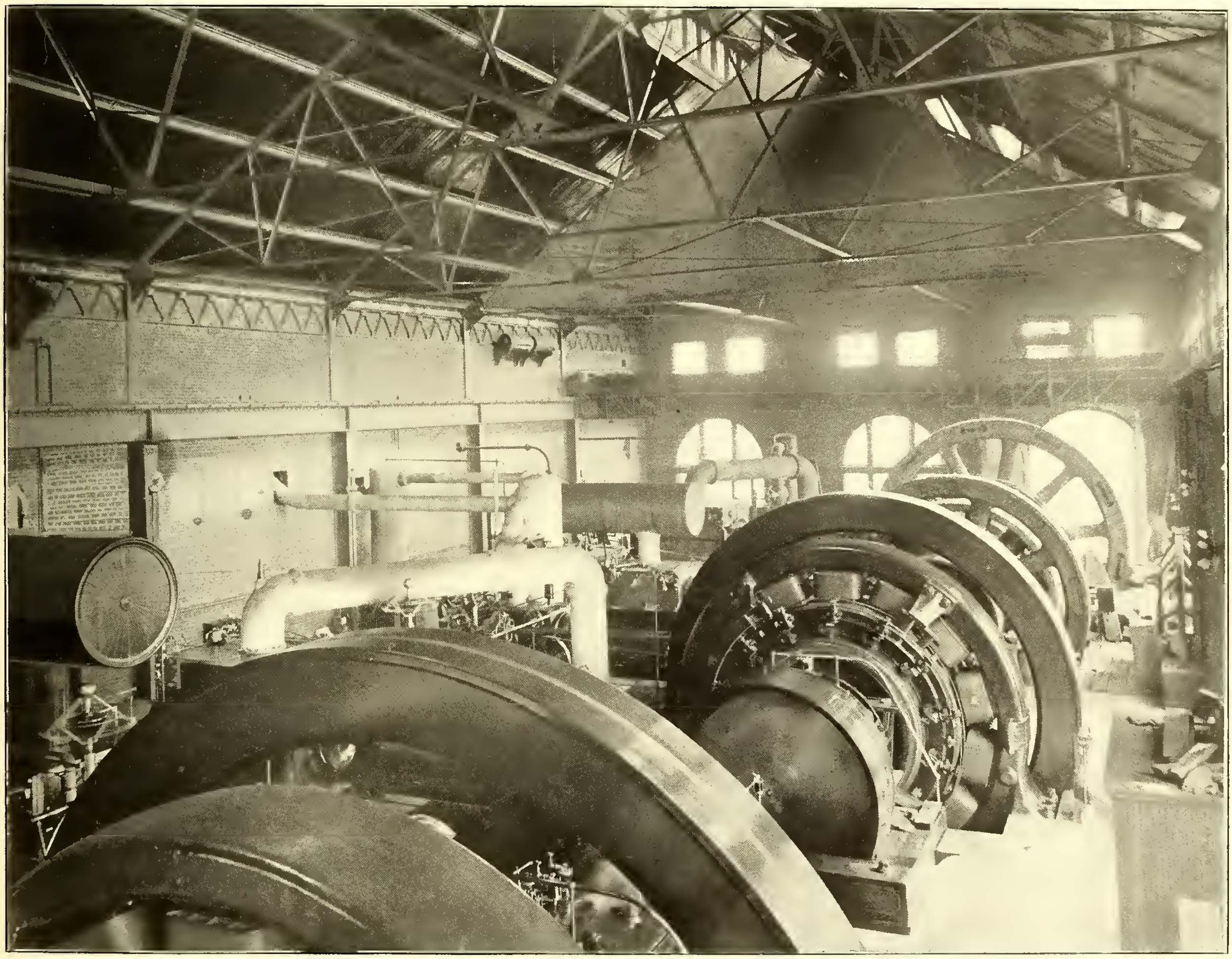
Street Railway Journal

Vol. XVI. NEW YORK AND CHICAGO, OCTOBER 13, 1900. No. 41.

THE STREET RAILWAY SITUATION IN THE TWO KANSAS CITIES

The unique topographical and other peculiar conditions of Kansas City have made the construction and operation of its street railway systems an unusually complex problem, and have developed many novel solutions of the problems presented. Forced by the very difficulties of their situation to adopt the very latest advances in the art of surface traction or to invent their own improvements on standard practice, the street railways of Kansas City have been as progressive as any in the continuous process of evolution of the last few years, and are now behind none in the application of the very latest improvements to apparatus and methods.

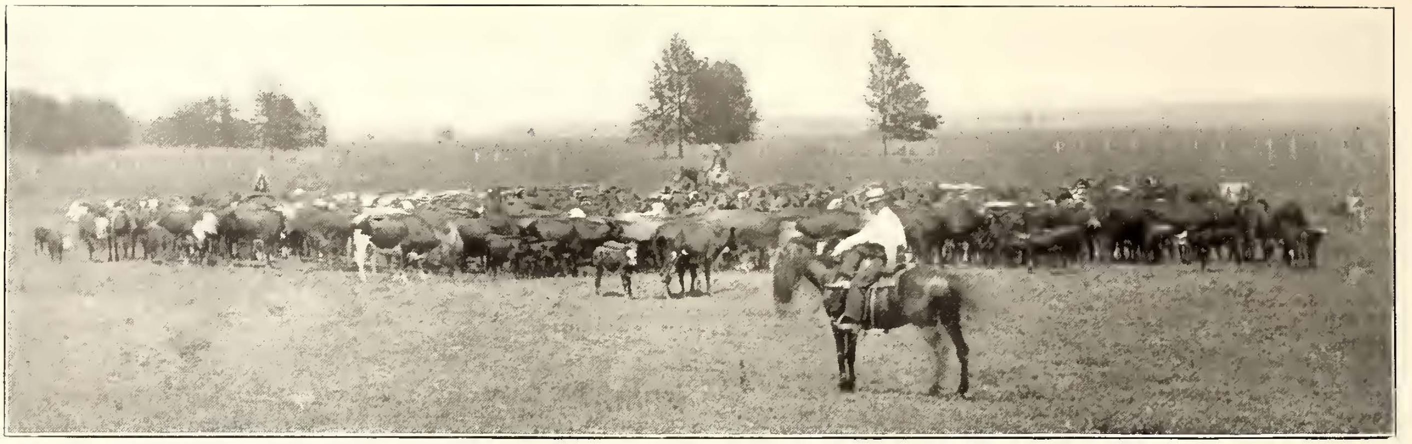


GENERAL VIEW OF KAW RIVER STATION, METROPOLITAN STREET RAILWAY CO.

Kansas City is located just on the State line between Kansas and Missouri. This line divides the city into two separate cities, with independent city governments. The larger of the two, and the one containing the business center and the best residence districts, is Kansas City, Mo.; the other, Kansas City, Kas., contains less expensive dwellings. The population of the two, as given in the United States Census for 1900, is 215,000.

THE CHIEF INDUSTRIES OF KANSAS CITY

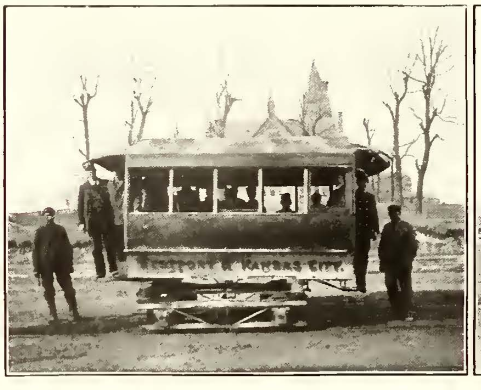
The city is fundamentally a great railroad center, serving as a collecting, jobbing and distributing point for the highly cultivated agricultural sections of Kansas, Nebraska, the Indian Territory, Colorado and the western part of Missouri. As these States and those further south and west are to a large extent engaged in the raising of live stock, Kansas City's greatest and most conspicuous

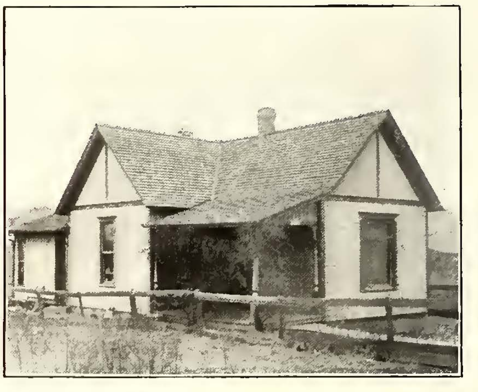


A TYPICAL GRAZING SCENE NEAR KANSAS CITY

industry is stock yards and their accompanying slaughtering and packing houses. Kansas City now ranks second only to Chicago in the volume of business in this line, and with the growing advantages of transportation of meat in refrigerator cars, as compared with the transportation "on the hoof," expects soon to rank ahead of Chicago.

It may be well to remark here that, in common with other Western cities, Kansas City's expectations are very great. Enthusiastic local patriotism, the outcome of rapid growth and development, is a strong characteristic of her citizens, all of whom are more or less imbued with the idea that "Kansas City has the brightest and most glorious future of any city on earth."





SOME HISTORIC VIEWS IN AND AROUND KANSAS CITY

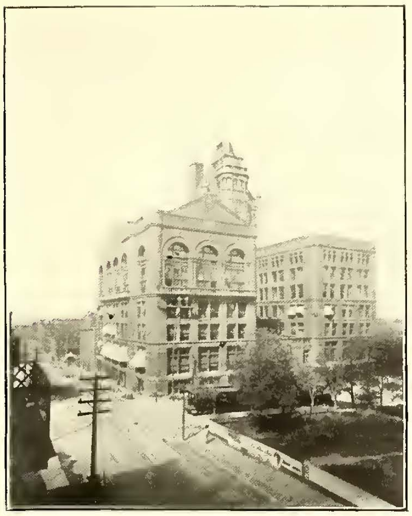
THE TOPOGRAPHICAL CHARACTER OF THE CITY

The most noticeable feature of the city from a street railway point of view is its extremely irregular profile. Along the bank of the river are low bottom lands, which are frequently flooded at times of extreme high water. The greater part of the city is located on high bluffs, the elevation of which averages about 150 ft. above the low lands. The whole area occupied by the city was originally a series of sharp hills and deep gulleys, cut by rushing brooks through the clay soil down to the limestone substratum. These have required extensive cutting and filling to get serviceable real estate, and in spite of this cutting and filling the city remains a series of hills and valleys both north and south and east and west. An idea of the inclinations of the present streets can be obtained from profiles of several of the street railway lines, given on one of the following pages. The Eighth and Ninth Streets lines run east and west, while the Holmes Street line runs north and south.

The whole city lies south of the Missouri River, there being no opportunity for growth on the other side owing to the great width there of bottom lands, which are so frequently flooded as to render them uninhabitable. The river sweeps around a curve in front of the city, as is shown

COLLISION BETWEEN TWO FREIGHT TRAINS, ARRANGED FOR THE AMUSEMENT OF KANSAS-CITIANS

THE NEW AUDITORIUM

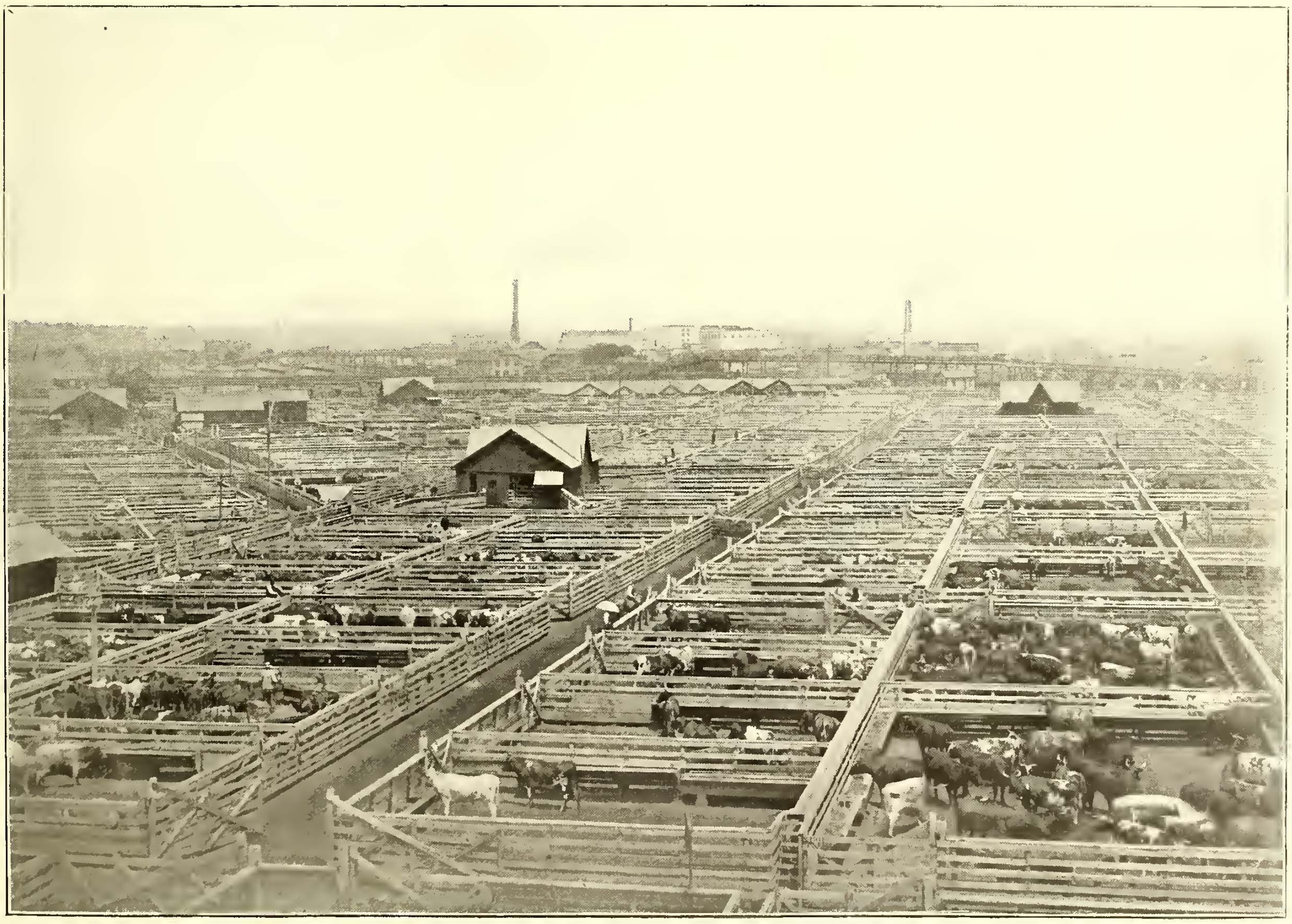


BOARD OF TRADE BUILDING

OLD AUDITORIUM THEATER

in the map, and threatens to cut across the low lands at any time and short-circuit this curve, leaving the city inland. Through Kansas City, Kan., there flows the Kansas or Kaw River, which must be crossed at several points to give access to the greater part of the Kansas portion of the city. No street railway lines whatever cross the Missouri, there being no population on the north side of the river.

In the low lands lying along the Kaw River, near its junction with the Missouri, is the Union Depot district, containing the depot—into which run almost all of the twenty-five railroads centralizing in Kansas City—as well as the stock yards with a large number of their employees. The district also contains many large jobbing houses, handling agricultural implements and other wares. To reach the business center from this low district or from Kansas City, Kan., which is west of it, it is necessary to surmount a high ridge, which is clearly indicated in the profile of the Ninth Street line. On the other side of this ridge is a hollow or valley, through which run some of the principal streets, and from which it is again necessary to rise to reach the residence section of the city. It is interesting to compare this profile of the Ninth Street line with that of another line also running to the Union Depot, but being elevated in the low lands and tunneling under the high ridge between the low lands and the depression, in which lies the business center. This line, with its lower



A VIEW IN THE STOCK YARDS

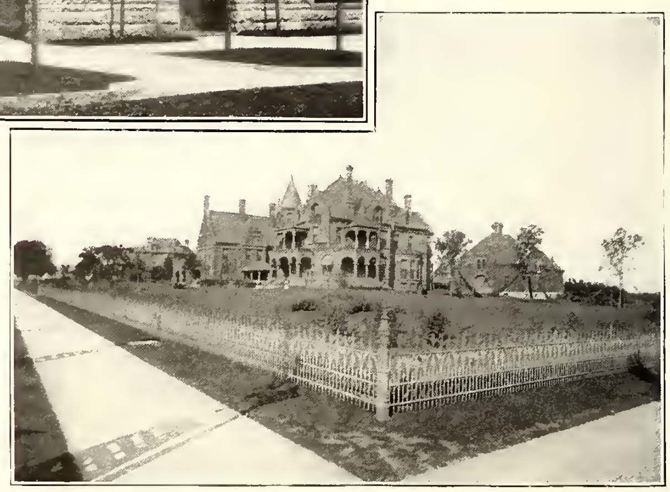
grades, is that on Eighth Street, the profile of which is shown below that of Ninth Street.

On account of these heavy grades the street railways in Kansas City have been largely operated on the cable system, although these cables are now being displaced by electric motors on all of the lines but two, the Ninth and Twelfth Street, on which the grades are so severe that cables are necessarily maintained. In fact Kansas City was for a long time the stronghold of the cable system in this country, ranking with San Francisco in point of mileage operated in this way. Before any lines were changed from cable to the electric system there were 63 miles of track operated by cables.

A BRIEF HISTORY OF KANSAS CITY AND ITS RAILWAY SYSTEM

Originally Kansas City was simply the river port town of Westport, now one of its residential districts. The real growth of Kansas City began about 1870; at that time Leavenworth, 25 miles further north on the Missouri River, was then the important river town, but as the latter place did not offer sufficient inducements to several railways building toward the Missouri River, they turned to the site of Kansas City as the crossing point. In earlier years the Missouri River traffic was an important element of the city's commerce, but the improvements of rail transportation have reduced this to a small factor. Some views of the early period of the city's history are given on a preceding page. The middle view is of the first street car operated; the left and right hand views, the homes of Jesse James, father and son. The growth since that time has been remarkably rapid, subject only to the usual ups and downs of good and bad times in the West. In 1885 and 1886 the city underwent a phenomenally vigorous "boom." It was then jocularly said of Kansas City that it was advisable to build residences on wheels in order that they might be easily moved from time to time out of the way of the advancing business section. In 1893 and following years the industrial depression generally felt throughout this country, and especially in the West, fell particularly heavy upon Kansas City, but the improved industrial conditions of the last few years with the good crops raised in the territory tributary to Kansas City have brought a revival of good times and a renewed but more healthy growth.

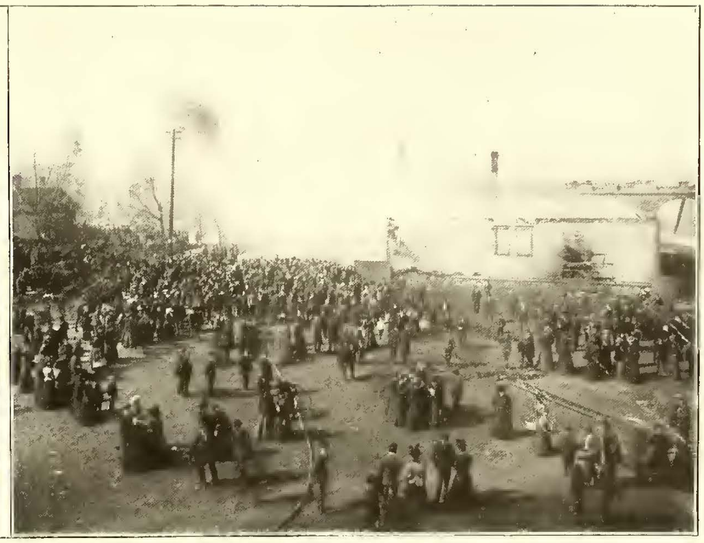
KANSAS CITY CLUB



GROUP OF KANSAS CITY RESIDENCES

The first horse car line in the city was started in 1871 between Kansas City and Westport, by Nehemiah Holmes, father of the Holmes brothers, now respectively president and general manager of the Metropolitan Street Railway Company. In order to convert this into a cable line and to build other lines, the Grand Avenue Cable Railway Company was incorporated on March 27, 1886. Another system of mule car lines was started in 1874 by a man familiarly known in Kansas City as Tom Corrigan. Five or six lines were built and operated frugally and shrewdly. The cable line built up Ninth Street by the Kansas City Cable Railway Company demonstrated the advantage of the cable over the horse system, but the Corrigan interests were unable to finance a change as expensive as the installation of cables, and in 1886 the Metropolitan Street Railway Company was organized to take over the system of the Corrigan Consolidated Street Railway Company and convert it into a cable system. The horse car lines were most antiquated in equipment, but were sold for $1,000,000 in 5 per cent first mortgage bonds. The Metropolitan Company has gradually absorbed nearly all of the other street railway

RUINS OF CONVENTION HALL

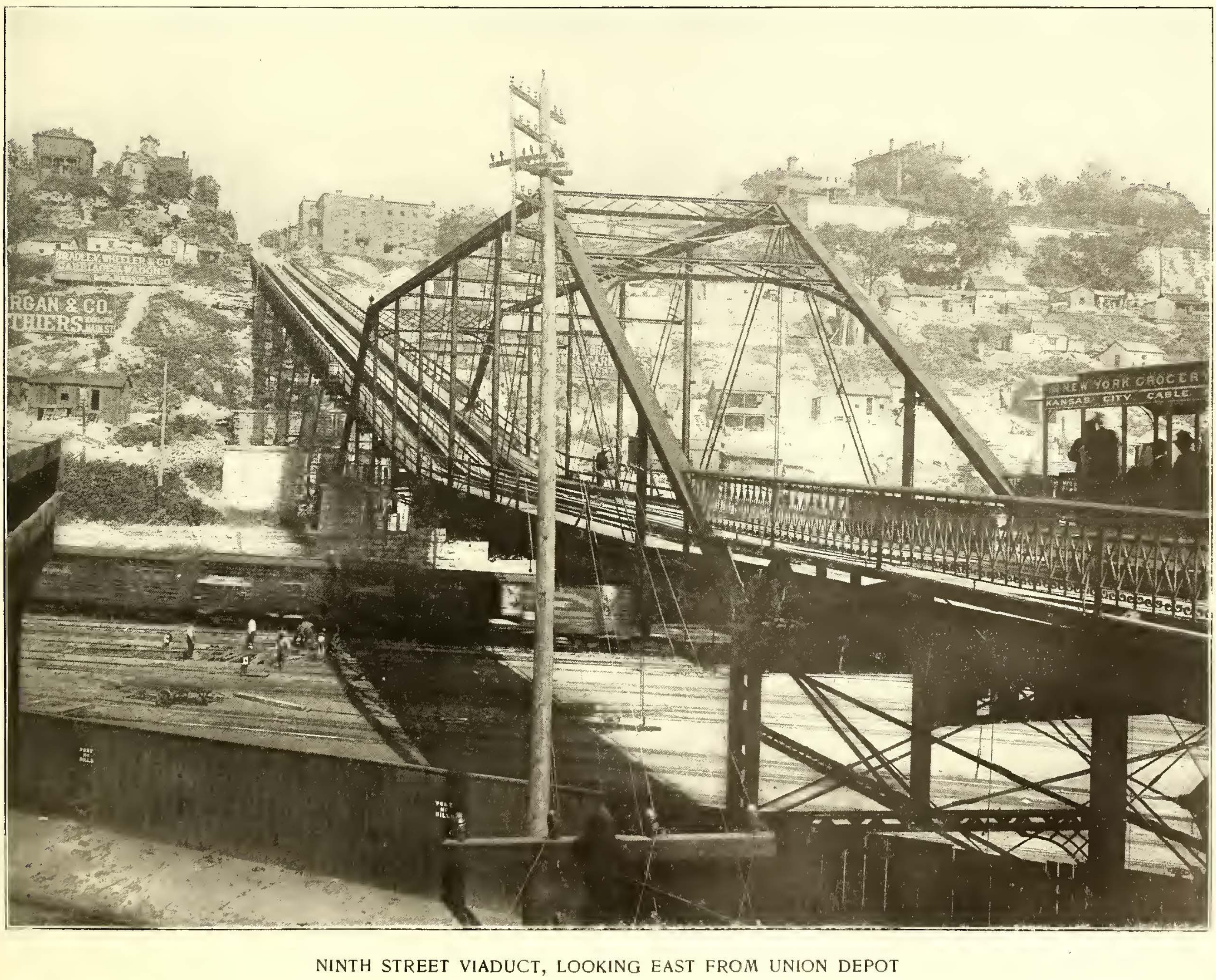


THROWING WATER ON CONVENTION HALL FIRE

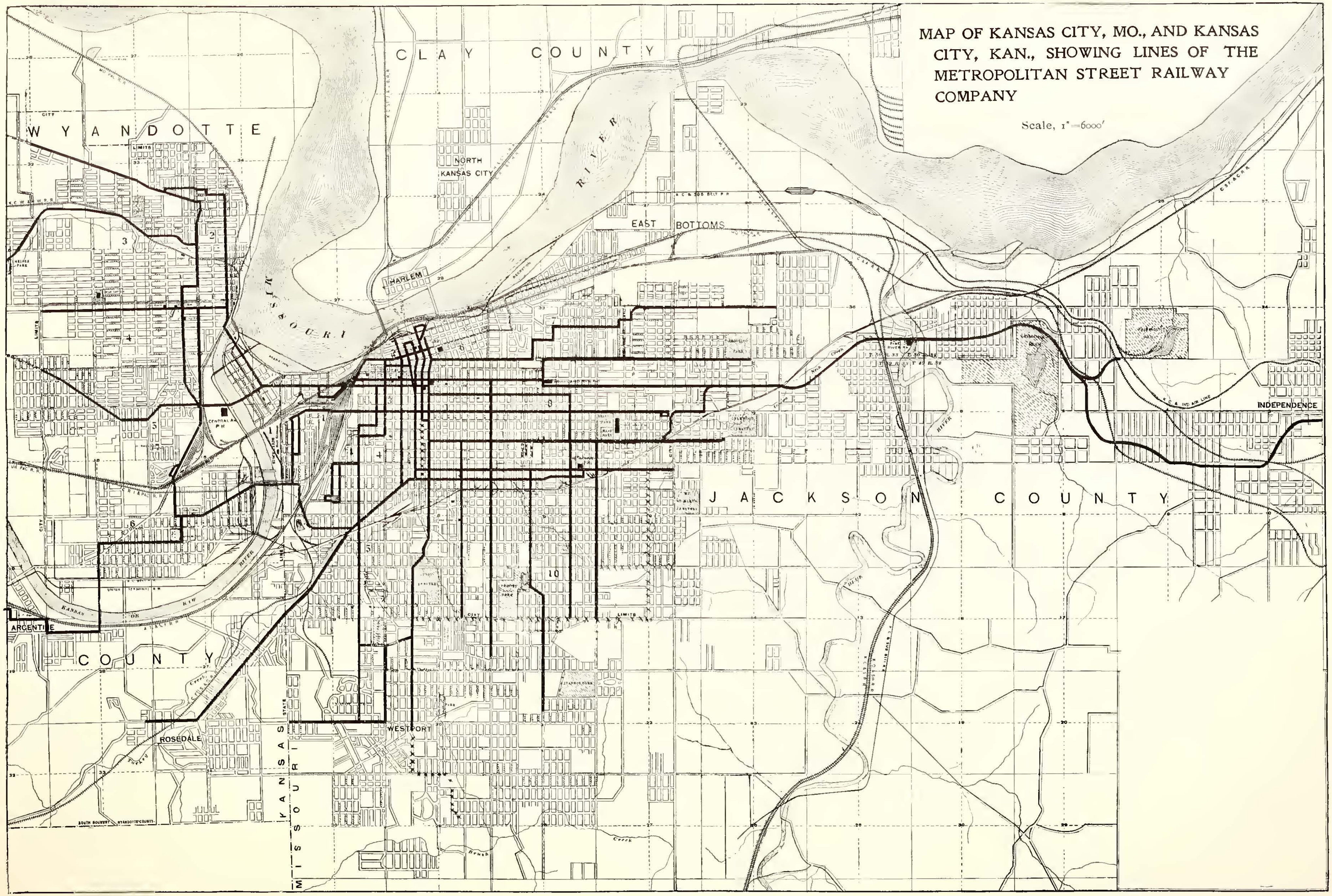
properties in the two Kansas Cities, having taken over the elevated railway in 1894, the Kansas City Cable Railway and Grand Avenue Cable Railway and others in 1895, and others since. The only line in Kansas City which it does not control is the East Side Electric Railway, running along the low lands near the river, and built by a brewing establishment, more to reach their brewery than for any other purpose. In addition to this there is an interurban line, the Kansas City-Leavenworth Line, which is not associated with the Metropolitan system. Otherwise, the twenty lines in the city, with an aggregate length of 160 miles of track, are all operated by the Metropolitan Street Railway Company.

THE PRESENT SYSTEM OF THE METROPOLITAN STREET RAILWAY COMPANY

Kansas City is laid out, as a reference to the map will show, on what is generally known as the Philadelphia system. The intersecting streets are, as a rule, at right angles

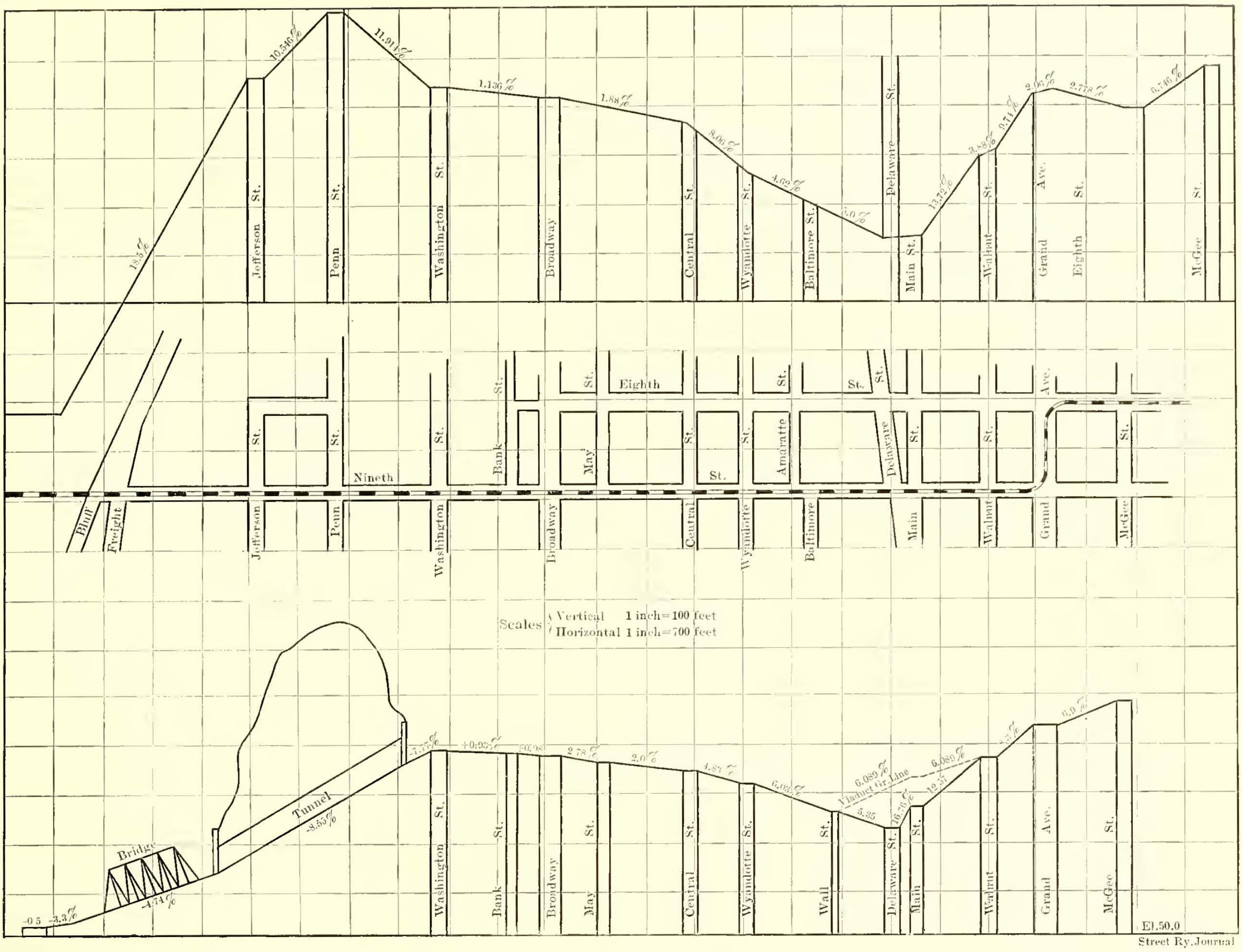


NINTH STREET VIADUCT, LOOKING EAST FROM UNION DEPOT

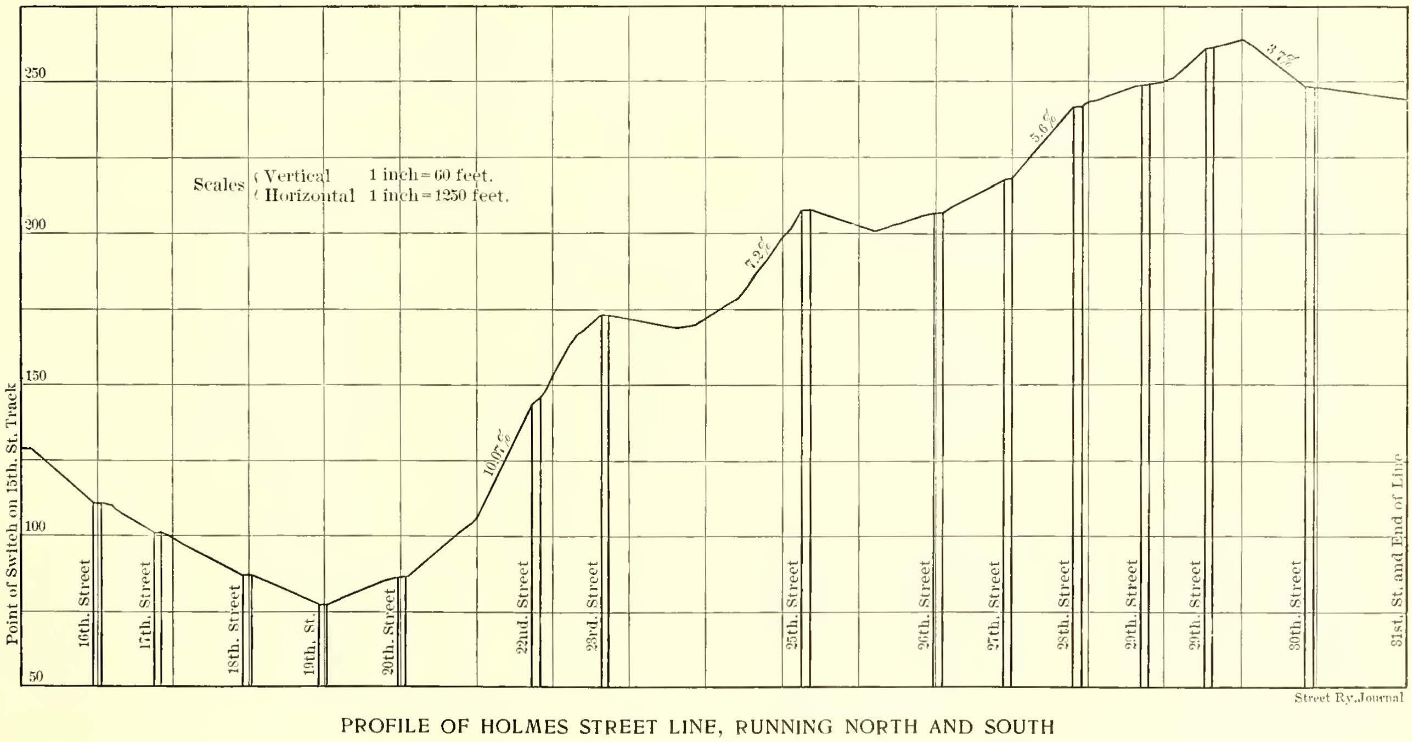


MAP OF KANSAS CITY, MO., AND KANSAS CITY, KAN., SHOWING LINES OF THE METROPOLITAN STREET RAILWAY COMPANY

Scale, 1" = 6000'

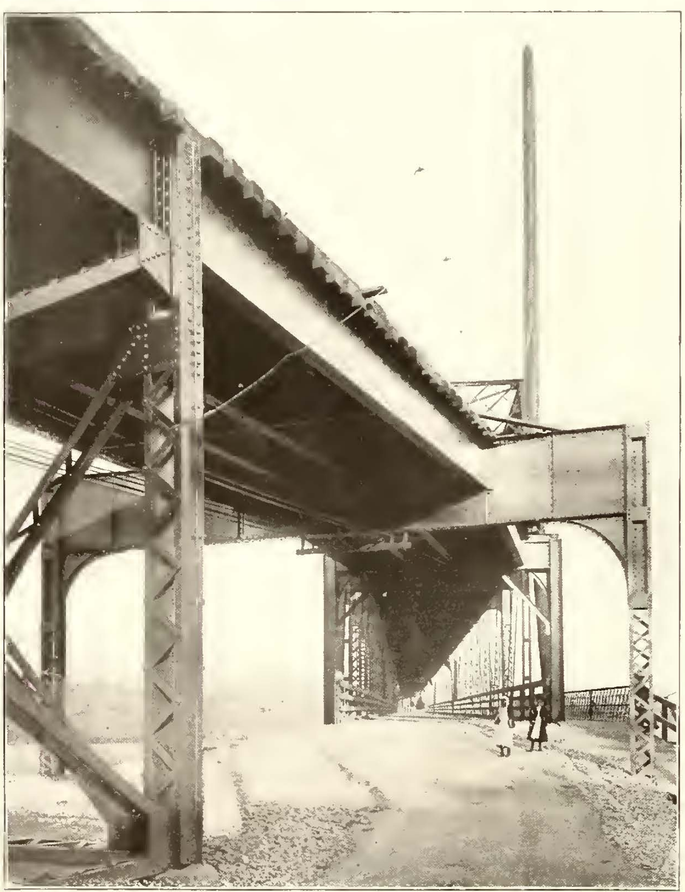


PROFILES OF EIGHTH STREET AND NINTH STREET LINES, SHOWING DIFFERENCES IN GRADES SECURED BY THE CONSTRUCTION OF THE TUNNEL AND VIADUCT ON EIGHTH STREET



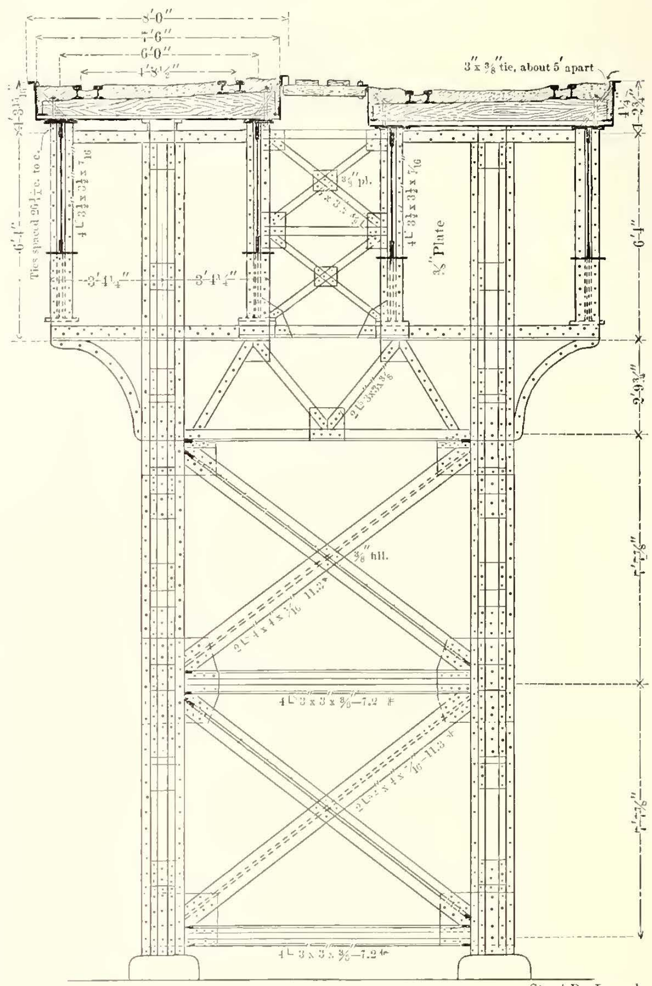
PROFILE OF HOLMES STREET LINE, RUNNING NORTH AND SOUTH to each other, and at regular distances apart. All streets running east and west are numbered, beginning at the river, and one hundred numbers are assigned to the buildings in each square; the streets running north and south are named and not numbered. The principal business streets in the city are: Main, Walnut and Grand Avenue. The greater part of the traffic of the Metropolitan Street Railway system converges at the post office corner, Walnut and Ninth Streets, where a constant succession of loaded cable trains comes up the 15 per cent grade from the direction of Union Depot, or descends the same grade toward the depot, these cars transferring a large number of their passengers to and from the lines running north and south on Walnut Street. Transfers are given generally on the Metropolitan system at about eighty-five points of intersection, so that any part of the city can be reached from any other part for a single fare. The company is now using about 70,000 transfers per day, that is about 25,000,000 annually, about half of its passenger receipts being represented by transfers.

Practically all traffic to Kansas City, Kan., goes down past the Union Depot, either on the elevated road or on the surface electric line, which runs under it in the low lands and swings around the hills by a rather circuitous route to the business center. The elevated line was orig-



ELEVATED STRUCTURE, METROPOLITAN STREET RAILWAY

inally operated by steam locomotives. The grade of 8½ per cent up through the tunnel was overcome by a grip car, which took the trailers from the steam locomotives. At present this grade is easily surmounted by the electric cars, as the rails in the tunnel are always dry. Before the present year the electric cars coming up from the elevated through the tunnel were unable to reach the main business section on Walnut Street and Grand Avenue and the district east of it. To overcome this difficulty a viaduct has been built in Eighth Street, bridging the valley through which run Delaware and Main Streets, as illustrated in the profile already referred to. By means of this viaduct, the tunnel and the elevated over the low lands, this route presents a much more level profile than is presented by the Ninth Street line, which closely



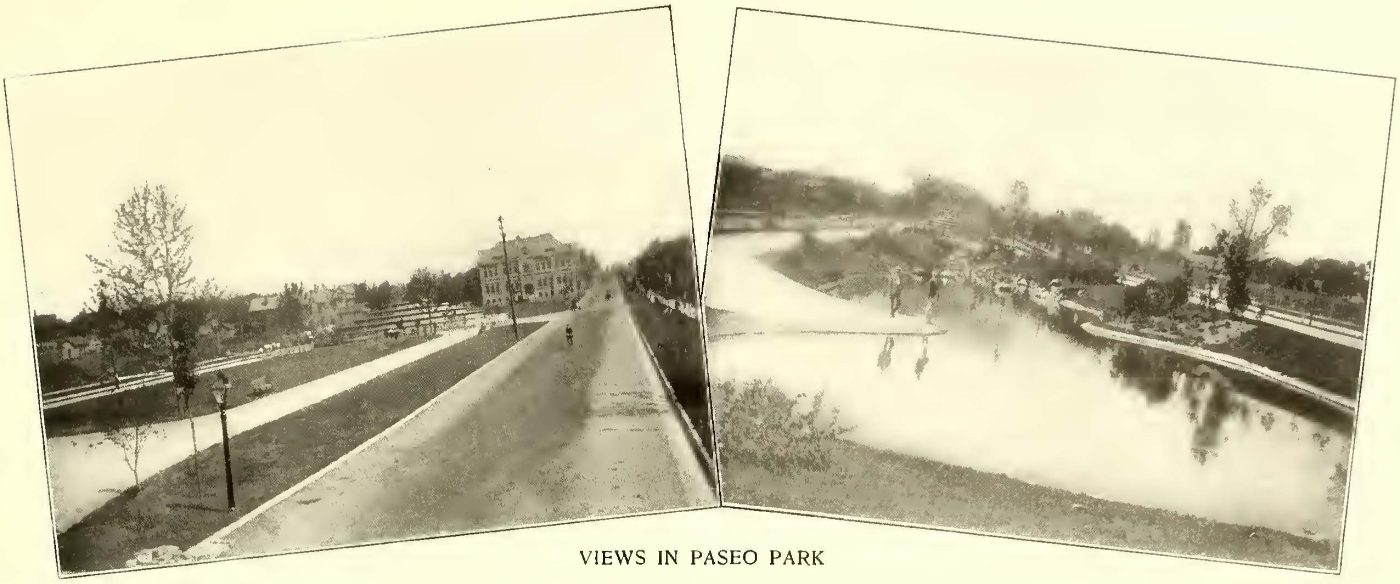
TYPICAL BENT IN VIADUCT

follows the surface, and is subject to such heavy ups and downs that electric cars cannot be run on it. Toward the southern and eastern directions from the business center the company's cable and electric lines form a regular gridiron through the residence districts, the grades being less severe in this part of the city, so that cable or even electric lines can be operated with no difficulty.

As noted above, the twenty lines of the Metropolitan system have an aggregate length of about 160 miles, of which about 120 miles are operated electrically, the remaining 40 miles being cable driven. About 23 miles of lines formerly cable driven had been, previous to the present year, changed over to the electric system, and during last summer more of the remaining 40 miles of cable road were being prepared for the change. Several new lines, with an aggregate length of about 15 miles, are also under construction at the present time.

THE INDEPENDENCE LINE AND FAIRMOUNT PARK

In the eastern end of the city there is a road about 9 miles long, running from a depot at Fifteenth and Askew Avenue, out across the Blue River, past Washington Park, to the suburb of Independence, with a spur to Fairmount



VIEWS IN PASEO PARK

Park. This road runs largely on a private right of way, and was originally a steam line, operated by the Kansas City & Independence Railway Company. It was purchased by the Metropolitan Street Railway Company in 1895, and is now operated electrically to accommodate the suburban traffic to and from Independence, a place of about 12,000 inhabitants, and to carry passengers to and from Fairmount Park—which is operated by the Fairmount Amusement Company, a corporation closely associated with the street railway company. The park, which was originally laid out by a steam railroad, covers about 250 acres, and is located about 10 miles from the center of the city.

The Independence line get its traffic from the Fifteenth Street line, from which it starts, and also from the Twelfth Street and Ninth Street cable lines, which it intersects. The rates charged are 15 cents for the round trip from the depot to the park, without transfers, making the total cost per round trip from any other part of the city 25 cents. Thirty-minute service is given regularly, with greater frequency on Sundays and holidays. Some twenty-five to twenty-eight 45-ft. cars of the type illustrated herewith are run to Fairmount Park, five more cars being in continuous operation to Independence. These cars are driven by G. E. 1200 or G. E. 57 motors, two per car. The park is equipped with the usual attractions—summer theater, boat house, bathing facilities, etc., which are leased by the Fairmount Amusement Company.

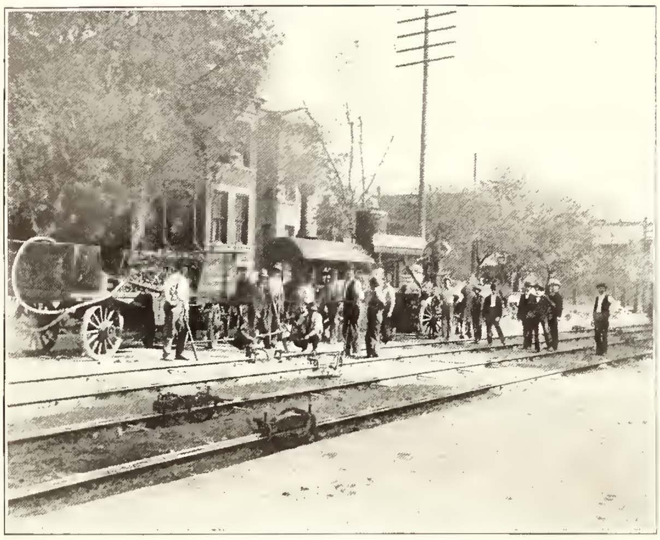
Another park also reached by this street railway system is Troost Park, which lies on the Vine Street line, and near the Troost Avenue line. This park is leased by the Kansas City Park Diversion Company, which is closely associated with the street railway company. The park, which is located about 3 miles from the center of the city, covers about forty acres. Music is furnished by an orchestra, and on account of the convenience and low cost of access to this park large crowds attend it on good days, requiring at times from forty to fifty cable trains to handle them.

TRACK CONSTRUCTION IN KANSAS CITY

Practically all of the tracks in Kansas City are laid with center-bearing rails—with the ball of the rail above the street level—the companies never having been compelled by city ordinance to use side-bearing rails. Some side-bearing rails have been put in, but have given trouble through tipping outward. All tracks recently laid are 103-lb. 60-ft. center-bearing girder rails, made by the Lorain Steel Company. In the asphalted streets of the downtown district the construction described by Mr. Butts at the Chicago convention, and illustrated on page 795 of the STREET RAILWAY JOURNAL for November, 1899, is used; the rails

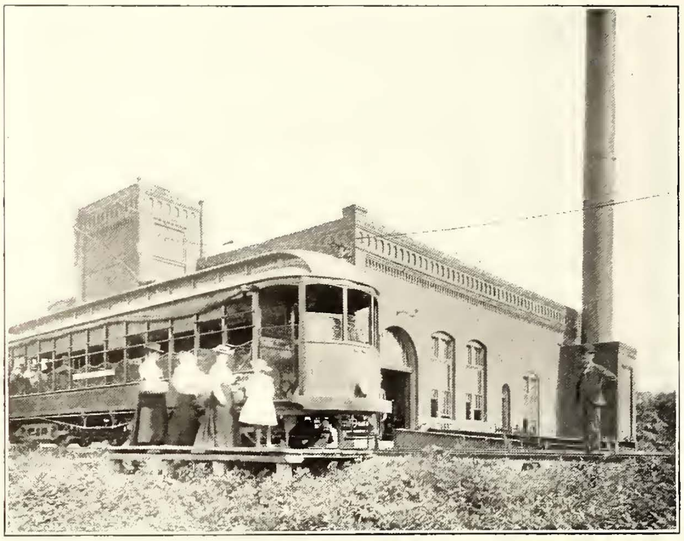
CABLE TRAIN ON TWELFTH STREET LINE

being bedded in a concrete stringer about 15 ins. deep from the top of the rail, and about 20 ins. wide over all. No ties or tie-rods whatever are used in streets which are asphalted from curb to curb, the rails being held to gage by the non-movable character of the street paving. Where the street is not asphalted outside of the tracks tie-rods are used to hold the rails to gage. It is claimed that this bedding of the rail in concrete considerably reduces the leakage of current from the rail to ground, and hence reduces danger of electrolysis of rails and underground piping. The construction is a simple one, a trench of the proper size for the concrete stringer being dug for each rail. The rail is then supported temporarily on wooden blocks, and the trench is filled with concrete, which is tamped tight about and under the rail. The rails are toothed on both sides with granite blocks to protect the pavement from wear. The company is obliged to pave between its rails and between its tracks, but is not obliged to pave any part of the street outside of its tracks. Brick paving is used between the tracks to a considerable extent, and in some cases between the rails, but at the latter place trouble is occasionally caused by frost raising the brick paving until it strikes the motors. All the cable lines are paved with stone. Where the concrete stringer construction described above is not used the various forms of track construction on wooden ties shown in the cut are made use of according to whether the pavement is of brick or asphalt.

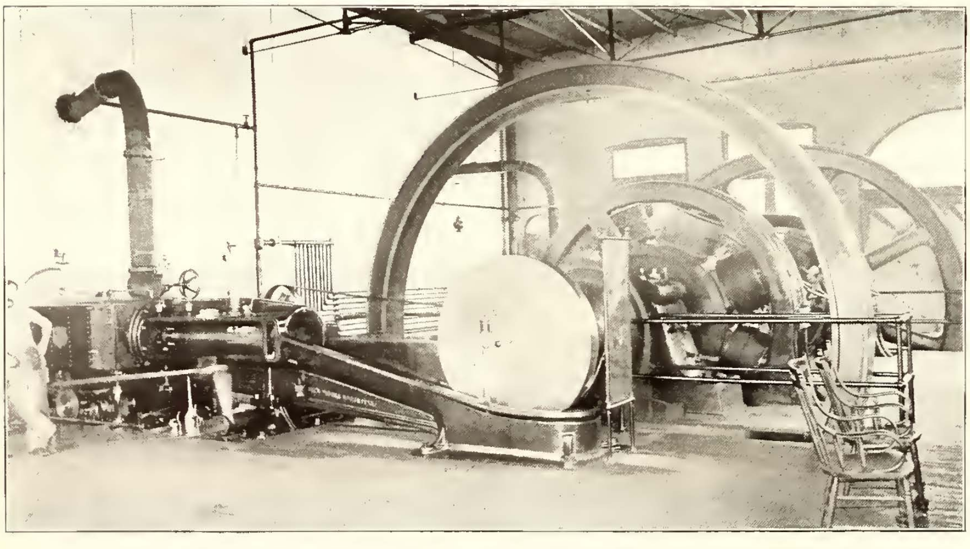


CAST-WELDING JOINTS

The joints throughout the entire system are to a large extent cast-welded, this work having been done by the Falk Company, which has also laid a large amount of track, and particularly of elaborate special work for the Metropolitan Street Railway Company during the last two or three years. Not only are the tracks of the electric lines and the cable lines, which have been converted into electric service, cast-welded, but cast-welds have also been put in on some of the cable lines where, of course, their electrical conductivity is of no value, the sole purpose being to preserve the joints. Cast-welds are not used on special work, which is all carefully bonded up to reduce the resistance of the return circuit. The North American Railway Construction Company has also done a large amount of cast welding and special work installing. The cast-welded joints have been found very satisfactory on the 6-in. and 9-in. sizes of rails, but have not been found satisfactory, owing to breakages, on the lighter $4\frac{1}{2}$-in. rails.



BLUE RIVER POWER STATION, INDEPENDENCE LINE



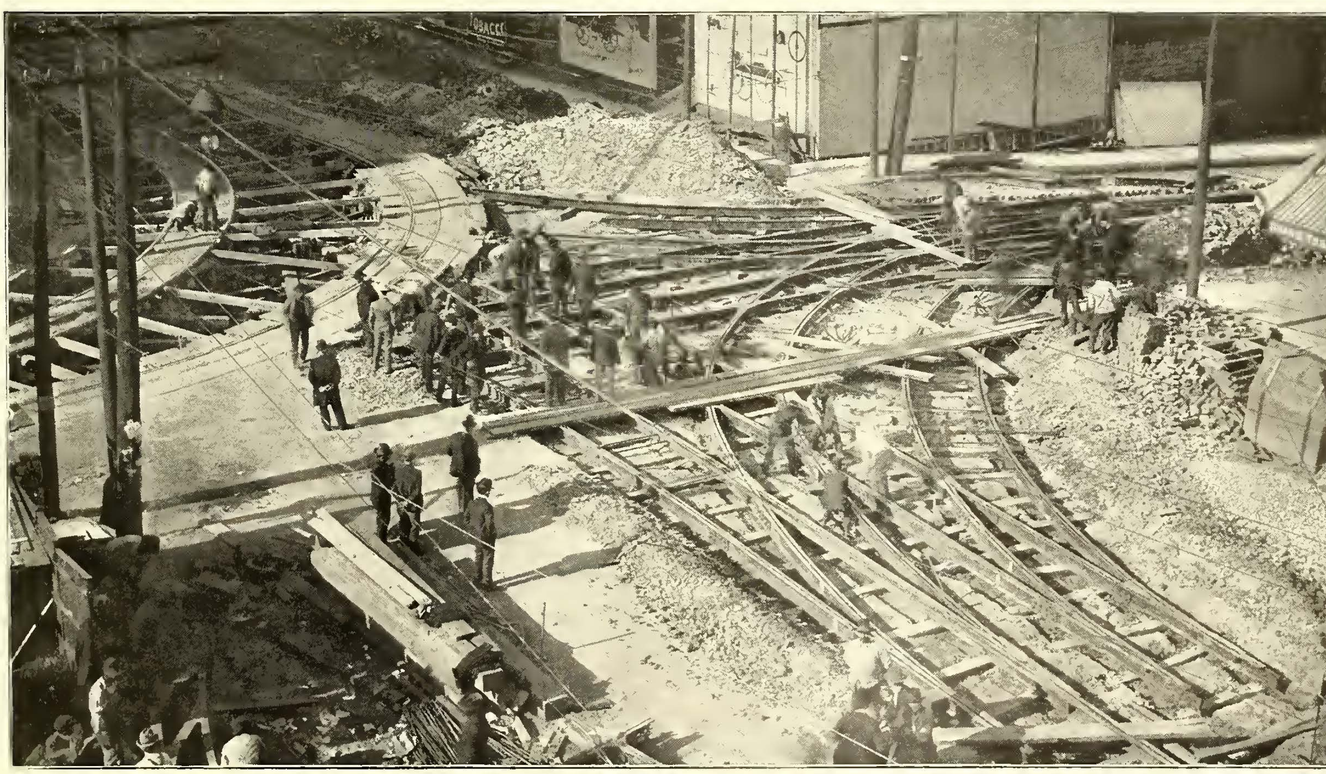
INTERIOR OF INDEPENDENCE STATION

In re-equipping some of the cable lines for electric cars the tie-rods holding the slot rails from closing have been cut, thus allowing the pavement to force the slot rails together and close the slot. It was found, however, that the slot rails do not always come together at the same level, one slipping under the other in some places, giving a bad surface. In the re-equipment of other lines the slots have been closed by filling the whole conduit with rock dust; this gradually settles and must be refilled several times, after which it leaves a firm foundation for paving in case at any time the slot rails are removed and the tracks repaved.

THE CARS AND CAR LICENSES

The company owns about 800 cars, about half cable and half electric of various types, shown in the group of different scenes herewith. These cars were made by the Stephenson Company, Laclede Car Company, St. Louis Car Company, American Car Company and Brownell Car Company, are mounted on Peckham, Brill and Dupont trucks, and are equipped throughout with General Electric motors. For possible, and an aisle has been cut through the center to give access to and from the platforms at a sacrifice of considerable seating space. The electric cars, almost all of which are closed, are provided with gates operated from the opposite platform, so that no one can enter or leave the

CONSTRUCTION WORK AT KANSAS CITY



LAYING A COMPLICATED DOUBLE-TRACK CURVE

the Westport line, which has an extremely long, heavy grade, the company recently ordered double-truck cars, each equipped with four G. E. 57 motors and with the Christensen air brake system, with independent motor-driven air pump. To avoid accidents the running-boards have been taken off from the sides of open cars as far as car until the motorman opens the gate on the rear platform, or after he closes it. While this causes some loss of time the reduction of the accident account is a great advantage.

For each of these cars the company is obliged to pay a license fee of $30 per year in Kansas City, Kan., as well as in Kansas City, Mo. Cars operating in both are obliged to have separate licenses for both, even in the case of those that simply cross the State line for a block or two at the end of their route. The road is obliged to put up in each car a separate license. Some 600 of these are taken out at the beginning of the year, and paid for at the rate of $20 apiece. At the end of the year the average daily run, on an eighteen-hour basis, is figured up and the cities are paid a sufficient amount over and above that paid for the original licenses to cover the average number of cars run at $30 per year. The total car hours per year on the system figure up equivalent to about 300 cars, eighteen hours, 365 days.

OVERHEAD CONSTRUCTION

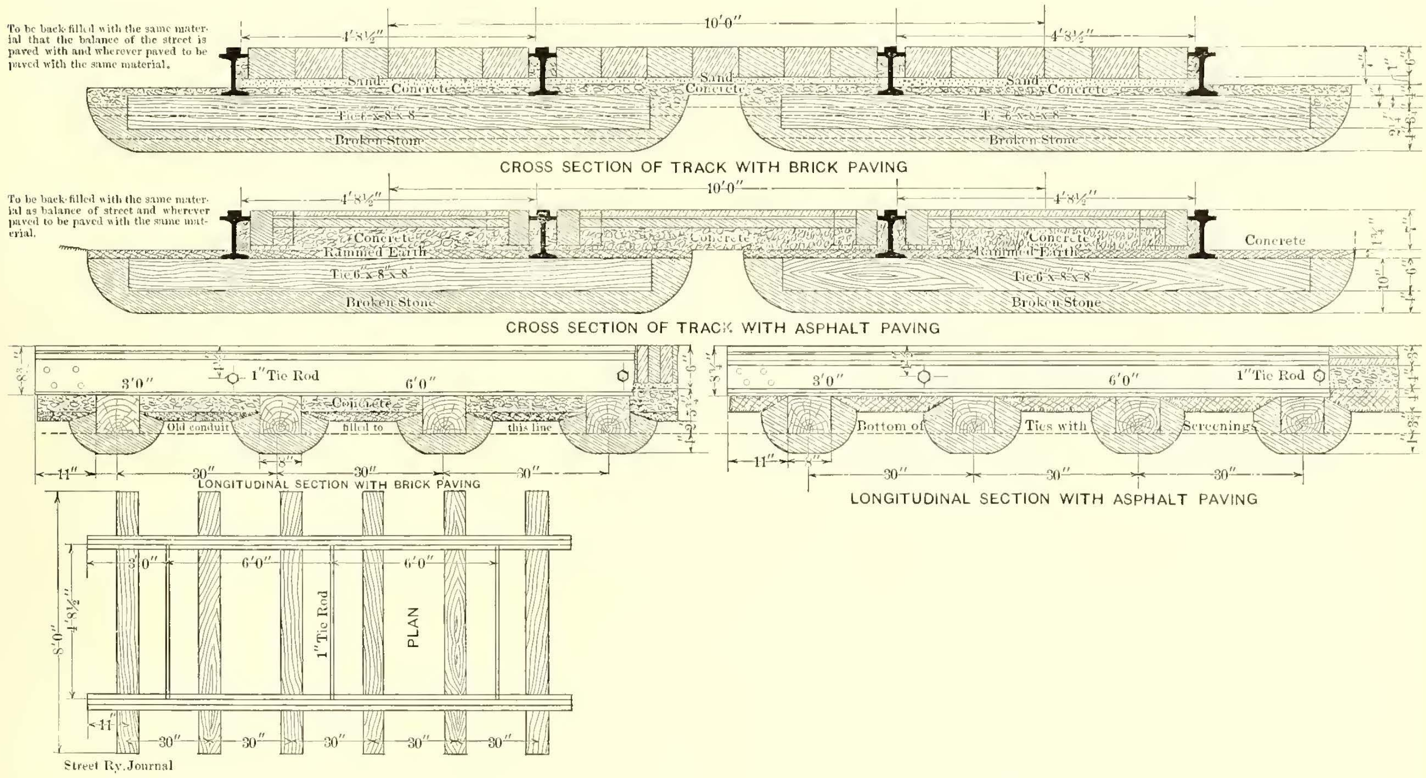
The methods used by the electrical department of the Metropolitan Street Railway for furnishing specifications for overhead lines and for keeping track of work already put in have some features differing from the practice of other roads, and will be of interest. This work is under the charge of Charles Grover, who is chief electrician of the Metropolitan Street Railway Company. Before any new construction work is done specifications are prepared for the entire route with drawings, showing the location and spacing of all poles, guys, section insulators, etc. If bids are asked on the work these plans form part of the specifications, and at any event they are the plans which the linemen follow for the work. All poles are 6 ins., 7 ins., 8 ins., and 31 ft. long, unless specified otherwise by a letter, which letter corresponds to some other kind of pole, as given in the side notes. The distance between each pole is given directly on the plan of the route. Blue prints of this kind for each section of the line are issued. One feature recently adopted is the drawing of a double circle for all poles not of the above dimensions, so that in glancing over the plans special poles are more easily distinguished. The feeders are indicated by a heavily dotted line on one side of the street and the distances on the other side. The explanations of all abbreviations used are to be found on one side of each blue print.

The insulated bolts used on this road are the same for both the trolley hangers and strain insulators, and are all interchangeable, so that only one kind is kept in stock. The copper data for the system, that is the location, length and size of conducting lines, both trolley and feed, are kept on another set of blue prints. These are in no sense maps, no attention being paid either to scale or direction, but the lines are indicated with notations, which refer to points on a large city map with which the different points on the sheet can be located. This avoids the necessity of elaborate care in drawing, with the accompanying expense, while it secures equally as exact results as a drawing to scale.

ELECTRIC LOCOMOTIVE

An electric locomotive is in use on the Independence line for hauling coal to the power station and for construction work. This locomotive was built in the Metropolitan shops, and has a number of features of interest, most prominent among which are the controllers, which are said to be the only ones in successful use to-day operating four motors in series, series-parallel or all in parallel without the use of any auxiliary commutating switch, and in the ordinary single revolution of the controller handle in acceleration. The four motors used are Edison No. 16, 30 hp. The controllers were designed by Charles Grover, the company's electrician, and were built in the shops. The motors are thrown four in series at first, then two in series, two in parallel and finally four in parallel. Four in parallel they run about 17 miles per hour. There are five series points, four series multiple points, and three multiple points. The controller is 44¾ ins. high, 22½ ins. wide at the back, and 11½ ins. deep. The cut-out switches throw the motors in multiple when one motor is cut out, and the controller is then only operated on five points when one motor is out. One of the strong points about the controller is the efficient magnetic blow-out. This is so strong in its action that it is not necessary to throw the controller entirely off before going from a higher point to a lower one, as there is little danger of starting an arc when passing from parallel to series. The blow-outs con-

ELECTRIC LOCOMOTIVE ON THE INDEPENDENCE LINE, DRAWING A TRAIN OF FREIGHT CARS sist of small, flat coils, located in the vulcanized fibre guards between the rings. These coils are made of a few turns of flat copper strip, wound in a 1-in. iron core. The axis of each coil is parallel to the controller shaft. This controller by its series combinations permits the hauling of heavy loads slowly with very little current, and at the same time good speeds can be made if desired. The locomotive, which is shown in the accompanying engraving, is hitched to standard steam cars, and hauls them wherever they may be needed for fuel or ballast on the Independence line. It is not uncommon for it to haul three loaded coal cars. It weighs 20 tons, is 34 ft. long over platforms, has 40-in. platforms, and the wheel base of each truck is 7 ft. 4 ins. It is used as a tower car, and inside the car is a tower that can be raised with a windlass. The company has found it very convenient in its construction work.



TRACK CONSTRUCTION ON TIES, USED ON EIGHTH STREET LINE

THE POWER HOUSES

For running the various cable lines there are several cable-driving stations scattered throughout the city. Some of these contain small electric generators, but practically all of the power for the electric lines is generated in the Kaw River power station in Kansas City, Kan. This station contains engines with an aggregate rated capacity of nearly 7000 hp, and is fitted with all the latest improvements, making it one of the most economical stations in the country, power being turned out at a cost of less than one-half cent per kw-hour. The building is a brick structure, with steel framework. The engine room is 144 ft. long and 63 ft. wide; the boiler room is 144 ft. long by 51 ft. wide, and the height of both is 33 ft. 7 ins. from the top of the foundations to the underside of the bottom chords of the roof trusses.

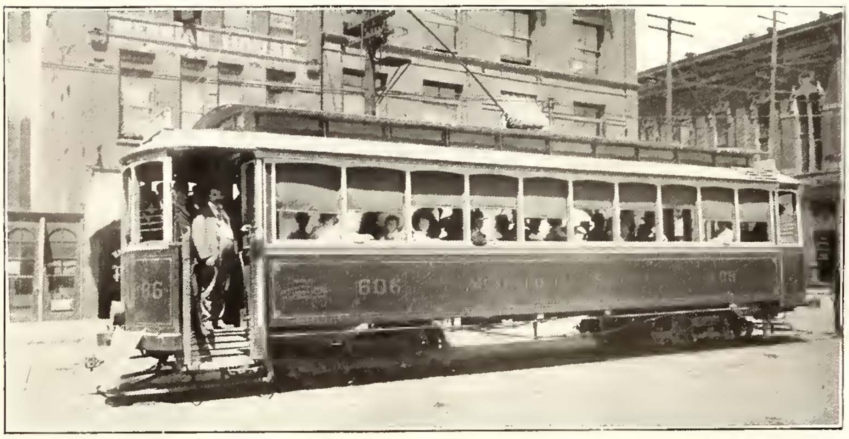
The boiler room contains both Babcock & Wilcox boilers, and Cahall boilers of the horizontal type, in batteries of 500 hp each. To these, four 500-hp boilers are soon to be added to bring the boiler capacity up to the power requirements of the engines. The boilers are fitted with B. & W and Green chain-grate stokers, which work very satisfactorily on the Cherokee slack, which is the fuel used in that part of the country, this fuel being mined a short distance south of Kansas City in Kansas. The steel stack of this station is 175 ft. high above the brick work. Coal is handled by means of a Hunt conveyor and cars into bins over the boiler room, with a capacity of 600 tons, from which bins it descends through chutes to the stokers.

The engine room, a view of which appears on the first page, contains four Allis-Corliss horizontal engines of various sizes and cylinder arrangements, some being tandem and some cross-compound. Two of these are direct-coupled to Walker generators, and two others to General Electric machines. The last of these four units was put in during the present year, and deserves more than passing notice, as it is one of the largest railway machines in the country. The engine is rated at 2500 hp, the generator being rated at 1600 kw, with a 40 per cent overload capacity for three hours' time. This engine has independent Allis air and circulating pumps, in this particular case the two machines being independent of each other. The engine exhausts into a Wheeler condenser with an effective surface of 5000 sq. ft. The shaft of this engine is of the hollow-forged fluid-compressed steel type; the fly wheeel is 24 ft. in diameter, with a weight of 160,000 lbs.

The switchboard of this station is double-decked, the feeder panels being put on the gallery. It is notable for the number of recording wattmeters in use, designed to give records of the amount of power used on the different lines, the lines being as a rule separately run on individual feeders, overhead copper not being cross-connected out on the lines. As this station supplies all of the electric lines with the exception of the Independence road, and as it is some distance from several of the roads on the Missouri side, a large amount of copper runs out from it, there being thirty feeders with a cross-section varying from 300,000 to 1,000,000 circ. mils.

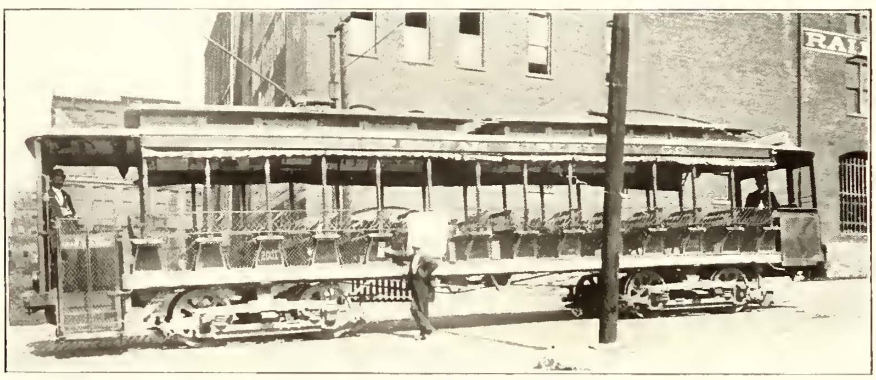
This station during the year 1899 turned out 5,608,000 kw-hours, burning 13,616 tons of coal, or 4.86 lbs. of coal per kw-hour. The coal burned usually is Cherokee slack.

The only electric power station outside of the Kaw River station is a comparatively small one on the Blue River at a point where the line to Fairmount Park and Independence crosses, this station running the Fairmount Park & Independence line only. This station contains a 250-kw and a 400-kw General Electric generator, direct-driven by simple, condensing Corliss engines. The boilers are of the horizontal tubular type, and manual stoking is used.

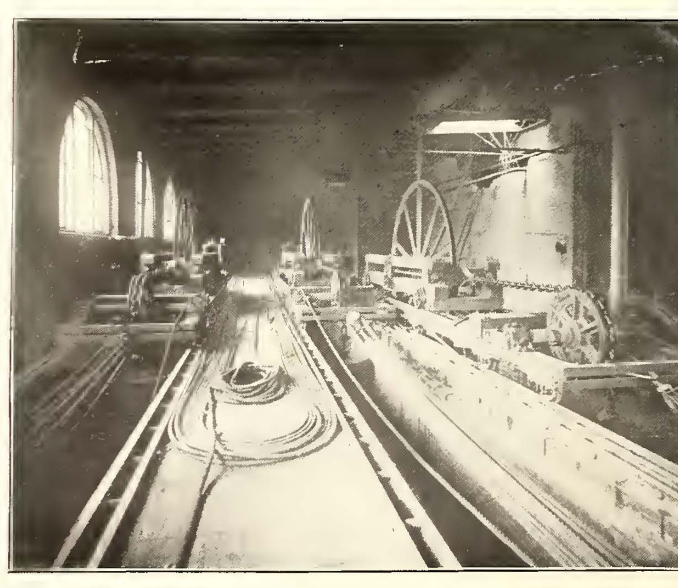


STANDARD DOUBLE-TRUCK CLOSED CAR

STANDARD SINGLE-TRUCK CAR



STANDARD DOUBLE-TRUCK OPEN CAR



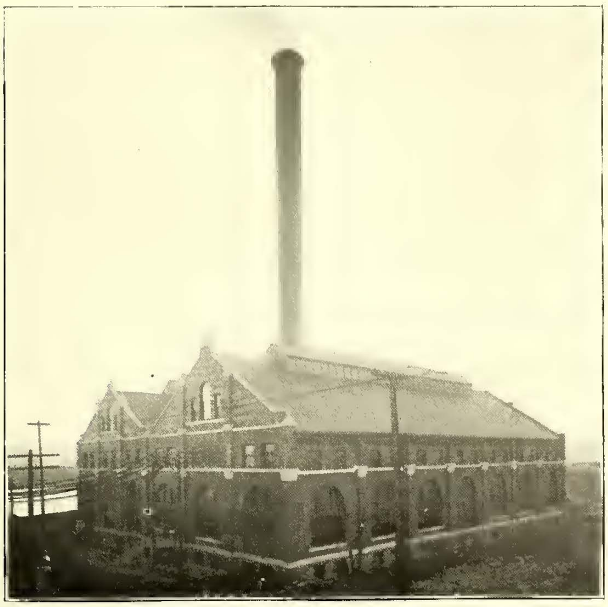
CABLE STATION AND TENSION RUNS, FIFTEENTH STREET AND GRAND AVENUE

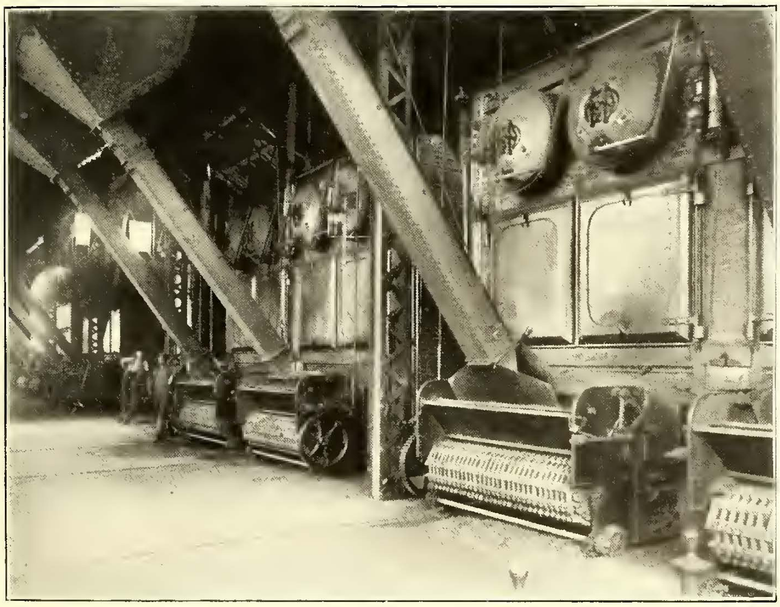
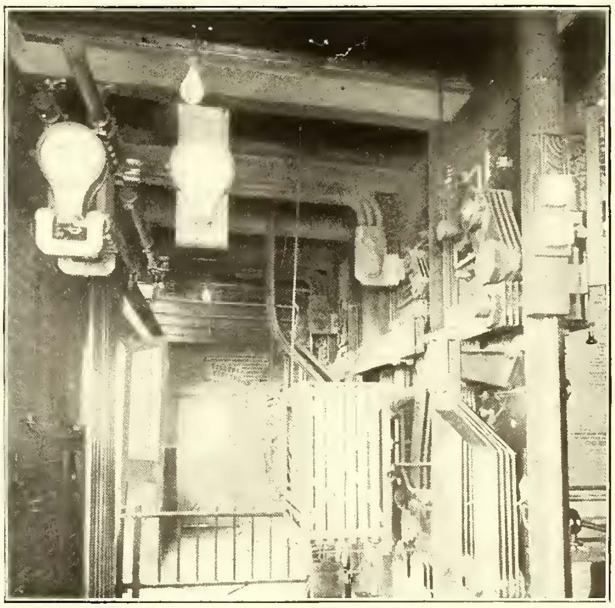
An interesting detail of the power stations is the motor-driven cable station, in which a 300-kw T. H. four-pole generator is used as a motor to drive 24,000 ft. of cable. About ten to sixteen trains are on this cable at one time, the line having one 10 per cent grade. The motor input varies from 200 amps. to 600 amps., running up to 800 amps. on heavy days. The motor is compound-wound, half of the original series coils being used for this purpose, the two coils on two opposite poles being cut in, the two other coils being cut out. The motor is started with a water rheostat. Complete duplicate motors, cable drivers and cables are provided on this line.

The cost of the cable system is considerable for renewals. The Ninth Street rope is 21,000 ft. long, and has to be renewed about every forty days, the ropes taken out from this line being used on more level and less heavily traveled routes, on which the cables will easily last from six to nine months. Before any of the cable lines were changed over to electric there were about 350,000 ft. of cable in use, which cost from $75,000 to $90,000 per year for ropes alone. The cables run at a speed of about 12 miles per hour, on some of the residential lines. The cable cars make a schedule of about 9 miles per hour, and the electric cars about 12 miles.

The cable road, whose power is now derived from an electric motor taking current from the main electric power station, is the Summit Street line. This line has a length of a little over 4 miles, measured as single track, and was formerly operated by a 24-in. x 48-in. Wright automatic cut-off engine. The power from the motor is transmitted to the original cable machinery by a belt 36 ins. wide, passing over a 34-in. pulley on the motor to a 24-ft. pulley on the cable machinery. The management of the company reports that the cable machinery has been operated more successfully and satisfactorily by the motor than it was by the engine, and with greatly reduced cost.

The rates paid gripmen, motormen and conductors in Kansas City are as follows: The men on the cable lines are paid 17 cents per hour during the first year, 18 cents during the second year, 19 cents during the third, fourth and fifth years, and 20 cents after that period of service. On the more important electric lines the men are paid just one cent less for the several different periods; on the smaller and less traveled electric lines 2 cents less.



VIEWS OF THE KAW RIVER POWER STATION

COST OF STATION OPERATION

Owing to the operation by the company of two stations with dissimilar equipment the opportunities for studying the economical production of electric railway power, under different conditions, are unusually good in Kansas City. The Kaw River, or Central Avenue station, has a national reputation as being one of the most economical in cost of power production of any in the country. The figures from this plant for the first seven months of 1900 show that the average total cost of power, exclusive of interest, taxes and insurance, was $.0041 per kw-hour for this period. The cost of coal runs about $1.20 per ton. The load was usually carried by two 1200-kw units, with a 550 kw to take the owl car load. At the present writing eleven men run the plant twenty-four hours.

The figures from the Blue River station show that the average total cost of power, exclusive of interest, taxes and insurance, for the first seven months of 1900 was $.0079 per kw-hour. This is not quite double that of the Central Avenue station. At first thought this might be credited entirely to the labor-saving appliances in the Central Avenue station boiler room, but the difference is not entirely there; in fact the difference in fuel consumption per kw-hour in the two plants is almost as great in proportion as the difference in total power cost per kw-hour. The differences in the equipment of the two stations, which are accountable for the differences in cost of power, are as follows: Large as against small direct-connected units, compound-condensing as against simple condensing engines, water-tube as against tubular horizontal boilers, and mechanical as against manual stoking. The comparison is especially valuable because both stations are owned by the same company, and operated in the same manner. It is also of much interest as throwing light on a problem many electric railway engineers have to face these days, namely, whether the economies of a large station and large units, as compared to a number of smaller stations with smaller units, is sufficient to warrant putting in a polyphase high-tension distribution system. The Blue River plant is a well equipped and modern plant, as stations of that size run. The conclusion that must be reached after comparing the efficiencies of the two plants in dollars and cents is that there is considerably more difference between the economy of well equipped large and small stations than has heretofore been generally thought. The object lesson in economical power generation furnished by the Central Avenue plant has been made good use of in Kansas City, as the Kansas City Electric Light Company, which is controlled by prominent stockholders in the Metropolitan Street Railway Company, will probably soon build a large central generating plant on some good river location, and distribute by polyphase high-tension currents to sub-stations. A similar plan has been talked of from time to time for the street railway, and it is not unlikely that it will ultimately be carried out for distribution to lines not economically supplied by the Central Avenue direct-current station. Charles Grover, chief electrician of the Metropolitan Street Railway, has given the matter of polyphase distribution considerable attention, and calculates that the Central Avenue station is now supplying a larger area than economy would justify if a polyphase distribution were in effect. He believes that the present limit of economical feeding direct from the power house is located on the east at about Grand Avenue, and that all east of that point could more profitably be fed in some other way. The present electric plants in cable power houses are, of course, not very economical, and what little they furnish to supply the trolley lines could better be furnished by sub-stations located in the same buildings. The ultimate solution of the power distribution problem in Kansas City will be watched with interest.

The polyphase generating plant, when built, will be erected on the Blue River immediately adjacent to the site of the present power house at that point. It will contain several 25-cycle 6600-volt generators of 1500-kw or 2000-kw sizes; the details of this equipment not having been determined by the consulting engineers, Messrs. Pierce, Richardson & Neiler, at the time of writing this article. Two rotary-converter sub-stations for the traction system will be put in at the present cable stations of the railway company, one at Eighteenth and Olive Streets, and the other at Eighth and Woodland. These stations will lift off a large part of the Missouri load from the Kaw River station, cutting down greatly the amount of copper required for feeders, and, as described, will leave the Kaw River station to supply only loads on its own side of the city.

W. H. HOLMES

C. F. HOLMES

W. A. SATTERLEE

CAPITALIZATION

The authorized capital stock of the Metropolitan Street Railway Company is $8,500,000, of which $5,586,000 is outstanding. The company has issued $5,100,000 in 5 per cent bonds, and has guaranteed about $7,500,000 of bonds of underlying companies. The gross earnings for the past four years are as follows: 1896-97, $1,774,892; 1897-98, $1,949,605; 1898-99, $2,094,378; 1899-1900, $2,353,267.

The dividends have been 2 and 2½ per cent annually until 1899, when 1 per cent quarterly was paid. This has been increased during the present year to 1¼ per cent quarterly, or 5 per cent annually. It is now proposed to reorganize the financial affairs of the company in such a way as to provide for the proposed changes mentioned above, and without detriment to the present stockholders.

The heaviest owner of the Metropolitan Street Railway Company is P. D. Armour. The officers are: P. A. Valentine, chairman of the board of directors; W. H. Holmes, president; L. E. James, vice-president; C. F. Holmes, general manager; D. B. Holmes and Frank Hagerman, general counsel; W. A. Satterlee, general superintendent; D. W. Dozier, chief mechanical engineer; E. W. Butts, civil engineer; Charles Grover, electrical engineer; J. A. Harder, auditor, and J. W. G. Becker, master mechanic.

The directors of the company are: C. F. Morse, Wallace Pratt, C. F. Adams, P. A. Valentine, W. H. Holmes, L. E. James, Norman B. Ream and C. F. Holmes.

THE EAST SIDE ELECTRIC RAILWAY AND ITS PARK

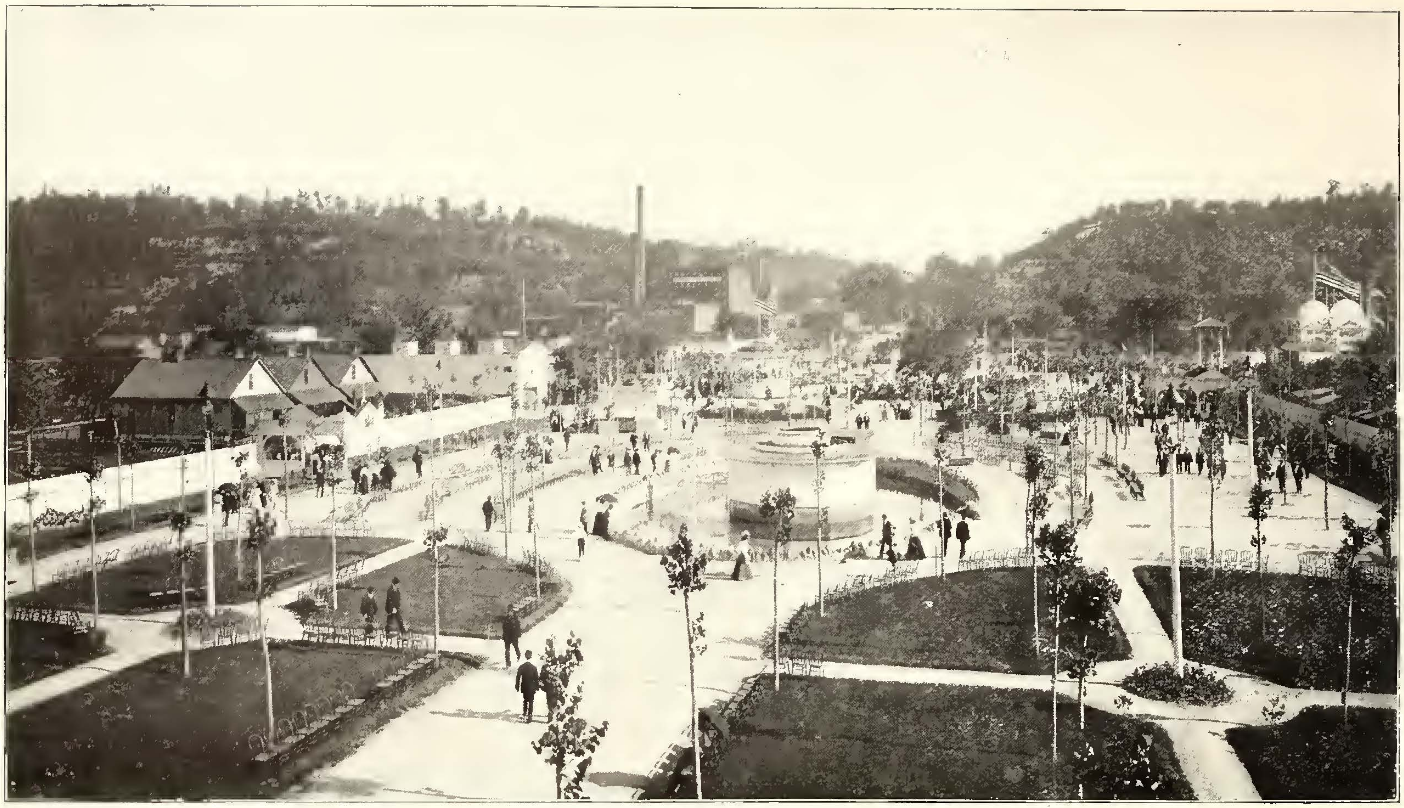
The only street railway line entirely in Kansas City and independent of the Metropolitan system, is that of the East Side Electric Railway Company, popularly known as the Heim line. The road was built by three brothers, familiarly known in Kansas City as Joe, Ferd and Mike Heim, the owners of a large brewery, to reach which was the primary object of building the line. The Heim brothers wished the Metropolitan company to build the line, but as the latter did not consider it a profitable extension, the brothers built it themselves. The line is 3 miles long, double track, and runs from the Market Square in a direction generally eastward along the low lands near the Missouri River. Extensions are now definitely planned which will make the line 7 miles in length, and further extensions are being considered for the future. The company has issued no bonds, and no stock to anyone outside of the owners mentioned above. The line is operated under a franchise running until 1925, calling for free transfers to the Metropolitan system, and requiring the same car license that is paid by that system, viz., $30 per car per year.

The construction of the line was commenced on June 22, 1899, and the cars were first run on Nov. 27. The track consists of Johnson 82-lb. rails, laid on ties 27 ins. between centers, bedded in concrete, which fills the space between and over the ties and over the foot of the rail. The joints were cast-welded by the Falk Company. The line owns fourteen cars, of which about ten are in use regularly. Six of these are very handsome, and are 40 ft. in length, with cross seats and smoking compartments. They were built by the St. Louis Car Company, and are driven by Westinghouse No. 49 motors, two per car. The remainder of the rolling stock is made up of single-truck open cars, designed for the heavy traffic to the park.

The power house of this line contains one unusually handsome and smooth working unit, consisting of a Siemens & Halske 200-kw generator, direct-coupled to a St. Louis-Corliss engine, running at 100 r. p. m. In addition there are two D 62s and two 110-volt lighting machines for illuminating the park. The 500-volt switchboard of the power house consists of an old T.-H. board, which has been remodeled, with back connections and instrument cases.

The park of this line, covering about twelve acres, is Kansas City's greatest summer-night attraction and vaudeville-entertainment resort. The theater, 140 ft. x 110 ft., with latticed walls, through which the breezes can blow, has a seating capacity for 3000 people, and a stage completely equipped with all desirable appliances for the vaudeville entertainments which are given with frequent change of bill, the theater being what is known in that part of the country as an Orpheum Circuit. Undoubtedly the greatest attraction of the park is the electrical spectacular fountain, built by C. A. Dunlap, of Providence, R. I., and equipped with the unique features of Dunlap fountains. These features are tableaus, dances, living pictures, etc., surrounded by a wall of jets of water. The characters taking part in the dances or other scenes are brought up from the base of the

VIEWS IN HEIM PARK



A GENERAL VIEW OF THE PARK

fountain to the field of view by means of an elevator with a glass platform, through which they may be illuminated by projectors from below. The jets forming the wall of spray about this little stage are all inclined outward, so that no water need strike the dancers. With the many possible changes of the figures produced by the jets and of the colors thrown into the water from below, as well as from projectors located in an operating cabin outside of the little pond around the fountain, the spectacle is an unusually beautiful one. The evening's display of this fountain is ended by sending up a fireworks frame on the elevator, the exploding fireworks being surrounded by a wall of illuminated spray. The park has the other usual features of resorts of this class, including a cinematograph, a band stand, bowling alleys, a billiard hall, etc. The whole is brilliantly lighted by current from the neighboring power plant of the line, 500 volts being used for the outdoor lighting and 110 volts for the theater lighting. A large number of Adams-Bagnall enclosed arc lamps are used, supplemented with incandescent lamps to trace out the architectural features of the buildings, and to illuminate some handsome shade trees, making them resemble by night enormous Christmas trees. An admission of 10 cents is charged to the park, seats in the theater costing 10, 20 and 30 cents extra.

The president of the East Side Electric Railway Company is J. J. Heim. The management and operation of the road are entirely in the hands of W. O. Hands, who constitutes the entire staff of active officers of this small line.

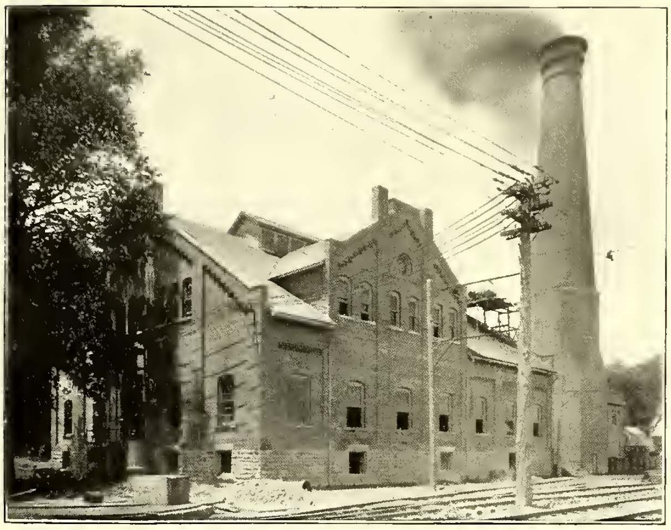
INTERIOR OF CLOSED CAR

CAR HOUSE

THE KANSAS CITY-LEAVENWORTH LINE

The only interurban line running out of Kansas City is that of the Kansas City-Leavenworth Electric Railway Company, which runs in a direction generally northward and parallel with the Missouri River to the city of Leavenworth, Kan. This place, which has a population of 25,000 inhabitants, is 26 miles from Kansas City. The district through which the road runs is a highly cultivated farming country with no intermediate towns of importance with the exception of one named Wolcott, in honor of some of the gentlemen associated with the road, at which place are located the power station, car houses, shops, offices, etc., of the line. The road has been in operation but a short time; its construction was commenced in April, 1899, and regular service was started in January of this year. The line is single track, runs almost entirely on its own right of way, and its rails and special work are of standard steam railroad form, so that the wide tread and deep flange of steam railroad wheels can be used, making possible unusually high-speed service.

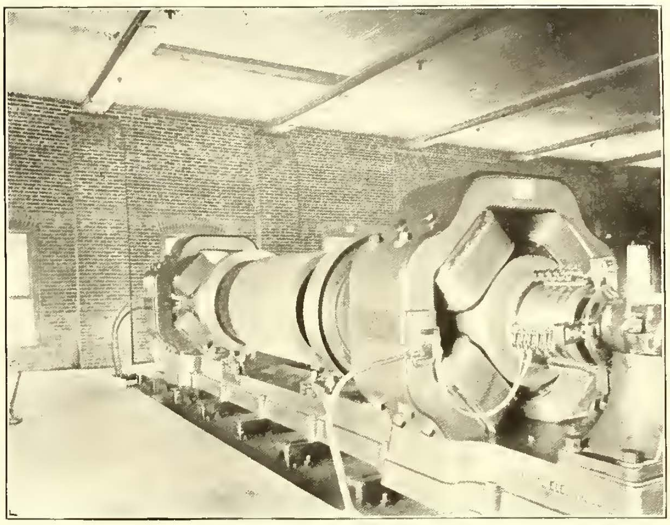
The road at present starts from Grand View, a point in



EXTERIOR OF KANSAS CITY & LEAVENWORTH STATION AT WOLCOTT

Kansas City, Kan., about 3 miles from the business center, reached by one of the branches from the elevated line of the Metropolitan Street Railway Company, but the interurban line has obtained a franchise to run down further into Kansas City, Kan., nearer the center of the city. In Leavenworth the road is associated with the local street railway company, and runs over its lines to the center of the city. The road winds in and out among the hills with many curves, but is, as a rule, fairly level, although there are some 4 or 5 per cent grades. The track construction consists of Johnson 61-lb. T-rails, on selected white oak ties, laid 2 ft. between centers on rock ballast 12 ins. deep. The company has its own motor-driven rock crusher, shown in one cut, for preparing its ballast. Spring switches and frogs are used in the turnouts, so that the cars can run through them at high speed. The rails are fastened together with American rail-joints, covering Atkinson protected bonds. Two 000 Fig. 8 trolley wires are used, suspended from brackets.

Practically the whole line is supplied with power from one generating station at Wolcott, Kan., about 12 miles from either end. At Leavenworth the line is electrically connected with the power house of the Leavenworth system, but the Wolcott station, 12 miles away, feeds the Leavenworth lines more than the Leavenworth power house feeds the interurban line. On account of the long distances over which current is distributed a large cross



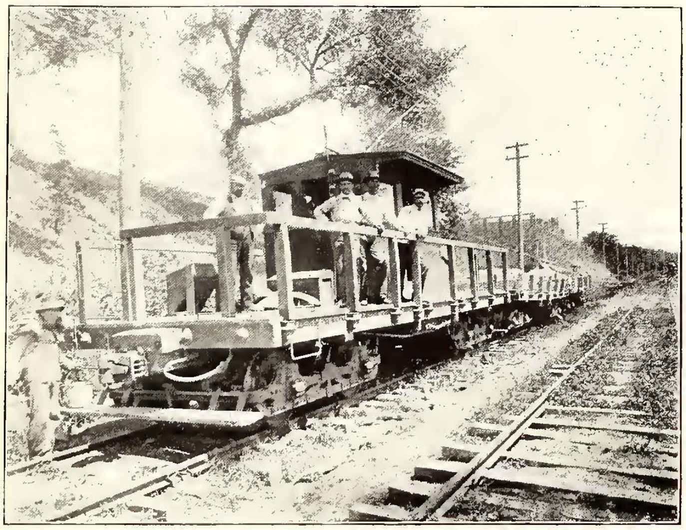
INTERIOR OF KANSAS CITY & LEAVENWORTH RAILWAY POWER STATION

section of feeders is necessary. These are of bare aluminum, with a cross section of 362,000 circ. mils. Nine of these feeders run out from the power house for various distances along the line, six in one direction and three in the other.

Through service from Kansas City to Leavenworth is given every hour on week days and every half hour on Sundays, the schedule time of covering the 25 miles between the two cities, with about fifteen regular stops, being one hour and fifteen minutes; this requires three cars on week days and six to eight on Sundays. The rates charged are 50 cents between the two cities in one direc-

KANSAS CITY & LEAVENWORTH SHOPS

tion, and 75 cents for the round trip, with local fares in proportion. A lower rate is made to inmates of the Soldiers' Home, near which the line passes, as well as to clergymen, sisters of charity and members of the Salvation Army. A newsboy distributes ice water and sells fruit and other commodities in the cars after the fashion common on steam railroad trains. There is considerable competition with the steam railroads, of which four run between Kansas City and Leavenworth, the Missouri Pacific Railway being the most active competitor, with seven trains each way per day, making the run in about fifty minutes, and charging $1 per round trip.



ELECTRIC LOCOMOTIVE AND CONSTRUCTION TRAIN

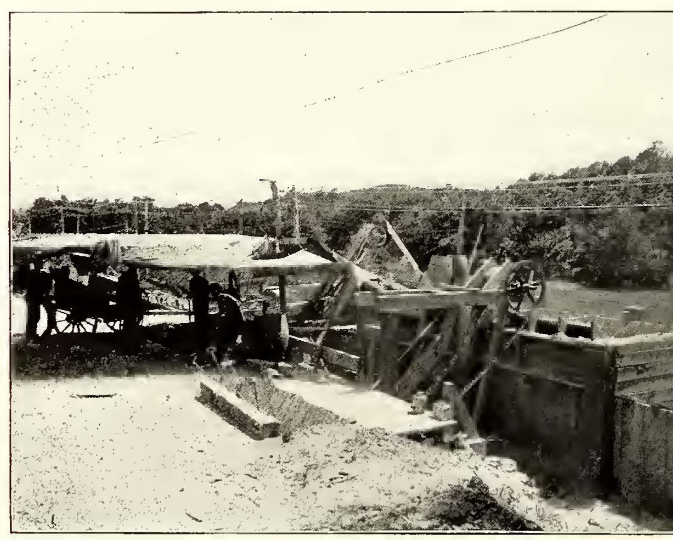
The ten cars constituting the rolling stock of this line—made by the American Car Company—are of the style shown below. They are 41 ft. long, with an unusually wide body, about 9 ft. over all, giving ample room for cross seats. All have smoking compartments, and some of them have baggage rooms. The weight is 22 tons each. They are driven by Steel 50-hp motors, four per car, geared up to a speed of 45 miles per hour. The motors are controlled by one Steel No. 44 controller per car, the cars being single-ended, and running around a Y at each end of the route. The cars are equipped with the Magann storage air-brake system, which is remarkably successful, considering the length of the run and the consequent

INTERURBAN CAR

length of time between re-charges. The air is compressed in the power station at the middle of the line by an Ingersoll-Sergeant air compressor to a pressure of 300 lbs. per square inch, and the storage tanks on each car have sufficient volume to carry the car two complete round trips, aggregating 100 miles. The air passes through a reducing valve before reaching the brake cylinders, so that it is impossible to apply full storage-tank pressure to the cylinders. This valve is set to give 45 lbs. per square inch.

The company also operates an electric locomotive with the same equipment of four 50-hp motors, geared down to 20 miles per hour. This locomotive hauls coal and ballast, and handles the work train. On holidays the road gets a rush of pleasure traffic, owing to the agreeable nature of the ride upon it over the picturesque rolling and farming country through which it runs. This heavy traffic is handled by means of some cattle cars which the company has converted to passenger uses, these cars being drawn by the electric locomotive. A park is to be built on several hundred acres of land owned by the company at Wolcott to accommodate and attract more of this excursion traffic. The company also owns a steam locomotive, which was used for construction work, and which appears in the accompanying illustration.

The power station at Wolcott is the substantial-appearing brick building shown herewith. A noticeable feature of the exterior of the station is the stocky chimney, which



STONE QUARRY AND CRUSHER

is unusually large in girth and heavily tapered for its height of 140 ft., so as to resist the high winds and cyclones common in this part of the country. The station contains four Stirling boilers, one Hamilton-Corliss single-cylinder engine, belted to two 300-kw General Electric four-polars set up in line with each other, and connected by clutch couplings to the central pulley. This equipment will necessarily be increased as the traffic grows, and on account of the length of the lines polyphase apparatus will probably be put in. The power station is of sufficient size to accommodate large extensions.

The line was built by the Cleveland Contracting Company, of Cleveland, Ohio, which company is interested in several interurban electric railway properties in different parts of the country, among them the Tiffin-Fostoria line, the Hamilton-Cincinnati line, and others. The officers of the Kansas City-Leavenworth Railway Company are: President, D. H. Kimberley; vice-president, W. H. Gabriel; secretary, C. O. Evarts, all of the Produce Exchange Bank, of Cleveland, Ohio. The general manager of the road is H. W. Wolcott, of Wolcott, Kan.

ELECTRIC RAILWAY PRACTICE IN FRANCE

BY A. N. CONNETT

The transformation from animal to mechanical traction of the street railways in France is an accomplished fact, or at least will be when the work now in progress is finished. The exceptions to this broad statement are the cities of Toulouse and of Paris. In the former city the reason is entirely local, and will probably soon disappear. In Paris much has to be done, and very important transformations are on the eve of being terminated. But even then much will remain to be done in Paris to give a first-class service. This transformation has been mostly electric. Other methods such as stored steam, compressed air, the Serpollet boiler, and even one feeble little single track cable road are in use, and these systems have their advocates. But here, as elsewhere, it is the trolley wire which has made this general transformation possible.

Municipal ownership and operation of tramways is as yet unknown in France. This may come in some form or other when existing franchises expire, and the properties revert to the State or the municipalities, as the case may be, this being a universal franchise condition. But it is more than probable that other arrangements will be made in the majority of cases. At least the tendency in France, at this moment, for concessions about to expire seems to be to prolong them, the companies making important concessions in the way of lowering their tariff and extensions during the period yet to elapse under their original agreement.

The taxes are not overburdensome. They appear in many different forms, payable both to the State and the municipality. For example, the municipal taxes paid by the Omnibus Company of Paris—the most important tramway company in France—are under eight different heads, and aggregate 7.6 per cent of the gross receipts—the State taxes under six heads aggregating 2.7 per cent of the gross receipts—the total being 10.3 per cent. Tramway companies in the provinces are not so heavily taxed—due to the fact that taxation is heavier in Paris than elsewhere. The length of franchises varies between one hundred years and thirty years, and there is no fixed law or rule regulating them. In general the practice is this: If the concession is one involving a heavy expenditure and probable light receipts a long time is given before expiration, so that the investment may be liquidated in a way not to be so onerous to the investors that the enterprise would be financially impossible.

Track construction differs very much in the substructure. Many lines have been and still are constructed by laying the rails directly on the earth with no prepared foundations. The rails are simply held to gage by tie-rods. The motion of the cars with any speed is bad from such an uneven track, and the joint problem, unsatisfactory enough at the best, is aggravated. This primitive method of construction is disappearing, as the results of experience are beginning to be more and more evident. The track foundation when now made is usually concrete. When the requirements of paving demand a concrete base the rails are laid upon it. When wooden permanent way is used, the concrete usually extends above the base of the rail, so that it is solidly embedded in the concrete. The disadvantages of this are evident, but it has one thing in its favor, viz., that the rails are better able to resist the enormous pressure due to the swelling of the wood. In the case of tracks on the side of the road, or "sur accotement," as it is called, the type of track is T-rail, laid upon wooden ties with gravel ballast.

The first type of rails used in France for horse cars was a rather peculiar form of the "strap" rail. This is called the "American rail." Other types were introduced with mechanical and electrical traction. There are now three forms in general use.

1. T-rails, which differ but little from American sections. Spikes are usually replaced by lag screws, and the rails are laid slightly inclined inward. Fig. 1 shows a typical rail section with fastening to the tie, and Fig. 2 gives a good example of cross section of the track. There is quite an extensive mileage of track so laid for tramways in France, because the authorities prefer to put the tracks to one side of the road by themselves whenever the width of the roadway will permit.

2. Double or "Marsillon" rails as they are called. Fig. 3 shows views of this rail with its cast-iron chair and the

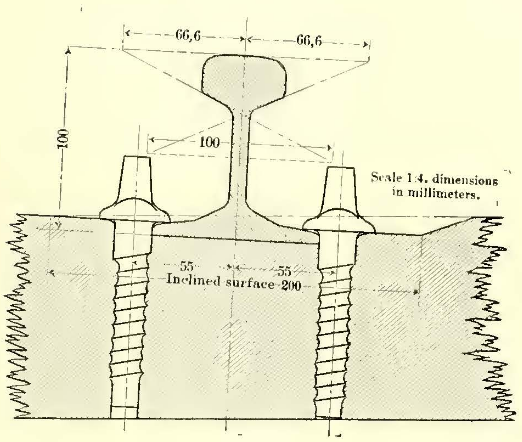


FIG. 1.—TYPICAL FRENCH T-RAIL SECTION

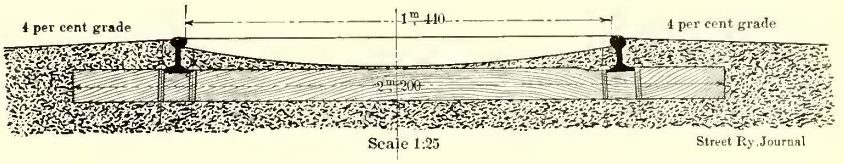


FIG. 2.—A TYPICAL CROSS SECTION OF T-RAIL TRACK

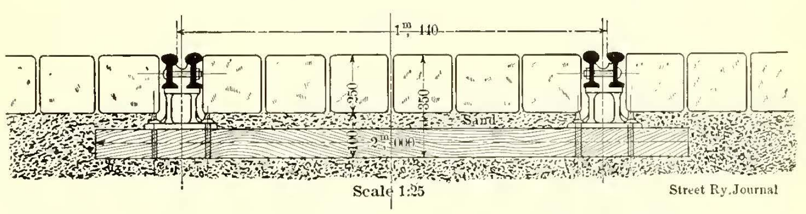


FIG. 4.—CROSS SECTION OF TRACK LAID WITH MARSILLON RAILS

method of fastening. Fig. 4 shows a cross section of the track with ties, and paved with Belgian block. In Paris, where shallow wooden blocks are used, resting directly on a concrete foundation, the chairs are omitted—the filler block being simply used with a plate under the bases of the rails. The rails are anchored by special dogs to the concrete base to keep them in position. This construction has little to recommend it. It is evident that the metal used is badly distributed to give good results and a long life. It has the convenience of being able to separate the rails on a curve, so as to give without any special rail a wider groove, and also that the grooves do not pack hard with

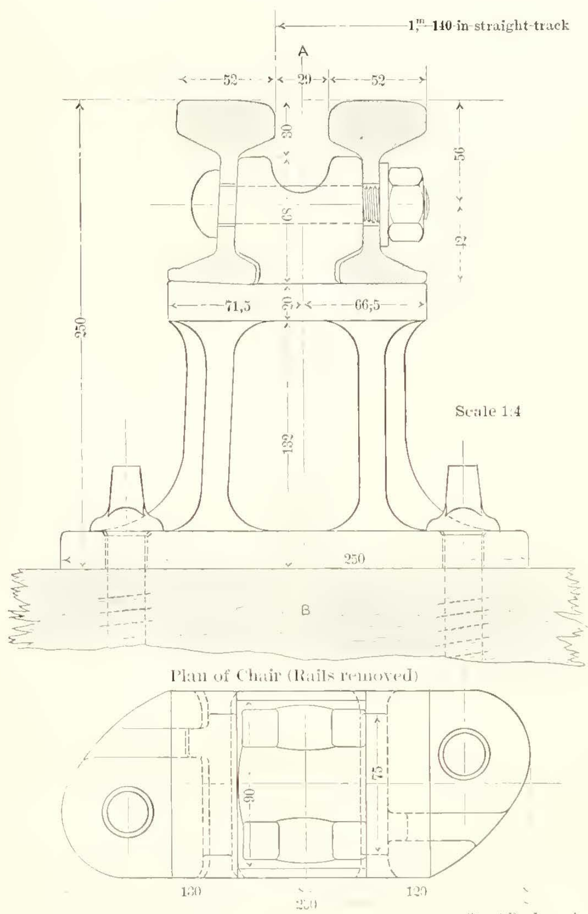


FIG. 3.—SECTION OF MARSILLON RAIL AND CHAIR

dirt, as with the ordinary grooved rail. Actual trials are said to have given lower traction coefficients with this rail. This form of rail is rapidly disappearing, and before many years it will probably be completely replaced by other types.

3. Girder rails are all of the full-grooved type, nothing else being permitted. Most of those in use are of French manufacture. Fig. 5 gives the sections of the principal types of girder rails rolled by the two mills in France which have taken up their manufacture. The first one shown is called the "T-H" section, and for this Fig. 6 shows the splice bars, and Fig. 7 the tie-rods. Fig. 8 shows the two rails tied together. It will be observed that this construction of tie-rod, while a very good one, requires that they should be made very accurately to the required length, so as to keep the track properly gaged. Fig. 9 shows the spacing of the tie-rods, and the manner of making the joints in practice. Rail specifications are very long, but on examining them carefully it is difficult to understand why they should be so voluminous. Great attention is given to cutting to length and to the drilling of the rails, and to the limiting variations which will be permitted from the specified dimensions. The carbon is seldom specified, but in its place is the resistance of the metal in tension. Some years ago the mills gave from 50 to 55 kilos. per square millimeter as the extreme limits, but these rails were much too soft, and they wear down in use very rapidly. But now under a little pressure the manufacturers are accepting 65 to 70 kilos., and even to 75 kilos. These rails are very satisfactory.

Fig. 10 is a cross section of the early track construction, with the rails laid directly on the earth or on a prepared

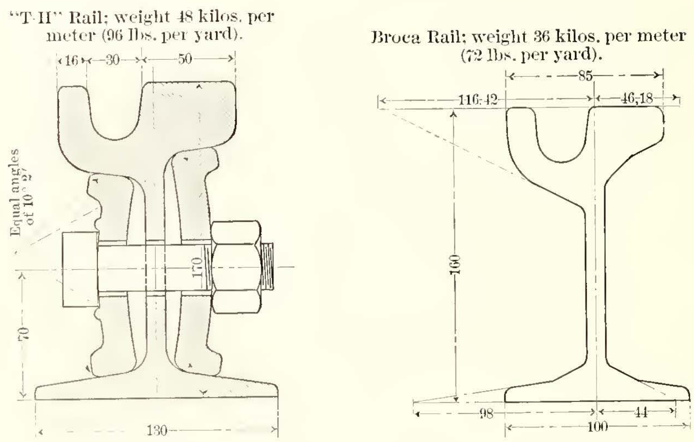


FIG. 5.—SECTIONS OF PRINCIPAL TYPES OF GIRDER RAILS ROLLED IN FRANCE

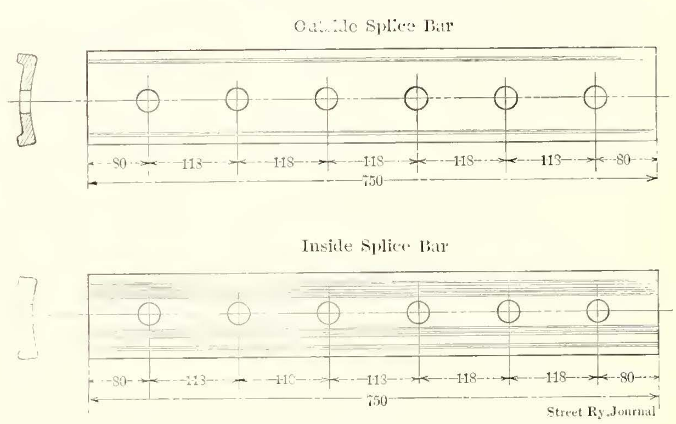


FIG. 6.—SPLICE BARS FOR T-H RAIL

bed of sand or gravel. As has been said before, this mode of track laying is rapidly disappearing. Concrete being cheap and wood dear, the former is used almost exclusively for rail foundations in paved streets. Fig. 11 shows cross sections of tracks adopted by one of the large tramway companies of Paris, one with wooden pavement and the other with Belgian block. Fig. 12 gives cross section of track adopted in one of the large cities. The bed of sand under the concrete stringers was a drawing requirement of the city engineer, but in actual construction it was naturally omitted.

The joint problem is forcing itself into attention now that the tracks of the earlier roads are going to pieces. The rail sections were very badly designed for good splicing, and the bars themselves were short, with four holes and small bolts. Naturally the conditions were the best possible for low joints, but attention is being given to this matter, and the later rail sections have been much improved, while the splice bars are usually the six-bolt type, with heavy bolts. Patented mechanical joints have not been introduced as yet. The "cast-welded" joint has been quite largely used. Where it has been used on an old track with a weak rail, such as the light "Marsillon" rail, it has given poor results, the track being stiff at the joints and very flexible between. In consequence the motion of the cars was bad, and the noise due to the pounding at the stiff joint was even accentuated over what it had been before. But with heavy girder rails these joints have given so far good results, and they are favorably regarded, not only for new tracks but also to save old ones.

Special track work in general is of a primitive character. This is a natural consequence of the conditions here. In the United States, as it is well known, there are splendidly equipped shops, which are often separate departments of a large rolling mill and steel works, and these shops, managed by practical and trained engineers, make nothing but street railway special work. The need of something better than ordinary "built-up" work became evident, and by a natural process it was soon forthcoming. In France it is the engineer of the railway company who must take the initiative in designing the special work, with the fact before him that if he gets up something very different from the ordinary shop practice he will get nobody to undertake to make it except on such onerous terms as to make it impossible. Therefore there is no incentive to try to adopt good methods in special work, and the best one can do is to be content with "built-up" work. This is often made in the field—the rails being cut, drilled and spliced together with usually a good heavy sole plate riveted to the frog.

The switches are made of rails assembled together; the tongue is straight on both of its sides. Fig. 13 shows one of the switches. Some cast-steel switches have been made here, and their use will become general probably in the near future. Curved rails are made on the ground with ordinary hand rail benders. The men are skilful at this work, and it is a cheap and efficacious way of making them. Rail bonds are generally of the standard American types, and there is nothing here novel about the bonds or methods of placing them. Track with cast-welded joints is not bonded at the joint, but the rails and tracks are frequently cross-bonded.

Overhead pole lines are much neater looking in France than in America. This comes from the fact that all work is treated from an æsthetic as well as from an utilitarian point of view, while in America the former is usually so subordinate to the latter that in actual results it is not visible. Trolley wire suspended in any way whatever in a public street cannot from the very nature of things be ornamental. The writer finds it difficult to say in just what the overhead wires differ in appearance from those put up in

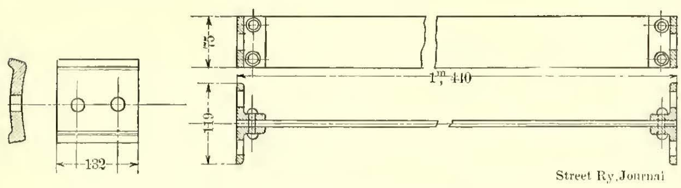


FIG. 7.—TIE RODS FOR T-H RAIL

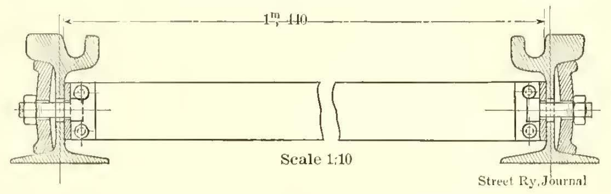


FIG. 8.—METHOD OF TYING

Track of 1 meter gauge, laid with Broca rail 36 kilos. per meter (72 lbs. per yard).

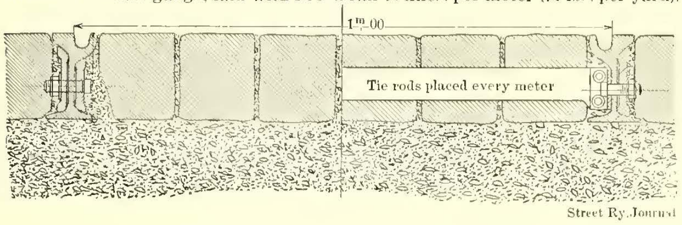


FIG. 10.—CROSS SECTION OF EARLY TRACK CONSTRUCTION

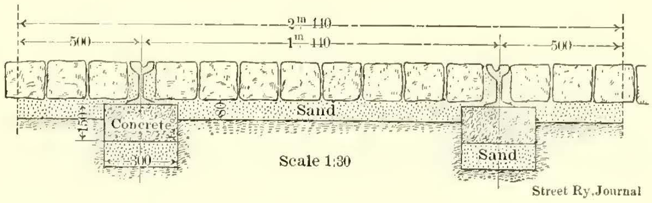


FIG. 12.—CROSS SECTION OF TRACK FOR CITY SERVICE

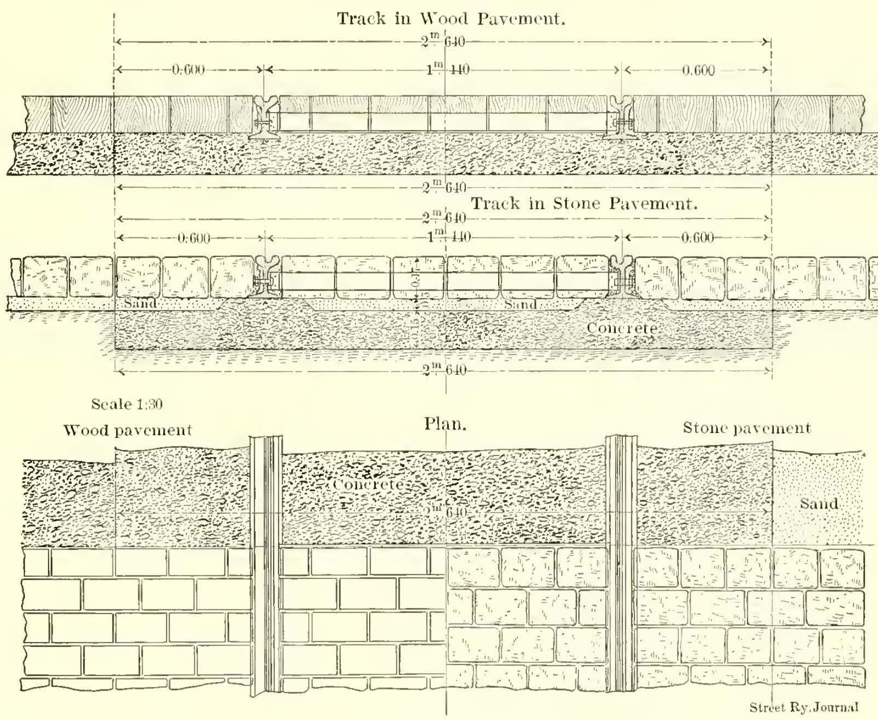


FIG. 11.—CROSS SECTIONS OF TRACK USED BY A PARIS TRAMWAY

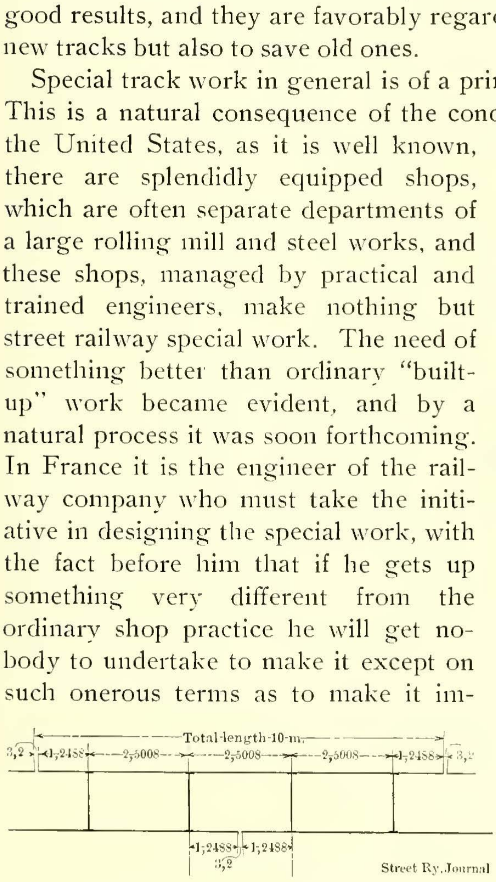


FIG. 9.—SPACING OF TIE RODS

America. The appliances are practically the same—line material which is made here being similar in material and

FIG. 14.—CENTER POLE CONSTRUCTION ON AVE. DUMESNIL, PARIS

form to American models. The difference in appearance must come then from the greater care taken in installing the lines not to shock the eye. But the greatest difference is in the poles. The bare poles themselves are the same in both cases, but they are decorated in French city practice so that they are in reality ornamental, and not an eyesore in the street perspective. Overhead feeders are nowhere permitted, and this one thing robs the overhead line of its most hideous feature, and makes the designing of an attractive pole a much simpler problem. The universal addition of ornamental cast-iron bases is also to be commended. These are often designed to be in harmony with the ornamental gas or electric light poles which may exist. Much interest is taken by the municipal authorities in this question, and sample poles have to be sometimes made (the ornamental bases being plaster models), and then put up in the street to see what the effect will be. The construction is often retarded in an annoying way, but in the end this extreme care is beneficial to all concerned. Where the street is wide enough, a center pole construction is usually adopted. About the pole a space is curbed and reserved for the use of pedestrians. These are called "refuges," a most appropriate name. They serve to direct vehicular traffic, and to make the crossing of a street a much easier operation than otherwise. The poles, with ornamental bases and handsome filagree brackets for the trolley wire supports, can also serve for electric or gas lamps. This construction is a most excellent one from every point of view, including the appearance of the street. It is difficult to understand why it is not more generally adopted on wide streets in America.

Fig. 14 shows a center-pole construction on the Avenue Dumesnil, in Paris, on the line of the Bastille-Charenton road. This is the only trolley line which has been permitted inside of the fortifications of Paris. The pole line is very fine in appearance. It shows what can be done to render poles unobjectionable in a public street. Fig. 15 gives the drawing of this pole, with the addition of two incandescent lamps, these being arranged for future application. Fig. 16 shows a center-pole construction in a provincial city. In this case the base is much less ornamental. The brackets are quite different, also due to the fact that this is a center trolley construction, while in the former case it is the side trolley. Fig. 17 shows a center trolley side bracket construction on the route between Nice and Villefranche. The overhead construction would be much more elegant, for this case, with the side trolley. Fig. 18 gives this latter case on the temporary line built just within the fortifications in Paris to carry people to the Exposition-Annex in the Bois de Vincennes.

This side trolley construction is being very largely em-

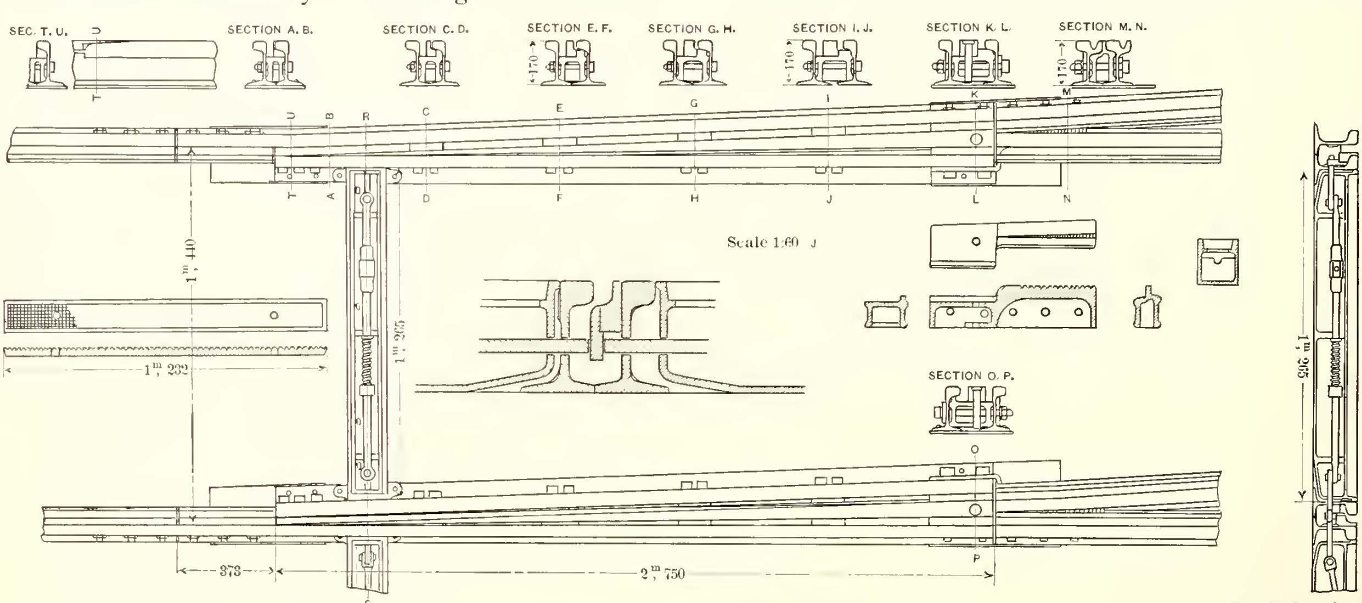


FIG. 13.—PLAN AND SECTIONS OF TYPICAL FRENCH TONGUE SWITCH

ployed now—due principally to its being required by the administration for æsthetic reasons. It increases the difficulty of operation, the trolley wheel being much more liable to leave the wire than with the center trolley construction. As the trolley head must be swiveled it cannot take an overhead switch "running on the point" without having a movable tongue or its equivalent to guide it on the proper wire. This may be counterweighted so that one wire can always be taken without any switching. But in the other direction the overhead tongue must be moved by external means—usually by a cord which runs down a pole, and which is pulled by an employee.

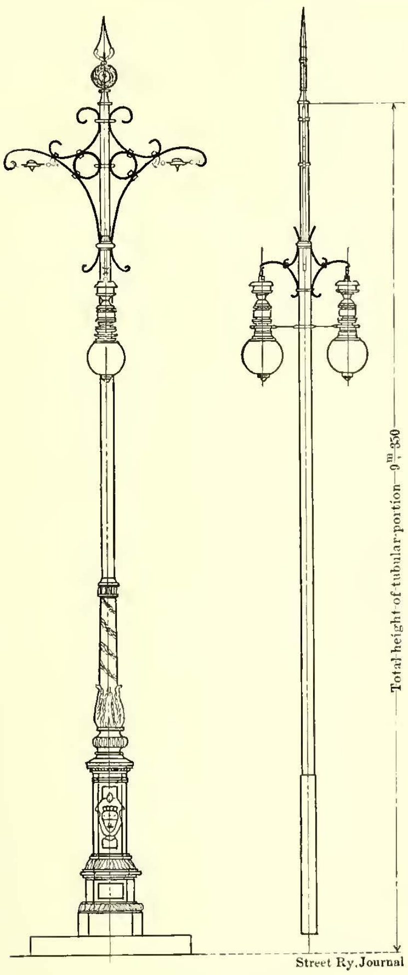


FIG. 15.—SIDE ELEVATION OF AVE. DUMESNIL POLE

Fig. 19 shows a rosette construction at Lourdes. The street here is very narrow, so much so that a flagman runs in front of the car to warn people to get into safe places while the car passes. Fig. 20 shows the construction of one form of these rosettes. They are very largely used in France. There seems to be no particular objection to their being anchored into the walls of private houses. In case of a refractory person, the threat of a pole before his property usually removes the objection.

The feeders are all underground cables. The insulation of these is of jute, paper or rubber—depending upon the price that is paid. The cables are almost invariably lead sheathed, and always armored. They are of French manufacture, and they are very well made. Wiped lead joints are not made, but junction boxes instead are employed. Drawing-in systems are practically unknown. The cables are laid in trenches of 60 cm ($23\frac{1}{2}$ ins.) depth, on

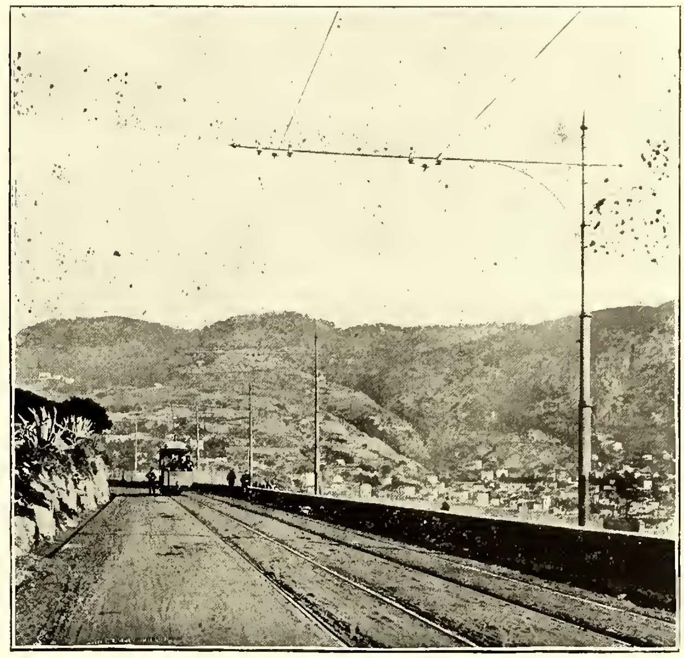


FIG. 17.—SIDE BRACKET CONSTRUCTION IN NICE

the bottom of which a layer of sand is first deposited; the cables on this are covered with sand, and then a wire netting is placed which is about 25 cm (19.8 ins.) wide. This latter is to warn workmen excavating that cables are laid close underneath. This is rather a rudimentary warning signal, and often the cables are damaged by a pick stroke before the workman discovers the netting. In and about Paris no cables can be laid in the street without being encased in an iron pipe. Therefore a cable laid under the sidewalk is protected only by the netting, but where it crosses a street it is laid in iron pipe, or if it is laid between

FIG. 16.—CENTER POLE CONSTRUCTION IN PROVINCIAL CITY

FIG. 18.—SIDE TROLLEY SIDE BRACKET CONSTRUCTION ON VINCENNES LINE

tracks for a tramway, the iron pipe is required the entire length. This is not a requirement in the provincial cities.

The writer will try to give a general idea of the conditions imposed by the authorities for electric tramways. There is now no one general law on the subject, but the one proposed by MM. Blondel and Dubois in their admirable work on electric traction will no doubt be adopted in its main features.

The installation of an electric tramway must be the subject of two official examinations or "enquetes," to use the expressive French word; the first is called that of public utility and the second refers to the underground and overhead electrical conductors. A preliminary project is submitted either to the Minister of Public Works, the Prefect or the Mayor, depending upon whether the concession demanded is national, departmental or communal, and this must contain the following:

1. The governmental map at 80,000 : 1 scale showing the projected route.

2. A general plan on a scale of 10,000 : 1 of the public routes followed.

3. A profile of the route on a scale of 5000 : 1 horizontally and 1000 : 1 vertically.

4. A cross-sectional outline of the rolling stock proposed, on a scale of 0.02 m. per meter.

5. Plans on the scale of 0.005 m. per meter of each crossing on the route of the proposed tramway.

6. A descriptive memoir giving the object of the enterprise, the estimated cost, the proposed fares, the kind of service proposed, the minimum radius of curves, the maximum gradient, the extreme width of rolling stock, the dispositions to be taken not to interfere with the access of abutting property owners to the public street, the minimum distance between the cars and the fronts of adjacent buildings—the extreme length and maximum speed of trains—the minimum number of trains to be put to the service of the public. These rules being defined by a law of 1881, before electric traction was thought of, the information is in reality supplemented by typical cross sections of the pole and overhead line. This "dossier" is examined and reported upon by every public service and private corporation which can be possibly interested in or affected by the proposed installation.

The Council of State, of which the titular head is the President of the Republic, finally issues a decree (assuming that the project is approved) declaring that it has examined these different reports, and that the project is one of public utility and its execution is authorized. The concession is granted according to the circumstances either by the State, Department or Commune, and the execution of the work is given by the decree either to the Minister of Public Works for the State, to the Prefect of the Department, or to the Mayor for the Commune. To the decree is annexed the formal agreement between the company and the State, Department or Commune as the case may be, which agreement includes conditions or specifications which vary, depending upon the proposed installation.

Taking as an example the concession given to the so-called penetrating lines into Paris, granted March 30, 1899, the conditions which may be of interest are as follows:

FIG. 19.—OVERHEAD CONSTRUCTION WITH ROSETTES IN LOURDES

The line of tramways in question is destined for the carrying of passengers, baggage and eventually express matter. This last to be subject to conditions to be mutually arranged hereafter between the government and the tramway. The traction will be by mechanical motors, overhead electric wires being only allowed outside of the city limits of Paris. The line will start from ———— and go to ———— on the following route. The following existing tracks on this route will be used. The plans will be presented two months from date, and the works will begin in four months, and be finished in one year from the date of commencement of work.

The extreme width of the cars must not exceed 2 meters and the height 4.60 meters. The distance between two cars passing on double track must not be less than one-half meter. The maximum radius will be 18 meters. The paving will be either wood or stone upon foundations of concrete 0.15 meters thick and established at the cost of the tramway company. The surface to be paved will be the tracks, between tracks, and 0.55 meters outside of outer rails. An interval of 2.60 meters must be left between the car and the curbstone for the passage of wagons. If this distance cannot be given on both sides, the tracks will be brought near to one curb, leaving a distance of 0.30 meters between car and curb. The waste resulting from the tearing up of the street for the tracks will be made good by the use of new material at the cost of the tramway. Old material not used will be the property of the tramway. The work of tearing up the streets, putting down concrete paving foundations and the paving may be done by the city at the expense of the tramway company if the city so decides.

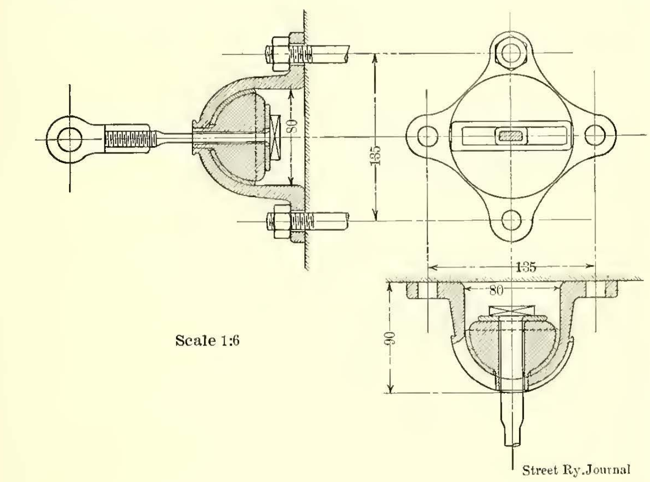


FIG. 20.—CONSTRUCTION OF ROSETTE

The rails will be full-grooved type, of a minimum weight of 40 kg per meter. The width of groove on straight track must not exceed 29 mm, and on curves 35 mm.

The drainage of the track to the sewers will be required. The cars can only take on and let off passengers at certain fixed points —to be determined after examination by the Prefect of Police.

The authorities have the power to prescribe waiting stations where, in their opinion, these may be necessary. The repairs necessary to keep the paving in, between and 0.55 meters outside the tracks in a perfect state of maintenance will be at the expense of the tramway company. Inside the city limits this may be done by the city if it so decides, but at the cost of the company.

If the construction or repairs of the road require any tearing up beyond the limits above mentioned, the paving repairs of such parts will be made by the tramway for a period of one year after their provisional acceptance as having been properly repaired. During the existence of the concession the company will bear any expense it may have to make to allow and facilitate regularly authorized work incident to changes or repairs of the streets and sewers on the public streets used by the company.

The minimum number of trips which must be made every day is ——. The authorities have the right to require an increase of this service. Trains shall not be composed of more than two cars—with maximum length of train of 25 meters.

The speed must not exceed 20 km an hour, and crossing streets this must be diminished to 16 km an hour. The number of second-class places must be double that of the first class.

The lighting and heating of the cars must conform to the demands of the authorities.

The duration of this concession will extend thirty years. At its expiration the city, department or State, as the case may be, will take possession of the tracks, power houses and all installations incident to the transmission of the power necessary to the operation of the cars.

In the five years preceding the expiration, the State will have the right to seize the revenues of the tramway and to employ them in putting in good condition the track and its appurtenances if the tramway company does not fill this obligation.

FIG. 21.—TYPE OF CAR USED IN ROUEN

The cars, car depots, workshops, etc., remain the property of the tramway company, but the State reserves the option to buy them in totality or in part at a valuation fixed by experts, the material so taken to be paid for in six months. The State is required, if the company so decides, to take, at expert value, its spare material, fuel, etc., but the amount of such material shall not exceed that necessary for six months' operation of the tramway. The above dispositions are only applicable if the State decides that the tracks must be maintained in totality or in part. If the government should decide to the contrary, the tracks must be taken up in all or in part, and the streets put in their original condition by and at the cost of the company, and under the express condition that no indemnity can be allowed. The State also reserves the right to buy back the concession before its expiration.

FIG. 22.—TYPE OF CAR USED IN VERSAILLES

The fares will be, in the city limits, 2 cents second class, and

3 cents first class. Outside of the city limits the fare is variable, depending upon the distance. Infants under four years and held upon the knees will be free. Non-commissioned officers and soldiers in uniform will have the right to first-class places on paying second-class fares. Packages, valises, etc., weighing less than 10 kg and carried without annoying other passengers, will be transported free. If required by the authorities, trains called theater trains leaving their terminus in Paris after midnight will be put on, double fares being charged.

The tramway company will put a special morning service of cars for workmen on all days except Sundays and holidays. Only

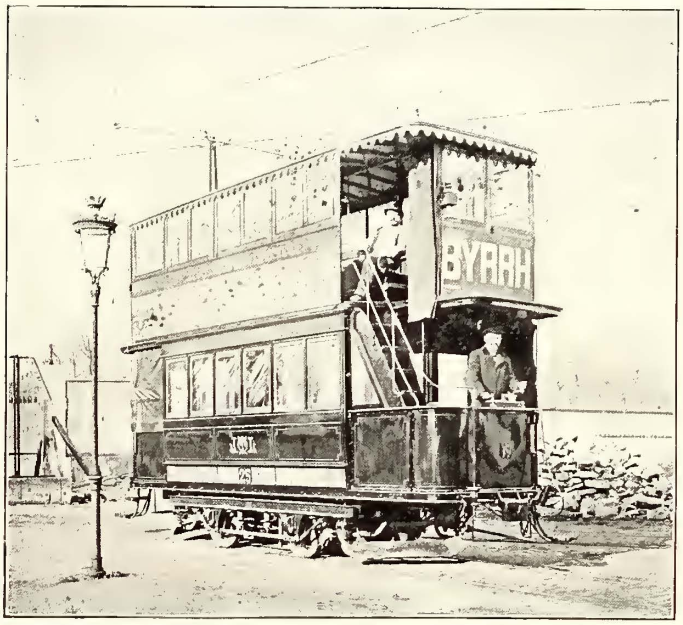


FIG. 23.—TYPE OF DOUBLE-DECK CAR USED IN LYONS

second-class places will be provided, and the fare will be one-half the regular second-class fare.

Passengers taking these trains will have the right to buy a ticket at the same reduced rate good for return evening trip. If another tramway line should be granted hereafter with the right to use a portion of the tracks hereby conceded to be built, no damages for loss of traffic or for right to use such tracks in common can be granted beyond a toll which shall be calculated on the basis of the car kilometers made by the respective companies on the common section of track, to pay the interest charge at 5 per cent of the cost of the common track, and the repairs and maintenance. The system of traction employed by the borrowing company cannot under any circumstances injure the operation of the present line. All expenses incurred to avoid such injury shall be borne by the borrowing company. The tramway company will not be forced to put at the disposition of the borrowing company the installation peculiar to its system of traction, nor to furnish electric current. Any agreement for a lower fare to individuals is forbidden, but this provision is inoperative for any agreement between the company and the government in the interest of the public, and to any reductions which may be made to paupers. Public officials and agents connected with the service of inspection of the cars and tracks will be transported free. The company must transport the mail under conditions and for remuneration to be hereafter agreed upon. Carriers of telegrams will be transported free to the limit of two for the same train. The company must pay f.75 annually per kilometer of track for the cost of the official service of control of tramways. Rents for the use of bureaus and waiting stations on the public streets will be paid for as provided by law. The right of standing cars in the public streets will be paid for at the rate of 6 cents for the departure of every car from a terminus situated in the limits of Paris.

The road must be operated so as to give every employee a vacation of ten days per annum, with free salary or wages paid for such time. Days lost on account of sickness, which is duly proved by a recognized doctor, will be fully paid for for a period not to exceed ninety days, and for a second period of the same extent this amount will be half pay.

In case of accident happening in the course of his work the workman will receive the amount fixed by law. The government can always demand such measures of security and health to the workman as it may see fit. The company will open with each employee an account with the National Savings Bank for a pension, retaining 2 per cent of each salary, to be so invested, and putting itself an amount equal to 6 per cent of each salary to the credit of the corresponding employee.

This resumé can be taken as typical of the conditions now imposed for concessions. The new features are those which pertain to the protection of the interests of the employees. The lately passed law for the protection of workmen in case of accident adds another very considerable safeguard to their material interests. The tendency now in France is to protect labor by legislation which may be thought to be Socialistic. The results will certainly be interesting and instructive.

The installation must also conform to the law of 1895, which has for object to protect the telegraph and telephone lines of the government. As in France the public telegraph and telephone service is a department of the postal service, it may readily be understood that this protection is rightfully considered of extreme importance by the government.

The articles of interest in this law are as follows: Overhead conductors cannot be established in a zone of 10 meters horizontal projection on each side of a telegraphic or telephonic line without a previous understanding with the service of post and telegraph. No conductor can be established above or below a public street without a permit given by the Prefect based upon the technical advice of the engineers of the service of post and telegraph, and in conformity with the instructions of the Minister of Commerce, of Manufacturers and of Post and Telegraph. A permanent

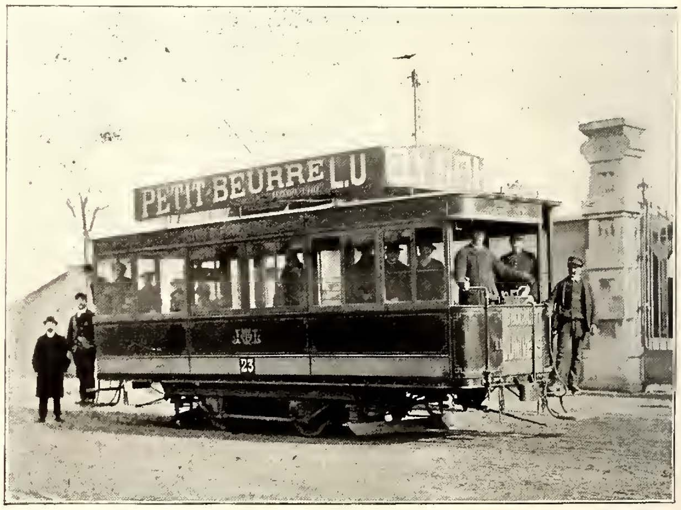


FIG. 24.—TYPE OF SINGLE-DECK CAR USED IN LYONS

electrical committee, one-half the members of which are composed of technical representatives of the important electrical works of France or works using electricity, is named by the Minister of Post and Telegraph to give advice upon the rules to be formed to carry out the intent of the law. Any electrical installation must be operated and maintained in such a manner as not to cause any trouble, by induction, leakage or otherwise in pre-existing telegraph or telephone lines. When the installation will require, to fulfil this obligation, the replacement or modification of existing lines, such work will be done at the expense of the installing company.

The instructions given to carry this law in effect, so far as they interest electric tramways, are as follows:

1. The distance between an overhead conductor and a telegraph or telephone wire must never be less than one meter.

2. At crossings the possibility of contact between the conductor and telephone and telegraph wires must be rendered impossible by some mechanical disposition, or if this is not acceptable the service of post and telegraph will install special fuses on their lines at the expense of the installing company.

The totality of the overhead conductor system must give insulation resistance of 1 megohm per kilometer.

Underground cables must be at least 1 meter distant from parallel post and telegraph cables, and 50 cm from the same at crossing points.

The resistance of insulation between the conductors and the earth expressed in ohms must never be less than five times the square of the voltage of the distributing system measured at the poles of the generator.

The conductivity of the track must be assured in the best possible conditions. The drop in voltage of the track must not exceed 1 volt per kilometer.

The track must be insulated from a metallic construction, such as a bridge which it may cross. The connections must be such that the mean fall of potential for a day's run between the two extremities of such a metallic construction will not exceed one-quarter of one volt. It is forbidden to use the earth to form part of the circuit.

The above prescriptions are those having the sanction of law at the moment, but undoubtedly they will be modified and supplemented by a new law in the near future.

The signing of the decree does not give the permission to commence work, which must come from the Prefect after examination of the project of execution. Modifications or extensions proposed by the installing company or individual can only be granted by the authorized administration, but this authority has the right to demand without indemnity such modifications which experience or changes to be made upon the public routes should render necessary. The service of control takes charge of the inspection of the construction and operation of the installation, and the reclamation of all the other administrative services must pass by this one, which is the only one in direct touch with the work.

FIG. 26.—VIEW IN LOURDES, SHOWING TYPE OF CAR USED

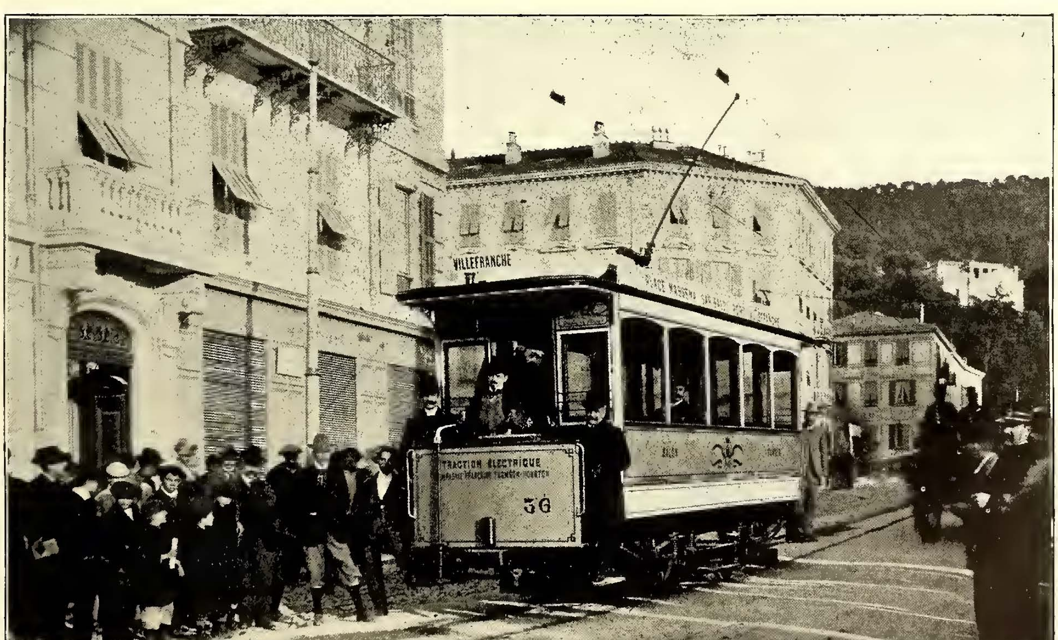


FIG. 25.—TYPE OF CAR USED IN NICE

All this is rather complicated; it takes a long time to fulfil the administrative formalities before commencing work, and after that the right of the control to modify often hinders construction in an annoying manner, and makes it unduly expensive. This is due to the system and not to the personnel of the control. The engineers forming this service belong to the corps of "Ponts et Chausseés," in which only a limited number of the first graduates of the Ecole Polytechnique have the right to enter. The splendid theoretical training that they there receive, taken in connection with the "esprit de corps" of this renowned body of engineers, makes it, without exaggeration, the picked body of men of France.

To verify the drop in potential of the tracks the companies install pilot wires, which depart from a special switchboard in the station to end at the track termini. These are often run by the service of post and telegraph on their overhead or underground lines by special agreement with the companies. These wires can be used also for private telephone purposes by the companies.

The cars used in the provincial cities of France are in general small and light.

Fig. 21 is a type of one in use at Rouen, Fig. 22 at Versailles, Figs. 23 and 24 at Lyons, Fig. 25 at Nice, Fig. 26 at Lourdes.

In some of these cities the cars are divided into first and second-class compartments. In general the first-class space is composed of an interior section of the car with upholstered seats. The second-class compartment has slat seats. The standing places on the platform are second-class also.

Fig. 27 gives the various views of the car for the tramway lines of Bordeaux. This car is one class only.

Fig. 28 shows a metal floor framing system. The use of iron or steel for the sills, cross-framing and platform knees, as here shown, is quite general in the construction of street cars, not only in France, but elsewhere on the Continent. The paneling is also generally sheet metal. The use of veneering for inside finish is almost unknown. The roof rafters show, and the under side of the narrow width roofing boards is varnished. The construction of monitor with re-enforced rafters, following the outline of the monitor, is now being largely adopted.

American cars have been imported to some extent, but this has been due principally to the long deliveries asked for by the French companies, on account of the congested state of manufacturing in France during the past year.

The cars are not handsome, but this is largely due to their restricted width over all; the cross section of Fig. 27 shows this clearly with the 1.770 meters over the sills, which the truck construction made necessary, and which, with any of the known types of trucks, could not be diminished much, if any—there is left only 0.115 meters, or about 6 ins. of swell for the car, the total extreme width over all being restricted to 2.00 meters. This—an average condition in France—explains the "boxy" appearance of the cars.

The cars made by the high-class manufacturers in France are well built, workmanship and material being excellent. There is quite a demand for cheap cars, which is catered to by second-grade manufacturers, and of these the least said the better.

In Paris the different types of cars in use are too numerous to mention. Some few examples only are given. Fig. 29 is a type of a double-deck car, which shows the upper deck closed for winter use; the side panels can be removed for summer use. The car will be equipped to run on a trolley and conduit construction, and also with a storage battery to run over a section of the route which is not provided with either of these sytems.

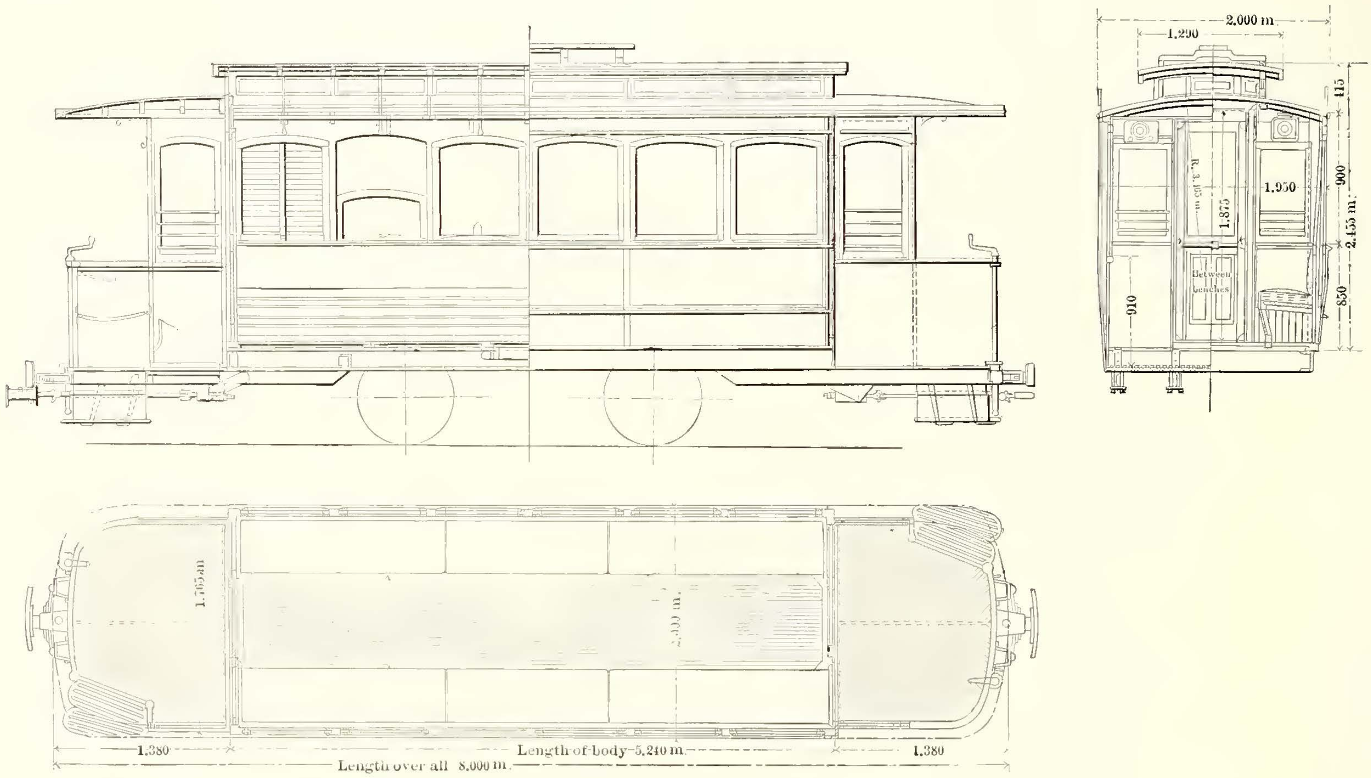


FIG. 27.—TYPE OF CAR USED IN BORDEAUX

Fig. 30 is a train of the Bastille-Charenton line. The motor car is provided with a plow, sections of the route being in conduit. The trailer is a good example of a European open car. Notwithstanding the beam construction of the sills these cars sag at the ends. The American construction of open cars is far superior. This is partly to be accounted for by the relatively small demand there has been for open cars up to the present time. When their advantages as means of attracting travel are more fully recognized no doubt the construction of such cars will receive more attention, and with beneficial results.

Fig. 31 is a train on the new conduit line in Paris, which has been constructed on some of the routes of the Compagnie Generale Parisienne de Tramways. The trail car is an example of a central platform car which is coming more and more in use in France, especially so in Paris. The construction is only practically possible with double trucks in the case of a motor car.

Trucks are largely of American manufacture. Those built here are often copied more or less closely from American models, though there are two or three trucks of French manufacture which are quite distinct from any built in America. But it can be safely said that the greater American experience in truck manufacture is fully recognized with the result to give the preference to American types in most cases. But whatever the type of truck used it is quite certain that they will be constructed mostly in France—though certain pieces which are expensive, due to the high-priced special tools necessary for their manufacture, may be imported in considerable quantities.

The regulations of the service of control for the equipment of mechanically operated cars are very severe. They are constantly being made more severe in the search for the ideal car which never gives rise to accidents of any kind.

Before taking up the question of the safe operation of the car—a word as to the requirements in the construction of the car for the convenience of the passengers.

The cars are limited as to the number of passengers that can be carried. A passenger is allowed 45 cm (about 18 ins.) length of seating room. At one time the seat was restricted to a height of $33\frac{1}{2}$ cm (a French engineer remarked that the half centimeter was a poem), but it was soon recognized that this height would not be acceptable, so it was increased to 43 cm.

The number of places allowed on the platform is determined by trial, a comfortable number being allowed without crowding. No passengers can ride on the front deck car can be readily adapted to these conditions. The windows must not lower more than 20 cm from the top, so that the passengers shall never be subjected to draughts. This restriction is extremely annoying in hot weather. With the front door closed, and the windows capable of opening only a few inches from the top the interior of a car becomes a furnace to be avoided at all hazards.

The requirements for brakes are very severe. Cars must

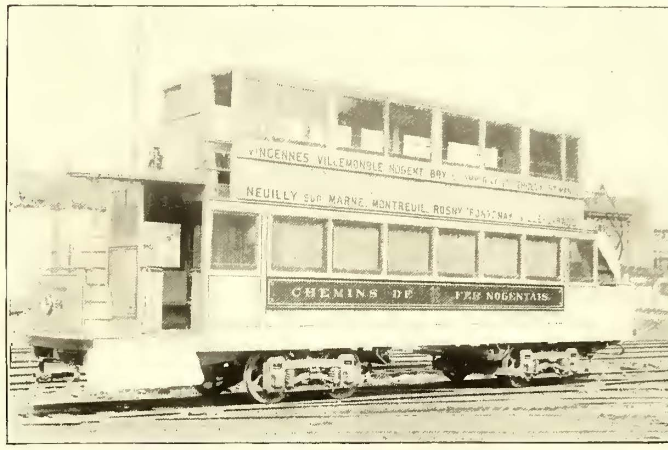


FIG. 29.—DOUBLE-DECK CAR WITH UPPER DECK CLOSED

be equipped with two systems—one in regular use and the other for emergency, in case of failure of the regular system. Each system must be sufficiently powerful to stop a

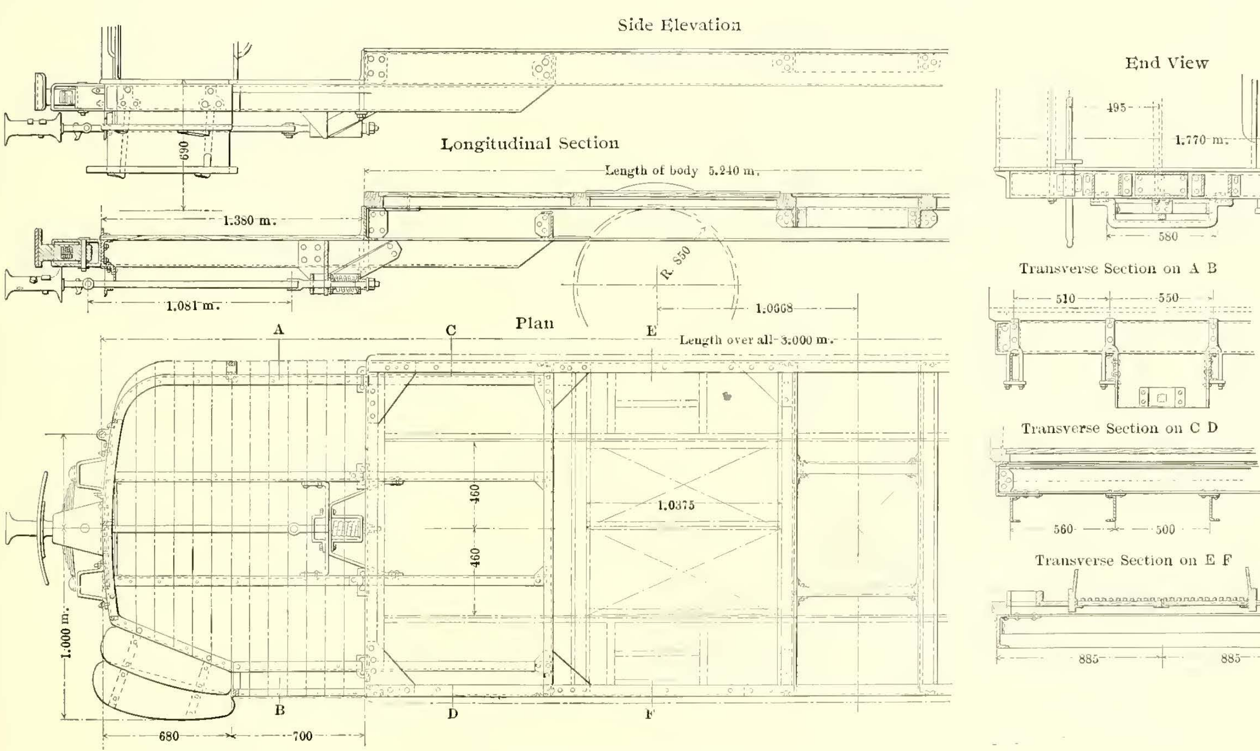


FIG. 28.—METAL FLOOR FRAMING FOR CARS

platform with the motorman. The front door must be kept closed, even in the hottest of weather, for fear that someone from the inside may distract his attention. Passengers wishing to reach the second-class compartment cannot pass through the first-class, but the contrary is permitted. Two-thirds at least of the total number of places must be second-class. These last two restrictions affect very seriously the design of a car, making it in many instances very difficult, and, in fact, only a center-platform, or a double-car in 20 meters on a down grade of 2 per cent at a speed of 20 km an hour, without the use of sand. Naturally a dry or a clean wet rail is necessary—otherwise the condition is impossible to realize. If trailers are used the trial must be made with an empty motor car and a loaded trailer. Hand brakes are considered for emergency use, and the brake in regular use must be a power brake. This power brake must be capable of application from the rear platform independently of the motorman. This makes impracticable the application of the electric brake as now constructed. Tramway companies in Paris have settled upon air brakes in some form or another as the only practicable system to fill the required conditions.

Three general types are in use on electric cars:

1. Stored air with charging stations at one or more points on the line.

2. Electric motor-driven compressors on the cars.

3. Axle-driven compressors on the cars.

All of the systems work well; but undoubtedly the first system is the simplest and requires less upkeep than the others. But it is not always easy of application, especially so with double-deck cars, where the room for reservoirs is very limited.

The second system is but little used on surface cars; it has been adopted, however, on the underground Metropolitan road.

The third system is extensively used on the new lines which have lately been put in operation. While it is too soon to say what difficulties in maintenance may be encountered later on, due to wear and tear, it cannot be denied that up to the present time the types of axle compressors in use, which are the result of long experience, are giving excellent satisfaction.

When trail cars are used, the requirements call for an automatic and "moderable" brake. This last means to be able to control perfectly the speed of a car on a grade by the brakes. This is difficult to do with what is generally understood to be an automatic system with the three-way valve, for, with this, to diminish the pressure on the brake shoes, it is necessary to release the brake entirely and reset it to the required pressure. Besides, a street car trailer fastened by a coupler and two heavy safety chains, as required here, is in practically no danger of becoming disconnected, and even if it should be there is always the hand brake to rely upon. The advantages of "straight air" for a street railway are so well recognized by the central engineers that they have permitted its installation with special devices to give the automatic feature in case of a rupture of the two cars. This requires two coupling tubes at each end of each car, with a chain to open automatically the valve which lets air in from the trail car storage cylinder to the brake cylinder. All this is an unnecessary complication, but it has to be done if one wants to avoid a three-way valve system.

When trailers are not used the motor cars have to be equipped in the same way as if they were used. The reason for this is that in case a car is "dead" for any cause, and is pushed in by another motor car, a man on the front platform can brake the two cars together regardless of the fact that the man who controls the power is on the front platform of the rear car. Each platform of the motor car must have a double reading gage, giving pressure in the air reservoir and the brake cylinder. A trail car must be equipped with one also for a conductor's use—though of what practical benefit this is it would be hard to understand.

Four sand-boxes are required. They must be connected in such a way that the motorman and the conductor can, independently of each other, sand in front of the wheels in whatever direction the car may be moving. For this two levers on each platform are required, but as the motorman has only two hands, which are otherwise occupied, a removable pedal is put in for his benefit, attached to the rods, sanding in front of the wheels while the car is moving forward. The motorman has under his control—alarm bell or trumpet, controller handle, air brake handle, hand brake handle, sand pedal for forward movement, and sand lever for backward movement of car, and two gage needles to look at. The conductor has two sand levers to use in emergency, and two gage-pressure needles to examine at his leisure. The conductor of a trail car has these latter also for his amusement. It is not to be wondered at that even with the very few mechanically operated cars now in service in Paris, serious accidents are of almost daily occurrence.

The proper maintenance of all these complicated "fixings" will be a most serious charge upon the tramway company. If the control spent less time in devising new complications to add to the cars, and more time in inspecting

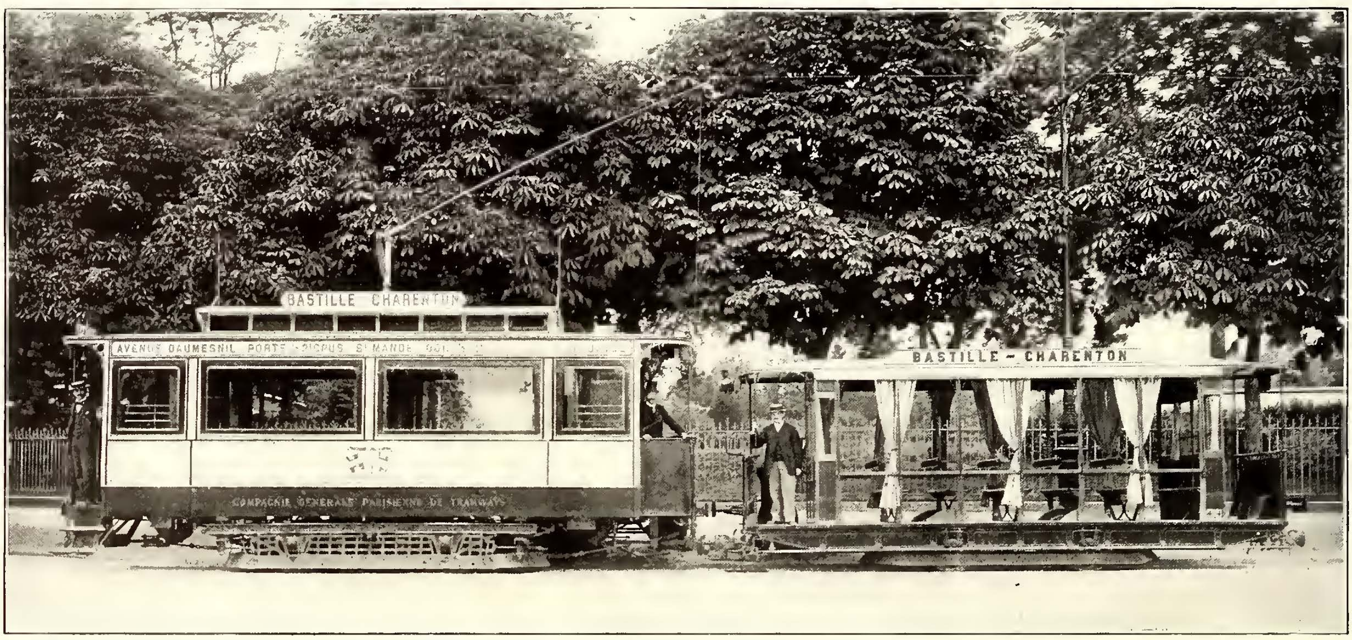


FIG. 30.—TRAIN ON BASTILLE-CHARENTON LINE

the operating condition of those already in use, it would not be a bold prediction that the result would be fewer accidents and a smoother operation of tramways in Paris.

The use of trail cars will undoubtedly very much diminish in Paris. The many operations necessary to couple and uncouple the two cars at the termini require an expensive equipment of men, besides the time required for these operations, added to that necessary for loading a car with "numerous" (order numbers), is such that the headway becomes too great to handle a heavy traffic. The abandonment of trailers, however, will be in line with the advanced street railway practice of the day. For Paris a long single-deck double-truck car, with central platform, fills the conditions of traffic requirements, with the exigencies of the control, in the most practical manner.

There is but little to be said about the electric car equipments. These have been largely of American manufacture, or, if built here, they have been, with but few exceptions, copied from American types. The local output of standard apparatus is taking such proportions that the home market will be supplied by French factories in a time not far distant. But for special apparatus, of which the amount required is limited, and for quick delivery work, it is probable that American manufacturers will continue to have the preference as in the past. The large use of American material can be traced to the fact that the strong French companies which have done most of the street railway transformation work, are commercially allied to the great American companies. The demand for material has been so great that the local manufacturing establishments belonging to these companies have been able to produce but a relatively small percentage of the total output. But this is changing now, as has already been said.

Power station practice is of no special interest in France. Small units for the unimportant tramways continue to be belted, but the important stations are now universally laid out with direct-connected generators. Boilers are usually parallel and close to the engines. French engineers generally use the "loop" system of steam piping; this, in their opinion being the best way to arrive at the advantages of a duplicate system. The piping is almost always of copper. Globe valves are in most general use even for larger sizes. It is strange that France should be so far behindhand in modern piping practice that an up-to-date job hardly exists.

The engines in use are almost wholly of French manufacture. In the early days of electric traction some few American engines were imported. But there are enough builders of good engines in the country to supply the present and probably any future demand. The best French engines are splendid examples of high-grade workmanship. They are designed especially with the view of giving the best possible steam consumption. The Corliss type of valve is much used. The governing mechanisms vary widely in type from those known in American practice.

Independent condensers are practically unknown; the prejudice against them on the score of uneconomical coal consumption is too strong to overcome their other advantages. Nearly all of the plants are condensing—the exceptions being too few to be considered. Cooling apparatus for the condensing water is so generally used that oftentimes no particular effort is made to locate stations near an unfailing supply of water. It is quite customary to drive wells for a water supply to supply the excess needed for the cooling apparatus. Various types of water-tube and return tubular boilers are in use. These need no description. Mechanical stokers have not been used up to the present time. The Babcock & Wilcox type of traveling grate is now being installed in a Rouen power house. The primary object of this is to comply with the desire of the municipality to reduce to a minimum the smoke nuisance.

Economizers are generally employed. Feed-water heaters are rarely installed in a condensing plant. Damper regulators are unknown—at least in the writer's knowledge. Fig. 32 is a view of the station of the Omnibus & Tramway Company, of Lyons. This was until lately the largest electric tramway station in France, but others, notably at Marseilles and Paris, have now passed it.

The limits of this article will not permit of an extended description of the installations which are of especial interest; they must, therefore, be only indicated very briefly.

FIG. 31.—TRAIN ON THE NEW CONDUIT LINE OF THE CIE. GENERALE PARISIENNE DE TRAMWAYS

The opening of the lines in and about Nice is the first example here of a large system operated from an hydraulic station, and connected to transforming sub-stations by a long-distance three-phase transmission line. This gives a special interest to this installation, which will, undoubtedly, be followed in other places in the near future. This plant having been described in the July number of the Street Railway Journal, leaves no other comment necessary until the results of operation can be accurately known The Potter surface contact system has been in operation for more than two years in Monaco. This was described in the May number of the Street Railway Journal. The only comment to be made is that this system has proved itself to be a "workable" one, and that for similar climatic conditions it could be safely installed.

The particularly interesting installations in Paris of surface street railways are those of the conduit and the Diatto surface contact system. The first was described by the writer in the December, 1899, number of the Street Railway Journal. The track work is about finished, and two of the three lines are in operation. It is too soon to give any figures upon the operating expenses, receipts, etc. The service is rapidly becoming well organized, so that the best results should soon be had. The special construction features of the line have proved efficient and practical. Conduit lines are favorably regarded by the authorities. The extension of this form of electric tramways on a large scale is more than probable.

The "Diatto" system, which was described in the STREET RAILWAY JOURNAL for July, 1899, has been adopted on nine of the new so-called penetration lines, or about 80 km of track. A portion of one of the lines from the Place de la Republique to the Opera House is in operation at the moment of this writing. It is evidently too soon to give any opinion upon the value of this system in such a city as Paris. That is was a bold undertaking to build so extensively in Paris on the basis of the small line operation in Tours is certainly incontestable. The "Diatto" system in Paris has a two years' lease of life, after which time it can be ordered to be taken out if it is not satisfactory to the proper authorities. This severe condition is usually imposed upon new systems.

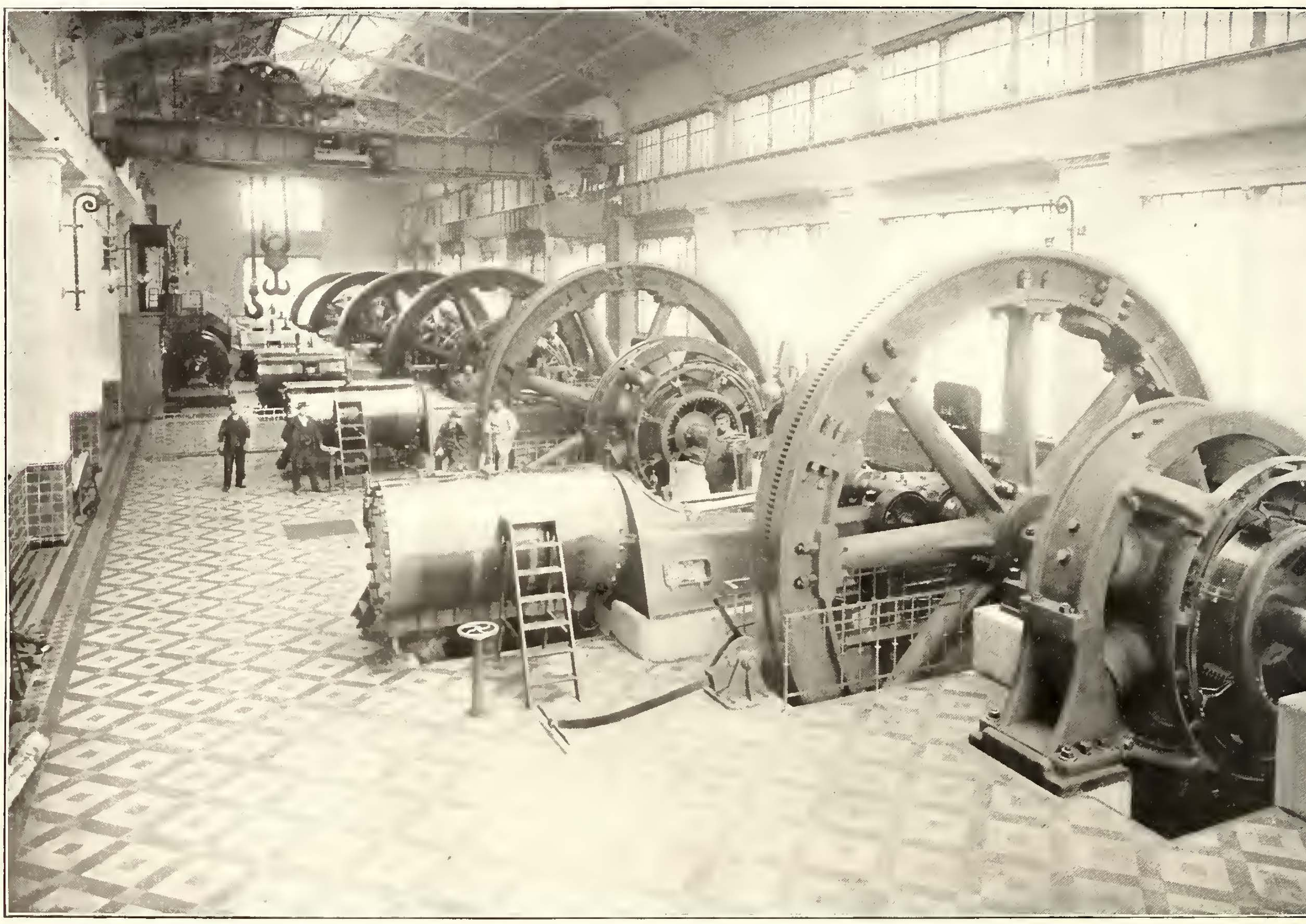


FIG. 32.—STATION OF THE OMNIBUS & TRAMWAY CO. OF LYONS

The Metropolitan underground system has one of its most important lines in operation since July 19. As a long article was published on this line in the September issue of the STREET RAILWAY JOURNAL, only a few words will be said of it here. Though the project of a great system of tunnel lines for city rapid transit has existed in various forms for many years, little progress was made before 1895, when the conflict between the State and city authorities came to an end in view of the pressing need of transit facilities for the Exposition of 1900. The last legislation necessary—that permitting the City of Paris to borrow the f.165,000,000 necessary—was passed in April, 1898.

The tunnels, viaducts, bridges, etc., are built by the city, and by it turned over to an operating company, which constructs the tracks and fits up the stations, supplies the motive power and rolling stock, and operates the road. The entire system is divided into six divisions, which will be delivered successively by the city to the operating company. The operating concession has a duration of thirty-five years for each division separately delivered. But this company will continue to operate the entire system until the expiration of the concession of the last division on the basis of an annual rental of f.45,000 per km, to be paid on those divisions whose time has expired. The city receives a percentage of the gross receipts, varying from 20 per cent to 40 per cent.

The Orleans railway is now in complete operation from the old station at the Pont d'Austerlitz to the magnificent new one on the Quay d'Orsay. This section is operated electrically by means of electric locomotives. The station is at Ivry, with two sub-stations, one each at the old and new stations. This installation, the first of its kind in France, is running very satisfactorily. About fifty trains are operated each way between the two stations, and this will in time reach eighty trains.

The electric installation of the West Railway will be very important, but it is hardly sufficiently advanced at this moment for a description.

THE DESIGNING OF LARGE TRAMWAY GENERATORS

BY HORACE F. PARSHALL

From a commercial point of view the process of dynamo designing may fairly be said to consist of determining the different dimensions so that some one abnormal condition, brought about by inconsistency of speed, current output or voltage, may be balanced against some other condition, so as to make the result as a whole satisfactory, although the individual constants chosen do not in themselves make for highest efficiency. I propose to limit the scope of the present article to the consideration of the designing of dynamos where there is no inconsistency between speed, voltage and current output, and where the individual values as to magnetic flux or electrical current are normal and make for highest efficiency. The surfaces of a dynamo are determined from thermal considerations. Particular dimensions, however, have reference to the magnetic limit of output. Experience has now become so extended that in the design of large generators the process can be greatly shortened by fixing in advance the efficiency as regards energy loss and allocating the individual loss to the several parts. Thus, for large street railway generators the efficiency may be taken to be between 94 per cent and 95 per cent, and the losses allocated as follows:

	Per Cent
C^2R loss in armature	2.25
Armature core loss	2.25
Field magnet loss	.75
Commutator loss, C^2R and mechanical friction	.75

The pole-piece loss is here included as a part of the core loss.

From the temperature rise per watt per square inch, as found in practice, and the permissible increase of temperature, the surface of the different parts for a given output is determined by the energy loss. The increase of temperature per watt per square inch at the periphery of an armature should be from 10 degs. C. to 15 degs. C. A 10-deg.-C. rise would be a very well ventilated armature; 15 degs. C. for one that is not carefully ventilated, and 12½ degs. C. is a good average value to assume for the purpose of calculation. This is at a speed of 2500 ft. per minute, which is normal, but calculations are not apt to lead to wrong results if the peripheral speed varies considerably from this result, since as between 2000 ft. and 3000 ft. per minute there is not more than 10 per cent variation of temperature rise. These figures refer particularly to the armature core, where the watt loss per square inch is about double that at the cylindrical end connections. In the normal case about 35 per cent C^2R loss is at the periphery of the core, and the remaining 65 per cent at the end connections. The above increase is by temperature thermometrically measured at the periphery of the armature. If the increase in temperature is to be calculated from the increase of resistance, the corresponding temperatures would be 15 degs. C. and 22 degs. C., respectively, measured from the increase of resistance of the armature as a whole.

In the field magnets, the temperature increase per watt per square inch external surface is about 60 degs. C. by thermometer and 120 degs. C. by resistance. In the commutator, the increase of temperature in the normal case is about 15 degs. C. per watt per square inch.

In the best practice it is the custom to limit the temperature increase of any part of a dynamo to 30 degs. C. by thermometric test, or 45 degs. C. by increase of resistance, the datum being 25 degs. C. Experience conclusively shows this to be a satisfactory value.

Hence, an approximate series of constants as to the requisite radiating surface for a given temperature increase per kw output can be fixed thus:

For the field, the radiating surface per kw output would be 15 sq. ins.

For the armature, the radiating surface per kw output would be 18.75 sq. ins.

For the commutator, the radiating surface per kw output would be 3.75 sq. ins.

Referring to the specific method of calculating, the C^2R loss in the armature needs no specific discussion, although it is the usual practice to limit the current density in large generators to about 1500 amps. per square inch, the rate of generation by heat at 40 degs. C. being 5.1 watts per pound loss in copper.

As regards the core loss, this can be calculated on assumptions from tests made on samples of iron as to hysteretic loss. Fig. 1 shows results of such tests on good commercial sheet steel. In practice, however, it is more expedient to establish a curve as shown in Fig. 2.

In the process of calculation of the core loss, the effect of distortion, which in good practice may increase the maximum density 30 per cent, should not be lost sight of, since the loss in the projections and core increases very considerably with such an increase in density. In a well-designed dynamo I should expect the densities to be taken so that the average loss in the armature core is less than 1 watt per pound.

Referring next to the commutator, with carbon brushes the current density should not exceed 40 amps. per square inch at full load. The contact resistance varies considerably according to the condition of the commutator, but a good average result is .03 ohms per square inch of contact, in other words, there may be 1.2 volts drop from contact resistance at full load. An ordinary pressure of contact is 1.5 lbs. per square inch, in which case at a peripheral speed of 2000 ft. per minute the mechanical friction is about 50 per cent of the C^2R loss.

As regards the losses in the field magnet coils, these have been given in extent. It is usual to calculate the amount of copper, assuming 600 amps. per square inch current density. Seven hundred and fifty amps. per square inch is commonly accepted as the limit in good practice in large generators.

Referring next to the design of the field magnets, it may be remarked that the function of the field magnets may be considered that of supplying at minimum cost of magnetic and electrical material, a magnetic flux of a certain magnitude and stability and the maximum armature reaction permissible, which is determined by the conditions of commutation. In the normal dynamo circuit, the following values at no load and full load are typical of a steel field-magnet, multipolar dynamo:

NO LOAD

	Percentage of total m. m. f.	Densities (C. G. S. lines per sq. in.)
Armature core	2.75	60,000
Teeth	5	120,000 Apparent
Air-gap	70	40,000
Magnet core	12	80,000
Yoke	10	65,000

FULL RATED OUTPUT

	Percentage of total m. m. f.	Densities (C. G. S. lines per sq. in.)
Armature core	3	60,000
Teeth	12	138,000 Apparent
Air-gap	60	46,000
Magnet core	15	102,000
Yoke	10	75,000

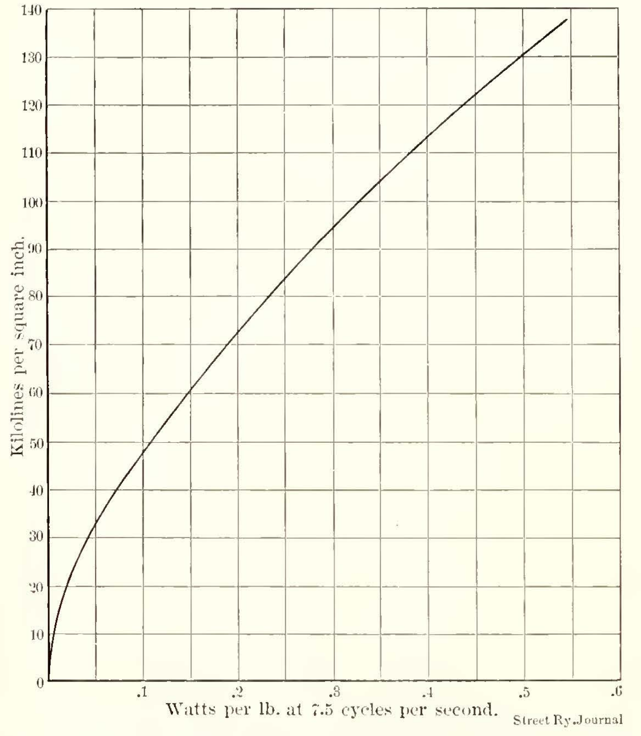


FIG. 1.—TESTING LABORATORY VALUES FOR HYSTERESIS LOSS IN GOOD COMMERCIAL SHEET STEEL

It will be noticed that nearly 80 per cent of the total m. m. f. is concerned with reference to the conditions to be maintained in commutation. The most economical densities in the field magnetic circuit will, of course, vary somewhat according to the relative market value of iron and copper. The surface of the field magnets, assuming reasonable depth of winding as stated above, is determined from the C^2R loss, the increase of temperature per watt per square inch and permissible increase of temperature. The cross section of the field magnet cores is determined particularly with reference to the magnitude of the magnetic flux and the most economical density. The magnetic flux is, as stated above, fixed from the maximum permissible armature reactions, and the density from the properties of the materials. The general dimensions, therefore, of the magnet coils, as to length and diameter, are within the limits of good practice determined by these factors. The amount of copper in the field magnet coils can be conveniently calculated from the following formula:

$$\text{Weight of copper per spool} = 31 \times \left(\frac{\text{Ampere feet}}{1000}\right)^2$$

Curves 3, 4 and 5 show the magnetic properties of commercial wrought iron, cast iron and cast steel. The cores should always be of wrought iron or steel, but the yoke may be of cast iron or steel, according to the market value of material. Laminated poles have not been a particular success, since they tend to make the flux at the pole face unstable as to surging on change of load from the coils under commutation.

The leakage or ratio of effective to maximum flux varies somewhat, but with large ring multipolar dynamos does not exceed 15 per cent, which may be safely assumed in calculation. Their leakage does not increase more than 20 per cent between no load and full load, or 3 per cent of the total flux, so, with normal magnetizations, does not greatly influence the amount of compounding.

The number of poles with multiple circuit armature windings is determined by the maximum armature reac-

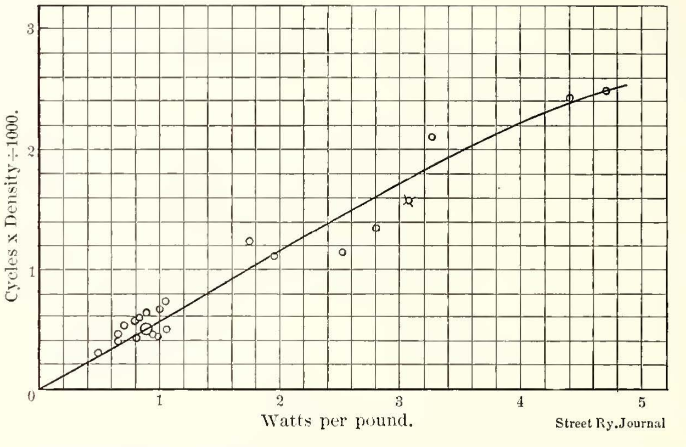


FIG. 2.—CURVE EXHIBITING THE RELATION BETWEEN CYCLES PER SECOND × KILOLINES DENSITY BELOW SLOTS ÷ 1000 AND WATTS PER SECOND IN ARMATURE CORE, BASED ON OBSERVED RESULTS IN TWENTY-THREE LARGE MULTIPOLAR COMMUTATING MACHINES

tion consistent with commutation, the minimum number of commutator segments, and the maximum permissible reactance of an armature coil, and the greatest economical contact resistance, and is therefore determined from the condition determining the maximum current which can be collected at a set of brushes, which in the kind of practice under consideration does not exceed 300 amps. at rated capacity.

MAGNETIC LIMIT OF OUTPUT

The limit of output of a commutating dynamo from a magnetic point of view is determined from the maximum value; that having regard to heating can be assigned to three independent variables. The first has reference to the m. m. f. underneath the pole piece, acting to produce distortion in the air gap, the amount of distortion being determined, as was shown by Hopkinson, by the m. m. f. under the pole piece (equal to the number of conductors multiplied by the current) and the magnetic reluctance around which this m. m. f. acts. The amount of distortion can be limited by making this reluctance comparatively great, and in the case of projection armatures can be made to increase very slowly with the m. m. f. or current in the armature by making the initial magnetization in the projections high, so that the reluctance increases greatly with the increase of magnetic density.

Secondly, the resistance of the collecting brushes, which, with dynamos with brushes at fixed lead for variable load, plays a most important part. Since the reversing field is only of proper value for one current output, this resistance acts (1) to prevent abnormal current when the coils are short-circuited in strength of field not corresponding to the current output, (2) to increase the rate at which the current falls off in the coils when short-circuited, and (3),

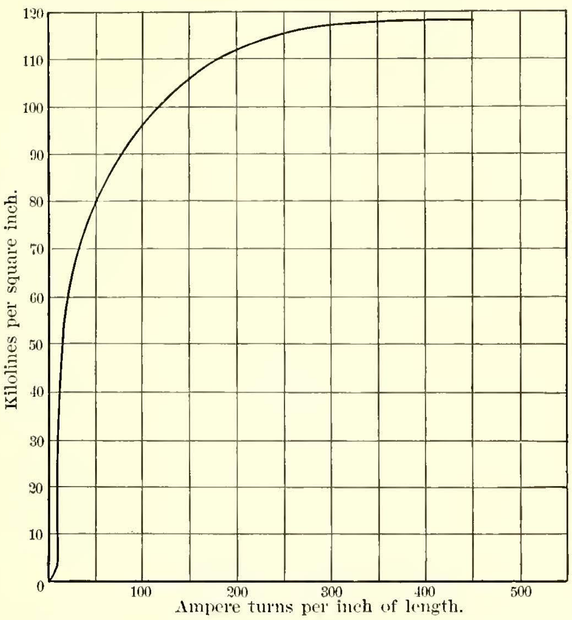


FIG. 3.—CURVE FOR GOOD QUALITY OF WROUGHT IRON AND SHEET STEEL

to shunt into a short-circuited coil a portion of the reverse current, so that on leaving a brush the current is in phase with the current in the main circuit. The contact resistance may be varied according to the quality of carbon used, which varies from 590×10^{-6} ohms per cubic inch to 3900×10^{-6} ohms per cubic inch, but in ordinary practice it is found advisable to limit the contact resistance so that the

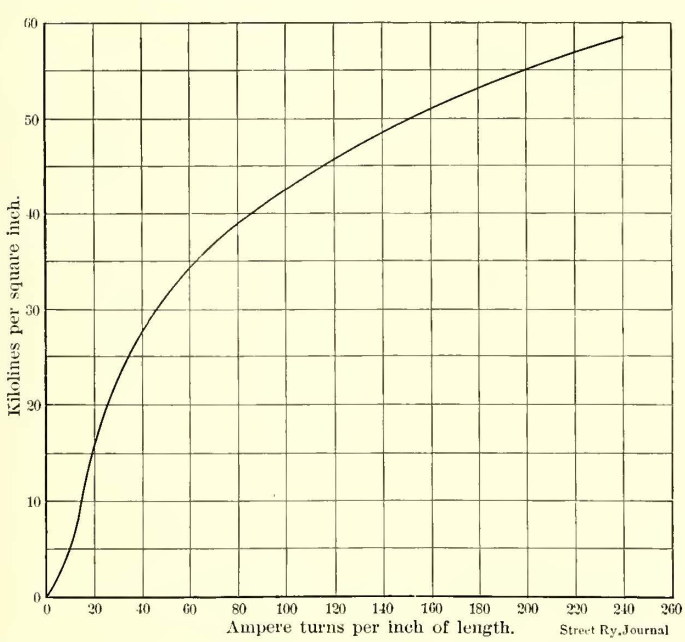


FIG. 4.—CURVE FOR GOOD QUALITY OF CAST IRON

drop in the brushes at full load amounts to not more than ½ per cent, otherwise the commutator becomes excessively large and costly and efficient collection difficult.

Thirdly, the self induction of the individual armature coils, which is a measure of the maximum field strength required for current reversal, as also the amount of distortion produced locally in the line of commutation, this distortion being backward for diminishing current, and forward for increasing current. This inductance voltage, which may be calculated from the laws of the magnetic circuit or on the basis of 20 c. g. s. to 25 c. g. s. lines per ampere per inch length of armature iron, has been limited in value in terms of the volt drop in the brushes, with full load current density, and in terms of the average strength of magnetic field as expressed by the average voltage in the commutator segments under a pole piece. Neither method by itself is entirely satisfactory theoretically, but practically

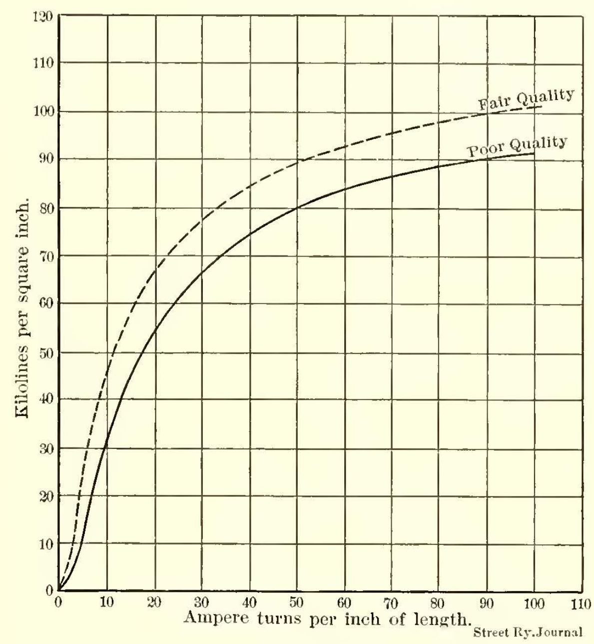


FIG. 5.—CURVES FOR CAST STEEL

the results are fairly consistent when the calculated inductance voltage does not exceed three or four times the drop in the brushes at full load or require more than one-third average strength for reversal. The self inductance acts at no load to prevent the generation of abnormal currents in the short-circuited coils, but at full load acts to prevent commutation, not necessarily by setting up a magnetic field, since this may be nullified by the m. m. f. of the field magnets, but by distortion of the magnetic field so that the current in the coils is not properly reversed as it passes from under the collecting brush into the open circuit position. The frequency of commutation varies in ordinary practice from 200 cycles to 300 cycles per second. The reactance voltage is a measure of the damage that can be done by a coil when not in proper field strength, and may therefore be increased if the contact resistance be increased to a corresponding extent.

The absolute frequency of the reversal is dependent on the distribution and strength of the reversing field. In practice the brushes generally cover three and a half commutator segments and are moved forward to a position such that the self-induced field at approximately full load is overcome by the field of the field magnets. With the inductance limited as above the light load induced currents in the short-circuited coils will not be more than one-quarter or one-fifth of the full load current. The limiting value for distorting m. m. f. is determined by the initial magnetizations, consistent with heating in the projections and conductors, but results of practice indicate that the m. m. f. acting under the pole piece should not exceed two and one-half times the entire m. m. f. of the magnetic circuit, or seven and one-half times the initial m. m. f. acting in the air-gap and teeth. As will be seen, however, from the observations made *re* the influence of highly magnetized projections and latitude in ventilation, these projections can vary widely.

As regards compounding, in good practice the pole pieces cover about 80 per cent of the circumference of the armature. The strength of the reversing field as given above corresponds in a projection armature to a position of the brushes approximately up to the pole, in which case the power of the armature for demagnetization is the number of conductors between the poles multiplied by the number of amperes in each conductor.

The length of the armature being determined by the inductance per unit of length and the total permissible inductance, this dimension divided into the surface gives the diameter. The remaining dimensions follow from the various constants set down above.

The number of commutator segments follows from the inductance per coil, and the maximum permissible armature reaction. The thickness of the brushes is determined from the contact resistance and the width of the magnetic zone of approximate uniformity, generally corresponding to the thickness of three to four segments. Thick brushes lessen the frequency of commutation, hence *inter alia* the advantage of shaping the pole pieces so as to have the reversing zone as wide as possible.

By the courtesy of E. W. Rice, Jr., I am able to give the following particulars of a generator designed by the engineers of the General Electric Company a number of years ago. It was particularly remarked at the time that the various constants were ideal from a designer's point of view. The practical results in the working of the generator have been so satisfactory that it may be fairly stated that this dynamo attains as near perfection as is possible in commercial practice.

DESCRIPTION

Number of poles	10
Kilowatts	550
R. P. M.	90
Terminal volts, full load	550
Terminal volts, no load	500
Amperes	1000

ELECTRICAL

Armature—Terminal volts, full load	550
Total internal volts	569
No load volts	500
Number of circuits	10
Style of winding	Single
Times re-entrant	Singly
Total parallel paths through armature	10
Conductors in series between brushes	180
Type of construction of winding	Barrel wound
Number of face conductors	1800
Number of slots	300
Number of conductors per slot	6
Arrangement of conductors in slot	3 wide x 2 deep
Resistance between brushes, 60 degs. C.	.0125 ohms
CR drop in armature at 60 degs. C.	12.6 volts
CR drop in brush contact surface	2.4 volts
Total CR drop	19
Amperes per square inch armature conductors	1560

COMMUTATION

Volts Between Segments, average	6.1
Armature turns per pole	90
Amperes per turn	100
Armature ampere turns per pole	18,000
Lead of brushes (number of segments)	9
Lead of brushes (per cent)	10
Demagnetizing ampere turns (per cent)	20
Demagnetizing ampere turns (per pole)	3,600
Distorting ampere turns per pole	14,400
Frequency of Commutation, cycles per second	254
Coils short circuited together per brush	3
Turns per coil	1
Turns short circuited together per brush	3
Conductors per group commutated together	6
Reactance Voltage, one coil (volts)	3.9

MAGNETIC

Megalines, from one pole no load and 500 volts	1.85
Coefficient, of magnetic leakage	1.125
Megalines in one pole, no load	2.08
Megalines in one pole, full load	2.36
Armature—Density no load (kilolines)	59
Density full load	67
Ampere turns, no load	190
Ampere turns, full load	320
Teeth—Apparent density, no load (kilolines)	108
Apparent density, full load (kilolines)	123
Corrected density, no load (kilolines)	108
Corrected density, full load (kilolines)	119
Ampere turns, no load	340
Ampere turns, full load	900
Gap—Density at pole face, no load (kilolines)	42.5
Density at pole face, full load (kilolines)	48.5
Ampere turns, no load	5,000
Ampere turns, full load	5,700
Magnet Core—Density, no load (kilolines)	78
Density, full load (kilolines)	88
Ampere turns, no load	880
Ampere turns, full load	1,530
Yoke—Density, no load (kilolines)	69
Density, full load (kilolines)	79
Ampere turns, no load	640
Ampere turns, full load	1,000
Saturation ampere turns for no load and 569 internal volts	9,450
Total ampere turns for full load and 550 volts	12,350

The density in the core = 67 kilolines.

$$\frac{C \times D}{1000} = \frac{7.5 \times 67}{1000} = .50$$

and from the curve the value of .88 watts per pound is derived for the specific weight of dissipation of energy in core loss.

The total weight of sheet iron in the armature = 12,600 lbs.

Hence, core loss = 12,600 x .88 = 11,100 watts.

The experimentally observed value was 11,000 watts.

THERMAL CALCULATIONS

Armature—

C^2R loss at 60 degs. C. = $1{,}000^2$ x .013 = 12,600 watts.

Core loss, 11,000 watts.

Total loss in armature at full load = 23,600 watts.

Peripheral radiating surface of armature = 12,000 sq. ins.

Watts per square inch of peripheral radiating surface	1.97
Peripheral speed of armature (feet per minute)	2250
Observed rise in temperature after eight hours' full load run, as determined by thermometer on armature surface	26 degs. C.
Observed rise determined from increase in armature winding resistance	38 degs. C.
Thermometric temperature rise per watt per square inch *peripheral* radiating surfaee	13 degs. C.
True temperature rise per watt per square inch *peripheral* radiating surface	19 degs. C.
Spool Windings—Total C^2R loss per spool at 60 degs. C.	422 watts
Total external cylindrical radiating surface of one field spool	1350 watts
Watts per square inch of external cylindrical radiating surface	.312
Observed increase of temperature by thermometer on surface of shunt winding after eight hours full-load run	26 degs. C.
Mean rise of thermometer	19 degs. C.
Thermometric temperature rise (mean) per watt per square inch of radiating surface	61 degs. C.
Rise of temperature by observed increase in resistance of shunt winding	45 degs. C.
Rise of temperature by observed increase in resistance of series winding	31 degs. C.
Mean rise of temperature of spool winding from resistance measurements	38 degs. C.
Terperature rise by resistance measurements (mean) per watt per square inch of radiating surface	122 degs. C.

COMMUTATOR LOSSES AND HEATING

Commutator—Amps. per square inch contact surface	40
Brush resistance positive and negative	.0024 ohm
C^2R loss at brush contacts, watts	2400
Peripheral speed, feet per min.	2040
Total watts lost in commutator	3670
Radiating surface, square inches	2400
Watts per square inch radiating surface	1.53
Observed rise of temperature after eight hours' run at full load	22 degs. C.
Observed rise of temperature per watt per square inch of *peripheral* radiating surfaee	14.5 degs. C.

THE ELECTRIC RAILWAY MOTOR

BY JOHN LUNDIE

The immediate function of the electric railway motor is to convert electrical energy taken from a contiguous supply into mechanical energy, and deliver it from its armature shaft.

A consideration of the motor *per se* should be independent of how potential is maintained or is changed between the motor terminals. In other words, we assume a definite potential between the motor terminals, say, 'oo volts, except as this potential difference is arbitrarily controlled on the external circuit during the starting of the motor. That a motor may not seem to do its work, or even be seriously abused by fluctuation of potential difference between its terminals, may be no fault of the motor, any more than would a steam engine be at fault in performing its work unsatisfactorily, or in pounding itself to pieces under a violent fluctuation of load, or of steam pressure, beyond the range of the compensation allowed for. Fluctuations of supply of energy to a motor are just as much to be guarded against, or provided for, as are sudden changes of load. Much mechanical injury may be done to rolling stock and its equipment by insufficient means of energy supply; for instance, by the sudden shutting off of current from one car or train, while another car or train thereby has the potential difference raised at the terminals of its motors. The operator may prevent continued excessive flow of current through the motors by means of his controller, but he cannot prevent the sudden shock to the machinery and cars, not to mention passengers.

In considering the electric railway motor, we may thus leave out of consideration any line questions bearing on sufficient energy supply, or any questions bearing on control, except as it varies the potential and consequently the flow of current, with resulting speed.

In seeking a motor for a specific railway service, it is primarily necessary to define the duty which it will be called upon to perform. Generally, a motor may be said to be required to deliver energy in such a way and at such a rate as to propel a certain mass, consisting of rolling stock and its live load, over a given track in a given time. This, however, is subject to many modifications. The amount of energy delivered to give this mass the required movement is dependent upon the work to be done against track and air resistance, in overcoming gradients and in giving motion to the mass at every start. The time in which the various elements of the total work to be done is performed determines the rate of expenditure of energy or the varying power to be exerted by the motors.

The service for which electric motors are best suited, in the present state of the art of locomotion, is that of fulfilling the requirements of municipal or suburban traffic, where short headways and frequent stops are called for. In order that satisfactory speed may be made with such a service, it is necessary that the method of acceleration and braking receive the closest attention. In any given run between two consecutive stops there is an absolute limit of speed, determined by acceleration and braking; the higher the acceleration and rate of braking, the greater the possibility of speed. Not only must this be borne in mind, but what appeals more forcibly to the railway manager when duly appreciated is the fact that in any given run between two consecutive stops in a given time it is easily possible to consume much more energy by wrong method of running than would be consumed by correct ones. Two hypothetical limits of method of running are:

First. Accelerating to a speed S almost instantaneously, as might be done by taking hold of a cable without any elasticity; running uniformly at that speed, and stopping against a bumping post.

Second. Accelerating uniformly to a speed $2S$ and immediately uniformly braking.

In both cases the same distance would be traversed in the same time, and approximately the same amount of energy expended in overcoming track, air and gradient resistance. The energy expended in the second case in giving motion to the mass would, however, be four times the amount in the first, being proportional to the square of the speed. Neither is an advisable method of running, but they illustrate why it may be possible to consume much more energy by one method of running on the same average speed than by another.

Again, to illustrate from actual running methods where the same maximum speed may be attained in a given run, we may accelerate rapidly to a given speed and "coast" until it is time to brake from the low speed the train has reached through resistance of one kind or another. On the other hand, we may accelerate slowly so that the train reaches the same speed as before just at the time we must apply the brakes in order to make our stop. In each case the same distance over the same track is made in the same time with the same maximum speed, yet more energy is required to make the movement in the second case than in the first. This is readily appreciated when we consider that in the second case we throw away all of the kinetic energy of the train in braking, while in the first case it is utilized to a great extent in overcoming train resistance, a limited amount only being dissipated in braking, corresponding to the square of the speed at which the brakes are applied.

It is thus properly in order to attack the problem of car movement and the method of making it with consideration of the varying amounts of energy required under different methods of operation, before turning to a consideration of the motor best suited for performing the service.

When we do turn to a consideration of the motor, we find that economic conditions react on the methods of making different movements, so that we must see our railroad problem in every phase before we can decide how best to equip with "motive power;" indeed, we may decide not to operate electrically at all, under certain circumstances. Assuming, however, that ours is essentially an electrical proposition, we have in a careful consideration of the questions indicated determined the average work required of our motor, and also the varying rate at which it must perform the work. On the basis of these determinations we are in a position to specify a suitable motor for our service.

The maximum demand for power will almost invariably be during the period of acceleration. Adhesion between the driving wheels and the rail—which may be estimated at 15 per cent of the weight on the drivers—will, with given gearing and wheels, determine the maximum permissible current. When such a speed is attained as corresponds to this current at line voltage—say, 500 volts—all resistance being cut out of circuit, then the motor is giving its maximum output of power. Working at a given constant traction (which may be the limit of adhesion, or less) requires a practically constant current; but, until counter electromotive force builds up by the speeding up of the motor, resistance must be introduced into the circuit to prevent an excessive flow of current, which would simply slip and grind the wheels, provided the requisite current estimated on produced exactly the torque giving the limit of adhesion at the rims of the driving wheels. Self induction on the first influx of current plays a useful part in modifying a jerky start. No satisfactory method of potential control has yet been devised except that of series-parallel operation, which saves, utilizes or stores the energy necessarily lost by the introduction of resistance into the circuit during the operation of the controller.

When a series motor has the full-line potential between its terminals after the operation of the controller is complete its speed, as a rule, continues to increase, and the current correspondingly decreases, dependent, however, upon the frictional or gradient resistances to car movement which are encountered, preserving a balance of speed and corresponding current; the power represented by the torque and speed of the armature being equivalent to the product of the counter electromotive force generated therein and the current then passing. A variation in the amount of power called for, such, for instance, as reaching an ascending gradient, immediately tends to retard speed, which in turn permits an increasing flow of current, preserving the mutual balance above mentioned. This balance between speed and current characterizes the operation of series-wound motors as distinct from the comparatively constant speed with varying current of shunt-wound motors, and, for many reasons bearing on railway operation, renders the former class of motor preferable to the latter for the nature of work called for by the present field of operation of electric traction.

A word on the application of motors to a railway vehicle. There is no excuse for a vehicle being heavier than is justified by the nature of the freight it has to carry and the modifications called for by the speed at which it has to travel. It is freight that pays and not dead load. Again, there is no excuse for trying to have the motors develop traction at the rims of the driving wheels greater than the co-efficient of adhesion between the wheels and the rails. In this connection, what may be called the "purchase" of a motor equipment, or the relation between the torque of the armature and the traction produced thereby at the rims of the driving wheels, should receive the closest attention. A given motor may be geared for any reasonable speed of car with the same power development at the armature shaft; but as the measure of power output at the rim of the wheel is the product of the traction and the speed, it follows that in order to procure traction, speed (with the same motor) must be sacrificed, and vice versa. On short runs, therefore, where we must pick up to a moderate speed quickly, it is necessary to use a low-speed gearing, whereas as the length of run between stops becomes longer, rapid acceleration is not so important, and we can better afford to use a higher speed gearing. As a rule, it is a high *average* speed that is desired in railway operation. This is too frequently confused with a high maximum speed.

Having sketched the duty required of an electric motor applied to railway traction, the specifying of the motor for the work to be performed becomes comparatively simple. As with all machinery, the selection of a motor begins with the assurance that it will deliver the mechanical energy at the rate required from its armature shaft. Next we desire the conversion of electrical energy into mechanical energy to be as economical as possible, all things considered. Finally, we desire the fatigue of the motor reduced to a minimum. It could hardly be considered the function of the railway manager to enter, in his specifications into a discussion of the metallurgy or the physical, magnetic and electrical properties of iron, steel and copper, or to discuss from the standpoint of a physicist the properties of insulating materials, except as such may appreciably affect the strength, operation, efficiency or life of the motor; nor is it necessary to display his knowledge of Ohm's law, magnetic flux or induction effects. The motor designer may be credited with being thoroughly conversant with such matters. What the motor designer does want to know, however, is the *direct* duty the motor is required to perform. This information is radically different from presenting to the manufacturer the whole railway problem to solve from his commercial standpoint as the seller of apparatus. This not uncommon practice has as much reason in it as would have the railroad manager who would rely upon the builder of steam locomotives to solve his transportation problems.

The principal elements of the duty a motor has to perform are:

First.—The maximum output of power required, determing the maximum current required, on line voltage.

Second.—The general cycles of variations of power required, giving the intermittent or continuous current requirement and also its average during continued service operation.

This information, together with that of space limitations, will govern dimensions of parts calculated to withstand the static and impact stresses indicated; it will determine the range of current throughout which commutation must be satisfactory; it will partially determine brush and commutator areas and the amount of copper required in the windings.

As the principal elements of duty a motor has to perform are classified under two distinct heads, so the limitations of capacity of the motor to perform this duty may be classified under two corresponding heads, viz:

First.—The capacity to commutate.

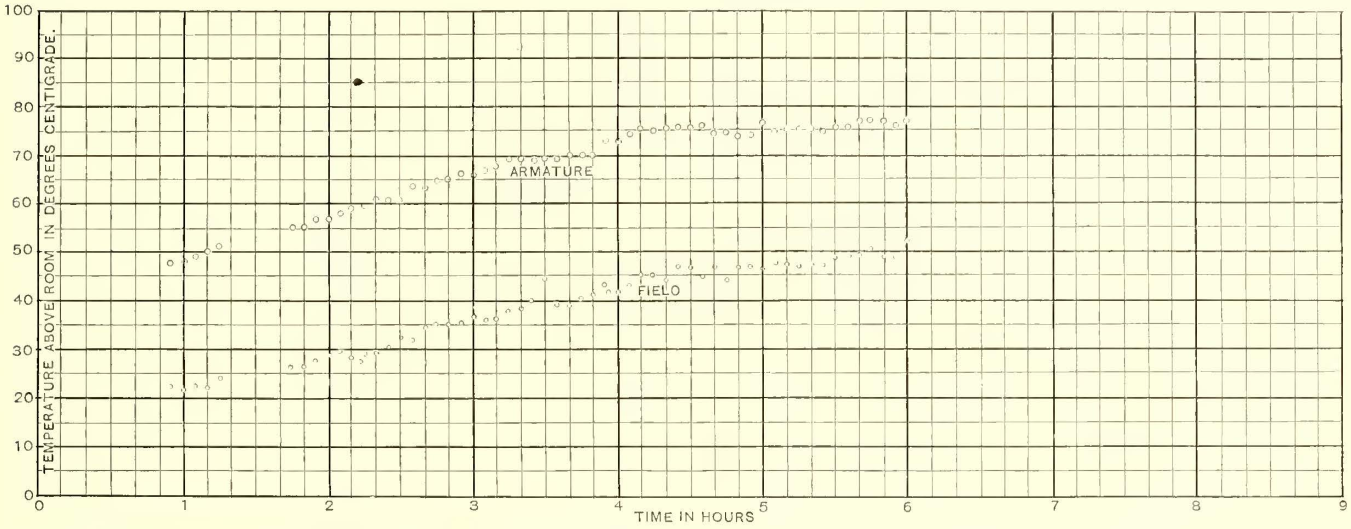
Second.—The capacity for fatigue.

The commutation limitation is definite and needs little comment. The capacity for fatigue of a motor is limited first by the mechanical fatigue to be provided for by careful mechanical dimensioning and facilities for proper lubrication. In service, it might be added, inspection and very significant remark is made: "In apparatus built for conditions of limited space, as railway motors, a higher rise of temperature must be allowed." This, of course, begs the whole question.

THERMAL TEST OF RAILWAY MOTOR X
RUN A 1
100 AMPERES. 60% OF TIME. 5 MIN. CYCLE.

Average Room Temp. 22.5°C.
Average Voltage 500
Average Speed 820

Current for Resistance Readings: Armature 59 Determinations, 84 Average Amps. 9.2 Average Seconds
Field 59 Determinations, 62 Average Amps. 12 Average Seconds



cleanliness will do much to add to the life of the motor. The latter points, however, can only affect the specifications for motors indirectly.

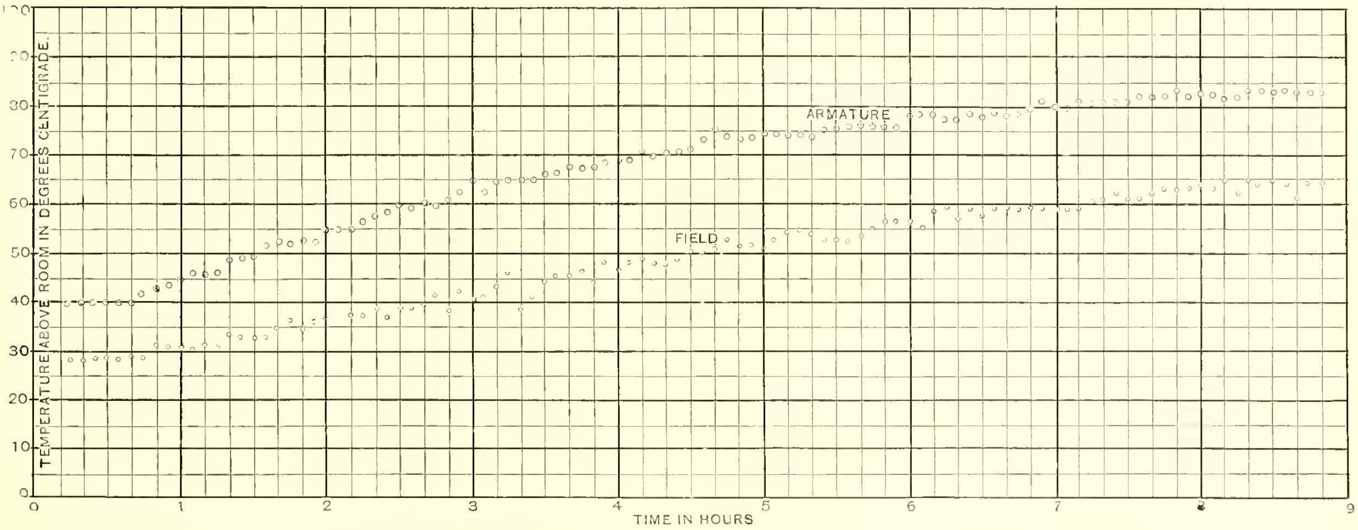
The fatigue of a motor due to heating is the most troublesome to provide for, and at the same time is inseparable from motor operation. Deterioration of insulation limits

On account of the high temperatures induced in the windings of motors otherwise operating satisfactorily in actual railway service, the selection of insulating material calculated to withstand high temperatures without undue deterioration has received attention at the hands of manufacturers. Asbestos insulation and mica supported by

THERMAL TEST OF RAILWAY MOTOR X
RUN A 2
150 AMPERES. 40% OF TIME. 5 MIN. CYCLE.

Average Room Temp. 22°C.
Average Voltage 501
Average Speed 690

Current for Resistance Readings: Armature 104 Determinations, 78.4 Average Amps. 10.5 Average Seconds
Field 104 Determinations, 58.5 Average Amps. 14.7 Average Seconds



the temperature at which the metal in a motor may be operated; thus, the prescribed limitation of temperature may well receive careful consideration. The committee on standardization of the American Institute of Electrical Engineers evidently had not time to consider fully the temperature limitation which ought to be placed on the railway motor, as while recommending a maximum temperature elevation on commutating machines of 50 degs. C. on field and armature coils, measured by resistance, the

fiber are used for this purpose in several types of motors on the market. The use of mica (being non-absorbent of moisture), provided the fiber packing is such as will prevent too much movement of the coils within the armature slots, would seem to meet the requirements of insulation calculated to withstand high temperatures. Here, however, we may encounter a difficulty tending to offset the advantages of the insulation, namely, that it may appreciably prevent the dissipation of heat.

There are two methods bearing on motor design by means of which temperature may be reduced:

First.—By increasing the amount of copper in the windings, so reducing the I^2 R generation of heat; also by reducing the facilities in the iron for heat generation from induced currents therein, by lamination, slotting, etc.

Second.—By facilitating the dissipation of heat as it is generated.

The dissipation of heat may take place by convection, by conduction and by radiation. Ventilation will facilitate dissipation by convection. Radiation is tributory to convection and conduction, the latter probably playing a not unimportant part in the dissipation of heat from the armature; the heat in the coils radiating to the core, and this heat, with that generated in the iron of the core, having a metallic path to a lower temperature. In this connection, some methods of construction calculated to reduce iron losses may so reduce the above mentioned metallic path for the heat as to result in retention of heat near the armature coils which might otherwise be dissipated by conduction.

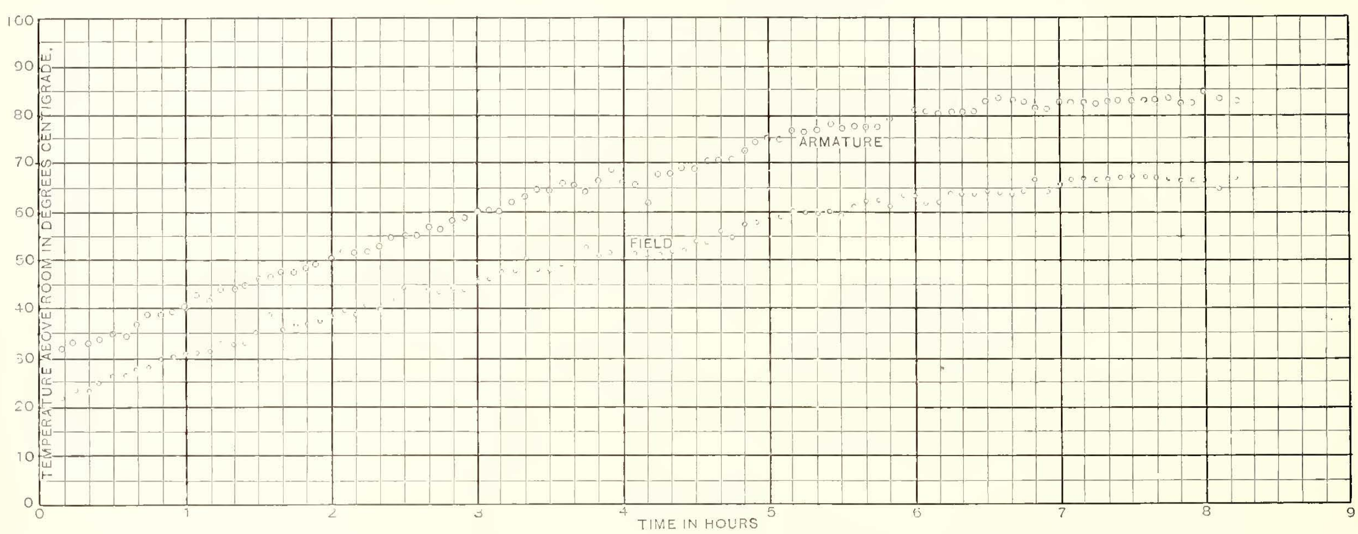
Accepted practice seems to point to about 100 degs. C. as the limit of temperature to which the windings of a railway motor may be heated without producing immediately appreciable deteriorating effects. This will permit of a temperature rise of about 75 degs. C. above atmosphere at 25 degs. C. Insulation experts may yet prove that this temperature may be exceeded with ultimate economy, even though a gradual deterioration does take place; and as the railway motor is a hybrid at best we must not be hypercritical, provided we are convinced by the maintenance account that higher temperatures may be safely maintained with economy. Be this as it may, the temperature limitation being granted at say 75 degs. above the atmosphere, we may base our acceptance of motors on such an arbitrary limit.

The heating of field coils is principally from I^2 R losses, and for this reason they ought to have sufficient copper so that under no circumstances of load should they govern the maximum temperature conditions.

With the armature governing the conditions of maximum temperature we have a combination of I^2 R and core heating, which throughout the range of current used in service operation together, may constitute practically a constant percentage of the input. This being the case, so long as the same average input is used in continued intermittent service, it will be a matter of indifference whether this average is impressed at a high or a low input, provided the current remains within the defined limits of operation, so far as average generation of heat is concerned.

If then the rate of heat generation in the armature is a constant and the rate of dissipation is a function of the difference in temperature of the windings and the atmosphere, then a temperature must ultimately be reached on continuous intermittent work which will cause dissipation of heat at the same rate at which it is generated. This temperature is that already referred to as the advisable limit on account of deterioration of insulation.

THERMAL TEST OF RAILWAY MOTOR X
RUN A 3
200 Amperes. 30% of Time. 5 Min. Cycle.
Average Room Temp. 18°C.
Average Voltage 500
Average Speed 625
Current for Resistance Readings: Armature 107 Determinations 82.5 Average Amps 10 Average Seconds
107 Determinations 60 Average Amps. 12 Average Seconds



Essentially the following method of railway motor rating, based on the above, has been proposed by the writer:

The power rating of an electric railway motor under actual conditions of operation on frequent intermittent load should be directly proportional to the average current input, independently of variations in current, except as the current may be governed by the limitations of satisfactory commutation.

Expressed otherwise, a motor can be readily rated as follows:

T = percentage of time the motor is operated on any current I. Then within the limits of current required, as hereinbefore discussed for service operation:

$\Sigma T \times I =$ motor rating in time-current units.

The integration of the product of current and percentage of time being a constant.

As an instance, a motor might be rated at 6000 time-current units to operate in service between current limits of 100 amps. and 250 amps. This motor on continued intermittent service ought not to have a greater temperature rise than the one agreed upon whether operating on 100 amps. 60 per cent of the time, or on 250 amps. 24 per cent of the time, or on any combined products of current and percentage of time integrating 6000 units.

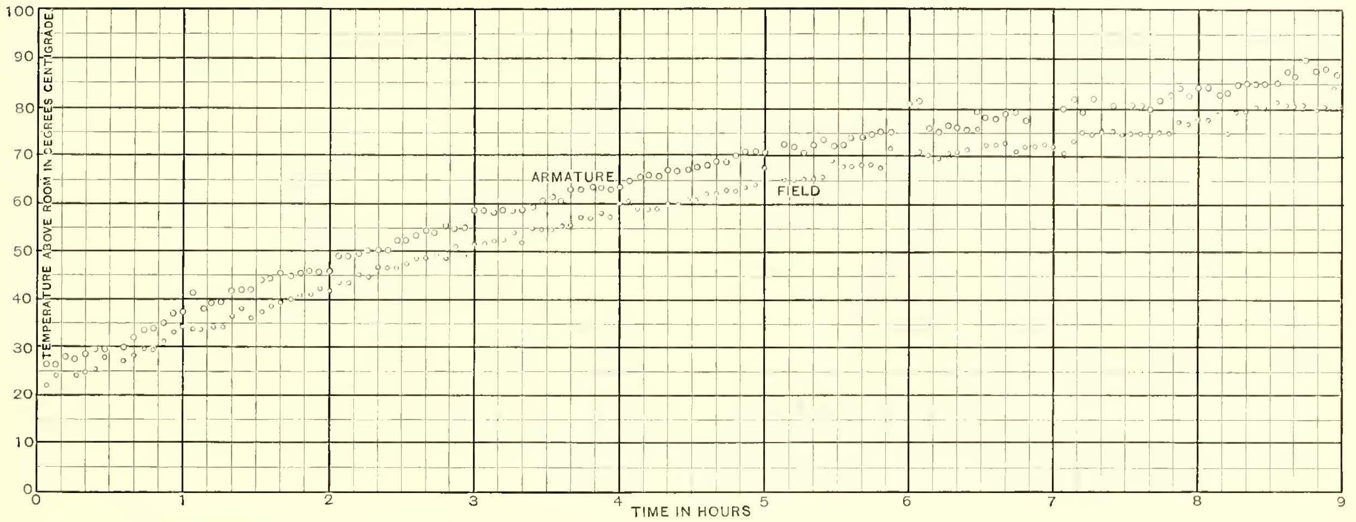
In testing, the total time of any cycle of test should be such that the temperature will not drop appreciably during the portion of the time that the current is off, this being the method of operation referred to as continued intermittent service.

designated "X," showing temperatures attained in field and armature, as measured by resistance, on the intermittent loads given in the above example. Whether or not this motor may properly be rated at 6000 time-current units may be judged from the temperature curves. Further

THERMAL TEST OF RAILWAY MOTOR X
RUN A 4
250 Amperes. 24% of Time. 4 Min. Cycle.

Average Room Temp. 22°C.
Average Voltage 500
Average Speed 580

Current for Resistance Readings: Armature 128 Determinations, 79.5 Average Amps., 7.6 Average Seconds; Field 131 Determinations, 60 Average Amps., 11.5 Average Seconds



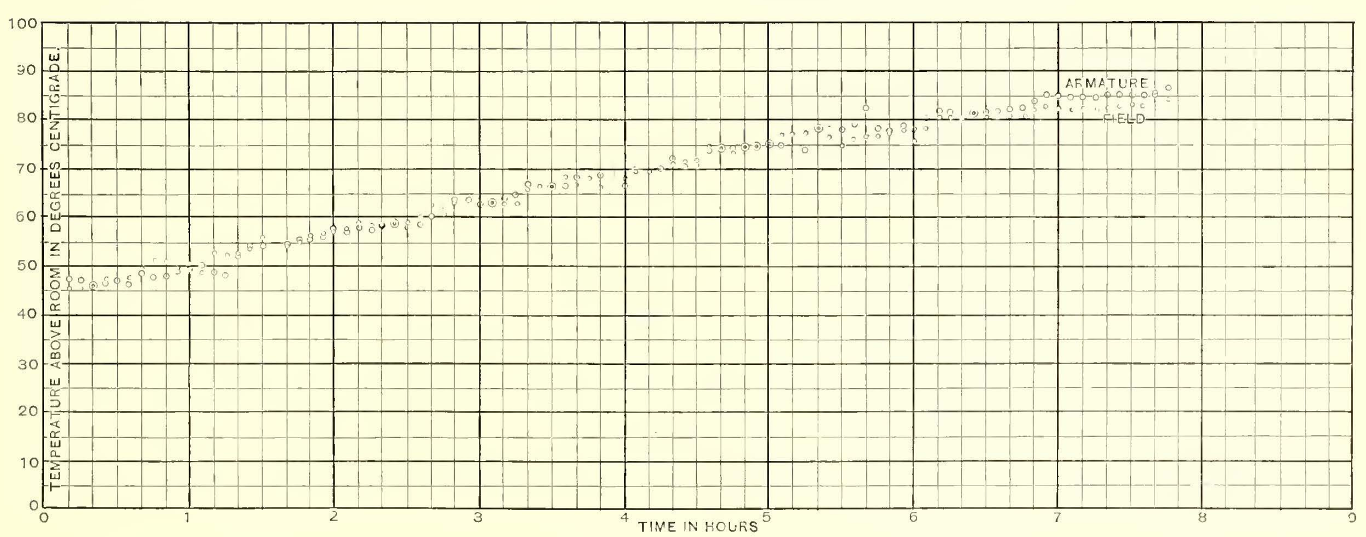
Objection may be made to stationary tests of a motor on this basis that service operation is calculated to induce better ventilation; also, that with varying conditions of starting on the rheostat, the core heating will differ from that produced by the same current at line voltage. To both comment on these tests would necessitate reference to specific professional work, which at present is undesirable.

The advantage of such a motor rating as has been proposed would simplify the selection of motors for specific service, for the following reasons:

THERMAL TEST OF RAILWAY MOTOR X
RUN A 5
300 Amperes. 20% of Time. 5 Min. Cycle

Average Room Temp. 22°C.
Average Voltage 500
Average Speed 545

Current for Resistance Readings: Armature 91 Determinations, 16 Average Amps., 6.7 Average Seconds; Field 91 Determinations, 56 Average Amps., 10.4 Average Seconds



of these objections may be given the general answer that if the motor will stand the shop test, then service operation on the average current ought to produce heating within the temperature limit, which certainly cannot be objected to.

The writer has had occasion to subject several railway motors to such a seriesw of tests, and submits herewith the results of a series of runs on a motor, for obvious reasons

First.—The rated capacity of the motor would be directly proportional to the average current required at the motor, being the average current multiplied by 100 in time-current units.

Second.—The sum of the operating motor capacities expressed in average current at cars would equal the load on the station after making due allowance for the modifications due to series-parallel operation and for line losses.

STREET RAILWAY JOURNAL

OCTOBER 13, 1900.

PUBLISHED WEEKLY BY

THE STREET RAILWAY PUBLISHING COMPANY

MAIN OFFICE:

NEW YORK, BEARD BUILDING, 120 LIBERTY STREET.

Chicago Office: Monadnock Block.

Philadelphia Office: 929 Chestnut Street.

London Office: Hastings House, Norfolk St., Strand.

Long Distance Telephone, "New York, 4044 Cortlandt."
Cable Address, "Stryjourn, New York."—Lieber's Code used.

TERMS OF SUBSCRIPTION.

In the United States and Canada	$4.00 per annum
In all Foreign Countries, per annum	$6.00 / 25/ / 31fr.

Subscriptions payable always in advance, by check (preferred), money order or postal note, to order of C. E. WHITTLESEY, Treasurer.

The importance of the convention at Kansas City this year and the extent of the street railway industry justifies the publication by us this year of an "International Engineering Number." The contributors to this issue are all eminent the world over as authorities on the subjects on which they treat, and, as the broad principles of electric railroading are the same in all quarters of the globe, the discussions will be equally useful to the railway manager in America, Europe, Asia and South America.

* * * * * *

American methods are shown clearly by the typical installation in Kansas City. Although the system there is not so large as that which other cities of greater population can boast, it is far greater than in cities of similar population abroad, and the recent electric equipment is modern and in accordance with the latest American practice. Figures are given of the cost of operation of the power station, which show that it ranks exceedingly high in the economy of its production. The park business has been well developed, as the various views in the first article amply testify, and the track and rolling stock are in excellent condition.

* * * * * *

How the methods employed in street railway engineering are modified to suit French conditions is the subject of the second article in this issue, by A. N. Connett. Mr. Connett reports that greater care is taken in France to secure a tasteful overhead construction than in America, and the methods followed, as well as some of the designs of details and overhead work submitted, are worthy the serious consideration of American managers. The statement is also made that mechanical traction has supplanted horses in the larger cities of France, with the exception of Toulouse and Paris, and that in the former city the delay has been due to local conditions, and will disappear within a few months. Mr. Connett is an authority on the subject treated by him, owing to his long residence in France, and seeing, as he does, through American eyes, his conclusions carry great weight.

* * * * * *

The subject of electric generators for street railway service is discussed by Horace F. Parshall. Mr. Parshall has treated this subject from a new point of view; that is, he has assumed an efficiency. That this is warrantable is apparent when we consider that the commercial value of a generator is determined by its efficiency; from the efficiency, of course, the losses are known. Mr. Parshall then proceeds to locate these losses in accordance with the best established practice, and from the constants assumed obtains the surfaces of all the parts. As the surface is determined from two dimensions, if one of these dimensions can be determined by some other feature, the dimensions of the generator as to length of armature field magnets, etc., are obtained. Mr. Parshall determines these dimensions in respect to the magnetic limit of output, particularly in regard to the self-induction and the maximum current per pole, consistent with the proper thermal conditions of highest efficiency. He then gives as an example the principal data of a 550-kw machine, which he has selected as a model.

* * * * * *

Mr. Lundie takes up a description of the electric motor. He first shows that a study should be made of most economical method of train operation, the effect of different accelerations, brakings, etc., being considered. These having been determined, the engineer must take up the capacity and durability of the motor for work; in this consideration, the ability of the motor to withstand heat is one of the most important factors. He then discusses a method of rating the horse-power of railway motors, which, he argues, on frequently intermitting loads, should be proportional to the average current input, independent of the variations in the current. This will be found contrary to the usual practice, but Mr. Lundie has long been an advocate of it, and brings many arguments to sustain his position.

* * * * * *

The broad principles of rolling stock is the subject next taken up, by H. H. Vreeland, president of the Metropolitan Street Railway Company, and the thread of argument is continued by Thomas Millen, master mechanic of the same company, who describes in detail the four standards used by the company in New York, with certain devices which they have found convenient in car construction and operation. Mr. Vreeland's paper is really more than an article on cars, for he treats on general traffic conditions and the best methods of handling them. While he expressly limits himself to the conditions existing in New York City, all that he says on the subject is valuable, as much of the practice of New York City is eminently suited to other cities' service.

* * * * * *

Mr. Clark devotes himself in his article to a study of financial conditions and methods of promoting companies abroad. He shows that these do not differ greatly from those in this country, and that foreign bankers are alive to the financial possibilities of the street railways, not only of their own country, but in America as well. Mr. Clark is a careful student of street railway finance, and his article will be read with much interest.

* * * * * *

The polyphase situation is summed up by Dr. Louis Bell, who has given special attention to this branch of electric railroading. Dr. Bell not only treats of the latest American practice in polyphase distribution, but also refers to the use of polyphase motors for railway work, and gives some particulars of the work of an American company in this direction. Heretofore the activity in this line has been confined almost exclusively to Swiss manufacturing companies, but with the wider experience gained in the use of polyphase motors, their application for commercial work in this country seems not so very far distant.

* * * * * *

Three foreign tramway systems are described: The Berlin elevated railway represents the latest practice in Germany in this branch of engineering, and views are given of the structure, which show that æsthetic conditions have been borne in mind by the engineers in charge of the work. The tramway system of Rio de Janeiro has never before been described. While the city seems naturally well suited for tramways, the different sections being separated from each other by high hills and mountain ranges, electricity has not played any considerable part in the service as yet, and only a short portion of the system is electrically equipped. Finally a typical British installation is shown in the case of the Carlisle tramways, with its double-decked cars and other characteristic features.

* * * * * *

In this issue also a most valuable set of figures is made public for the first time in the table showing in detail the operating expenses, total and per car mile for the past year, of the cable and electric systems of the Metropolitan Street Railway Company, of New York. That the change of the Broadway line from cable to electric power is justified is clearly shown by this comparison, and to the managers of the company is certainly due the gratitude of all others engaged in electric railroading, for the generosity with which this company has presented its detailed operating expense sheet to the public.

* * * * * *

Finally, a brief sketch is given of some of the important Americans who are managing tramway affairs outside of the United States. This will be a surprise to many, who, while aware that many workers in this field have taken up residence across the water, have not realized the extent to which this has been done, or the influence exerted in tramway affairs by American engineers and managers. In this connection it may not be amiss to bear in mind that this predominance of Americans in the world's tramway affairs, up to this time, has been due, in large part certainly, to a practical absence of competition in the manufacture of tramway apparatus in all countries outside of Germany and possibly Austria. That this will not continue in the same degree, however, is evident from the energy with which the British manufacturers, not to mention those of other countries, are entering the field. There are already at Preston, in Lancashire, works for the manufacture of electrical apparatus and cars, which rival in appointments and capacity some of the largest in this country. Other important companies in England are also acquiring or increasing their facilities for the manufacture of electric railway apparatus. We believe that the growth and extent of the business during the next ten years in all parts of the world will certainly be sufficient to tax all the manufactories of this class of machinery, as well as those projected, but it is certain that in many classes of apparatus American makers will no longer have the same monopoly abroad that they have heretofore enjoyed.

The Balance of Trade in Engineering

For the past fifteen years engineers on both sides of the water have been busily engaged in working up the apparatus of electric lighting, traction and power transmission, and now that we are passing through a somewhat quiescent period in development, a period characterized rather by refinement of method and increase in the scale of engineering works than by striking novelty or brilliant invention, it is a good time to look over the field and estimate as nearly as may be the importance of the friendly services which have been rendered by engineers here to those abroad, or vice versa.

Following the progress of any one particular invention or method, one often finds a curious tendency for it to shift back and forth across the Atlantic through many hands and many diversities of fortune before it settles into a definite, accepted place in the world's engineering. So, if one were to attempt to draw up a balance-sheet of the trade in improvement and invention between America on the one hand and England and the Continent on the other, it would be puzzling, indeed, to adjust equitably the relative debits and credits of the case. Nothing more than a study of this kind shows the respective intellectual tendencies of engineers on the two sides of the ocean, and with them the moving spirits of the countries they represent. For example, take so familiar an object as the great direct-connected dynamo, with which the generating stations of the world are, broadly speaking, now equipped. Substantially, this practice of direct connection had, at least on a commercial scale, its origin in the "Edison Jumbo" dynamos—nearly twenty years ago the great steam-driven dynamos that were to revolutionize the world's practice.

These machines produced a tremendous sensation, and, moreover, some of them did sterling work for nearly a decade; but the example set so early and clearly produced a relatively small impression on the art in this country. Year after year went on, and station after station was equipped with high-speed, belt-driven apparatus. Meanwhile, very slowly, but with certain steps, the multipolar design worked its way into favor abroad, while much neglected on this side of the Atlantic. With the multipolar dynamo came slow speed, and with it, again, direct connection to the motive power.

When apparatus of this kind began to find favor abroad, none seized upon its advantages more promptly than the American engineers, and they immediately set to work to develop multipolar, direct-driven generators to a point hardly imaginable by those who introduced the practice. The result is that at the present time America leads the world in the building of colossal direct-connected generating sets, while the more conservative engineers abroad are still clinging to belt and rope-driven apparatus in many cases, where an American would unhesitatingly use direct connection.

This is only one of numerous examples of a similar kind. The induction motor, for instance, was invented on this side of the Atlantic, but in spite of its sensational character the invention made small progress in this country until its possibilities had been demonstrated abroad at the Frankfort Exposition of 1891. Immediately the Americans jumped to the front in the development of polyphase apparatus, and have pushed forward the art of power transmission until there are more plants running in some of our States than in whole countries of Europe. The development of this branch of the art has been, in fact, the feature of the last decade, and the American engineers have been ahead, and kept ahead, most of the time. Even the rotary converter, which has now taken such an important place in street railway practice, has passed through similar vicissitudes. Invented in our own country by Bradley, it was brought into prominence, far less, however, than it deserves, by the Frankfort Exposition of 1891. To tell the truth, it was at that time and place so overshadowed by the Lauffen-Frankfort transmission that its real importance was dwarfed. It is probably safe to say that if that sensational feat of power transmission had not been performed the rotary converter would have been the most striking exhibit at Frankfort. The cue, however, was promptly taken by the American engineers, urged on by the impending installation of the great works at Niagara, and since that time the rotary converter has come rapidly to the front to see itself as part, and an important part, of the material of railway engineering. We Americans have been most zealous in its adoption—perhaps even too zealous sometimes—but, as in the other instances named, it has crossed and recrossed the ocean. Possibly, as in the case of whisky and cotton-seed oil, the sea voyage may have been assumed to do it good.

Sometimes, however, the initiation and development of engineering methods abroad have not met a prompt response here, and only slowly and even grudgingly have other improvements been recognized, whether the original invention was American or foreign. A fine type of this phase of the case is found in the slotted conduit electric road, which found its practical initiation in the United States from the pioneering skill of Bentley and Knight, very early in the art of electric traction.

The rise of the overhead trolley, which offered a cheaper means of attaining the same end, put the conduit out of sight; for Americans were not yet ready to go to the necessary expense to make it successful. Taken up abroad and developed as a practical working method at Buda-Pest and elsewhere, it was very slow in coming home again, and American engineers and tramway managers were only driven to its use by the iron hand of necessity. When once, however, they took up the problem seriously success was very quickly attained, and the development along this line has since been brilliant and widespread.

In similar fashion, the use of polyphase motors for traction purpose, although early suggested in this country, came to nothing; while abroad it has been taken up and has become one of the recognized methods for operating railways of the interurban or long-distance types. What its future fate in the growth of the art will be it is hard to say, yet it would not be surprising to see the history of other developments repeat itself and the polyphase motor finding its way into considerable, if by no means general, use here.

The grooved rail for urban traction is another excellent example of tramway practice brought into great prominence abroad before being adopted to any considerable extent in this country. American engineers have not liked it, nor do they like it to-day, yet it is forcing its way into widespread use.

It would be possible to go on citing instances of apparatus shifting back and forth across the ocean to a far greater extent than we have here attempted, but the examples already described are sufficient to show the general and important character of this form of international trade. It, perhaps, is not safe to generalize in such a manner, but it would look a little as though the good American motto of "nothing succeeds like success" finds another application in this instance.

American engineers have always been daring in invention, but unless large returns are not only in sight, but within grasp, the inventions are very slow to be adopted. Possibly the key to the situation may be found in the fact that until very recently the average return on investments in this country has been assumed to be conspicuously greater than abroad. Here we have for years expected at least 5 per cent or 6 per cent, where in England and on the Continent, 3 per cent or 4 per cent has been relatively as good a return upon the investment. Consequently, methods looked on as dubious here from the standpoint of financial return, might easily there be judged as likely to lead to fairly economical results. Whether this be the cause of the phenomenon or not it is certain that it has often been necessary for apparatus and methods to be reduced to working success abroad before they have found acceptance here, even when they were American in their origin. American practice has systematically pounded away at methods not always the best possible, but known to be profitable from the American standpoint. The result has been that the growth of engineering works in this country has been concentrated for a considerable period along a certain line of progress, and has only been deflected therefrom by necessity or by the certainty that some other line would yield equal or better returns. Abroad, while usually sluggish in taking up radical departures, it has been possible for engineers to adopt methods from which the Americans have turned in the hope of greater profit elsewhere. Eventually all these questions are determined on their strict merits.

Nothing shows better than this growth of the art back and forth across the ocean, the intuitive quickness of the American spirit in grasping opportunities for great and rapid profit, and the cautious conservatism abroad in selecting methods practically adaptable to their environment—even when the prospect of immediate return was less.

American energy and fertility of invention has produced a pronounced effect on the growth of all the electrical arts, but perhaps the comparative slowness and caution of the foreign engineers has, on the whole, exercised a salutary influence in steadying and rendering more symmetrical the rapid progress of American engineering.

J. A. RIGG

H. H. VREELAND

N. S. HILL, JR.

J. M. ROACH

C. S. SERGEANT

J. R. GRAHAM

OFFICERS AND EXECUTIVE COMMITTEE, AMERICAN STREET RAILWAY ASSOCIATION

F. G. JONES

W. H. HOLMES

T. C. PENINGTON

C. W. WASON

W. F. HAM

W. G. ROSS

C. K. DURBIN

C. N. DUFFY

J. F. CALDERWOOD

C. L. WIGHT

OFFICERS AND EXECUTIVE COMMITTEE, STREET RAILWAY ACCOUNTANTS' ASSOCIATION OF AMERICA

E. M. WHITE

W. B. BROCKWAY

C. O. SIMPSON

THE COMING CONVENTIONS AT KANSAS CITY

KANSAS CITY AS A CONVENTION CITY

The American Street Railway Association has turned westward for the second time in two years for the place of holding its annual convention, and in Kansas City will be nearer the Pacific Coast than at any time of its previous meetings. While some of the street railway companies belonging to the association, who are located in the far East, may think that the West has been unduly favored in the selection for two successive years for a gathering place, they will find much to interest and instruct them in the city selected for the October convention. Historically, the city has played an important part in the electric railway industry. Partly from topographical reasons, which made the employment of mechanical power on its system important, the city was one of the first, east of the Rocky Mountains, to introduce cable traction. It is an interesting fact that many of these cable lines are still in operation in spite of the progress made in electric methods of propulsion. Again, in 1886, the city was the site of the early electric railway experiments by Henry, and boasts the great distinction of being the first city in the world in which the overhead trolley was successfully applied to commercial work. In the later improvements in the science of electric railroading, the city has kept abreast with the times, and under the able management of the Holmes Brothers, the Metropolitan Street Railway Company, the principal company in the city, has been brought to a high state of perfection. Although extensive alterations in power generation and distribution are being considered, the company's existing station is equipped with the latest large 1600-kw generators, and, as described elsewhere, shows an economy of operation and low cost of power production, which is perhaps not rivaled by any other railway power station in the country, using steam engines.

The topographical features of the city, while inducing street railway traffic, have also thrown upon the street railway company expensive engineering work, and the way in which the different problems relating to high climbing and in overcoming grades have been solved will prove of interest to those who operate street railways in cities similarly situated. The company has also made advances in track construction, introducing a number of new ideas, particularly in the use of concrete for supporting the rails. Some of the most important of these features of track construction were described by Mr. Butts at the Chicago convention last year, and other details of the company's practice in Kansas City are described fully elsewhere. The park question has also been carefully considered, and some of the most attractive parks in the city are owned and controlled by the traction companies. Outside of the city the principal interurban line is to Leavenworth, Kan. This is a modern high-speed road, and an excellent example of the many of its type which are being gradually introduced in all sections of the country.

Summing up, the American Street Railway Association made no mistake in selecting Kansas City as its meeting place for 1900. The list of papers prepared by the secretaries of the Street Railway and Accountants' Associations are on important subjects, which will be treated by well known authorities, and the convention promises to be the best yet held by the association.

AMERICAN STREET RAILWAY ASSOCIATION

The papers to be read at the nineteenth annual convention of the American Street Railway Association have been announced by the secretary as follows:

"Consolidation of Street Railways and Its Effect upon the Public," by Daniel B. Holmes, counsel, Metropolitan Street Railway Company, Kansas City, Mo.

"A Comparison of the Various Systems of Electrical Distribution for Street Railways," by C. F. Bancroft, electrical engineer, Massachusetts Electric Companies, Boston, Mass.

"Painting, Repainting and Maintenance of Car Bodies," by F. T. C. Brydges, superintendent of car shops, Chicago Union Traction Company.

"The Store Room and Store-Room Accounts," by N. S. Hill, Jr., general manager, Charleston Consolidated Railway, Gas & Electric Company, Charleston, S. C.

"Double-Truck Cars: How to Equip Them to Obtain Maximum Efficiency Under Varying Conditions," by N. H. Heft, president, Meriden Street Railway Company, Meriden, Conn.

Regular sessions of the association will be held on Oct. 16-18. Friday, Oct. 19, has been set apart as a day for the examination of the exhibits. No session of the association will be held on that date, so that all may have plenty of time to view the exhibits. It is earnestly requested that managers have their heads of departments present on that day. The annual banquet will be held at the Coates House, Friday evening, when the officers elect will be installed.

The headquarters of the association will be at the Midland Hotel.

STREET RAILWAY ACCOUNTANTS' ASSOCIATION OF AMERICA

The programme of the convention at Kansas City of the Street Railway Accountants' Association of America shows that a most interesting meeting may be expected. In addition to the papers and reports to be presented a very important addition has been made to the collection of blanks; thus the interest aroused at Chicago will be continued this year. An examination of this exhibit gives an understanding of the part taken by blanks and forms in the construction and operation of the properties, an understanding necessary to the successful financial, operating or accounting officer.

As required by the by-laws, formal notice has been given that a change is proposed in Article VII. of the by-laws. This change will undoubtedly be the subject of earnest discussion.

Following the plan of the third annual convention, the programme provides for three half-day sessions, allowing the whole fourth day for examination of the exhibits. This includes the exhibition of blanks, which will be open the whole day. The value of this exhibit has been greatly enhanced during the past year by the addition of the blanks and forms of new member companies, as well as of other companies which have not exhibited before. In addition to the regular forms used in accounting Secretary Brockway has been assiduous in collecting, during the past year, samples of rubber stamp impressions used in street railway work. In this connection he requests the assistance and co-operation of those companies who have not contributed to this collection. The stamp exhibit will be in a separate book from the present files, and the impressions will be in general on separate sheets, about 4 ins. x 6 ins.

The programme, in detail, is given below:

MONDAY, OCT. 15, 1900

7:30 p. m. Meeting of the executive committee at the Midland Hotel.

TUESDAY, OCT. 16, 1900

10 a. m. At the convention hall.

Address of Welcome.

Annual Address of the President.

Annual Report of the Executive Committee.

Annual Report of the Secretary and Treasurer.

Regular business routine.

Paper: What does the General Manager want to know from the Accounting Department? By John I. Beggs, general manager, Milwaukee Electric Railway & Light Company, Milwaukee, Wis.

Report of Standing Committee: On a Standard System of Street Railway Accounting. Chairman C. N. Duffy, auditor Chicago City Railway Company, Chicago, Ill.

WEDNESDAY, OCT. 17, 1900

10 a. m. Convention Hall.

Paper: The Routine of a Street Railway, Electric and Gas Lighting Company. By C. O. Simpson, auditor Augusta Railway & Electric Company, Augusta, Ga.

Report of Committee: Is a Standard Unit of Comparison Practicable? Chairman H. C. Mackay, comptroller Milwaukee Electric Railway & Light Company, Milwaukee, Wis.

Paper: Departmental Accounts. By H. L. Wilson, auditor Boston Elevated Railway Company, Boston, Mass.

THURSDAY, OCT. 18, 1900

10 a. m. Convention Hall.

Paper: Material and Supply Accounts. By W. M. Barnaby, accountant Brooklyn Rapid Transit Company, Brooklyn, N. Y.

Informal Discussion upon any subject in Street Railway Accounting. (This is to be in every sense informal.)

Reports of Convention Committees.

Election and Installation of Officers.

Adjournment.

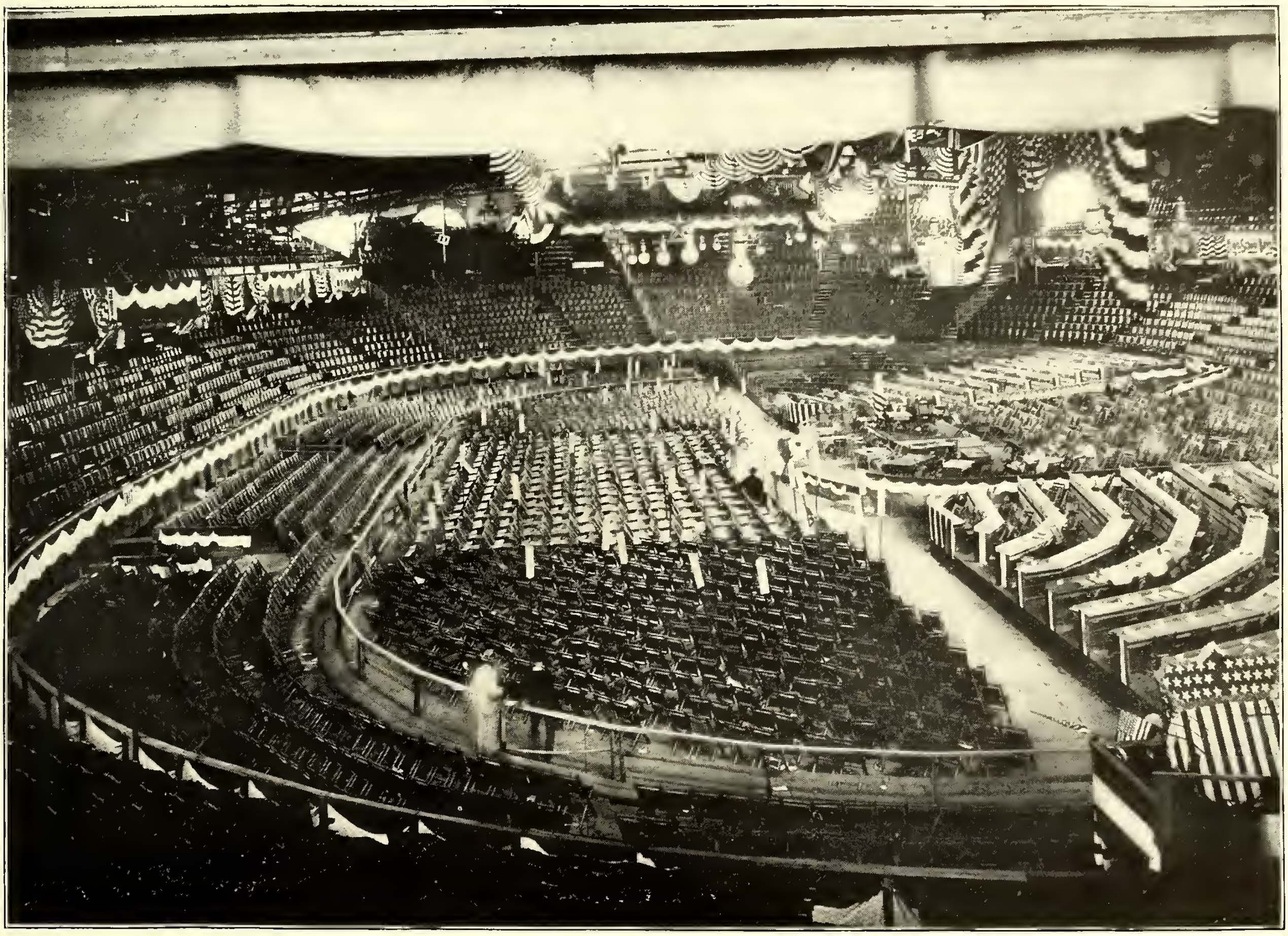
EXTERIOR OF CONVENTION HALL, KANSAS CITY

THE EXHIBITS

The exhibits, as announced, will be shown at Convention Hall, which is one of the largest open halls in the country, and is admirably adapted for this purpose. It was erected this spring to replace an older hall on the same site, which was destroyed by fire, and is easily accessible from the principal hotels in the city.

The applications for space from companies intending to exhibit have been unusually large, and at the time of going to press practically all the space available had been taken. A general plan of the convention hall was published in the Street Railway Journal for Sept. 8, with the assignments of space which had been made up to that time. The headquarters of the Street Railway Journal will be found close to the entrance, on the left-hand side, and all visitors will be cordially welcomed.

Two views of the Convention Hall are shown in the accompanying engravings, one of which is of the exterior, the other of the interior. In the latter the arena is filled with seats, as the photograph was taken just before the hall was used for a national political convention last July. Of course during the street railway convention these chairs will be removed for the accommodation of the exhibits.



INTERIOR OF CONVENTION HALL, KANSAS CITY

TRANSPORTATION TO KANSAS CITY

A special rate of a fare and a third will be granted, as usual, to attendants at the convention. Persons purchasing tickets will pay full fare going to Kansas City, and should ask the ticket agent for a certificate, which, when properly countersigned at Kansas City, will entitle the holder to a return ticket at one-third fare.

Any of the principal lines from Chicago to Kansas City including the Burlington, Alton, Santa Fe Route and Rock Island will be found convenient from that city. From New York and the East the transportation committee appointed at the last convention has made arrangements for special accommodations over the New York Central Railroad, the Big Four and Wabash Railroads. These companies will run a special train, leaving New York about 10 o'clock Sunday morning, and reaching Kansas City Monday evening. A representative of the New York Central Railroad will accompany the party to Kansas City. The train from Boston leaves that city at 10:45 Sunday morning, and is due to reach Kansas City at 7 a. m. Tuesday.

A full statement in regard to the several trains running to Kansas City will be found elsewhere in this issue.

THE ENTERTAINMENTS

A full programme of the entertainments to be provided for the delegates and the other attendants at the two conventions has not yet been published. There are many interesting points to the visitor, however, in the neighborhood of Kansas City, and the local committee has intimated that this feature of the convention will be well cared for. Of course the principal feature of the social side of the convention is the annual banquet. This will be held at the Coates House on the evening of Friday, Oct. 19, when the officers elect will be installed.

CARS AND CAR SERVICE IN METROPOLITAN NEW YORK

BY H. H. VREELAND

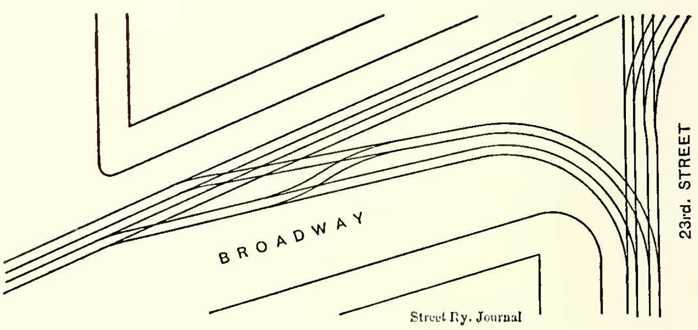
When I first came to New York in 1893 I assumed charge of a horse railway system comprising 123 miles of track, the backbone of which was the Broadway line, running from the Battery to Fifty-Ninth Street. On this Broadway line an unusually fast horse car service, with 16-ft. cars, was being given, while on the rest of the system 12-ft., 14-ft. and a few 16-ft. cars were run on comparatively slow schedules. The upper part of the city above Fifty-Ninth Street seemed like a country town, with horse cars dragging lazily along at intervals of from fifteen to thirty minutes.

I found the Broadway cable system nearly ready for operation. The first cable cars were 22 ft. in body length, and 30 ft. 6 ins. over all. The width at the windows was limited to 7 ft., on account of the small distance between the two tracks on Broadway, and the danger of crushing wayfarers between the cars. The cars were mounted on four-wheel trucks, were equipped with the Millen safety brake, and were protected by heavy bumpers. They had a (crowded) seating capacity of thirty-two passengers, and entrance and exit were made as easy as possible by ample platforms, low steps and double sliding-doors. The window space was also large, Pintsch gas was adopted for lighting, and, altogether, the first Broadway cars had a bright, clean, elegant appearance, which made them the most popular in the city.

Enough of these cars had been purchased by the former management of the Broadway system to provide for a one-minute schedule on that line, but it quickly became evident not only that such a schedule could not possibly serve half the people who wanted to ride, but also that interest could not be paid upon the enormous cost of the original line and its cable equipment. Orders were quickly placed, therefore, for additional cars, aggregating several times the original order, the load on the cable lines and station was so divided as to carry this larger number of cars, a sufficient force of inspectors was distributed along the line to properly pass the cars over crossings and through terminals, patrol wagons were placed within easy reach of the different parts of the line, so as to help in breaking up blockades —and cars have been running on Broadway at ten to fifteen second intervals for many years past.

The Columbus and Lexington Avenues extensions of the Broadway cable system involved no special traffic difficulties except at Twenty-Third Street and Broadway, where Lexington Avenue cars running at twenty-second intervals have to be thrown in between the Broadway main line and Columbus Avenue cars, passing, often, at fifteen-second intervals. This is quite a pretty little problem in switching, and it was feared at first that it would give us some trouble, but a way was found to do this work satisfactorily by means of what may be called "auxiliary waiting tracks," which meet and depart from the Broadway line on curves of such large radius as to expedite the car movement, and reduce delays to a minimum. Fortunately Broadway broadens at this point, so that this can be done.

Switchbacks at various points on the Broadway, Columbus Avenue and Lexington Avenue lines have been established so as to serve the different classes of travel, and it has been for some years impossible to materially increase the very large number of moving cars along the main Broadway stem from Fifty-Ninth Street to the Battery. The average time interval between cars on any line is, of course, determined by the number of cars which can pass through its most congested crossing or terminal—not by the average number which can be distributed along the entire line. The limit of the car movement on Broadway is fixed by the Twenty-Third Street crossing, not by the south Battery terminal, as many may suppose, for the number of cars which reach the latter point are by no means the entire number on the line, but are comparatively few, and can easily pass around the Battery Park loop or through the South Ferry stub terminal. At Twenty-Third Street and Broadway, however, a line of north-bound and south-bound cars, each crossing at ten-second intervals, meets a line of east-bound and west-bound cars, each crossing at fifteen-second intervals, and 200 ft. away comes another heavy switching point for the Lexington Avenue cars. The only way in which crossing work of this kind can be done is shown herewith. A Twenty-Third Street east-bound car almost touches the rear platform of a Broadway south-bound car as the former enters and the latter escapes from the crossing. It is evident that such crossings are made possible only by the most carefully trained force of inspectors, and I may as well here express my belief, in a somewhat emphatic way, that the secret of properly moving cars through congested districts is found in an ample force of inspectors, trained to save every second, and take advantage of every opening.



PLAN OF TRACKS AT BROADWAY AND TWENTY-THIRD STREET

The beginnings of our electric system were, as is well known, made on Lenox Avenue, north of Central Park, and it was here that the experiments were made which led us to decide to equip a large part of our system with a motive power which is, on the whole, vastly superior to the cable system, both in capacity for handling traffic and in economy of operation. In place of the slow-moving, infrequent and wholly uneconomical horse cars, we have put upon several of our main north and south lines and a few of the crosstown lines a clean, rapid, frequent and largely patronized electric service, which has probably done more to build up the city north of Fifty-Ninth Street than any other one influence of the last ten years. Three years ago horse cars made the round trip from Madison Avenue and 138th Street to City Hall and return in about three hours, and less than 200 cars were needed to handle the 17,000,000 passengers who offered themselves for the journey. To-day the round trip is made in less than two hours by the electric cars, and some 300 cars, each nearly double the passenger capacity of the old horse cars, are required to carry nearly 50,000,000 passengers, who patronize this route. I do not know much about the public of other cities, but I do know that the New York City public responds instantly to every improvement in traffic offered, and the balance of popularity between the elevated and surface lines or between parallel surface lines is so delicately adjusted that a single improvement in one or the other often means a change in the daily riding habits of thousands upon thousands of residents.

VIEW AT CORNER OF BROADWAY AND TWENTY-THIRD STREET, SHOWING CONGESTION OF CAR TRAFFIC AT THAT POINT

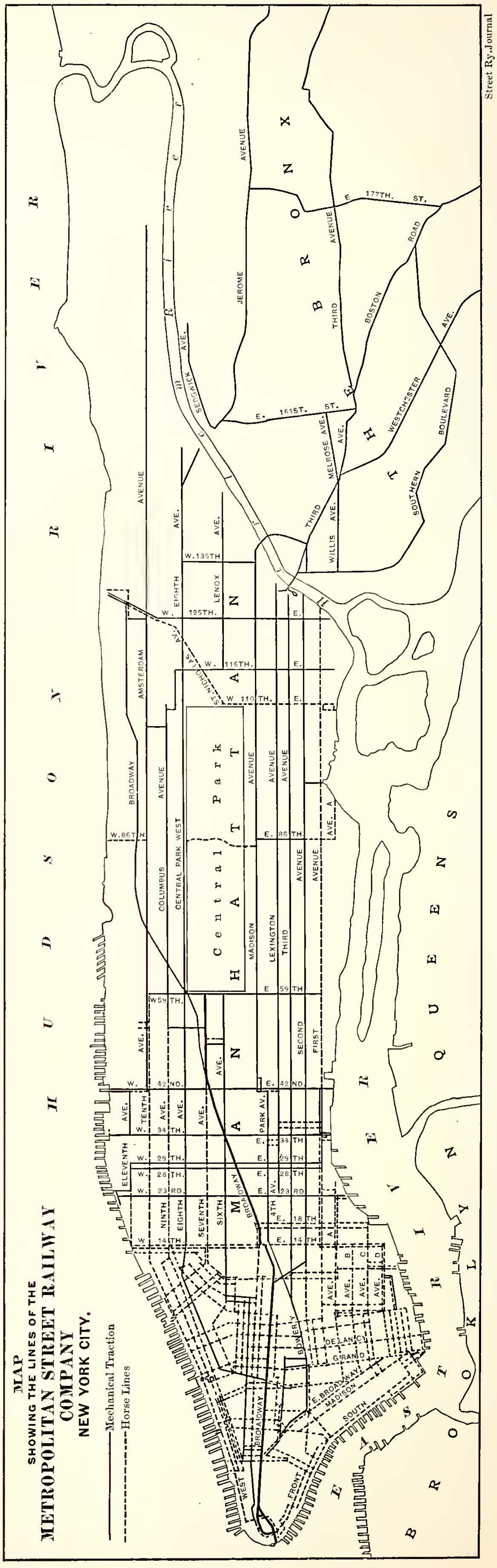
When we first started on our electric railway experiments, we used the same type of car as had proved popular on Broadway, namely, the 22-ft. body, with a single (extension) truck. We soon found, however, that the increase of travel along our electric lines was so rapid that the limit of car and passenger movement would be too quickly reached, and we therefore determined to adopt long, double-truck cars, both open and closed. These have a greatly increased passenger capacity, but can be passed through the most congested "neck" of the system practically as rapidly as the smaller cars, thus adding about 40 per cent to the passenger carrying capacity of our lines without increasing the car unit capacity. By these cars also we can, of course, reduce the transportation cost of conductors' and motormen's wages per passenger carried. A limit to the building of these long cars is, however, set by the heavy trucking along New York streets, by the narrowness of many of these streets, by the sharp curves which are in many places unavoidable, and by the elevated railroad pillars, which are oftentimes badly placed with reference to these curves. Even where there are few difficulties of this kind in the large north and south lines, there is sometimes a limit to the width and length of the cars by the narrowness of a few cross streets, as by Fifty-Ninth Street, for example, through which the Sixth Avenue cars must pass to reach Amsterdam Avenue. To show how closely we have to consider every little detail in the matter of car widths, etc., I would say that we are unable to use straight sided cars in New York because the 2 ins. gained by "cutting under" the lower panel means the difference between passing through a street crowded with trucks or getting blockaded every 100 ft. The outer hubs of trucks standing close to the curb in many of the streets, particularly in the lower part of the city, would strike a square sided car and prevent its passage.

The car finally selected as our standard electric car has a 28-ft. body, mounted on double pivoted trucks, and gives us an increased carrying capacity of about 40 per cent, with but very slight advance in the cost of car service, motive power and maintenance. The pivotal trucks take the curves well, and save a good deal in wear and tear of roadbed, while the body of the car is only an inch higher than that of the four-wheel car. Large as they are, these cars start quickly owing to the increased tractive force in the motors, made possible by the disposition of greater weight on the driving wheels, and they are easily controlled by hand brakes similar to those used on cable cars. In general appearance and in exterior and interior finish these cars are merely larger editions of the 22-ft. single-truck cars originally described.

For several years after the establishment of a cable service on Broadway, closed cars only were used, as it was then believed impossible to pass open cars through so crowded a street without too great danger of injury to passengers. The traffic on Broadway was, of course, very heavy in the morning and late afternoon, and was almost equally heavy in the middle of the day, because of the vast amount of short distance riding to and fro on this street both for shopping and business purposes. After the uptown movement at night was finished, however, there were four or five hours yet left of the evening, and the traffic during these hours, particularly on lower Broadway, was small and unsatisfactory. I determined to cultivate traffic at these hours by putting on open cars, and I privately determined, also, to quietly extend the open car service experimentally into the other hours of the day to see whether the fears which were entertained were or were not justified. As a result of these experiments the evening traffic immediately increased very largely, and has since been uniformly satisfactory in the spring, summer and fall months, while there have really been quite as few accidents on the open cars traveling in daylight as on the closed cars. The New York public is sensible, and knows how to take care of itself, and has always recognized the wisdom of the rigid rule which we adopted from the start of allowing no one to stand on the footboards of open cars. The side bars used on the inner side of the car, in connection with our rule that the conductors must turn up the footboards on that side to a vertical position before starting on their trip, has been completely effective in preventing accidents on that side of the car. The open car service in New York City is as firmly established and as successful from every point of view as it is in any country village of the land.

Not long after open cars came into use with us, the city health board made a rule that a certain percentage of our cars must be closed—thus quite properly providing for invalids or others who could not stand the breezes of the open car. This rule finally led us to decide upon a plan which had been in our minds before, namely, to experiment with the "California type" of combination open and closed cars. Twenty of these cars (illustrated in the following article) were ordered, and while complying, as they did, with the requirements of the board of health, they also gave such general satisfaction to the public that the number has since been largely increased, and further purchases are steadily being made. The closed compartment seats sixteen people, and the open part thirty-five. Smoking can be indulged in in the open section, and this feature of the cars has been so popular that in response to what was practically an imperative public demand, these combination cars were run almost through the entire winter of 1890-1900. To the man who is well bundled up for winter travel in the comparatively mild climate of New York, a ride in the open section of such a car is a pleasure in itself, particularly when he has in addition the privilege of a quiet smoke.

I have said that the car capacity on the Broadway cable line was practically up to its limit. The passenger capacity also is nearly there so long as the road remains a cable line. By the adoption of electricity, however, with all that this means in increase of size of cars, increase in speed, ability to make up lost time, better handling of cars on crossings, etc., the passenger traffic at least will be materially increased, sufficiently so, we think, to earn a good return upon the cost of conversion, apart from the many ad-



MAP SHOWING THE LINES OF THE METROPOLITAN STREET RAILWAY COMPANY NEW YORK CITY.

——— Mechanical Traction
- - - - Horse Lines

vantages of having the entire system run by one motive power. We shall use on this line the double-truck open car, the double-truck closed car, and the double-truck combination car, such as are now used on our other electric lines.

The Metropolitan Street Railway Company has sometimes, I believe, been criticised for what is thought to be its reckless waste of money. "Why should you have two fenders on your cars?" many a manager has asked me. "I have only one, and my conductors and motormen change that to the other end of the car on the return trip." "What is the good of that mechanism for raising the footboard," another manager asks. "If you want to raise it, why don't you have your conductor and motorman do it." My answer to these questions is: "My dear sir, every second of time saved at terminals has an immense value in the operation of cars on a ten-second interval. If I should make my conductor and motorman lift off a fender from one end, carry it to the other end and attach it there, and lift up the step, it would take at least a minute, and my ten-second schedule would be thrown to the winds. Every device which we can put on a car to save time, no matter at what cost, is true economy from every point of view—it sends more cars down the line, the public has better service, and gross receipts are increased by a sum far greater than any picayune saving in interest on the cost of that device."

A few words about transfers and their influence upon gross and net earnings may not be out of place. Manhattan Island is long and narrow, and the trend of traffic is down in the morning and up at night. The cross streets are short. New Yorkers are busy people, and usually ride for a purpose. They do not care to make any more changes than necessary, and they will choose a through route rather than a transfer route, if they can find one fairly convenient at hand. The innumerable crossing points of the different lines on so large a system mean, of course, immense complexity in the scheme of transfers, and at first sight it would seem impossible to prevent large loss of revenue from the adoption of a general transfer system. We no doubt do lose many million fares each year that could otherwise be gotten, but we have proceeded on the broad ground that everything that will promote public comfort and convenience in this particular city will, in the long run, have a reflex action upon our own prosperity.

We have not, however, gone about this transfer business in a blind way. A force of inspectors is constantly studying traffic and traffic conditions, is finding out how people travel, and how they want to travel, is experimenting with new transfer routes, reducing congestion on this line and filling the cars on another, and in general is trying to so distribute the immense mass of the New York

VIEW OF LOWER BROADWAY

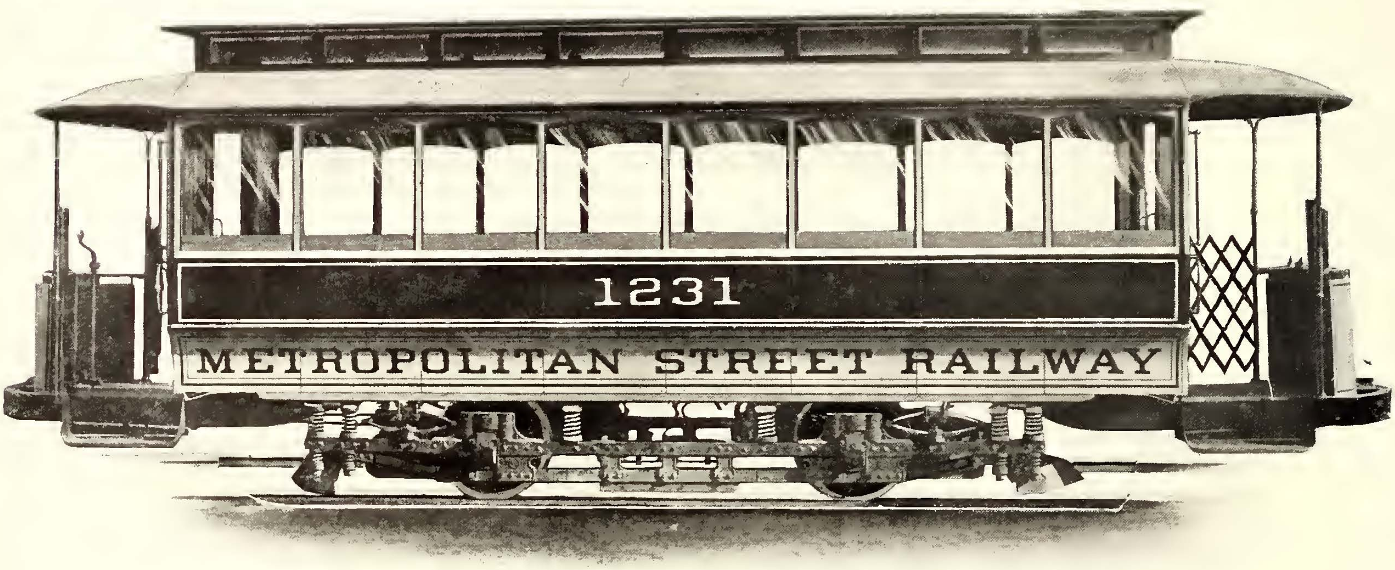
riding public which forces itself upon our cars as to give the greatest comfort and the best service to all.

The methods which we adopt in New York, however, will probably not be suited to any other city in the world. They rise purely out of local conditions, and if applied elsewhere might quite as easily lead to bankruptcy as to prosperity. All we know is that for our own conditions we are satisfied with the results, despite the fact that our gross and net revenues might very possibly be larger were we not so generous with the public.

THE STANDARD CARS OF THE METROPOLITAN STREET RAILWAY COMPANY, OF NEW YORK

BY THOMAS MILLEN

Elsewhere in this issue Mr. Vreeland has discussed the general traffic conditions in New York City, so far as they have affected the types of cars employed by us, and has given the governing reasons which have led to the adoption by the Metropolitan Street Railway Company of its four types of standard cars. The purpose of this article is to describe in detail how the principles laid down in the paper referred to have been applied in practice to our car construction, and to give, as well, some of the practical kinks which we have developed from our experience in operating cars in New York.



STANDARD SINGLE-TRUCK CLOSED CAR, NEW YORK

A wrong idea of the practice employed in the construction and operation of cars in New York City will be derived, however, unless the reader bears constantly in mind the conditions under which we operate. Of these conditions the most important is undoubtedly that of economizing time, many other considerations being sacrificed to this end. The immense traffic carried on most of our lines, the consequent short headway necessary, together with the somewhat cramped terminal facilities of many of the divisions, all give the question of time an importance which would not obtain, perhaps, in many other places. Thus, we have been criticised for equipping each end of our electric cars with fenders. This would undoubtedly be an unnecessary expense if we could afford to hold our cars at the termini long enough to allow the conductor and motorman to transfer the fender from one end to the other, but under our own conditions the time saved by not making this transfer amply repays the additional first cost of the additional equipment. Working in the same direction, we have provided handles on our open cars for raising and lowering the running-boards. With this device the side steps can be raised or lowered from the platform by either the motorman or conductor, when the car is in motion. This might seem to some an unnecessary refinement, but to us it means the saving of several seconds by each car. In the first place, the steps can be changed at the end of a route without delay; again, they can be temporarily raised from either platform to pass a vehicle of any kind in a crowded or narrow street.

In fact, if a certain operation on the road requires a minute, the energies of the operating force are bent toward reducing that minute to fifty seconds; if it takes fifty seconds, we endeavor to bring the time to forty; and if forty, to thirty-five or thirty.

A second consideration, probably ranking next in importance after that mentioned, is durability. For this end we have made a study of the best wearing body color, the most serviceable lettering, the character of interior finish most easy to keep clean and in good condition, and other details of that character, and have adopted them as standard on our system so far as the different characters of cars used permitted of their employment. Some of the methods used by us in this department are more particularly mentioned in connection with the descriptions given below of the several types of cars in use.

A third consideration is that of simplicity. This sometimes has to be sacrificed to gain running time, as, for example, in the instances mentioned above, but where it has been possible, we have sought to avoid complexity of apparatus and elaboration in finish and decoration. To those who have been accustomed to ornate ceilings, lettering, colors and other rolling-stock decorations, our cars may appear severe, almost plain. Our interior finish is ash with bird's-eye maple for the ceilings and panels; there is no colored glass in the deck-light; the seats in our closed cars are covered with Wilton carpet of tasteful design, not upholstered in plush or rattan; the main panels are painted in orange with lower concave in cream. We believe, however, that this simplicity gives a rich effect, which in the end is more satisfying than more pretentious decorations, besides being more durable. Certainly, so far as the effect is concerned, we have had no complaints from New Yorkers, who, as a rule, are pretty strict in their artistic tastes, while we have had many compliments from authorities in art, whose opinions in matters of this kind admit of no question.

Taking up now briefly the four standard types of cars in use, I will describe first the four-wheel closed cars.

The four-wheeled closed cars are 22 ft. long over the corner posts and 30 ft. over the dashers; width at sills, 6 ft.; width at belt-rail, 7 ft. They have eight windows on each side; the sash is glazed with Chance's English or an American glass, and fitted with Stephenson metal stiles, which gives a greater area of glass and makes the sash less noisy. The car has a full monitor deck roof, strengthened with five concealed steel rafters $\frac{5}{8}$ in. x 1 in., with eight movable ventilators on each side, glazed with white chipped imitation beveled-edge glass and two end transoms, which are stationary; this is done to prevent leakage in a driving storm. Double doors, with mutually operating mechanism, are used.

The open platforms at each end are 4 ft. long, with unusually strong channel steel gates; both right-hand side openings of platforms are used for loading and unloading. Each platform is held up by four platform knees or bearers made extra heavy and strong. It extends out beyond the crown pieces and takes a $3\frac{1}{2}$-in. x $7\frac{1}{2}$-in. angle iron, bent to circular shape to act as a bumper. This buffer not only assists in supporting the car body, but is a great saver of broken and bent dashers. Before our cars were furnished with buffers we had from ten to twelve dashers bent or broken every day, through collisions with trucks and other heavy vehicles. Our first buffers were of oak, with steel facing, but our new cars are now all being equipped with the angle buffer mentioned. Since the addition of these buffers it is a rare thing to have a bent or broken dasher. No radiating bar is used, but instead the platforms are equipped with a strong malleable iron draw-head having a large open mouth, which permits of a radiation of sufficient length necessary to haul a trailer around the shortest curves. The gates are hinged to the hood supports, and fold in toward the dashers. The inside and outside trimmings are of solid bronze. The dashers are made of No. 12 sheet steel, with the usual number of posts secured in the usual manner, but the dasher has the additional support of a strong angle iron at the bottom, which is fastened to the platform crown pieces and riveted to the dasher. There is a bracket fastened to the outside of the corner posts at diagonally opposite corners for a signal lamp. The cars are fitted with Sterling's safety brake, which multiplies the leverage and power, and with Sterling sand-boxes and registers.

STANDARD DOUBLE-TRUCK CLOSED CAR, NEW YORK

The inside finish of the cars, as stated, is pure white ash without specks or streaks, and the ceilings are of bird's-eye maple veneer. The latter is divided into panels by ash moldings; there is no decoration of any kind on the ceiling. The seats and backs are of three-ply veneer and paneled underneath with white ash, and covered with heavy Wilton carpet of rather an odd, but pleasing, design. Some of the older closed cars are fitted with Venetian blinds, but the greater number of our cars have pantasote curtains. The floors are covered with Lewis' diamond mats, which are not very largely used and not generally liked by railway men; as a rule, they prefer the wood strips fastened to the floor.

Owing to the length of these cars and the difficulty of keeping up the ends incident to the tremendous overhang, the cars are fitted with $\frac{1}{2}$-in. x 5-in. plates placed on the inside of the sills, with a foot turned on them taking the end sill, and there is also a high inside truss on the truck, so that the ends are amply supported and capable of carrying the heaviest loads without deflection. The cable cars are fitted with Gold hot-water heaters and the electric cars are fitted with Consolidated electric heaters and electric headlights.

The lighting is the Pintsch gas system on the cable cars, and electric lights on the electric cars. There are four

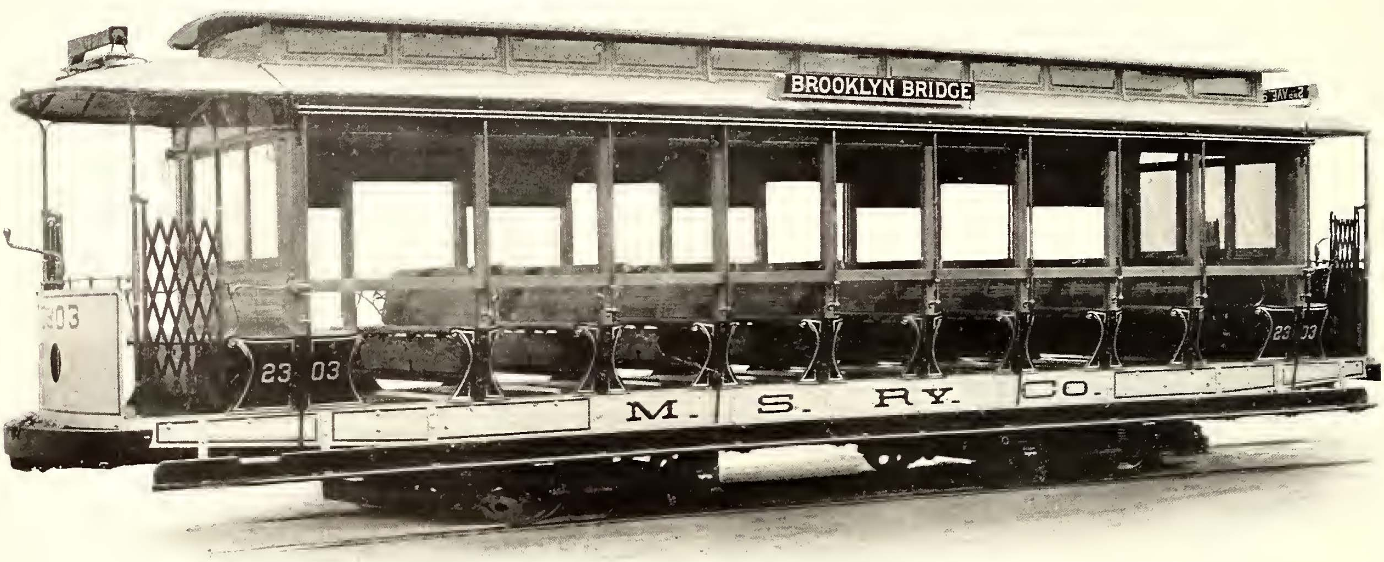
Millen revolving signs to each car, one on either side and one on each hood operated inside of car. On the electric cars an innovation has been introduced in the lighting of the signs at night by an electric light and a hood reflector.

The cars at the present time are not so elaborately painted as formerly; there is no scroll-work, the striping being plain and the lettering of plain block letters. The color of the center panel is of a deep orange, which is a strong and lasting color, and the color of the convex, or sunk, panel, and between the windows and dasher, is a light cream, which we think makes a good combination. The sash-rails on the later cars, instead of being varnished, are now painted and varnished, which we think is an improvement, so far as economy and durability is concerned, over the plain varnish, which was formerly the practice. The cars are bound at the corners with heavy iron bands, and are bolted to the rails and corner posts, making strong and stiff corners; there are also corner brackets at the corner posts onto the sills.

The standard truck used on the single-truck cars is the "Metropolitan special," made by the Peckham Truck Company, and on the electric lines these cars are equipped with two G. E.-1000 motors.

The standard double-truck closed electric cars are 28 ft. over the end panels and 36 ft. over the dashers. They have a width of 6 ft. 6 ins. over the sill, and 7 ft. 6 ins. over the belt-rail, being 6 ins. wider at both points than the four-wheeled cars. There are ten windows on either side and ten ventilators. The standard of finish, bumpers, trimmings, sash, seats and backs and everything as far as practicable is the same as the four-wheeled cars, excepting the dimensions, as stated above. Of course, the body framing in these cars is different from the four-wheeled cars, so as to enable the use of pivotal trucks of the Brill Eureka maximum traction type. As the supporting points in these trucks are not as far apart as on most cars, for reasons mentioned later, an additional support to the body is given in the shape of a truss-plank $2\frac{1}{2}$ ins. x 12 ins., gained about each post and fastened to the corner post end with a cambre, so as to support the ends and the center at the same time; this plank is in addition to the high truss-rod, which is fastened to the post, and the straining-rod. The interior of the car is lighted with three three-light clusters of lights and heated with Consolidated car heaters.

The Brill maximum traction trucks are fitted with 30-in. driving wheels and 20-in. trail wheels. They carry the motor between the wheels, and the weight of the body is carried on the side and pivot rub-plates. There is an automatic device in the truck, so as to throw more weight on the little wheel when going around curves. The advantage of this form of truck over other forms is that the motor is on the inside and not on the outside, which enables us to use a stronger platform with longer knees and more of them. Trucks of the pivotal type with the motor on the outside in radiating interfere with the platform timbers, and in consequence it is difficult to keep them in alignment. These trucks are also fitted with the Sterling brakes, the same as the four-wheeled cars. Owing to the necessity of having a narrow car, because of the narrow streets, the use of any other truck than a truck of the type adopted was out of the question, it being necessary to keep the cars down low, and with this type of truck we have practically the same rise from the ground to the step and from the step to the platform, as an ordinary four-wheeled car.



STANDARD DOUBLE-TRUCK OPEN CAR, NEW YORK

The double-truck open cars have a length over the dashers of 35 ft. 11 ins.; width at posts over seats, 7 ft. $2\frac{1}{2}$ ins.; width at sills, 6 ft. 5 ins., making twelve seats in all. There are three end sash arranged to lower between the backs of the end seats. The seats and backs are of cherry and ash slats properly spaced, the backs being framed and pivoted by arms or levers pivoted to the posts. The seat-end panels are of the malleable iron type, with Brill's patented round corners and curtain guides, so as to allow the curtains to come to the top of the sill, thereby closing the whole of the opening. The roof is of the monitor-deck pattern, and is strengthened by six concealed iron rafters. On the water-table on either side there is a drip, or rain-gutter, so as to catch the dripping of the rain from the roof, arranged at both ends with outlets through the grab-handle to a point below the step, and also two similar spouts between the ends making four on either side. The steps, as stated, are arranged to hinge, and are kept under control by the motorman or conductor from the platform of the car. The entrance guard is of the Brill type, and when not in use is pushed up under the water-table and held in place by gravity catches. In the first lot of cars made for the Metropolitan Street Railway Company the sill-plates were $\frac{5}{8}$ in. x 7 ins., but in the later cars we have had them made $\frac{3}{4}$ in. x 10 ins., which allows a projection down beyond the sill of the car by 3 ins. The necessity of this plate was caused by the fact that we were obliged to make the centers between the trucks 10 ft. from each end, because of the transfer tables in the several car houses. This tremendous overhang we found extremely difficult to take care of, and in consequence we were obliged to use this enormously heavy and unusual-sized plate. I am pleased to say that the cars have stood up wonderfully well. The corners of each step are protected by an angle iron bent to shape and properly bolted to the step.

The combination open and closed cars of the "California" type have a length of 36 ft. $\frac{1}{8}$ in. over the dashers.

All of our recent cars have been supplied by the J. G. Brill Company, which is also the manufacturer of all the double (maximum traction) trucks used on the system.

The lettering on the cars is a subject to which we have given a great deal of attention, the objects in mind being to secure a neat and tasteful design, which would be at the same time economical to put on and maintain, and would at the same time be legible by day and night. For our signs we have tried white letters on a black ground, black letters on a white ground, and a large variety of color combinations, and have finally settled on the first named as giving the best results. All striping on the main panel is in aluminum, and all figures on the dash and lettering on the sunk panel is in Indian or tuscan red. The form of letters employed is shown herewith, which is a reproduction, exactly one-sixteenth the size of the first three letters of the company's name as it appears on the sunk panel.

STANDARD COMBINATION CAR, NEW YORK

They are 6 ft. 5 ins. wide over the sills, and 7 ft. $2\frac{1}{2}$ ins. wide over the posts. The sills are $4\frac{1}{2}$ ins. x 7 ins., and the plates are $\frac{3}{4}$ in. x 10 ins., tapering at each end. The closed compartment has four windows having a length of 11 ft. $4\frac{3}{8}$ ins., and has double doors at either end, the general style and finish being the same as the ordinary closed cars. The open compartment has five reversible seats and two double seats, and generally comports in finish to the standard open car. It has an entrance guard, rain-gutter and gates. The folding steps on this type of car are somewhat different from the first lot employed. They had the folding steps made the whole length of the car body, and the sills running from end to end. In practice, we found it necessary to have a low platform for old and decrepit people, and the side step was cut off just at the junction of the closed and open ends and an ordinary step similar to that on closed cars was fastened to the platform. This is the way in which one hundred cars of this type are finished, and we consider it a considerable improvement.

The air cars which we have in operation on the Twenty-Eighth and Twenty-Ninth Street lines are generally the same as the 22-ft. single-truck cars, with the exception that they have a little greater width at sills to allow for the bottles, or air reservoirs, under the seats, and the framing is somewhat different for the air machinery.

We use on both the single and double-truck cars a standard 30-in. wheel, with $\frac{3}{4}$-in. flange and 2-in. tread. They are made by the Rochester and New York Car Wheel Works, and weigh from 300 lbs. to 325 lbs. each. The maximum traction truck trail wheels, as stated, are 20 ins. in diameter. Our brake-shoes are of the Lappin and Diamond types, and on the single trucks we use a special gravity brake-shoe hanger, which dispenses with the usual spring.

During the summer all closed cars are thoroughly overhauled and put into shape for the winter service, while the winter is spent in our repair shops in renovating our open cars. We do not find that six months is any too long for

STANDARD LETTERING USED ON SUNK PANEL

putting one-half of our rolling stock in good condition, and have not had any trouble from the deterioration of cars in storage, of which some roads complain. Our overhauling is most thoroughly done. As a result of this thorough fitting up, the cars during their six months of service have no work put upon them outside of a daily cleaning, except in case of accident.

MODERN METHODS OF TRAMWAY FINANCE

BY WILLIAM J. CLARK

Financiering, like human nature, is much the same the world over; true, certain features incidental thereto are more conspicuous in one country than in another, like the differing characteristics of individuals. The great monetary centers of the world, however, are now in such close contact that no great differences in underlying financial principles do or can exist between them.

The general conditions are simple. About these centers there is capital; this in the possession of two different elements; the first consists of bankers, capitalists, financial institutions, syndicates, etc., who to a great extent may be considered temporary investors, although upon them generally rests the direct burden of carrying all large undertakings to a successful conclusion. Hence such element is entitled to liberal compensation for the risks which it assumes in so doing, and for successfully reaching that other element "the fickle public," which, in the strictest sense of the word, is the permanent investor. The latter class can only be reached through the former.

The essential features to permanent successful financiering are meritorious projects, and the proper presentation of the same in accordance with the local practice of the various monetary centers. The merits of some particular undertaking may occasionally carry it through, even though badly presented to the first mentioned element, but rarely, if ever, is the result successful when such a presentation is made to the second. Frequently the financiering of projects of little merit is successfully carried through by ingenious presentation to either class. These incidents, however, may scarcely be considered as affording a permanent plan for successful financiering.

The proper channels and correct methods for street railway financiering in America are so well known to the Street Railway Journal's readers that no detailed description thereof is necessary.

Such variations in the details of financial practice as are found in different countries may be attributed more to the effect of local laws, precedent and tradition, than to any material difference in the ideas of financiers at London, New York, Paris, Berlin, Brussels or Antwerp, either as regards methods or the value of investments. This is illustrated by stating that it has not been timidity in European financial circles, nor suspicion of tramway investments, which has retarded the development of tramways in Europe itself, for the part which European capital has played in the development of American street railways disproves this.

As the street railways of the United States are operated by American companies, no records are available in Europe to show the exact amount of European capital invested therein, but, to the writer's personal knowledge, English capital to the extent of at least $35,000,000 is invested in American street railway securities, and it is reasonable to suppose that the total of such investments must be larger than that figure. French, German and Belgian capital to a considerable amount is similarly invested.

With few exceptions European capital has not been placed in American securities by direct subscription in the United States. It has bought American street railway bonds that have been underwritten by American financial institutions and syndicates. This condition of affairs, however, is now rapidly changing, owing to the great prosperity of America and a stringent money market in Europe, so that to-day it is not uncommon to hear of European projectors of tramways seriously contemplating the possibility of financiering their undertakings at New York. Up to the present, however, but a small amount of American capital has been invested in European tramways, although the financiering of two large Continental enterprises of this character has been successfully carried through by Americans aided by European funds. Though the commencement of American investment in foreign tramways began but recently, the progress has been rapid in countries other than those of Europe, so that to-day the total investment of American capital in tramways outside of the United States aggregates $25,000,000, or approximately the same sum as is similarly invested by Continental Europe.

With the exception of those properties in which they are, or intend to become, interested, Americans have not, however, acquainted themselves as thoroughly with important tramways abroad as have the Europeans, and the knowledge thereof which is possessed by the great financial institutions of Europe will surprise the American not familiar with the subject. In fact, it would be difficult to find one of these large financial institutions of Europe which did not possess more or less knowledge concerning the physical features and earning capacity of all the larger electric railway and tramway enterprises of the world, no matter where they are located. To illustrate this, some months since the writer had occasion to discuss a prominent American street railway with the officials of a large Continental bank, when, to his surprise, there were produced complete data upon the property, analyzed most carefully in every detail. On inquiry, the fact was revealed that in the files of the bank were similar data on practically every important street railway in existence. It is questioned if a similarly complete collection of such information on properties in the United States alone could be found in any American bank or trust company.

From the above it will be seen that the American promoter who is ambitious to float some street railway project in Europe need not expect that the financiers do not or will not know fully concerning his enterprise before they invest therein.

The European public has been, and is frequently, imposed upon in connection with companies whose securities are given out for general subscription, but the European financier is rarely placed in this position.

The extent of European investments in tramways, according to national boundaries, cannot be accurately traced, for with companies organized under the laws of countries abroad, in which certain European capital has been placed, such fact is not made apparent by available records, nor with companies organized under the laws of certain countries of continental Europe is it always possible to tell in which country the capital, or more properly, certain proportions thereof, are invested.

In Great Britain accurate figures are obtainable, however, both as regards the capital invested in home undertakings and in companies organized under its laws to operate tramways elsewhere. This, of course, does not cover British investments in companies organized elsewhere, but comparison between the two first mentioned characters of investment is interesting, as may also be certain figures on the authorized and subscribed capital of the tramways in Great Britain itself, and on the expenditures of the same that have been made, together with their extent, equipment and results from operation:

TRAMWAYS IN GREAT BRITAIN. AUTHORIZED CAPITAL SHARES AND DEBENTURES, INCLUDING COMPANY AND MUNICIPAL UNDERTAKINGS

Year	Shares	Loans and Debentures	Total
1878	£4,557,149	£2,028,962	£6,586,111
1882	8,525,007	4,061,036	12,586,043
1896	12,590,453	5,050,035	17,640,488
1890	12,426,454	5,376,627	17,803,081
1894	11,121,632	6,621,403	17,743,035
1898	12,567,326	11,868,101	24,435,427
1899	13,024,762	13,572,630	26,597,392

PAID-UP CAPITAL AND DEBENTURES

Year	Shares	Loans and Debentures	Total
1878	£3,177,146	£918,318	£4,095,464
1882	5,950,693	2,478,610	8,429,303
1886	9,104,680	3,284,824	12,389,504
1890	9,582,165	3,919,861	13,502,026
1894	9,112,094	5,000,479	14,112,573
1898	8,313,760	7,606,644	15,920,404
1899	8,516,716	9,536,057	18,052,773

TOTAL CAPITAL EXPENDED

(Actual Investment in the Properties)

Year	
1878	£4,207,350
1882	8,261,815
1886	12,573,041
1890	13,735,769
1894	14,388,698
1898	16,492,869
1899	18,603,222

These actual expenditures up to 1899 were divided between municipal and company undertakings as follows:

In tramways belonging to municipalities	£8,134,530
In tramways owned by companies	10,468,692
Total	£18,603,222

This means, on a basis of 830 miles owned by municipalities and 834 miles by companies, an investment of approximately £9,800 per mile of single track for the tramways owned by the municipalities, and an investment of £12,552 per mile by the companies. In explanation of this feature it should perhaps be stated that up to June 30, 1899, when the official statistics, upon which these figures are based, were published, electric traction had been more generally adopted by the companies than by the municipalities.

Still digressing from the title of this article, a word will be said concerning the equipment and results from operation of British tramways. The official Parliamentary report for the fiscal year 1898-1899 gives the following:

Total number of horses	44,171
Total number of cars	6,323
Total number of locomotives (including motor cars)	584
Total number of passengers carried	924,820,247
Total number of car miles run	96,078,503
Gross receipts	£4,879,602
Gross receipts per car mile	1s. 0.192d.
Operating expenses	£3,675,559
Operating expenses per car mile	9.12d.
Net receipts	£1,204,043
Net receipts per car mile	3.072d.

On January 1, 1900, British companies organized to operate street railways abroad were authorized to issue the following securities:

Shares	£14,444,025
Debentures	4,099,492
Total	£18,543,517

On these the following sums have been paid in:

Shares	£9,854,372
Debentures	2,793,777
Total	£12,648,149

To ascertain the total amount of British investment in foreign street railway companies, it is necessary to add to the foregoing figures an estimate of £4,000,000 obtained from a well known banker for shares and debentures of Continental companies held in Great Britain, £2,000,000 invested in similar undertakings organized under the laws of the Colonies and of countries outside of the United States and Canada, and £6,770,000 for British capital known to be invested in the securities of American and Canadian street railway companies. This would make a total of £25,418,149, or, roughly, $127,000,000, as the total investment of British capital in ex-territorial tramway undertakings, or, say, $34,000,000 greater than the sum invested in the tramway undertakings in Great Britain itself. The latter class of investment, however, is now being rapidly increased through the introduction of electric traction and additions to trackage.

The investment of Continental capital in tramways is of much greater importance than that of Great Britain, but, as already intimated, it is impossible to locate such capital either in accordance with the countries of its origin or where it is expended, for, in addition to what has already been said on this feature, to a great extent the Continental financial circles which have made or placed these investments are organized on international lines—the bankers of Belgium, Germany, France, Holland, Austria and other countries frequently participating in a single undertaking.

Brussels has been, and is yet, probably, the greatest center for tramway investment in Continental Europe; this because of Belgian wealth, a long established preference for tramway investments and because Belgium is a neutral country, in whose companies and financial circles capitalists of other Continental countries can consistently unite in investment. Even British capital occasionally finds an outlet through this channel.

Financial groups and companies, with their headquarters in Belgium, control many of the more important tramways in all portions of Europe, especially in the southern countries and in Russia, and are taking a more active part in the present great internal development of this character in Russia, than are the financial interests of any other country.

The separation of Belgian, German and French investment in tramways outside of Europe is impossible, for the reasons already stated, but the aggregate of such investment cannot be far from $25,000,000. Were an attempt made to subdivide this, it would be suggested that approximately $13,000,000 of the amount is actually German capital, $7,000,000 French, and $5,000,000 Belgian.

The actual investment in all the tramways of Europe is difficult to reach, owing to a lack of statistics in certain countries, and to varying titles given to local transportation lines in others, all, or most, of which would be considered street railways in the United States. These subdivisions are such as light railways, steam tramways, tramways for the transportation of passengers and baggage, tramways for the transportation of passengers only, etc.

In some countries all of this class of railways are considered as tramways; in others, only such lines as transport passengers, or, at most, passengers and baggage, within municipal areas, are so considered. The best illustration of this condition is obtainable in France, where statistics upon the various characters of local transportation are available up to the first of the present year, which can be summarized, as shown in tables Nos. 1 and 2, in which the figures are close approximations.

TABLE No. 1.

	Length in Miles	Investment in Dollars	Gross Receipts		Operating Expenses	Net Earnings	Percent Op. Ex. to Gross Receipts
			Total	Per Mile of Track			
Local steam railways guaranteed by State	1,958	$45,866,641	$2,398,116	$1,224	$2,018,442	$379,673	84
Local steam railways not guaranteed by State	779	34,334,058	2,255,209	2,891	2,252,209	1,512,198	67
Total of local steam railways	2,737	$80,200,699	....	......	....	......	..

TABLE No. 2.

	Gross Receipts		Operating Expenses	Net Earnings	Percent Op. Exp. to Gross Receipts
	Total	Per Mile of Track			
Tramways for transportation of passengers and merch. guar. by State	$1,234,233	$983	$1,093,669	$140,564	87
Tramways for transportation of passengers and merch. not guar. by State	1,342,022	4,092	904,173	437,848	67
Tramways for transportation of passengers and baggage	1,168,601	6,834	1,073,819	94,782	92
Passenger tramways, Department of Seine	6,768,063	40,048	5,866,049	902,013	87
Passenger tramways outside Department of Seine	5,357,728	14,062	3,757,282	1,600,446	70

The investment in the local transportation lines of France has been materially increased since the foregoing figures were compiled; this by the new railways at Paris, opened during the present year, which are not included in the immediately foregoing.

Were a rough estimate to be made upon the total investment in all Continental local transportation lines, which in the United States would be considered tramways, street railways or interurban systems, the writer would place the figure at from $700,000,000 to $750,000,000; about half of which represents the investment in electric lines. An enormous figure, it is true, but when it is remembered that a similar investment of nearly $2,000,000,000 exists in North America, demonstration is, of course, made of the fact that the American financier has had greater experience in tramway finance than has the European, despite the larger sums of capital available to the latter. And, as is well known, the American tramway undertakings have been financed entirely by private capital with the sole object by general investors of profiting from their earning capacity.

The sources from which European investments in both domestic and foreign tramway undertakings have come, and the methods employed for procuring such capital differ somewhat in the various countries.

In Great Britain these may be divided under two headings:

First. For municipal undertakings, in connection with which the procedure is simple: Borrowing powers—so called—having been secured by the municipality under a special act of Parliament, bonds—or more properly, shares of redeemable municipal stock—are issued and placed either through bankers or by invitations for public subscription as readily as is done with the securities of the more important American cities at home.

Second. Investments in tramway company undertakings, either for Great Britain or abroad, are floated entirely upon the supposed financial merits thereof, as demonstrated by actual or prospective earning power. But the process ordinarily followed is somewhat complicated from the American standpoint, the essentials thereto being: First, influential solicitors in financial circles, next an engineer of prominence, then a proper underwriting syndicate, which, if the project is to be given to the public, is usually followed by diplomatic overtures to the financial papers, and then a judicious presentation in a set form of prospectus, inviting public subscriptions.

It is to be questioned if this last mentioned detail of "going to the public," so called, is as popular as was the case formerly, for a compilation of figures made from the London *Times* shows that during 1899 the aggregate of successful prospectuses of this character floated in London amounted to but £1,343,100. During the same period many times this amount of capital was quietly raised by London bankers for tramway purposes without the formality of issuing public prospectuses.

On the Continent, where governments and municipalities have assumed the ownership of tramways and local transportation lines, these have been financed on lines similar to those adopted in Great Britain. Continental tramway company undertakings, however, whether to be operated locally or abroad, are, to a great extent, financed from different motives than those which exist in America and Great Britain, consequently causing a variation in procedure between different Continental countries, as well as between American and British practice.

In Holland—as thoroughly as would be the case in America and England—the reason for tramway investments has been dependent purely upon the merits of the same. In Belgian companies the same is almost equally true, but in certain of the largest tramway circles there the influence of the Continental electrical manufacturer is apparent.

In France is found a close connection between the large financial institutions and certain important electrical manufacturing concerns, so that many of the larger tramway and electrical undertakings are financed for the joint purpose of benefiting from the earning power thereof, and to afford business for the electrical manufacturing companies. The wonderful financial ability of the Frenchman, and the exceeding care which he exercises in investigating every project in which he proposes investment, has prevented unfavorable results arising from a practice which operated so unfortunately in America a few years since.

In justice to the French it must be said that they investigate more thoroughly, and carry through their undertakings with less unnecessary formality than is done almost anywhere else; wherever French capital is found invested in tramway enterprises, it can be considered to be safely invested. As characteristic of other investments in France, tramway securities are widely scattered in small individual holdings, but the financial institutions that have caused their issue show their faith therein by retaining large blocks as their permanent investment. The essentials to reach the funds of either the French or Belgian financial circles is, first, suitable introduction; next, a meritorious project; then production of full facts which will permit investigation; after that few formalities.

In Russia the existing tramways, with the exception of those controlled by the powerful Belgian syndicates, have been principally financed locally, either as close private companies or by one or two wealthy individuals assuming the same as private or personal undertakings. In connection with the adoption of electric traction, which has just commenced, the financial circles of Belgium, France and Germany are playing a most important part, while British capital also seeks investment there.

From a financial standpoint a condition prevails in the smaller and less important countries of Europe not unlike that in France, as, to a great extent, the tramways in such countries have been financed either with German, French or Belgian capital, or perhaps more properly co-operating with local capital which ordinarily represents minority holdings in the various enterprises.

In Germany, and wherever private German capital is invested in tramways, the closest relationship in financiering exists between the large German electric manufacturing companies and the strong financial institutions of Germany. In fact, it is rare to find a local undertaking of this character in which some German electrical manufacturing concern does not either directly or indirectly, through its banking connections, exert financial control. One such manufacturing company publishes a list of such local interests controlled by or affiliated with it, aggregating a capital investment of over $60,000,000.

The total capital and debentures of the German electrical manufacturing industry is creditably announced as exceeding $200,000,000, which is excessive, for its conduct as a purely manufacturing industry. Associated with the manufacturing companies are banks, financial companies and groups said to have a total capital of over $500,000,000. As the total capital invested in the local electric railways and lighting plants of Germany itself does not exceed $250,000,000, some idea may be gained as to how extensive the investment of German capital must actually be in other countries.

So far, the practice of close co-operation between the financial interests of Germany and its electrical manufacturing industries in local investments of this character has resulted favorably to the manufacturing companies, to the financial interests in the development of local enterprises, and to the extension of German influence; but it is to be questioned if it has not been carried to the extreme, and that if the desire to extend the business of the manufacturing companies and to increase German trade and influence has not reached a point where in certain cases it is liable to react unfavorably upon the investors, be they powerful financial groups or humble individuals.

The decline of the past few months in the market value of shares in the financial companies and similar organizations, which have been most heavily interested in such matters, would indicate that such condition already prevails to a certain extent.

Germany, however, has a remarkable banking system, which, though a general business and financial depression should prevail in Germany, or even throughout the world, would prevent any such serious results occurring as would be the case under similar conditions in the United States, while, of course, Germany is to be congratulated upon having made more wonderful progress during the past few years, both financially and commercially, than has any other country in the world, excepting the United States.

Probably German foreign investments have been made less judiciously than those of England and France, and such enterprises on the whole are not so advantageously managed, but the courage of German investors and financiers is superb, while time will, of course, remedy those possible mistakes into which they have been led by a desire to rapidly advance the best interests of the Fatherland. Upon one detail of the German system of finance affecting tramways, it may be safely said that no large enterprise of this character can be financed in Germany without some one of the large German electrical manufacturers having more or less direct connection therewith.

The average American reader may possibly wonder where the large sums of American and European capital already referred to as being invested in countries outside of Europe and the United States is placed. He may not be familiar with the fact that in one South American city there is an investment of this character of over $25,000,000. In another, above $10,000,000 is similarly invested. Scattered elsewhere outside of Europe and the United States are other properties in which the investment is from $1,000,000 to $7,000,000.

POLYPHASE RAILWAY APPARATUS AND METHODS

BY LOUIS BELL, PH. D.

The advent and extensive development of polyphase apparatus and methods in connection with street railway service is perhaps the most striking modification of tramway practice within the last decade. A long and formidable list could be made up, and, indeed, one has recently been published in the STREET RAILWAY JOURNAL, showing the numerous roads which are dependent on the methods of polyphase power transmission for their working current.

Power transmission with polyphase apparatus and methods began to be practiced in this country about eight years ago, and it is interesting to know that concurrently with that development in the art, motors for street railway service were assuming practically their present form. It is a striking thing that street railway motors and controlling apparatus have remained for so long a time in substantially the same general form and possessing the same general characteristics. By this it is not intended to assert that there have not been many and great improvements, both in motors and in accessory apparatus, in the last seven or eight years. That there have been such improvements is too well known to need comment; nevertheless, the iron-clad motor with a magnetic circuit of cast steel, with but a single gear reduction between armature and coil, and used with series parallel control, we have now had with us for a considerable time. The working voltage for street railways has remained unchanged, and with the gradually widening circles covered by the street railway service about every city, the burden of copper for the carrying of the large amounts of power required at this very moderate voltage has been steadily growing greater. It has, however, gradually been becoming apparent that the distances of transmission sought to be covered in street railway work are generally too great for the direct distribution of current at or about the working voltage now used; hence the immense development during the last few years of polyphase apparatus for traction purposes.

Looking over the list of electric roads using such transmission one quickly finds that there are two distinct classes enumerated. One has the ordinary case of power transmission from a waterfall to one or more points along the line of the electric road concerned. This is a problem in pure power transmission, all, or substantially all the stations which serve the road being rotary converter stations. Under such circumstances the apparatus usually presents few striking features, and while the system may be interesting as a transmission sytem, it does not show the characteristic features which have been brought out in the other class of polyphase tramway work. This consists in the roads using methods such as have just been described in connection with a large central station.

It is not the writer's purpose here to discuss the economics of power transmission from one great central station to sub-stations with rotary converters, as against the use of the auxiliary stations with their own prime movers. This, of itself, is a very large subject, and one about which it is particularly unsafe to generalize, since the economics of the matter are really determined in the long run by local circumstances of somewhat complicated character.

In any case of power transmission from a central station with reconversion at rotary converter stations, there is, as is well known, a considerable loss of energy, and a very considerable added cost. Both these items of loss must be recouped for a successful economic result by decrease in the cost of generating power at the central point. When, however, it becomes clear on thorough investigation of the local conditions of operation that a saving of 25 or 30 per cent in the cost of power can be obtained by concentrating the generating plant, then power transmission by polyphase currents from this central generating plant to substations with rotary converters becomes desirable; and in such cases it has been, and is being, introduced on a very large scale.

The first result of the demand for this particular class of power transmission was the development of the big engine-driven polyphase generator, a machine already foreshadowed in occasional hydraulic work, but only brought to its present form in virtue of the requirements of street railway transmission.

When it becomes necessary to design a polyphase generator of one or several thousand kilowatts capacity for direct connection to an engine, the designer has to face serious problems of an unfamiliar character. In the first place, the speed of rotation at which it is possible to work very large engines of the kind now in general use is limited. Engines of 2000 hp or 3000 hp are built to run between 75 r. p. m. and 90 r. p. m. This low speed is very easily met in the design of large direct-current generators; but when it comes to the evolution of the polyphase generator of the same speed, the question of frequency comes up, and causes trouble. The result is a rather extreme form of multipolar design, for as the rotative speed goes down the number of poles has to go up, to preserve a frequency sufficient to insure proper utilization of the material in the transformers, which form a part of every railway transmission system. With this increase in the number of poles necessarily comes a very great increase in diameter of the field system. It is impracticable to retain a moderate diameter and to make the poles very long and narrow, on account of the large waste of material involved, the crowding of the armature coils—if the generator is to be of great capacity—and various minor electrical difficulties of a forbidding character. Hence the field magnet frames had to grow enormously larger than usual, and the outer circle of the machine had to be stiffened against flexure by deep flanges.

The designing and construction of an enormous field magnet ring is no easy matter, even for the largest direct-current generators; and the requirements of sound mechanical design have, even in this latter case, led to the development of a field magnet ring which is not only flanged, but which literally forms a circular truss, the better to resist deflections, due both to weight and to inequalities of magnetic stress.

Fig. 1 is a very striking example of the extremities to which designers have been driven by the requirements of very large, slow-speed machines. It shows the field magnet structure of a 2700-kw direct-current generator, built by the General Electric Company for the Boston Elevated Railway Company. The speed is 75 r. p. m, and the gigantic field ring has thirty-six poles. In polyphase alternators of corresponding size one has to face still further difficulties, since, if used in transmission plants for railway work, high voltage on the line is necessary. This means either that high voltage must be generated in the machine, or that it must be derived from raising transformers, which are a serious addition to the expense, with the low frequency now in use, and, moreover, tend to diminish the efficiency of the transmission as a whole. Hence there is strong reason for building a generator itself of high voltage, and with this requirement for high armature voltage has come the stationary armature with revolving fields, which is now the feature of power transmission apparatus on a large scale.

With the stationary armature the difficulties of winding for high voltage are obviously much diminished, and while it has been possible to construct generators with revolving armatures as high as 5000 volts or 6000 volts, for these high pressures it has now become the almost invariable rule to build generators with stationary armatures.

Fig. 2 shows the stationary armature of one of the enormous 3500-kw direct-connected generators built for the Metropolitan Street Railway Company, of New York City, by the General Electric Company. The armature laminations are here carried on a similar circular truss structure to that which appears in Fig. 1. The windings are not in place, and the form of the slot shows clearly. Resting beside the huge frames, however, are some of the armature windings, laid out in the relative positions which they occupy in the big generator.

Such a machine is a most striking example of the problems which the requirements of street railway service have forced upon the designer and builder of polyphase apparatus.

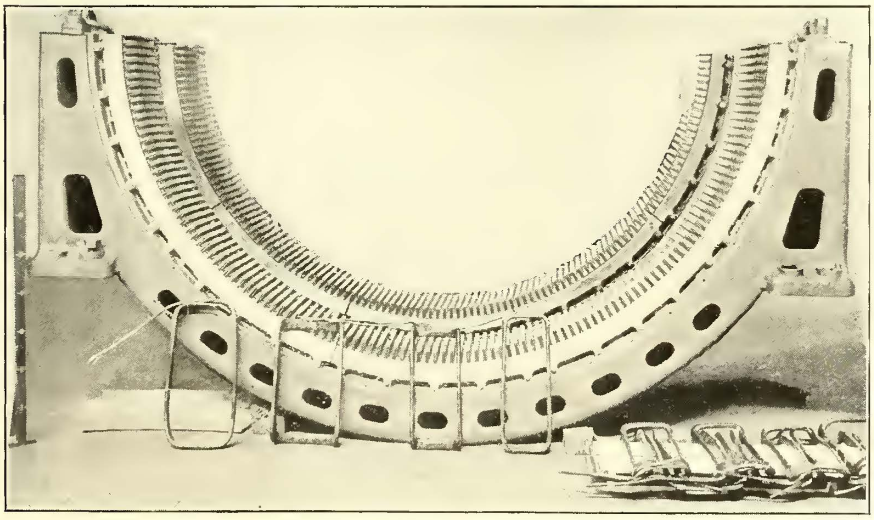


FIG. 2.—STATOR OF 3500-KW DIRECT-CONNECTED ALTERNATOR FOR METROPOLITAN STREET RAILWAY, NEW YORK

In spite of the disadvantage of low rotative speed, the immense dimensions of these modern direct-connected units give peripheral speed to the armature, ranging as a rule from 2500 f. p. m. to 3000 f. p. m., and consequently there is speed enough for the efficient production of electric motive force. The result is that while slow rotative speed has generally a tendency to reduce efficiencies, these big generators are not only highly efficient but have a remarkably steady efficiency under varying load. For example, the machine shown in Fig. 1 has a commercial efficiency even at half load of 94 per cent, which rises at three-quarter load to 95 per cent, and at a full load to 95.5 per cent, where it steadily stays, up to an over-load of 50 per cent. The large polyphase machines have similarly high efficiency. Aside from modifications in form induced by the serious structural problems encountered in building fields and armatures of so large dimensions, many other unusual modifications have been superinduced by the great dimensions. For example, in the multipolar generators, especially the polyphase generators with a very large number of poles, the matter of winding space on the individual poles becomes serious. The amount of energy required for excitation is not very large, but the space is so limited that it is not easy to get on sufficient cross sections of copper for efficient working, when using windings of the ordinary form. Consequently, for big machines like that shown in Fig. 2 and other similar ones, the very curious and ingenious field winding shown in Fig. 3 has come into use. It is a copper strap, carefully insulated by wrapping, and laid on edgewise in the manner shown in the cut. The edgewise coil thus assembled is placed on the pole piece, and affords a winding of great cross section without the wast-

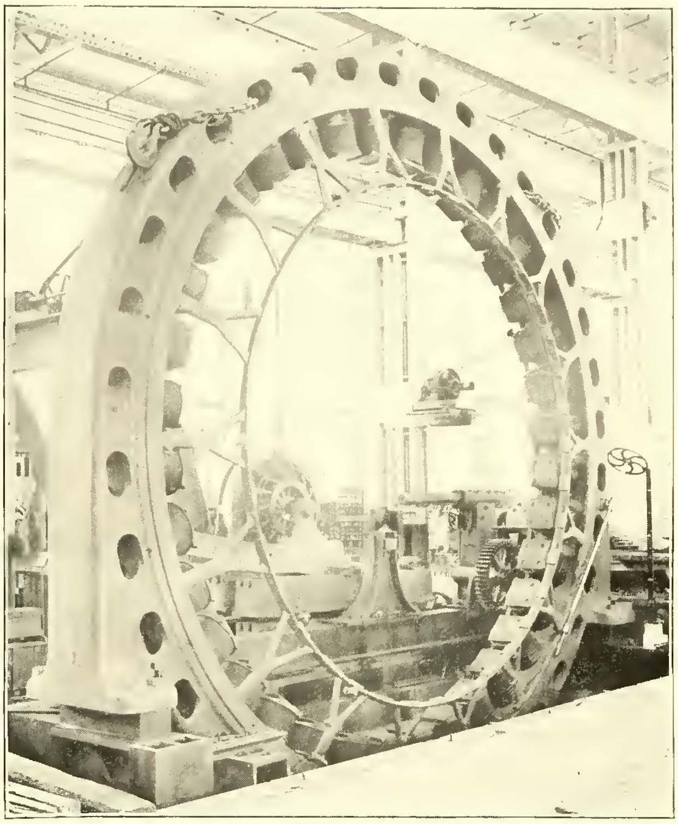


FIG. 1.—FIELD MAGNET FOR BOSTON 2700-KW 500-VOLT GENERATOR

ing of much space for insulation or by reason of bad packing of wire. It may obviously be objected that the radiation surface of such a winding is small. This is perfectly true, but the energy wasted is relatively so small that the question of heat is eliminated from the problem, particularly with the advantages for cooling afforded by rotating poles.

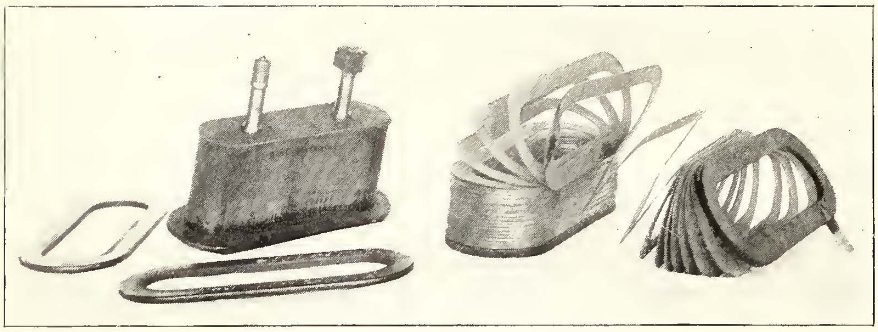


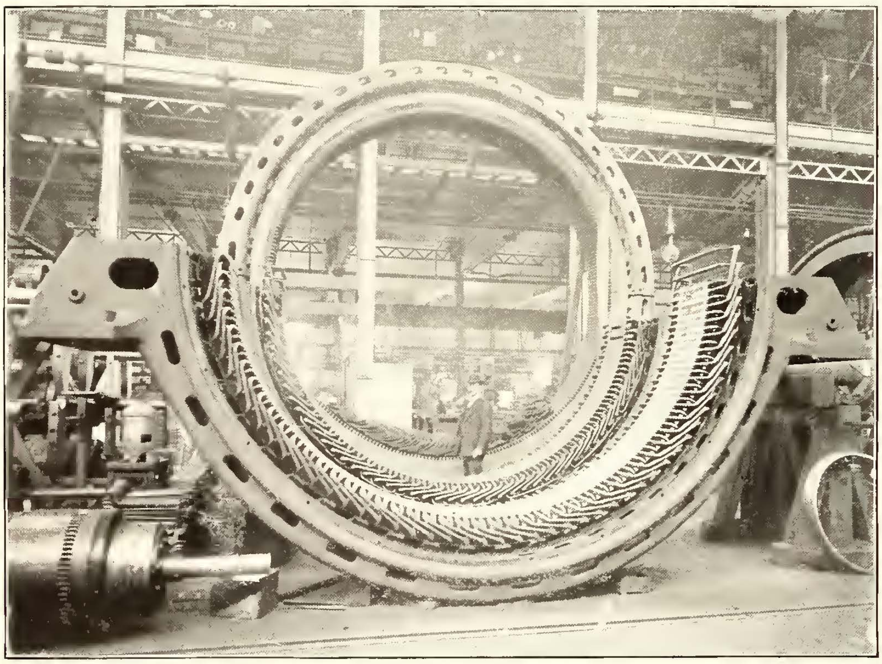
FIG 3.—FIELD WINDING USED IN LARGE GENERATORS

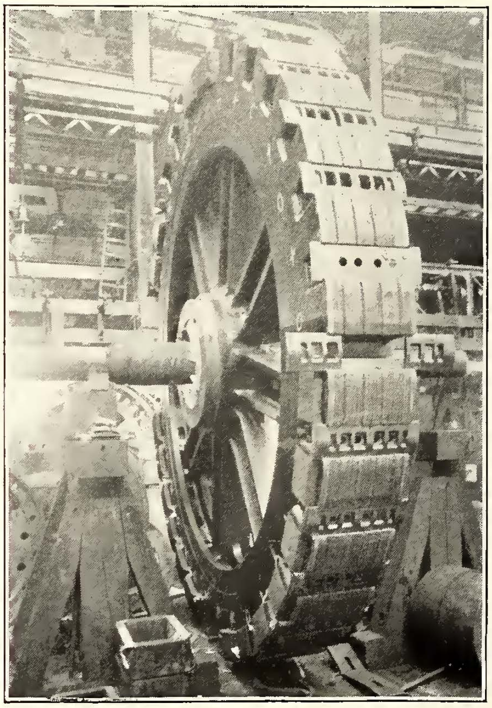
Another beautiful example of direct-driven polyphase generator is shown in Fig. 4, which exhibits the stationary armature of a 750-kw slow-speed three-phase generator of 25 cycles per second, built by the Westinghouse Company. This is to generate 6600 volts directly from the armature, and the engraving gives an exceedingly clear idea of the way in which the coils of the successive phases are laid into the armature slots. These coils, like all coils of modern machines, are wound on forms, thoroughly insulated, and slipped into place. The general design of the armature frame shows the same device of a circular truss, which has already been referred to, and the engraving gives a very impressive idea of its size.

The revolving field of this particular machine is shown in Fig. 5, which is particularly instructive as showing the care taken in the ventilation of the laminated poles and the extremely ingenious and useful method of locking the field coils into place by heavy, cast, bridge pieces, which span the space from pole to pole and secure the coils in the most thorough manner, besides being otherwise useful. The whole structure of the revolving field is made solid and heavy, and serves to give an admirable fly-wheel effect in the operation of the machine.

The exceedingly substantial design of this generator and others of this class appeals very strongly to the mechanical engineer. There has been no skimping in amount of material, and all material has been put where it will do good.

Fig. 6 shows the detail of the winding of the field shown as a whole in Fig. 5. The laminated poles with slots for ventilation, the compact and substantial field coils and the solid bridges, which hold them in place, are here excellently shown. These cuts of the large polyphase generators readily explain the ease with which high voltages can be generated directly from stationary armatures. With machines of the revolving pole form it is easy to get sufficient space for well-insulated coils, and questions of the overlapping at the ends of armature coils having great difference of potential are eliminated, since in the absence of centrifugal stress and in the presence of ample room at the ends of the armature, the coils can be kept extremely well clear of one another. The efficiencies of the large polyphase machines that have already been mentioned are very high, and as a whole their performance is exceedingly satisfactory in every respect.





FIGS. 4 AND 5.—STATOR AND ROTOR OF 750-KW, SLOW SPEED, THREE-PHASE GENERATOR

In building plants using direct-connected units of so great output as those to which reference has been made it becomes necessary to deal with large quantities of current at fairly high voltages, and the result of this requirement has been the development of an entirely new line of station appliances in the way of switches and cut-outs. It is no joke to handle currents of several thousand amperes at several thousand volts, and the old familiar apparatus has not proved adequate to the new task of so large proportions. Switches now in use dealing in such work are relay switches operated by fluid pressure, so that the man in charge of the switchboard can work the complete equipment of switches for a complicated system of generators and feeders by means of a set of valves all within reach of his hand. Such apparatus is rapidly coming into use, and it is needless to say that it implies a far greater facility of control than has ever hitherto been obtained in a large central station.

In polyphase distribution for tramway work, whatever the character of the line—two-phase or three-phase, overhead or under-ground—the essential apparatus at the other end of the line is the transformer and the rotary converter. The voltage of the line may be 5000 or 20,000, obtained from machines with stationary armatures or from generators with raising transformers, but wherever the rotary converter is, there must be the raising transformers to send into the collecting rings current of the proper voltage to reappear as direct current of standard railway voltage at the commutator end of the machine. This is one of the inconveniences of the rotary converter, which has to be tolerated on account of the other virtues of the machine.

A considerable number of types of transformers have been used in the past, but they have gradually simmered down to two so far as high voltage work is concerned. The principal problems which have to be met in the construction of large high-voltage transformers are adequate insulation for the potentials employed, and some proper and efficient way of getting rid of the large amount of heat generated. Inasmuch as the output of the transformer varies almost directly as its mass, which increases as the cube of the linear dimensions, it is clear that transformers of a very large output are likely to be somewhat short of radiating surface for getting rid of heat generated, which, small in relation to the output, may become absolutely rather large. In one of the usual and familiar types of transformer the structure is thoroughly ventilated with air passages, through which a blast of air is forced, rapidly cooling off the heat generated in the coils and core. In the other type, which is also widely used, particularly for very high voltages, the core of the transformer and its coils are similarly provided with ventilating passages, which, however, are filled, not with air, but with oil, the whole transformer structure being immersed in a tank of dimensions sufficient to permit adequate radiation from its exterior.

A fine example of this construction is shown in Figs. 7 and 8, of which Fig. 7 shows the coils and core, and Fig. 8 the containing tank of a Westinghouse 375-kw transformer for a primary voltage of 15,000. The coils and core are made up into a compact and well ventilated mass, conveniently arranged for handling, and this, in itself thoroughly insulated as regards the coils and core, is plunged into a metal tank, shown in Fig. 8. This has on its surface very deep corrugations or their equivalent, so that the actual cooling surface is very much greater than the linear dimensions of the tank would imply. The oil with which the tank is then filled rapidly transfers the heat from the core and coils of the transformer to the surface of the tank, where it is thoroughly taken care of by natural radiation.

As regards rotary converters themselves, they are very generally familiar to the reader. An interesting type of modern practice is, however, shown in Fig. 9, a 250-kw transformer of Westinghouse manufacture, designed for the somewhat unusual frequency of 60 cycles per second. Aside from this peculiarity, however, the striking feature of the machine is the method employed in starting. The starting of rotary converters always entails more or less trouble, since, while they will come up to speed themselves if the main current is thrown on, a large amount of current is required to perform the feat. Hence whenever feasible they are started by auxiliary motors or from the direct-current side. The present machine has assembled directly upon an extension of its armature shaft the armature of an induction motor, of which the field is mounted upon the frame casting of the converter itself. The starting motor is thus made a simple and integral part of the rotary converter as a whole, avoiding all inconvenience of belts and belt shifters, on the one hand, or of severe call for current from the line, on the other. The simplicity and convenience of such a starting arrangement is obvious without further comment.

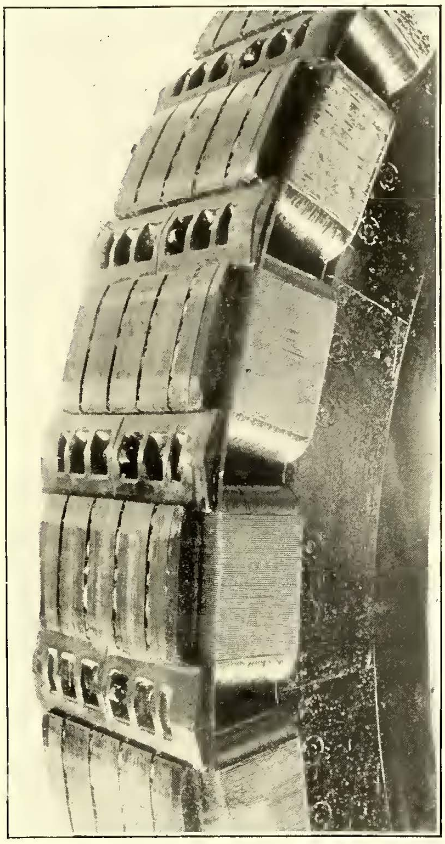


FIG. 6.—DETAIL OF WINDING OF FIELD SHOWN IN FIG. 5

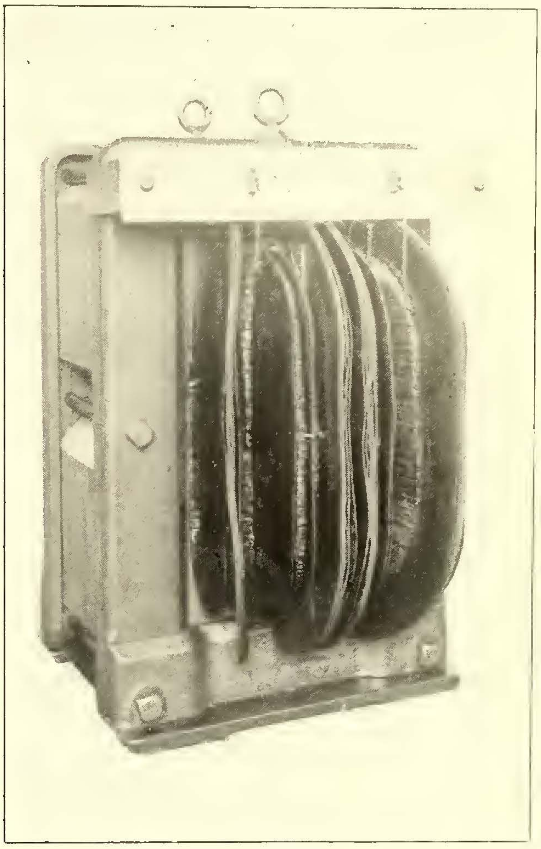


FIG. 7.—COILS AND CORE OF 375-KW TRANSFORMER

But there is another branch of polyphase transmission for tramway purposes which has not yet found its way into commercial practice in this country, although it is becoming well known abroad. This is the direct operation of the motor cars by means of polyphase motors, thus superseding at one stroke the whole complicated mechanism of transmission, reconversion, and subsequent transmission through the ordinary feeding system. It must be remembered that in spite of the useful economic results obtained by transmission to rotary converters, the feeding system has in great measure remained unchanged. There has been, of course, saving of feeder copper from the use of sub-stations, but the increase of sub-stations with rotary converters is not a thing which, involving as it does somewhat costly apparatus and the necessity of attendance, can be carried on indefinitely. If the amount of feeder copper necessary for extended distribution is to be greatly reduced it becomes necessary to derive from the transmission lines the working current for the distributing system by means more simple than sub-stations with rotary converters. At the present time the use of induction motors directly upon the cars has not yet been completely worked out. It involves generally the use of two trolley wires, which is of itself an inconvenience, and with the almost universal present use of direct current for tramway purposes, polyphase currents may never find more than a casual use in this field; still the indications are that for special purposes, and particularly long-distance roads, traction by polyphase motors is likely to increase. The experiments which have recently been tried in Europe, and particularly those in which the voltage of the working conductors has been very considerably increased, looking toward carrying the reducing transformers on the car, indicate that we cannot pass by the possibilities of this form of traction. In this connection, therefore, it is of interest to know that American manufacturers are not by any means behind the game. Fig. 10 shows a pair of polyphase tramway motors with their controller, under test in the shops of the General Electric Company at Schenectady. Although not mounted on the cars, these are something more than experimental machines, since they were developed upon a regular contract placed abroad. It will be seen that the motors are in general arrangement closely similar to direct-current railway motors, the same general characteristics having entered into the mechanical design. Their performance has been such as to indicate that we can, in this country, successfully compete with anything which has yet been done abroad in this particular line of operation. The matter is referred to here with no intention of broadly recommending polyphase motors for tramway service, but the writer desires to point out in most emphatic terms that there are cases where the adoption of such motors would constitute a most material advantage, and would, in fact, make the difference between failure and success. Such cases are principally to be found in the extension of electric traction to long-distance railroads.

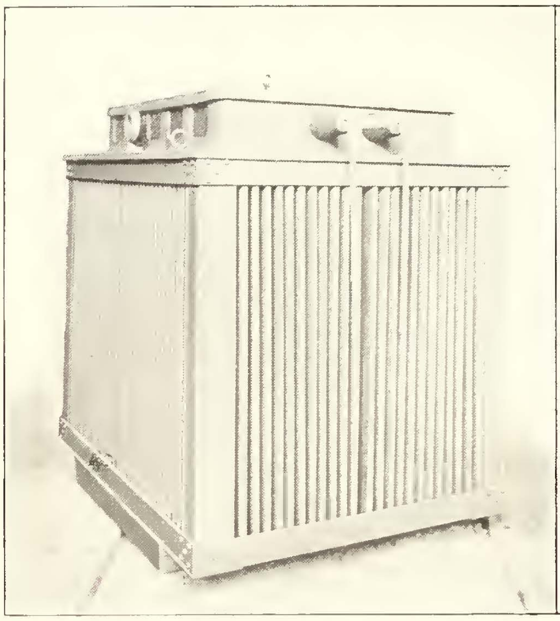


FIG. 8.—CONTAINING TANK OF 375 KW TRANSFORMER

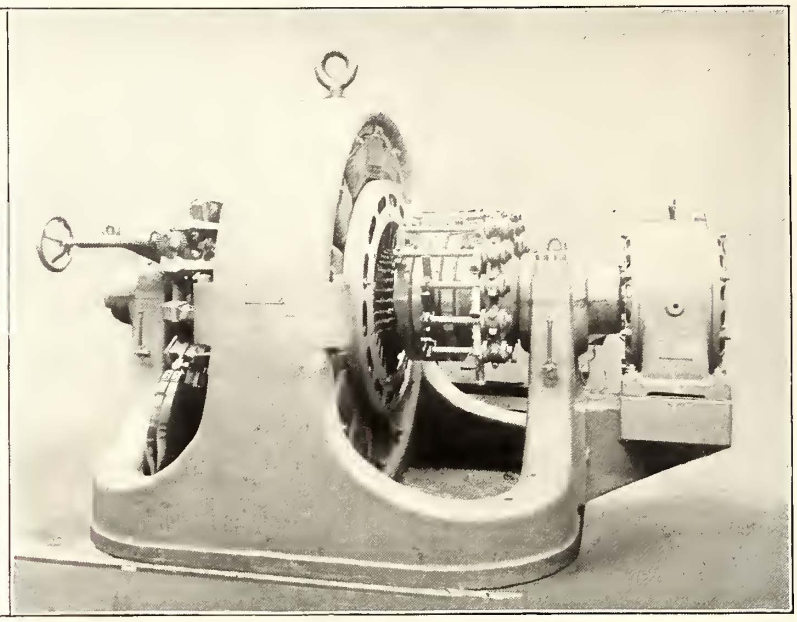


FIG. 9.—250-KW ROTARY CONVERTER

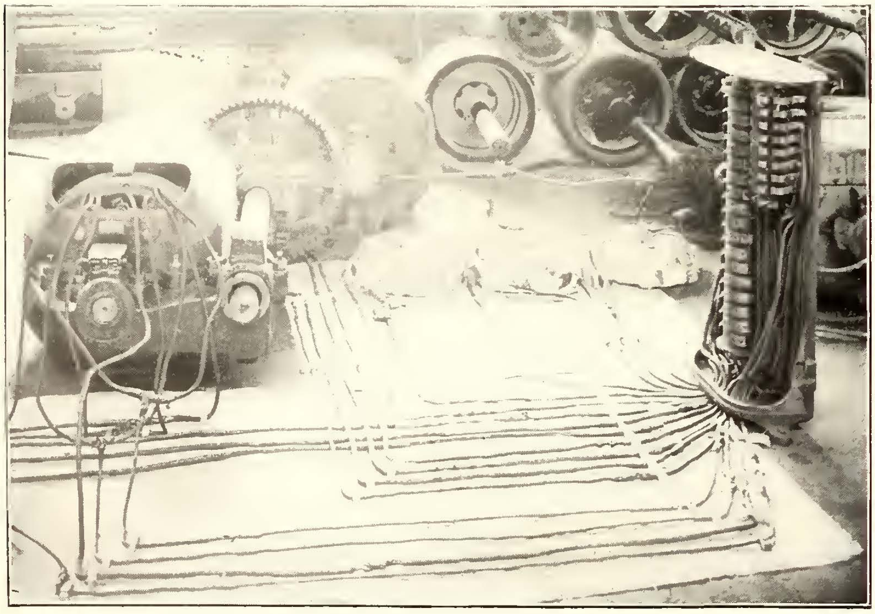


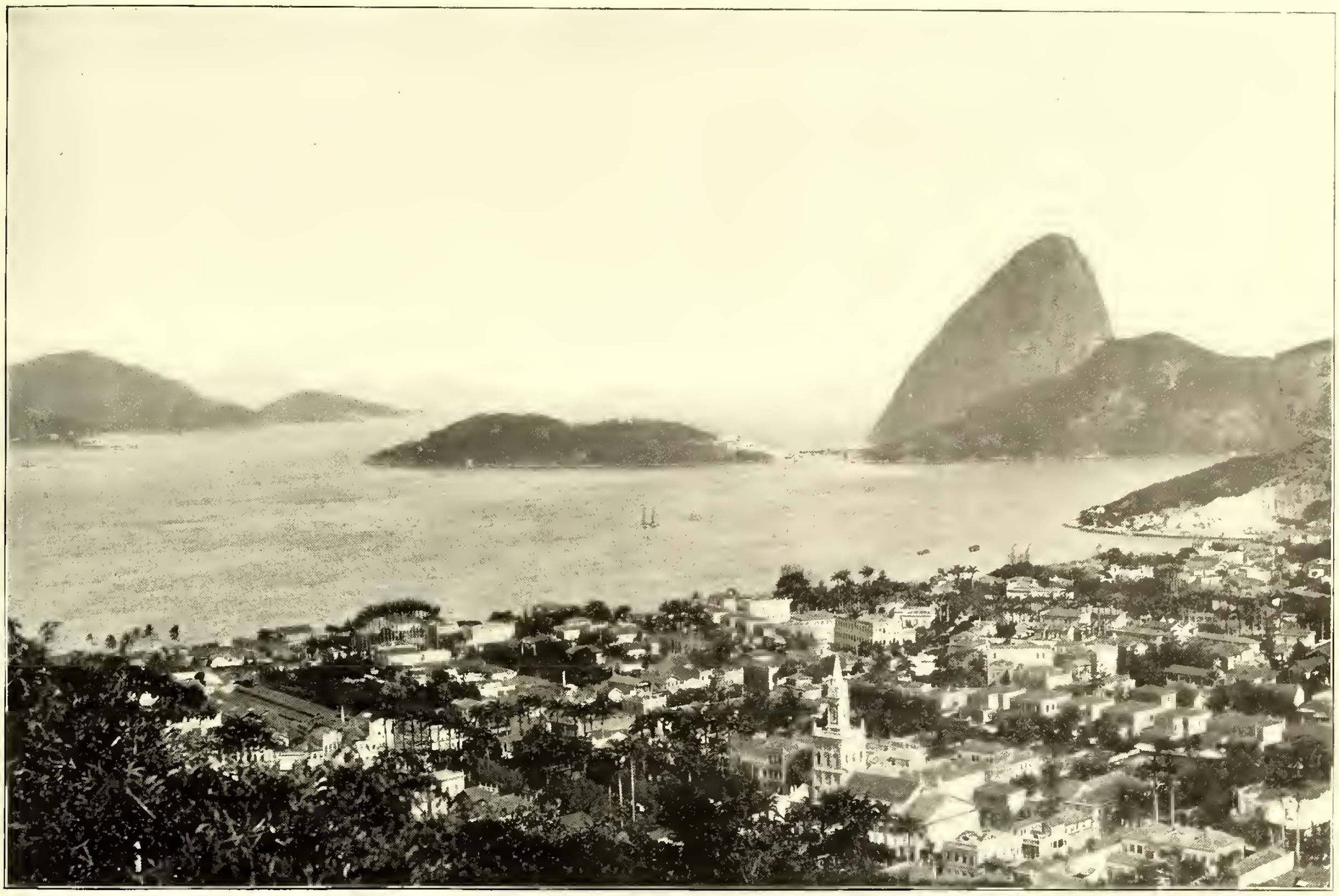
FIG. 10.—POLYPHASE MOTORS WITH CONTROLLER

THE STREET RAILWAYS OF RIO DE JANEIRO

Rio de Janeiro, the capital of Brazil, is one of the largest and most important cities in South America. Those whose business interests lie entirely in the Northern Hemisphere do not often realize the size and extent of cities lying south of the equator, so that it may possibly be a surprise to some to learn that this city has a population of 800,000, and in the appearance of its streets and parks will bear comparison with any other city of equal size in the world. So far as its natural location is concerned, Rio de Janeiro is probably the most picturesque of any large city, undoubtedly surpassing even the famed Naples. As will be seen from the accompanying views, the bay is dotted with many islands. Many of these are merely barren rocks, fashioned into picturesque and fantastic shapes, but the great majority are covered with vegetation, and are inhabitable. Owing to the mountainous character of the land on which "Rio" was built, the city is exceedingly irregular in shape, and its suburbs are widely separated from each other, making the city an ideal one for tramway operation. The greater part of it lies on an extensive, low plain. The suburbs to the westward are probably the most picturesque and salubrious, and are occupied by the more expensive residences. There are also other important suburbs to the west and northwest.

The harbor, of which an excellent idea can be obtained from the engraving on this page, is one of the best on the coast of Brazil. From its position Rio is naturally the great mart of Brazil, and is a large export city for the products of the country, notably for cotton, sugar, coffee, rum, timber, hides and minerals of various kinds. It is also the terminus of several lines of railways.

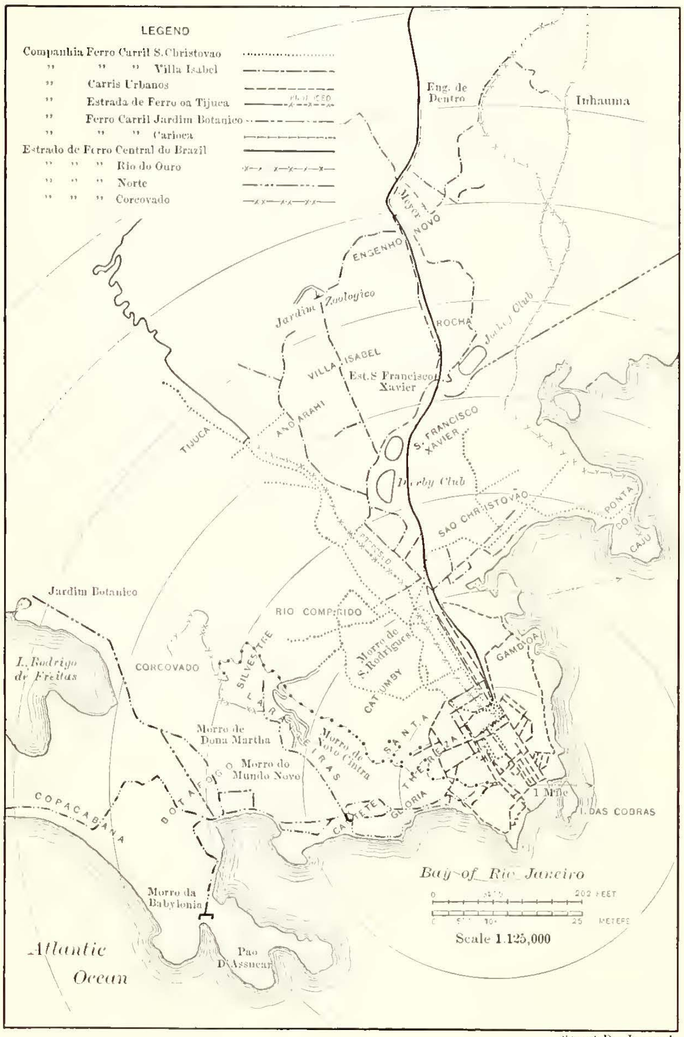
The streets in the old town are for the most part narrow, and the majority of the buildings of the old style, built principally of broken stone and mortar, plastered on the outside or faced with illuminated tiles. Recently, however, better taste has been shown and more cut stone for building material used. The principal streets are well paved with granite blocks, but most of the back streets still retain their old cobblestone pavements. In the newer parts of the city are many very handsome residences.



ENTRANCE TO THE HARBOR OF RIO DE JANEIRO

The city and the suburbs are amply supplied with tramway lines, most of which are yet to be equipped electrically. Nearly all of these lines run from points near the Rua do Ouvidor, as a center, to the suburbs and principal places of interest. Few cities are better supplied with tramways, and there are equally few, perhaps, where the difficulties of creating a thoroughly convenient system are greater. The configuration of the land upon which Rio de Janeiro is built has, in a great measure, compelled the building of these lines so as to radiate from a common center. On the other hand, the intervening hills obstruct cross connection between the suburban extensions, thus frequently compelling the riders from one adjoining suburb to another to take the long trip into the city or to some other central point in order to pass from one locality to another close at hand. The fact that many of the suburbs are widely separated from the city by the severe and abrupt hills, a good idea of which can be obtained from the engravings, has also compelled the construction of very long lines. With animal traction, a trip to these suburbs nearly always involves three hours of continuous riding with but one or two breaks.

The five principal tramway lines in the city are the Jardim Botanica, Carris Urbanos, Sao Christovao, Villa Isabel, and Carioca, or Santa Thereza. The total number of paying passengers on all lines entering the city does not aggregate much less than 350,000,000 per annum. The total number of passengers carried by the four principal street railway companies in "Rio" during the twelve years from 1887-1898, with the average number of passengers



MAP SHOWING ALL OF THE LINES ENTERING RIO DE JANEIRO

carried per year during this period, is given in the table below:

Name of Line	Passengers Carried 1887-1898	Average Per Year
Villa Isabel	87,837,523	7,319,793
Sao Christovao	215,153,999	17,929,499
Jardim Botanico	199,634,118	16,636,176
Carris Urbanos	264,631,650	22,052,637
Total	767,257,230	63,938,105

This average has been greatly exceeded during the last few years, and recent figures show a constantly increasing traffic.

Rio de Janeiro is, theoretically, divided for the purpose of the allotment or disposition of tramway franchises, or concessions, into so-called "zones" of monopoly. These "zones" are very clearly shown on the accompanying map. Thus, the Jardim Botanico tramways monopolize the south-western, or the bay and Atlantic Coast, section of the city and suburbs. To a degree, the Carris Urbanos Company has monopolized the old and congested part of the city, while the Sao Christovao "zone" is actively enjoyed by

VIEW IN RUA OUVIDOR, THE PRINCIPAL RETAIL BUSINESS STREET

both the Villa Isabel and Carris Urbanos lines, and is threatened by the Tijuca Electric Railway—now in operation in the distant Tijuca territory. This particular "zone" is also being penetrated as well by the Central Railway of Brazil. This railway, which is owned by the government, is one of the most important railways in South America, and runs daily ninety accommodation trains, admirably disposed as to hours of movement—for the accommodation of the suburbs reached by it. These suburban lines reach out approximately 12 miles, and the system appears in every way to be exceptionally well conditioned and well operated.

As already stated, the central districts of the city are served by the narrow-gage lines of the Carris Urbanos. These lines are very convenient for short trips through the central districts of the city, for visiting the theaters, public gardens and squares or public buildings, as well as for reaching the main station of the Central Railway of Brazil. The universal fare on this line is 100 reis, equal at the present exchange to approximately 2 cents in American money. This line is operated entirely by animal power.

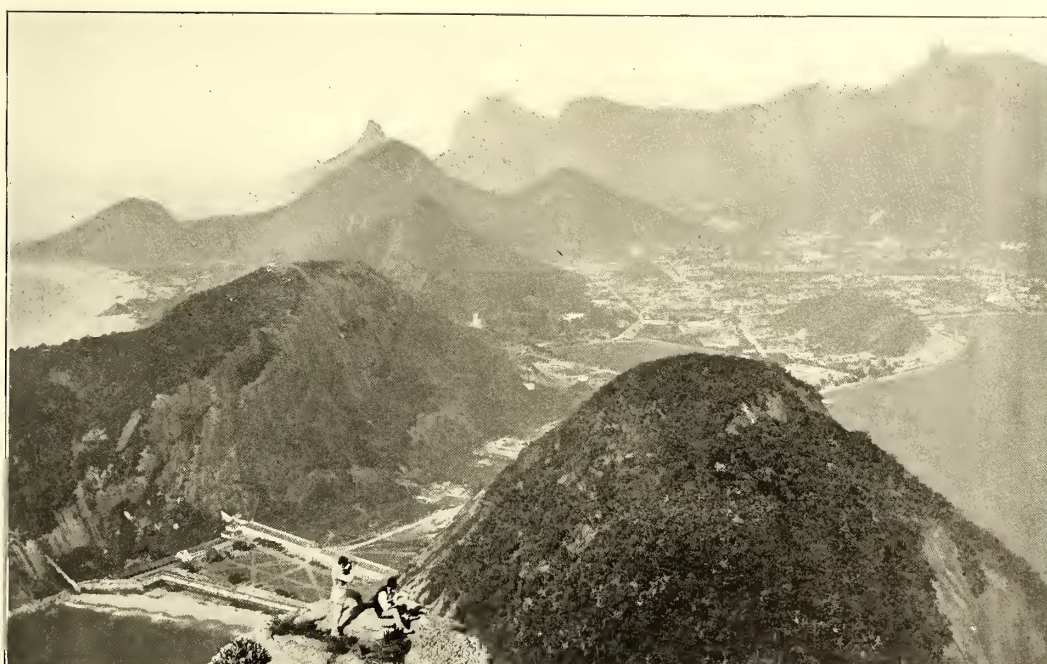
The Jardim Botanico, or Botanical Garden Tramway—city portion—3 miles of which is operated by electricity, serves to connect the city with the suburbs to the southwest. Most of the sections through which this line was built are comparatively modern, and the streets and residences are very pleasing to the eye. The horse cars themselves do not reach the downtown section, but stop at a point some considerable distance before the city terminus is reached. Here the horse cars are coupled to electric motor cars, and, as trail cars, proceed in trains of four or five cars to "Largo Carioco," the city teminus.

The Jardim Botanico is said to be the oldest tramway line in South America, and was built by an American company, which owned and managed it until 1882, when it passed into local control.

The Sao Christovao lines, which are operated by animal traction, communicate with several of the common suburbs to the north and west, and also serve several cemeteries.

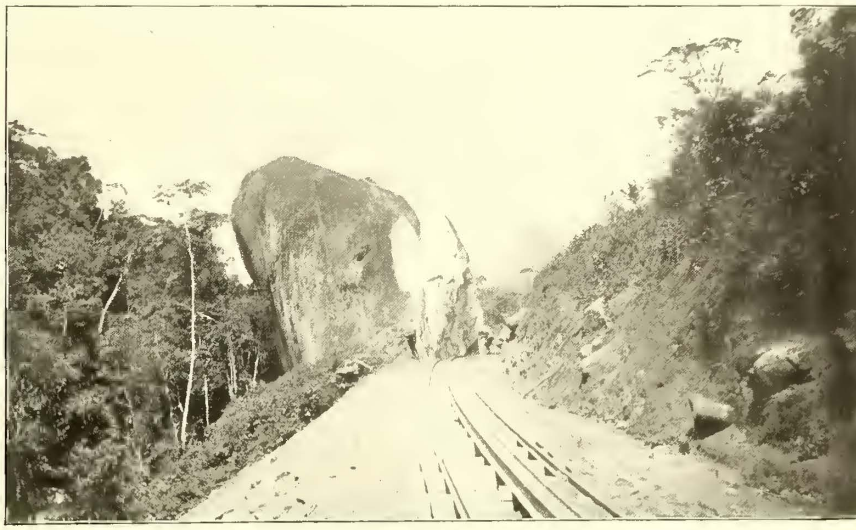
The Villa Isabel line, which is also operated by animal power, connects with a suburb of Villa Isabel to the west and with the intermediate points, and to a large extent serves the same territory as do the lines of the Sao Christovao Company, prospectively the Tijuca Electric Railway and the Central Railway of Brazil. The latter is a large steam railroad system, already mentioned, belonging to the government.

The Carioco line, which has been equipped with electric



A VIEW OF THE CITY FROM SUGARLOAF MOUNTAIN

power, starts from Largo Carioco and also from the head of Plano Inclinado, an inclined plane railway operated by cable power, and extends to Sylvestre. The streets are steep and crooked and the grades and curves are very severe. These grades in many places are as steep as 7 per cent and 8 per cent, a few being more severe. The cars on the inclined plane run every half hour, starting on the exact hour and half hour, except for a short period in the morning and evening, when they are run on fifteen-minute intervals to accommodate the increased traffic. The inclined plane cars were formerly drawn up the hillside by means of a stationary engine and a $\frac{7}{8}$-in. wire cable, passing around a horizontal drum, and attached to a descending



A VIEW ON THE CORCOVADO COG RAILWAY

car as a counterbalance. This power is now electric. The total length of this inclined plane is 1683 ft. (513 m), and the grade varies from 14 per cent to 16 per cent. There are three viaducts, two of iron and one of wood, and the "upper" one is at a considerable height, particularly on the eastern side, where the hill slopes sharply into a narrow valley. The view on this side is very picturesque. This road was opened to traffic in 1877.

On the top the traveler enters an electric car, which carries him around sharp curves and up steep grades until the greatest elevation is reached at Hotel Sylvestre. The greater part of the way the train follows the old aqueduct road, the hill rising abruptly on the left and descending sharply on the right, leaving but few places on which residences can be built. The views out over the city and upper bay are indescribably beautiful. The Tijuca Mountains are seen on the left, the open country appears beyond Villa Isabel and Engeno Novo, and in the distance are the Tingua Mountains, whence comes one of the water supplies. But, as magnificent views can be obtained from so many hundreds of places in and about the city, particular mention would fill a large volume.

The Corcovado cog railway has a three-rail track, which climbs the mountain side with grades of 25 per cent to 30 per cent. The locomotive, which weighs approximately 13 tons, possesses a central cog-wheel, which runs on a central cog-rail (Riggenbach system). The total length of the road is about 2 1/3 miles, and the altitude of its terminal station 2198 ft. (670 m), making an actual ascent of 2077 ft. After leaving the train, a slight ascent on foot brings one to the summit of the peak, a small, walled-in space of a few yards, 2329 ft. (710 m), railway measurement,

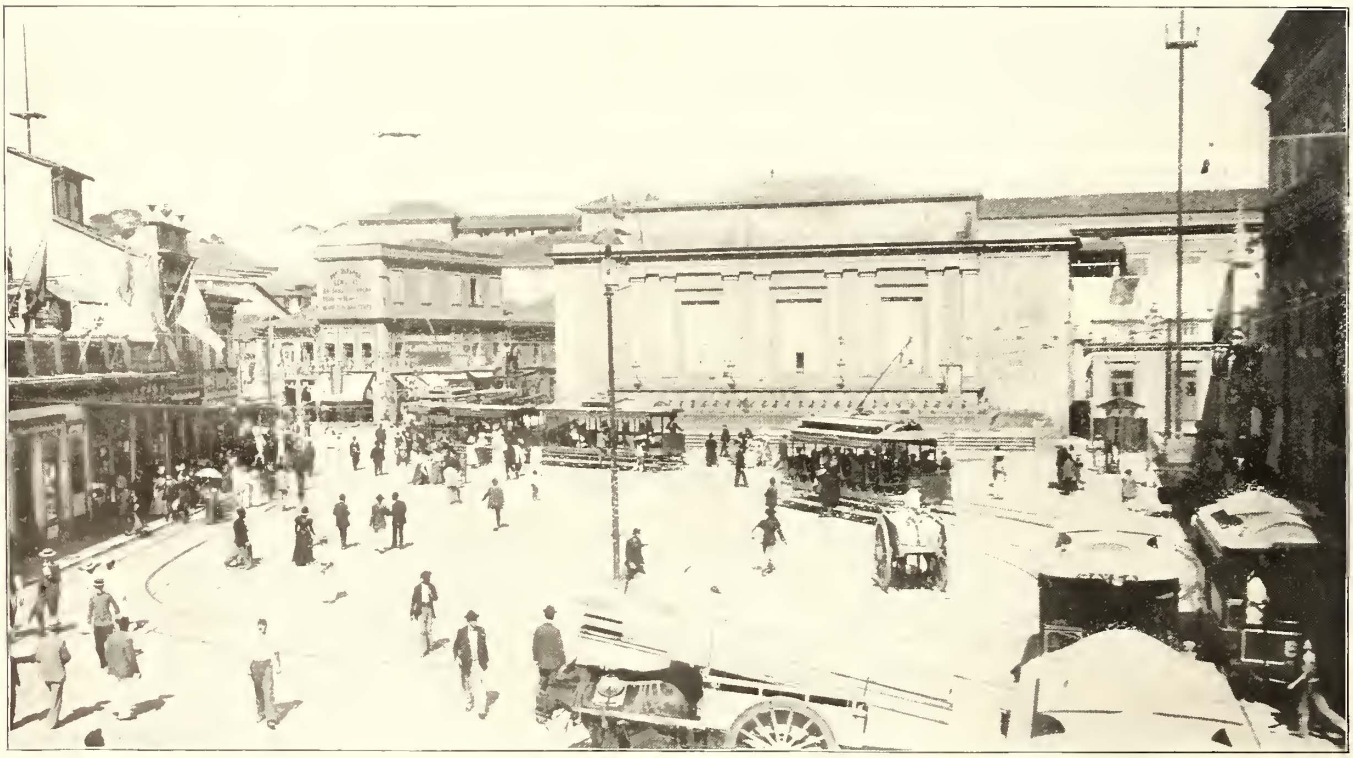
STREET VIEW IN FRONT OF JARDIM BOTANICO

above the sea level, commanding views of sea, city, bay, forest and mountains. The whole expanse of the bay then lies stretched out like a map, and the eye can follow its curving shores for miles.

But little has been done to encourage traffic, as compared with the practice in the United States. The railway companies have done nothing in the way of establishing parks or pleasure resorts. Possibly this is due to the fact that boards of directors, and, to a large degree, the managers as well, are usually men engaged in other business, and are not practical railway men.

The track construction in Rio de Janeiro is of a great variety. The Jardim Botanico, which is partially an electric line, employs $3\frac{1}{2}$-in. to $3\frac{7}{8}$-in. T-rail (section 428 of the Barrow Steel Company—about 40 lbs.), laid on wooden ties, 5 ins. x 6 ins. x 7 ft., and spaced about 4-ft. and 5-ft. centers; a flat rail, laid on wooden stringers, the old "American" pattern—or a rail of the Spillman type, is also extensively used. This latter rail has an irregular section somewhat like an inverted L, with web which has no lower flange or base. It is set into a cast-iron chair and is held in place by a wooden wedge. Most of the rail in "Rio," however, is of the "T" type, weighing approximately 30 lbs. to the yard. The ties, which are of native woods, are laid 3-ft., 4-ft. and 5-ft. centers, and, when the rails are of the flat type, carry the stringers, which in turn support the rails.

The fares charged on the tramway lines vary from 100 reis, approximate 2 cents in American money, to 300 reis, 6 cents. The lowest fare, which is 100 reis, is that charged on the Carris Urbanos lines, and is independent of the distance traveled. This same fare is also in force during certain times of the day on parts of other lines. The collection is made by conductors, who are expected to detach a ticket from a supply given them, for each fare taken. The writer has witnessed many "omissions," however, and the invitation for peculation afforded by this system can readily be imagined, there being no registers used. Passes are given out to a large extent for various reasons by the managers of all the roads, and the gratuitous passengers carried amount to perhaps 10 per cent of the total number carried in the city. Schedules are a subject, also, to which much attention is not given, and it is no unusual thing for a train of five cars, motor and four trailers, to stop several times within a "block," or 300 ft., to pick up passengers, not only wasting much time, but also much energy, animal or electric.



LARGO CARIOCO, NEAR THE CENTER OF THE CITY, AND THE TERMINUS OF THE PRINCIPAL ELECTRIC LINE

Another very peculiar feature of railway operation in "Rio" to an American manager, although it is the common rule in all the Spanish speaking countries, is the legal practice to hold the servant and not the master responsible for accidents. Thus, under this ruling, there is no liability on the part of the company for damage suits, the law holding the driver, motorman or otherwise the responsible party. The practical effect of this rule, in case of an injury to a person or property, is that the "servant" contributor to it usually runs away and disappears. Thus the companies have no damage suit account to eat into their earnings, as in other countries; in fact, none of the companies even keeps an account of the "casualties" occurring through accidents on its lines.

All of the electrical machinery and apparatus now in use on the tramways in Rio de Janeiro are of the General Electric type (Thomson-Houston), and, as has already been said, are in use only on the lines of the Jardim Botanico, the Carioca and Tijuca railways. As the latter two are very small properties, and as the Jardim Botanico at present has only about 4 miles under electric operation, the extent of electric railways in the city is not large.

The franchises as a rule have a life of from thirty to fifty years, and require the maintenance of that part of the streets occupied by tracks lying between them.

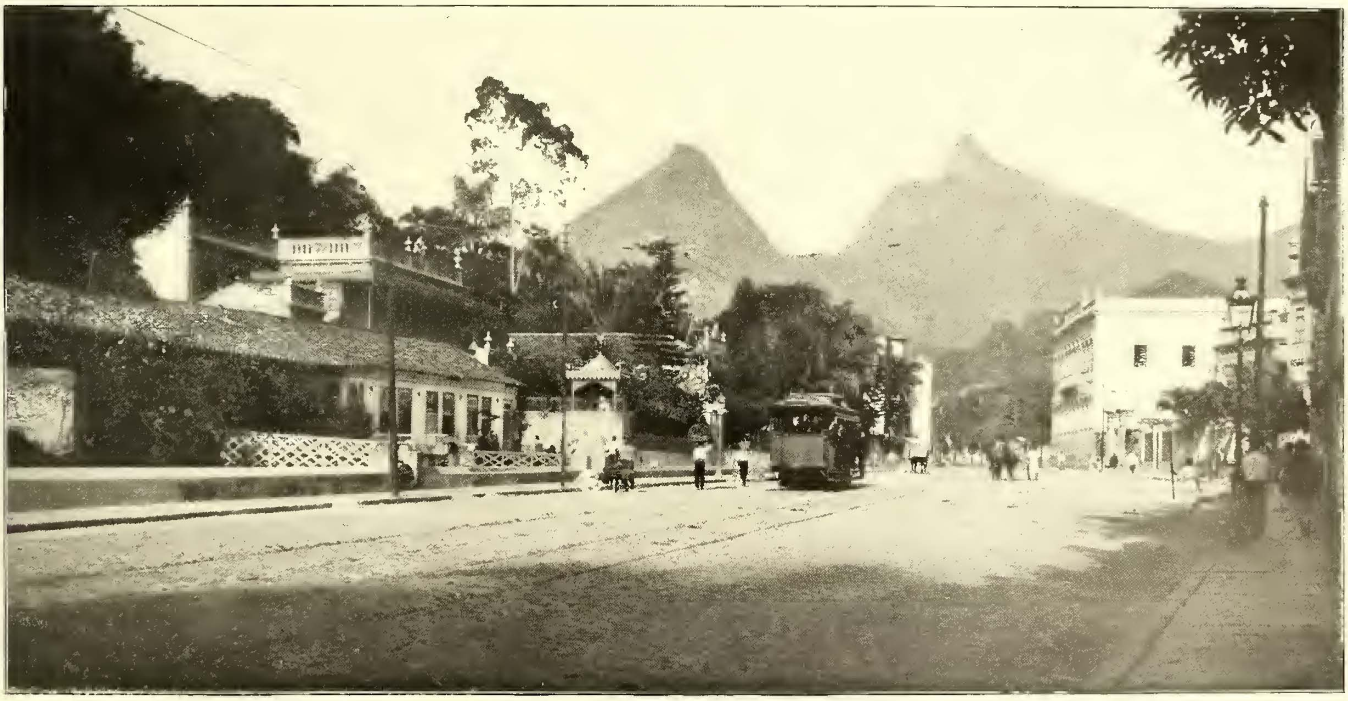
The animals used on the animal traction lines are what is known in the United States as the Mexican mule, an animal of small size, usually from 13 hands to 14 hands high, but admirably adapted for this work. They are usually brought from the Argentine Republic, though some are obtained in Brazil.

Almost all materials, car wheels and fixtures and supplies generally of the many kinds needed by a tramway company have to be imported from Europe or the United States of America, but generally from Europe.

slow going of the existing system, which should add greatly to their earning power. While the present equip-

VIEW IN RUA PRIMERA DO MARZO

ment, track, etc., is antiquated and useless, this is rather an advantage, as it reduces the value of the material which



RUA LARANJEIRAS, A FINE RESIDENTIAL STREET

The wages of the employees vary from an equivalent in United States money of from 40 cents to 60 cents and 75 cents per day for common labor. Conductors and drivers are paid from 60 cents to $1 for twelve hours' work. It would seem as if in most respects the city is admirably adapted to a system of electric transportation. The long distances to be traversed would give to the higher speed of the electric cars an enormous advantage over the present

would have to be scrapped. The only possible drawback is the high price of coal, all of which has to be imported. That this is not an insurmountable hindrance, however, is shown by the experience in other cities similarly situated in regard to their fuel supply, where it has been shown that the advantages of electrical working are very patent, even in competition with horses and mules in a region where animals and fodder are exceedingly cheap.

THE BERLIN ELECTRIC ELEVATED ROAD

The constant growth and development of the German capital has demanded so large an increase in transportation facilities that the present rapid transit roads which are independent of the street car lines, that is, the Berlin City Railway (Stadtbahn) and Belt Line (Ringbahn), have long since been inadequate to take care of the traffic. In the most frequented streets, where one street car follows another, and where, besides omnibuses and carriages and numerous other vehicles are met, rapid progress has become an impossibility, and the construction of a new means of transportation in the form of elevated and underground roads has become a necessity for the city of Berlin.

In view of this fact, the firm of Siemens & Halske some time ago petitioned for a franchise to build and operate company was organized on April 27, 1897. Its present capitalization is M.25,000,000, one-half of which consists of 4 per cent bonds, the other half of ordinary shares.

This company has an agreement with Siemens & Halske, by which it acquires and assumes all contracts and rights acquired by the firm which relate to the building and operation of the road, while the latter has agreed to build the road and operate it at its own risk for one year, with a guaranteed net profit of 4 per cent. Only after the road has been in operation for one year will the same pass into the hands of the operating company. In consideration of operating the road for this time, Siemens & Halske will receive 25 per cent of the net profits in excess of the guaranteed 4 per cent. As a great deal of territory will be re-

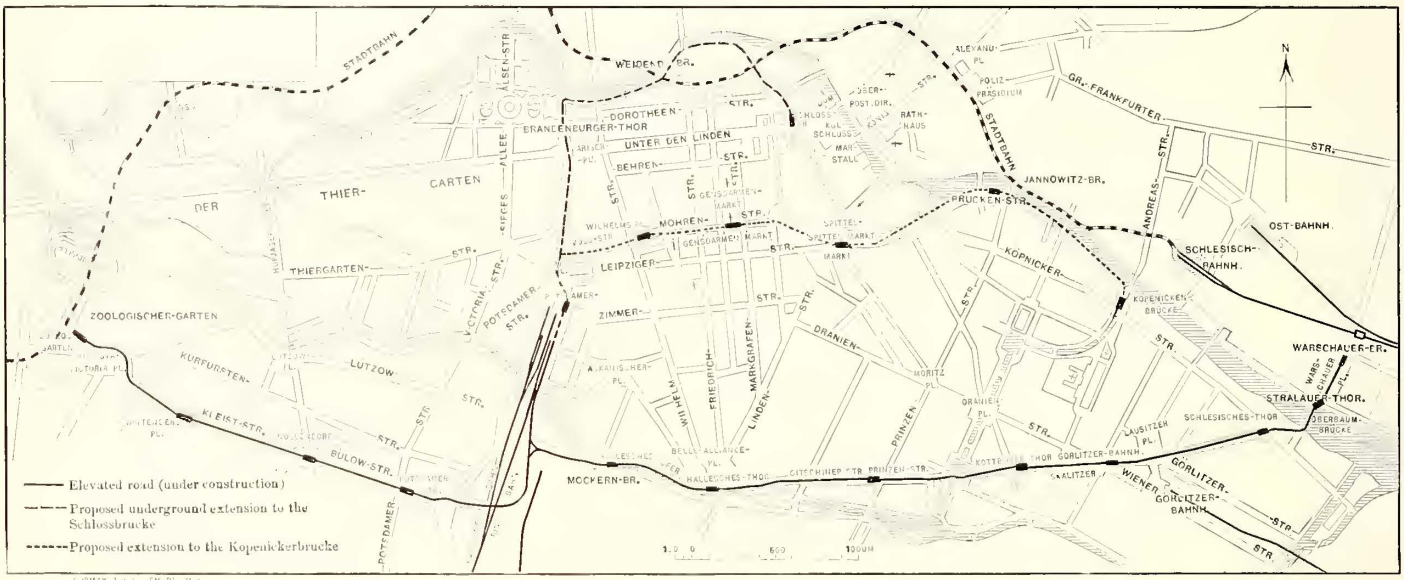


FIG. 1.—MAP OF BERLIN, SHOWING ROUTE OF THE BERLIN ELEVATED RAILWAY AND STADTBAHN

an electric road extending east to west, and branching out into the south and southwest, to be in the form of an elevated road within the city limits of Berlin and an underground road in Charlottenburg.

The preliminary franchise for the building of this road was granted March 22, 1893, and agreements were made between the cities of Berlin, Schoneberg and Charlottenburg for the use of the streets and highways. Subsequent to this, on Sept. 10, 1896, actual work on the road was begun.

In making these agreements with the municipalities it was distinctly understood that the latter would abstain from the building of street railway lines. The State Railway Commission also declared that it did not consider the new road a competitive one to the existing roads. On the other hand, the Siemens & Halske Company considered that the electric elevated road to be erected was but the first portion of a continuous network of rapid transit lines such as it had planned for some time. In view of this, a responsible banking institution was appealed to to furnish the necessary financial backing, resulting in the Deutsche Bank joining the firm in the founding of a company for electric elevated and underground roads in Berlin. This quired by the company for the building of the road, the municipality on Aug. 28, 1897, granted it the entire right of way from the Warschauer Bridge to the Zoological Garden and a branch to the Potsdamer station. The new electric road will be standard gage and double track. The maximum speed permitted, which is in accordance with the regulations for standard gage roads, is 50 km per hour.

The territory traversed by the road is shown in the map, and it will be noticed that a triangular switchback is being constructed, which makes it possible for the cars to run directly to the Potsdamer railway station to the Zoological Garden. The trains will run in both directions, with a headway of five minutes. More trains can be added as the traffic requires, so that the headway can be reduced to two minutes. The elevated road will have ten stations and the underground road three. The total length of the road will be 10.4 km, of which 8.8 km are in Berlin, .2 km in Schoneberg and 1.4 km in Charlottenburg. The State franchise for the operation of this road and permission to use public, as well as private, thoroughfares, squares and lots, which are necessary for the construction and operation of the road, covers a period of ninety years, beginning with March 15, 1896. For the use of this territory the company has to pay the following amounts each year:

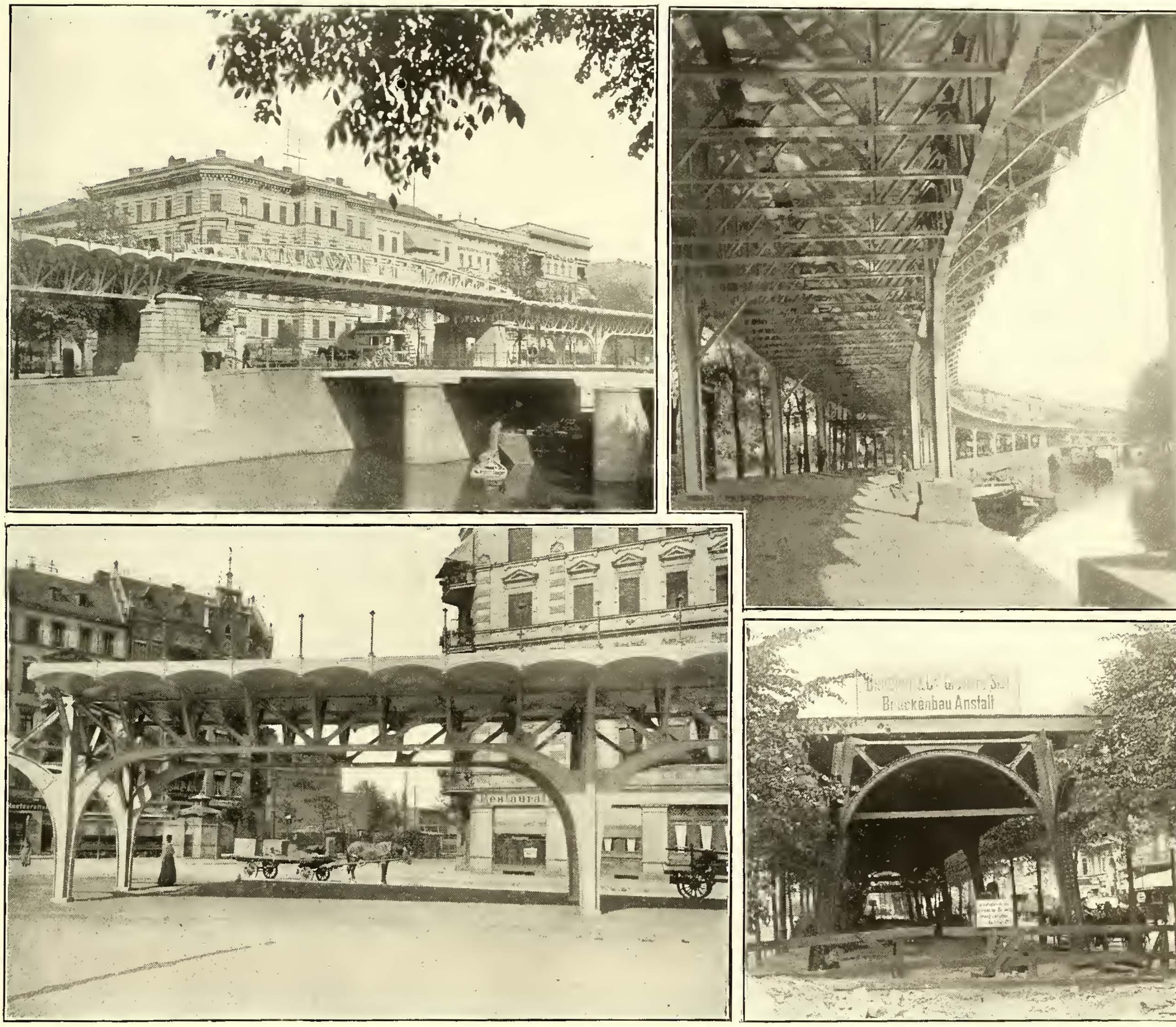
First—To the city of Berlin, if the yearly receipts amount to M. 6,000,000, the city receives 2 per cent; if M. 7,000,000, 2¼ per cent, and so on, for each million marks ¼ per cent additional goes to the city. After four years from the granting of the franchise, that is, the beginning of the fifth year, the least amount given to the city is M. 20,000.

Second—To the city of Schoneberg; this city receives 8/36 per cent of the total receipts up to M. 7,000,000, 9/36 per cent of M. 8,000,000, and 1/36 per cent additional for each increase of M. 1,000,000. After four years the amount to be paid to the city must be at least M. 3,500.

The Commissioners of Berlin, Schoneberg and Charlottenburg have reserved the right to purchase the entire road from the company. The road cannot be acquired, however, until after thirty years have elapsed from the granting of the franchise, and the right can only be exercised during ten years thereafter. In case the cities have such an intention they must notify the company two years in advance before they wish to carry it out, and cannot possibly retract thereafter. After the expiration of the franchise the entire road and accessories will become the property of the city. The city reserves the right to cancel all permissions granted, should the road not be finished in the specified time, or in case the company should fail twice in succession to pay the percentages due the city, and, thirdly, in case the company should make an assignment. In the latter case, the city has the right to restore all thoroughfares to their former condition at the expense of the company.

The following details relating to the construction of the road are of interest: The distance between center and center of track is 3 m. The tracks have a standard gage of 1.435 m, and the roadbed has a width of about 7 m. Standard gage was chosen, so that it will be possible at any later date to run the elevated or underground cars over the street railway company's tracks.

At several points the road will have very sharp curves, one in the so-called triangular switchback having a radius of 90 m, and another having a radius of 80 m. In general, however, the curves have a radius of 100 m. The total length of the curved portions of the road is 27 per cent of the entire road. The height of the elevated tracks is practically determined by the fire department regulations, which state that the pillars of the structure must be at least 2.8 m above street surface. Where the road passes



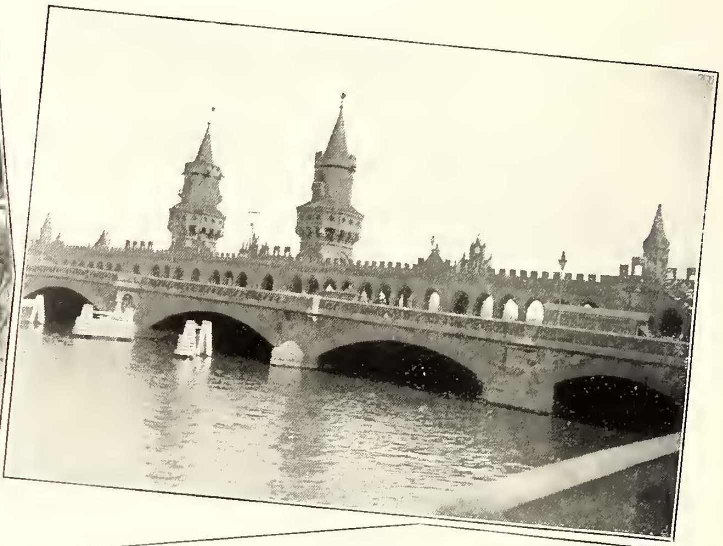
FIGS. 2-5.—DIFFERENT VIEWS OF THE ELEVATED STRUCTURE

over the Wannsee road and the Belt line the height is 4.8 m, and at various other points, for specific reasons, other heights were chosen. The superstructure of the elevated road consists in general of iron viaducts. Stone pillars are used only at depots and river crossings, as shown in Fig. 2. Stone viaducts are employed at several places, especially where the road passes between a row of houses. Where iron pillars are used each track is laid on a single longitudinal girder and only a single row of pillars has been built. As far as the height conditions permitted, the main pillars are situated under the tracks, and are 3.5 m apart. Fig. 3 shows standard construction for a 12-m span at the Oberbaunstrasse, and in Fig. 4 is shown a peculiar type of construction, which was adopted in order to gratify the wishes of a number of property owners who desired to have that portion of the road especially attractive, as the houses along this line are the property of well-to-do citizens.

In addition, the construction has been so chosen that no water can trickle down on the streets below. For this reason, the entire structure is lined with sheet iron, which is laid between the ties and girders. This iron is covered with gravel, so that it not only serves as a roof for the street below, but also dampens the noise considerably. The sheet-iron plates are 3 mm in thickness and do not have to support any of the weight of the tracks. Nevertheless, they strengthen the entire structure considerably. Pipes drain the water from this overhead construction and lead it into the sewer pipes.

Quite an interesting construction has been adopted in the building of a viaduct over the canal bridge of the Anhalter road and the Landwehr Canal, shown in Fig. 5. It was necessary to build a large iron bridge 8 m in width, having a 78-m span on special construction. Structural ironwork was erected 1.85 m above its supports, in order not to interfere with the railway traffic, and after the girders had been constructed they had to be lowered on to the supports. For this reason the bridge was supported at each of its four corners on three hydraulic presses, which had a total carrying capacity of 144 atmospheres. Clearing the structure was done in such a way that the pressure of all the twelve hydraulic presses was reduced simultaneously, which was essential, in view of the fact that the structure weighed about 40,000 kg. Each operation lowered the bridge 12 mm. The builders had to contend with a large number of difficulties, in spite of which the work was done in four days without the slightest accident. The height of the structure above the surface of the water is 15 m.

That portion of the road starting from the switchback and leading to the Zoological Garden traverses for a length of 269 m the Potsdamer railway station. The construction is such as to permit a change of position of the railway tracks in case this is deemed advisable at a later date. Fig. 7 shows the Oberbaun Bridge, 146 m in length, over which the elevated road passes the River Spree. On this bridge the tracks run on an arcade-like structure, which harmonizes in every way with the bridge structure itself. The

FIGS. 6-9.—VIADUCTS AND STATIONS

building of this portion of the road the city undertook for the round sum of M. 170,000.

One of the most interesting portions of the entire elevated structure is the triangular switchback above referred to. A very interesting problem has been solved here, and it may be worth while to give some of the details.

It is proposed to so arrange the running schedule of the road that trains can run back and forth from west to north and north to east and west to east. The switchback is so constructed, being double tracked throughout, as to permit such an arrangement. Perhaps the most interesting feature of the switchback is the fact that there is absolutely no crossing of tracks. The plan was proposed by the well known engineer, Kemmann, and was executed by Siemens & Halske, to whom great credit is due. After its completion it will be difficult to find a place of vantage from which it will be an easy matter to distinguish the mixed network of viaducts, bridges, etc., which form the structure. There are no steeper grades than 1.38, and no curves on double tracks having radii less than 95 m.

The average distance between the thirteen stations, ten of which are intended for the elevated road and three for the underground road, is 930 m. The shortest distance is only 340 m, and is between the stations Stralauer Thor and Warschauerbrücke, and the greatest distance, 1940 m, is between the stations Potsdamerstrasser and Potsdamer Platz. This great length is accounted for by the fact that the road has to pass over the enclosure of the Potsdamer railway station.

The architecture of the stations is comparatively simple. Most of the stations are located along the center of broad streets, and are so built that the traffic beneath is unobstructed. The sub-structure harmonizes in every way with the adjoining viaducts, that is, it is supported by two rows of wrought-iron pillars and cross-beams on which the tracks are laid. A number of the stations resemble that at the Görlitzer railway station, shown in Fig. 9. Two of the stations differ from the last named by being accessible through buildings, as shown in Fig. 10, instead of steps. The platforms are 3 m in width, and are located similarly to those on the Liverpool Electric Elevated Road, on each side of the elevated structure. As seen in Fig. 9, the width of the structure is 11.5 m, and is covered for a distance of 50 m by a flat sheet-iron roof, while the remaining 30 m remain uncovered. The height of the platform above the top of the rail is 85 cm, and it is 6.15 m above the level of the street.

FIG. 10.—ENTRANCE TO THE PRINCESSENSTRASSE STATION

Several of the depots, on account of their location, demanded a more elaborate architectural construction. Fig. 11 shows a southeast view of the depot at the Schlesisches Thor. The difficult problem presented here was successfully solved by the architects Gresebach and Dincklage, to whom the commission was given by Siemens & Halske. As will be seen in Fig. 12, the stairway approach on the one side is balanced by a spacious waiting-room on the other. A portion of the structure is fitted up as a restaurant, and another portion for stores. The former is connected with the upper waiting-room by means of a winding stairway, for the reception of which a tower has been built.

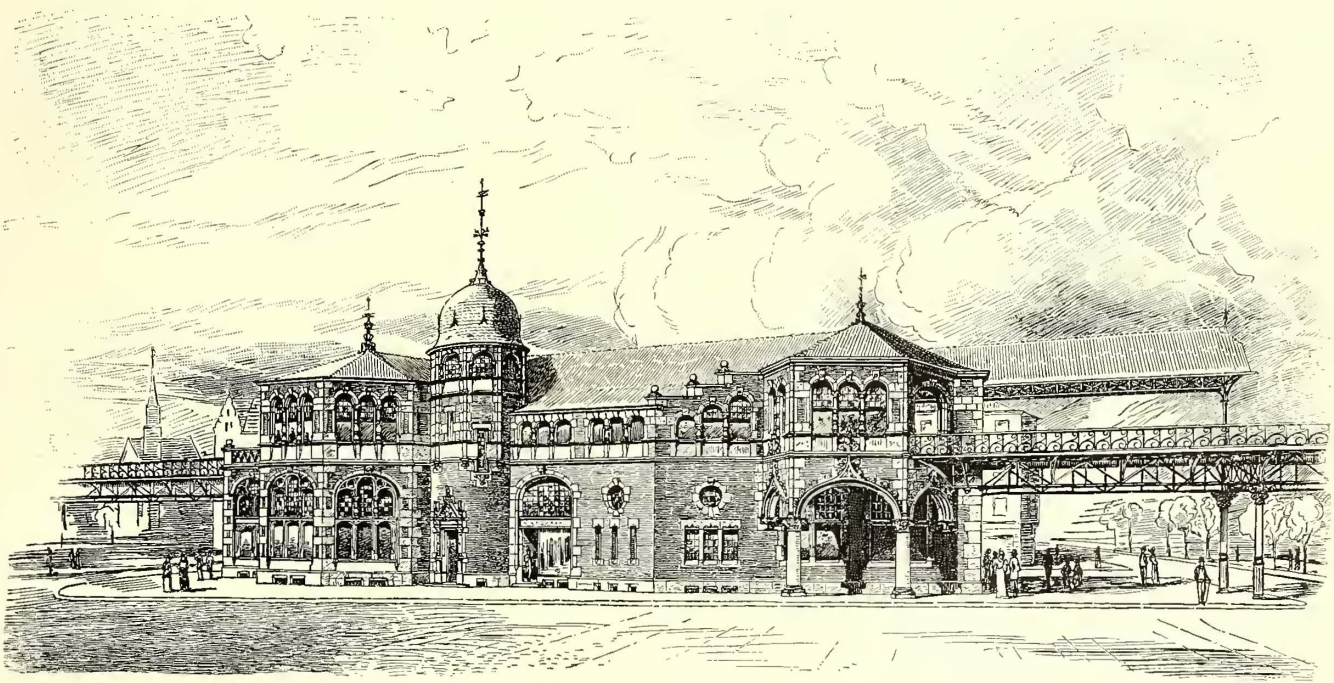
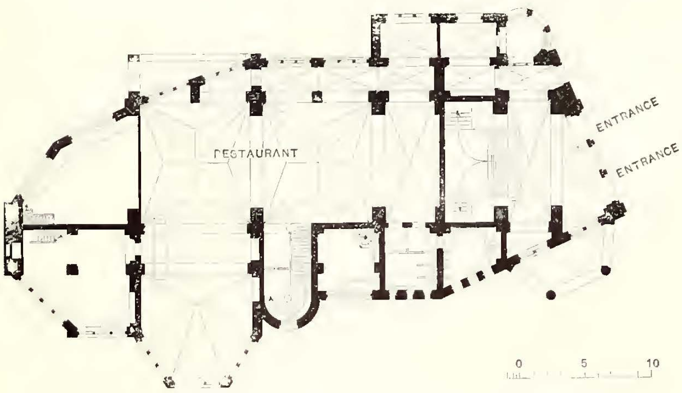
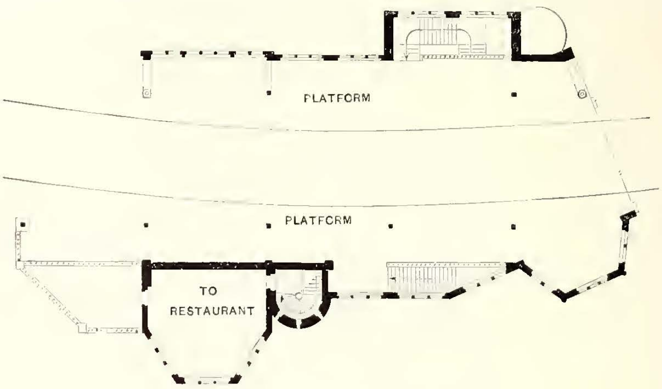


FIG. 11.—SOUTHEASTERN VIEW OF STATION AT SCHLESISCHES THOR

The largest station will be that at the terminal at the Warschauer Bridge. It is 300 m in length and 26.5 m in width. One-half of this length is in the form of a curved viaduct; the other is an iron viaduct on stone pillars. Besides the depot, which is 50 m in length and is situated on the viaduct with its three platforms each 80 m in length, a car house will be built at this point, in which twelve trains, each 45 m in length, may be stored. There is also a carpenter and varnishing shop on the viaduct. In the lower portion are located the other workshops, to which the cars to be repaired are sent by means of electric elevators. The remainder of the viaduct arches will be let out for storage purposes.





FIGS. 12 AND 13.—PLAN OF GROUND AND SECOND STORIES, SCHLESISCHES THOR STATION

Fig. 14 shows the proposed depot at the Nollendorf Platz. The viaduct leads from Bulowa Strasse to the railway depot, which is a light structure built on sandstone pillars. The whole is surmounted by a cupola, which forms the central point of a square. Close behind the station the road begins to descend. On the other side of the square the structure is flanked by obelisks, which correspond to the parklike surroundings.

The building of the underground portion of the road was begun but recently, and for that reason we are not in a position to present any illustrations of this part of the undertaking. As will be seen from the plan, there will be two depots, one at the Wittenberg Platz and the other, the temporary terminal station, at the Zoological Gardens. This latter station will adjoin the present station of the city belt line, and for this purpose the Hardenbergstrasse will be widened from 17 m to 43 m. These stations are reached by means of stairways which are flanked by simple balustrades. These approaches have the advantage of great ease in reaching the station, as the stairs are only 3.5 m in depth. The underground stations are handsomely equipped. Cream-colored porcelain slabs cover the walls and ceiling. As the stair shafts are uncovered they also serve as ventilators for the tunnel.

The total height of the tunnel above the rails is 3.3 m. Through the center there will be a row of supports .25 m in width. On each side of this row there will be a space of 35 m, then the width of each side of the car itself, which is 2.3 m, and between this and the walls of the tunnel 3.5 m more, making the total width from wall to wall equal to $(2 \times 2.3) + (4 \times .35) + .25 = 6.25$ m. At the curves the tunnel must, of course, be somewhat wider. The tunnel will be constructed of cement, and the 1-m walls and bed are made water-tight by means of asphalt felting. Above the cement bed a brick layer will be built, which contains a water drain. This roof is composed of iron beams, which rest on the cement walls 1 m apart. Between these beams cement arches will be constructed similar to those in Buda-Pest. These arches are leveled off on top by means of a layer of cement, above which is laid a water-tight covering of asphalt felting. Above this the pavement is laid.

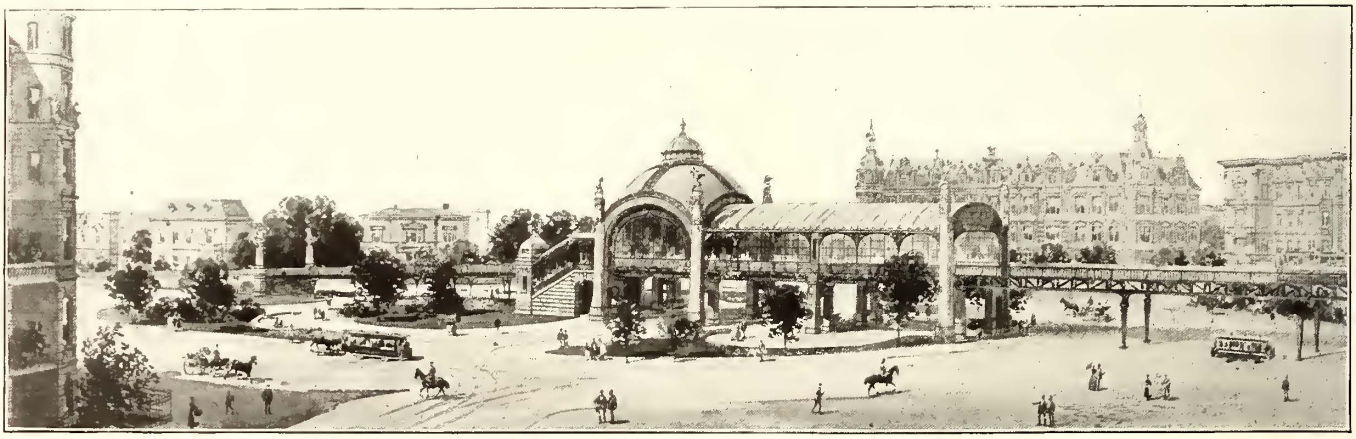


FIG. 14.—PROPOSED DEPOT AT NOLLENDORF PLATZ

The tunnel is built during the day in those streets only where the traffic permits it. In other streets the walls are built separately during the daytime, and the core of the tunnel is removed from the end. According to the municipal regulations, the tunnel covering must be built at night in streets where traffic is heavy, and the latter must be provided for during the day by a temporary wooden street surface. That part of the tunnel lying behind the Köthenerstrasse, which is 344 m in length, is now in course of construction. After crossing the Landwehrkanal the road passes through the yards behind the western row of houses in the Köthenerstrasse. It is intended that beginning at this point the underground road will some day be continued into the city, and for this purpose all the houses on the line of route have been purchased by the company.

The rails used are 115 mm in height and weigh 28 kg per meter. The so-called "Blättstoss" is used to connect the separate rails. Where the rails are laid from girder to girder without the use of sleepers they are 180 mm in height and weigh 43 kg per meter, as they will be unsupported for 1.5 m. The rails are thoroughly insulated from the iron structure by hard wooden blocks, which are laid beneath the rails. Between the wooden blocks and the rails layers of felt are placed.

The conductors at present consist of bare steel rails, which are located at the center of the tracks. A wedge-shaped shoe is pressed against these rails by means of springs.

There are at present forty-two motor cars and twenty-one trailers. The cars rest on two two-axle trucks. The cars are fitted out with longitudinal seats, like the West Side cars in Chicago. The motor cars will seat forty and the trailers sixty passengers, so that a train consisting of two motor cars and one trailer between them will seat 140 passengers. The total weight on one motor axle is calculated not to exceed 6 tons, while the weight on the running axle is from 4 tons to 4½ tons. The wheels on the motor axle are .9 m and those on the running axle .75 m in diameter. The distance between the wheels of the truck is 2 m. The car body is 2.3 m in width, about 13 m in length, and has a height of 2.18 m. Although it is proposed to use magnetic brakes, a hand-brake is provided, and in extreme cases a short-circuit brake may be used.

It is intended that the trains should have a headway of five minutes, which, in accordance with an agreement with the city of Berlin, may be extended to ten minutes during some specially designated hours when traffic is not very great. This headway will probably be decreased soon.

The extensive power house, which has been designed by the director of the company, Mr. Wittig, is partially completed, as shown in Fig. 17, and the equipment of the same has been begun. The lower part of the building will be the engine room, which contains three steam engines, each having a normal capacity of 900 effective horse-power and a speed of 115 r. p. m. There are, further, three direct-current dynamos, each having a capacity of 800 kw, and the necessary accessories. The dynamos are directly connected

FIG. 15.—GENERAL VIEW OF ELEVATED STRUCTURE, WITH TEMPORARY TRACK FOR TRANSPORTING MATERIAL ABOVE

to the engines. On the next floor six water-tube boilers are located, furnished by the Gehre Company, each having a total heating surface of 234 sq. m. The boilers have a superheating pressure of 10 atmospheres and an hourly capacity each of 3200 kg. Above the boilers the coal is stored in large sheet-iron funnels, from which the coal is fed automatically to the boilers. They are supplied with coal from canal-boats by means of Hunt conveyors. The engines and boilers are being installed at present. The feed-water is obtained from the Landwehr Canal, and is led to the station by a pipe .75 m in diameter, and, as the same is located 1.5 m below the level of the ground-water, a suction plant had to be installed, so as to lower the ground-water level 2 m. After the water has been used the oil is extracted from it and it is led back into the canal by an .8-in. pipe. The chimney is 80 m high, 7 m higher than the highest building in Berlin—the City Hall.

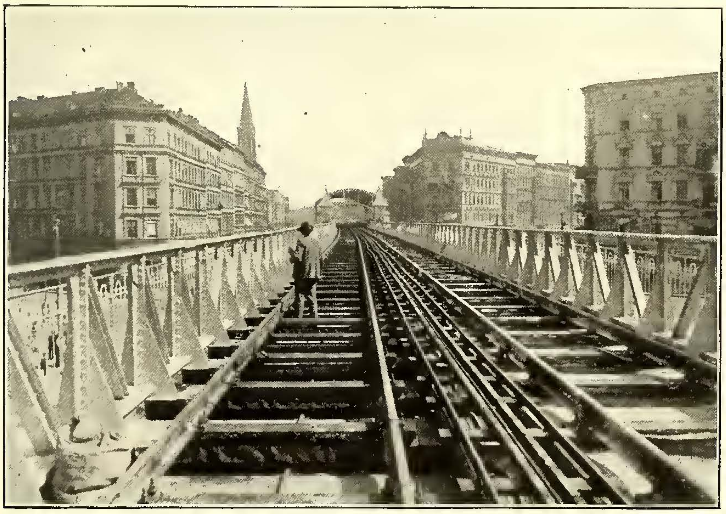


FIG. 16.—VIEW OF STRUCTURE WITH TEMPORARY TRACK FOR WORK TRAINS

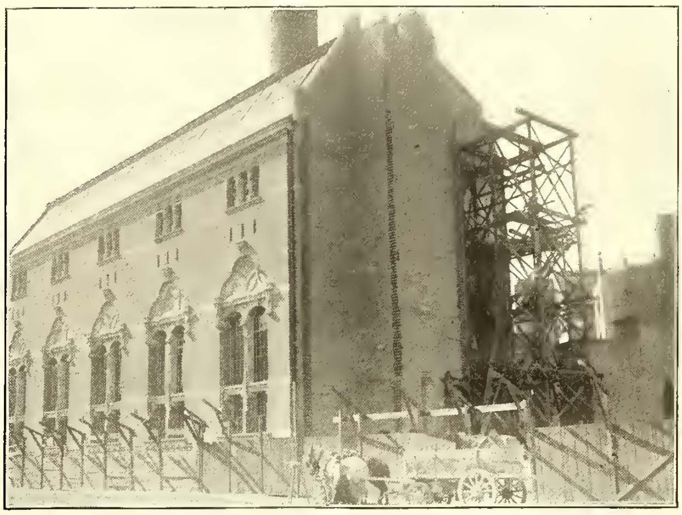


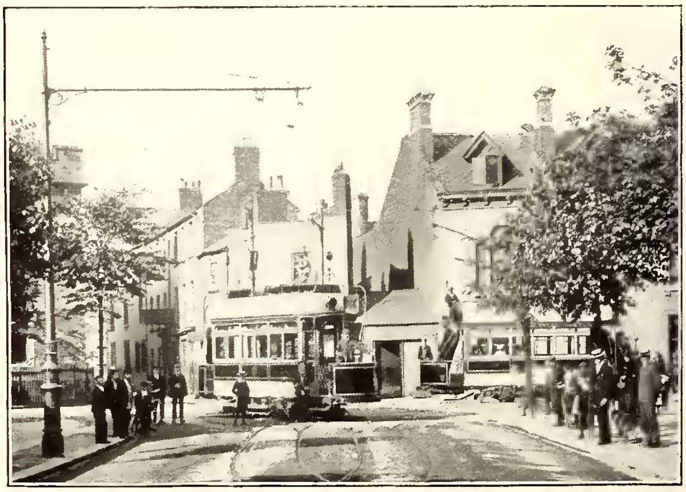
FIG. 17.—VIEW OF POWER STATION WITH SCAFFOLDING FOR ERECTION OF BOILERS

THE ELECTRIC TRAMWAY SYSTEM OF CARLISLE, ENGLAND

The rapidity with which the idea of municipal ownership and operation of tramway properties has developed in Great Britain since the introduction of electric traction has left only a limited field in this direction for the application of private enterprise. Practically all the larger corporations, excepting Dublin and Bristol, have in hand, or are committed to, schemes for municipal control of the tramway undertakings within their own borders, and in many cases considerably beyond them. Keeping in view the magnificent earning power of an electric tramway in any large center of population, it is not unlikely that even with the drawbacks incident to municipal control these undertakings in large cities will prove to be exceedingly remunerative. It is quite a different matter, however, where we have to consider towns of less than 100,000 inhabitants, and especially where the population falls below 50,000. American experience has shown that a satisfactory financial outcome in such small cities is almost altogether a matter of good equipment without extravagant initial outlay, and with careful and economical subsequent management. That with these two essentials success is more likely to be obtained from private than municipal control is a contention which very few will venture to gainsay. The Carlisle electric tramways, which are about to be described, afford an interesting example of a company undertaking, under British conditions, the operation of a street railway in a small city, in which all the conditions leading to success have been observed, and where the results are, from a financial point of view, correspondingly satisfactory.

SIDE AND CENTER POLE CONSTRUCTION

CAR HOUSE



LONG BRACKET POLE AT TURNOUT

The city of Carlisle is an interesting and historical English town, situated upon the Scottish border, and the scene of many a stirring event in the early history of what is now the United Kingdom. It has a population of from 40,000 to 50,000, and from the way it is laid out is what can be called a good tramway town. The City of Carlisle Tramways Company, after obtaining the necessary concessions, commenced work in September, 1899. The plans and specifications of the undertaking were prepared by the consulting engineers of the company, Alfred Dickinson & Company, of Birmingham.

The whole work was practically completed by the end of July, 1900. The total length of the various routes is $5\frac{1}{2}$ miles, of which $3\frac{1}{4}$ miles are single track, the total track mileage being therefore $7\frac{3}{4}$ miles. A condition of the company's agreement with the corporation was that it should take current from the municipal electricity works upon the basis of 2d. per unit for the first 50,000 B. O. T. units (kw-hours), $1\frac{3}{4}$d. per unit for the next 100,000 units, and above 150,000 units $1\frac{1}{2}$d. per unit. The tramway company at the same time guaranteed to pay the corporation for a minimum consumption of 100,000 units per annum. It will be seen at once that this combined source of supply of current for lighting and traction affords to the corporation a very good market for a considerable and steady output during the entire year, and that at the same time the tramway company is saved the expenditure of capital required for the installation of the necessary power station. At the same time the price it agrees to pay for its current is perhaps not more than its cost from an independent installation of its own.

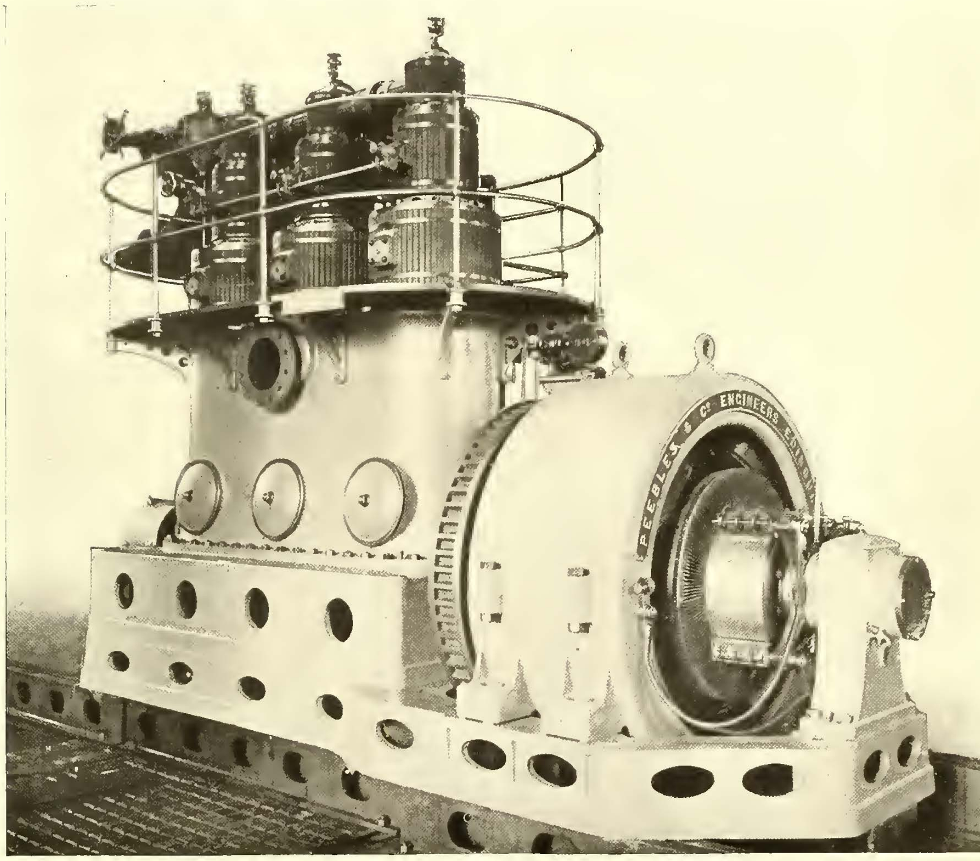
The contract for the whole of the work embraced in the equipment of the undertaking, including permanent way and overhead and feeder construction, and the furnishing of the necessary electric motor cars, etc., was placed in the hands of Dick, Kerr & Company, Ltd., London, and it is certainly indicative of the satisfactory results attending the English practice of placing the whole of such an undertaking in the hands of one competent firm of contractors that the work should have been completed in so short a time.

PERMANENT WAY

In the $7\frac{3}{4}$ miles of permanent way constructed no important grades occurred, the most considerable being one of 1 in 14 for a distance of about 60 yards. The curves, however, are fairly numerous, the radius of the sharpest being 40 ft. The narrowest width of street on the system is 14 ft. 6 ins. The line passes over three river bridges and under seven railway bridges, the lowest of which is 12 ft. 11 ins. above the rails, so that on this section single-deck cars only can be used. The gage of the track is 3 ft. 6 ins., laid with girder rails, weighing 83 lbs. to the yard. The fish-plates are of steel, 2 ft. long, and weighing 50 lbs. per pair, embodying the method of fish-plate construction known as the "Dicker" patent joint. The rails are bonded with double Neptune bonds, no cross bonding being used. All the special track work, consisting of junctions, etc., was manufactured by Dick, Kerr & Co. at their works at Kilmarnock, Scotland. The rails are laid on a foundation of 6 ins. of cement concrete, extending 2 ft. outside the rails, and the paving consists of whinstone and granite setts.

OVERHEAD EQUIPMENT

As will be seen by the illustrations, the overhead construction is carried out generally upon the lines which are familiar in America, but with that greater attention to detail and appearance which makes overhead construction in Great Britain distinctly tasteful. Side-pole construction is principally used, though a small amount of center-pole work has been found necessary. The Dickinson side-running trolley, with side-pole construction, is used. The poles are of steel, drawn taper, 28 ft. to 30 ft. in length, the diameter at the base being 7 ins. The bracket construction departs from the usual English practice, in the fact that cast iron is used. The result, while giving an ample margin of mechanical strength, has rendered possible a very ornamental and artistic design, which is exceedingly handsome in appearance. The feeder system is exceedingly complete. The cables are insulated with vulcanized bitumen, protected by double braiding of hemp yarn, and are of the drawn-in type, laid in Sykes patent conduits. The usual feeder pillars are arranged at half-mile intervals, each terminus being in telephonic communication with the power station.



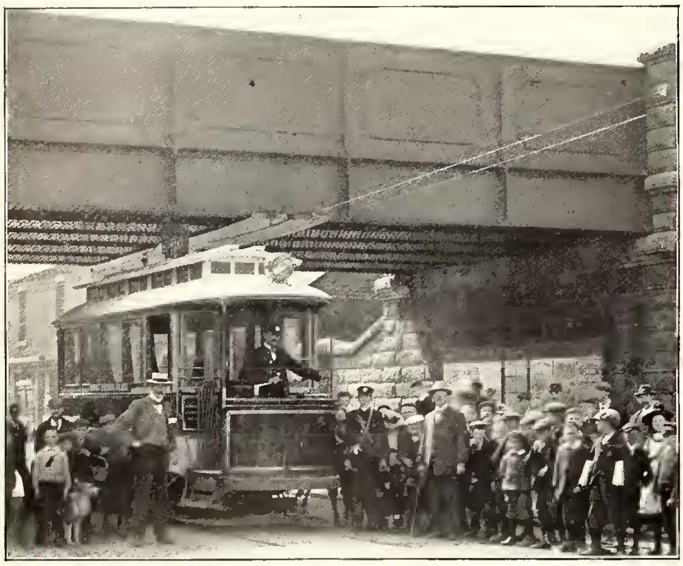
ENGINE AND GENERATOR SET

ROLLING STOCK

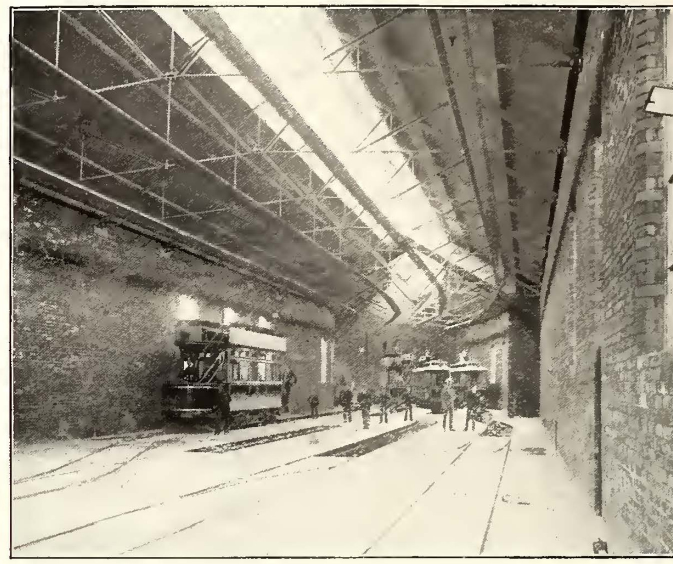
The rolling stock consists of twelve four-wheel motor cars, of which nine are of the double-deck and three of the single-deck type. The bodies were built for Dick, Kerr & Company by the Electric Railway & Tramway Carriage Works, of Preston, and are mounted on Brill 21-E trucks. all, have a seating capacity of twenty-two passengers.

GENERATING UNITS

A view of one of the generating units is given on the previous page. It consists of a 300-kw Peebles generator,



PASSING UNDER LOW BRIDGE



INTERIOR OF CAR HOUSE

VIEW OF ONE OF THE FIRST CARS

The electrical equipments are of Dick, Kerr & Company's standard type, with solenoid blow-out controllers. The length over all of the double-deck cars is 26 ft. 6 ins., and their seating capacity is forty-three passengers. The single-deck cars, which are of the same length over

which is direct-connected to a Willans' 3-A 450-hp engine, running at 340 r. p. m. This set is capable of running from no load to 25 per cent overload without sparking. The combined efficiency of the plant is 85 per cent. Two of these sets are installed.

AMERICAN ENGINEERS AND TRAMWAY MANAGERS ABROAD

It is a well known fact that a large portion of the electric tramways now being installed in different parts of the world outside of the United States are sending to America for their supplies, and are largely following American methods in construction. It may not be equally as well known, however, that a large part of this work is being done under the supervision of American engineers. This need not be surprising, however. Whatever may be the condition a few years hence, it is only reasonable to expect that the country in which the greatest development in electric railway construction has taken place should be the field where the widest experience in the railway construction should be secured, and that consequently America has been the point to which foreign capitalists have looked for engineers when engaging in tramway construction. It has not been only to assist in building roads, however, that American railway engineers have taken up their residence abroad. Many have gone to Europe to engage in the manufacture of electrical apparatus in branches of parent manufacturing companies in America; the services of still another considerable number have been secured by foreign manufacturing companies to carry on abroad the manufacture of apparatus after American patterns and ideas. The reasons for this are natural. If the development of American electrical apparatus abroad has been in advance of that of other countries, the cause must lie in the greater experience and consequent skill of the men who produce the article, so that it has been only reasonable that those who wished to meet American competition should desire the services of American experts in the different lines.

The list of American street railway managers and superintendents whose services have been engaged for operating electric roads abroad is also a lengthy one, for it is only reasonable to suppose that a road using imported apparatus could best be operated, at first at any rate, by those whose experience has made them familiar with the working of the machinery used. Moreover, American operating methods are looked upon with the highest respect by foreign owners; the proverbial push and business energy of the American manager have won great respect, and their services are eagerly sought for in all parts of the globe. Still other Americans, seeing the possibilities of electric railway operation abroad, have crossed the water to purchase and equip systems in cities where the nearer capitalists failed to recognize the financial possibilities offered, and in this way have secured control of important tramway systems.

While it would be impossible to mention all of those tramway men who, for business reasons, have taken up their residence outside this country, it may not be amiss to refer to some of them as showing the influence exerted in tramway affairs the world over by Americans.

In Great Britain, the American tramway colony has now reached considerable proportions. The pioneer was undoubtedly R. W. Blackwell, who, in 1889, settled in London to engage in the sale of American electrical apparatus. Previous to this time Mr. Blackwell had taken a prominent part in the development of the electrical lighting and railway industries of America, and in 1884 to 1889 was president of the Bentley-Knight Electric Railway Company, which was one of the strong pioneers in the field of electric traction. After taking up his residence in London, Mr. Blackwell, for a number of years, acted as European representative for prominent American manufacturers, and in addition carried on a business as contractor for electric railway, power and lighting systems. In this work Mr. Blackwell was eminently successful. Early in 1899 he merged his entire business into the limited corporation of R. W. Blackwell & Company, with strong financial backing, which puts his company in the front rank of the electrical industries. The next electrical engineer to take up an English residence was probably Horace F. Parshall, the well known consulting engineer. Mr. Parshall had also been one of the pioneers in the electric railway development, and had designed some of the early electric motors which had proved most successful. His engineering work with the Sprague Electric Railway & Motor Company, and later with the General Electric Company, stamped him as one of the leading designers of electric railway apparatus, so that when a strong engineer was desired during the early nineties for the British Thomson-Houston Company, Mr. Parshall was selected. During the last few years Mr. Parshall has acted as an independent consulting engineer in London, and has achieved a most successful record. The largest transportation plants in the country have been placed unreservedly in his hands, and his authority on all matters pertaining to the engineering of electric railroading is unquestioned. Two other engineers, who have also enjoyed a large degree of success, are J. F. Macartney and J. A. McElroy, of Macartney, McElroy & Company. Mr. Macartney was the first to take up his residence in England, and found so much demand for electric railway engineers and contractors that he was soon joined by his partner. These gentlemen had previously been well known in America as successful electric railway contractors, and have carried through a number of the important installations in England and Scotland.

As announced recently, the new British firm of J. G. White & Company, Ltd., is another organization with American connections which has entered the field as consulting and contracting engineers under the most favorable auspices. The new company has been organized with J. G. White as chairman of its board; O. H. Baldwin, as managing director, and A. N. Connett and E. P. Jones, as chief engineer and mechanical engineer respectively. While Mr. White is an engineer of recognized ability, he is also an experienced business man and his selection as chairman is a most fitting one. It is sufficient to say of him that he is probably the best known and most successful engineer and builder of electric railways in America. Mr.

Connett is generally regarded as one of the leading authorities, if not the leading, on the construction of underground conduit electric railways. Having a brilliant record in America as an engineer of cable and electric conduit railways in New York, Baltimore and Washington, Mr. Connett took up a Paris residence and became chief engineer of the French Thomson-Houston Company. While in this capacity he installed a number of important French tramways on the trolley, underground and surface contact systems, and, becoming very conversant with French conditions, as he was with American methods, was able to make such modifications of the latter as to suit the circumstances as he found them. Mr. Connett was individually awarded a gold medal at the recent Paris Exposition in recognition of his ability in trolley road construction, and his connection with J. G. White & Company, Ltd., adds great strength to that company. Mr. Baldwin, whose long experience and extensive acquaintance with British requirements makes him an exceptionally strong man for the position, is the managing director. His electrical experience was secured first with the Westinghouse Electric & Manufacturing Company, and later with the Westinghouse Electric Company, Ltd., of London, of which, in 1892, he was appointed chief engineer, and in 1894 managing director. Mr. Jones is a mechanical engineer of high reputation in America, having been for a number of years connected with the Union Iron Works and the Risdon Iron Works, both of San Francisco. One of the resident directors of the J. G. White Company, Ltd., is Edward B. Wyman, who is also interested in a number of electrical tramway undertakings abroad, particularly in Australia. Mr. Wyman is also an American, having lived for a long time at Niagara Falls. He was for a number of years the New York representative of the Central Electric Heating Corporation, and in this capacity acquired an extensive acquaintance in the street railway field.

Among the Americans to take up their residence in London recently are W. J. Clark and E. H. Johnson. Mr. Clark, as general manager of the railway department of the General Electric Company, for a long time occupied a prominent position in the tramway affairs of this country. His experience in electric railroading dates back to the early days, and the important pioneer work of the original Thomson-Houston Company was due largely to his personal efforts. Mr. Clark is not only an engineer, but has paid a great deal of attention to the broader questions of electric railroading, and is authority on manufacturing and street railway finances. He is equally conversant with foreign railway and commercial conditions, and to this expert knowledge was largely due his selection to take charge of the entire foreign business of the General Electric Company. E. H. Johnson, although only recently a London resident, has passed much of his time during the last ten years in England, and his name is a familiar one in London financial and electrical circles. For a long time president of the original Edison Company, Mr. Johnson was the first to introduce the Edison incandescent lamp to the English public. Although recently he has interested himself more particularly in the financial end of electrical enterprises, Mr. Johnson is also an inventor of note, and has patented many important devices in different branches of the electrical industry. His recent residence in London is due to his connection with the formation of the Johnson-Lundell Electric Traction Company, Ltd., in the promotion of which he is meeting with great success. Another General Electric man to make headquarters in London is A. K. Baylor. Mr. Baylor made a host of friends in this country while a member of the railway department of the General Electric Company, and his original commission abroad was to occupy the position of general manager of the railway department of the British Thomson-Houston Company, in which position he was very successful up to the time of his resignation to open an office as an independent engineer. Mr. Baylor is now interested in several financial syndicates operating tramway properties in Great Britain and elsewhere, and enjoys to a marked degree the confidence of the leading street railway men of Great Britain.

An English company to secure a large number of Americans in the engineering department is the English Electric Manufacturing Company, Ltd., of Preston. The technical director of these important works is Prof. S. H. Short, recently of the Walker Company, of Cleveland, Ohio, and formerly the head of the Short Electric Railway Company. These works, which have recently been completed, are built largely after the best American models, and are equipped throughout with the most modern and up-to-date machinery which the American builders could furnish. Prof. Short's work in America is too well known to need further description, and there is no reason to doubt that he will achieve success abroad in the construction of apparatus for electric railway service, as he did in this country. The company is now employing about 1000 men, and the output of the works is now from five to six equipments per day. Adjoining the works of the English Electric Manufacturing Company at Preston, and in close business connection with this, is the plant of the Electric Railway & Tramway Carriage Works, Ltd., the leading street railway car builders of Great Britain, in charge of E. A. Stanley, also an American. Mr. Stanley went to Preston from the car shops of the Jackson & Sharp Company, of Wilmington, Del., and is a well known authority on car building and construction. Under his able management the company's cars are now running on many of the English tramways, although the works have been in operation for only a short time. The superintendent of the works is Mr. Angerer, formerly of the Gilbert Car Manufacturing Company, of Troy, N. Y. These works employ about 500 to 600 men, and are turning out three cars a day. Closely allied with the English Electric Manufacturing Company, Ltd., and the Electric Railway & Tramway Carriage Works, is the firm of Dick, Kerr & Company, engineers and railway builders, the leading firm of its kind in Great Britain. The entrance of this company into the electric railway field was announced some time ago, and it is not surprising that an American should be found in charge of its railway department. This gentleman is F. C. Armstrong, who went to London from Toronto, Canada, resigning the position of chief engineer of the Canadian General Electric Company. Mr. Armstrong is now well known on both sides of the Atlantic, and under his supervision a number of the most important roads in Great Britain have been electrically equipped.

Another prominent manufacturing company to be represented abroad is the J. G. Brill Company, whose foreign business has reached large proportions. Its London representative is M. E. Curwen. Mr. Curwen has spent so much time abroad that he is fully conversant with British conditions, and has done much to advance the interests of the Brill Company in Europe.

Another American electrical engineer abroad is A. C. Shaw, manager of the Street Railway Journal in Great Britain and Europe. Mr. Shaw, though Scotch by birth, has spent the greater part of his professional career in America, and is well known as a newspaper man and an able writer on electrical subjects. He was for many years manager of the *Electrical Engineer*, of New York, but for some time past has been the European manager of the Street Railway Journal. His headquarters are in London.

Connected with the Westinghouse interests in Great Britain are several well known Americans. This is true not only in the engineering, but in the business department as well. In the former are found W. W. Blunt, E. N. Sautelle, M. Maclaren and H. M. Southgate. Mr. Blunt is a graduate of Lehigh University. After spending several years in the service of the Westinghouse Electric & Manufacturing Company, of Pittsburgh, he was selected for an important position with the British company. He has been in London for the past three or four years. Mr. Sautelle is also a graduate of Lehigh, and served with distinction as an electrical engineer in the government service during the Spanish war. He has been in London for about a year and a half. Mr. Maclaren is a graduate of Princeton, and has been in London for two and a half years. Mr. Southgate is a graduate of the Worcester Polytechnic Institute, and while in Pittsburgh was connected with the laboratory and engineering department of the Westinghouse Electric & Manufacturing Company.

Prominent in the business department of the Westinghouse interests is Arthur Warren, who can also be considered a resident of London, as he spends very much of his time in that city. Mr. Warren, who is at the head of the publishing department of the Westinghouse companies, has had a brilliant career as author and newspaper writer, having been for a number of years the London correspondent of the Boston *Herald*, and essays and criticisms from his pen have appeared in many magazines and attracted widespread attention. His recent work in London has been in connection with the organization and other important developments of the Westinghouse interests abroad.

Among the street railway managers to be found in London is Granville C. Cuningham, manager of the Central London Underground Railway Company. Mr. Cuningham is well and favorably known among the street railway managers in this country, having for a long time been general manager of the Montreal Street Railway system. The system now under his charge is the most important of the underground roads in London, and that he should have been selected to control its interests is the highest testimonial which could be given to his ability and training as a railway manager.

While the above list by no means includes all of the Americans who are occupying prominent and responsible positions in British tramway affairs, the space at the disposal of this article compels a stop here to cast a brief and equally cursory glance over Continental affairs.

This immediately calls attention to the fact that some of the most important electric work on the Continent is being conducted by a syndicate of which Stephen D. Field is the chief engineer. The place of Mr. Field's latest operations is in the neighborhood of Geneva, Switzerland, where, as described in a recent issue of the Street Railway Journal, the entire tramway system, consisting formerly of several small roads, has been consolidated and electrically equipped, while important extensions are contemplated. Mr. Field was the builder of the "Judge," the first locomotive in the United States, and has always occupied a prominent position in electric railway matters in this country. Associated with him in his work is Richard McCulloch, formerly chief engineer of the Cass Avenue & Fair Grounds Railway Company, of St. Louis, and son of Captain Robert McCulloch, general manager of the Chicago City Railway Company. Although a young man, Richard McCulloch has acquired a wide experience in electric traction service, and is an excellent representative of the young American electrical engineer abroad. Quite recently also Mr. Field's staff has had an accession in his son, Dudley Field, lately of the electrical engineering corps of the New York Telephone Company.

Germany, which has always been a leader in electric railroading, has not had as much need to call on American talent in this direction as some other countries. It is notable, however, that the manager of one of the largest electric manufacturing companies in Germany, the Union Elektricitäts-Gesellschaft, is an American. This gentleman, Louis J. Magee, is a graduate of Wesleyan University, Middletown, Conn., entered the electric works of the Thomson-Houston Company at Lynn in 1885, and installed a number of electrical plants in New England and elsewhere. Later he spent a year and a half in electrical work in Lima, Peru. From that time on Mr. Magee's work has been chiefly in foreign countries. In 1888 he was appointed in charge of the engineering office of the Thomson-Houston Company in Hamburg, and in 1892, on the organization of the Union Elektricitäts-Gesellschaft, he was appointed its manager. Under Mr. Magee's direction, the company has done a large amount of electric railway construction, and had great success in the manufacture of electric railway apparatus and electrical apparatus for power transmission.

One of the first Americans to see the possibilities in the electric railway industry in France was Charles LeBlanc, who gained his experience in electric railroading with the Sprague Electric Railway & Motor Company, of New York City, but about ten years ago went to Paris, where he has been very successful in the organization of tramway companies and in the equipment of electric tramways. Mr. LeBlanc has made several trips to America since he took up his residence in Paris, and has been a close student of American electric railway methods.

The Société Industrielle d'Electricité Procédés Westinghouse, the French Westinghouse Company, is also largely conducted by Americans. The "sous directeur" of the company is Maurice Coster, who, though born in Holland, is in every practical sense an American. Mr. Coster is a graduate of Stevens Institute of Technology, and spent the active part of his life in this country until his services were secured by the Westinghouse Company in establishing its French branch. Mr. Coster has done a great deal to help advance the Westinghouse interests in France, and his latest and most important contract is that for the equipment of the Metropolitan Underground Electric Railway in Paris, which was brought to a most successful conclusion, and is one which reflects great credit upon the Westinghouse Company. The managing director of the company is Mr. Albert Schmid, a resident of Havre, the location of the company's factory. Mr. Schmid, although a native of Switzerland, received his practical electrical education in this country, having come to America in 1882. During the greater part of his time while in America he was connected with the Westinghouse interests, first with the Air Brake Company and later with the Electric & Manufacturing Company. Associated with Mr. Schmid are H. L. Kirker, W. E. Reed, H. U. Hart and C. P. Smith. Mr. Kirker is engineer in charge of the testing room of the Westinghouse Works in Havre, and is a graduate of the Ohio State University. Mr. Reed, the electrician of the Havre Works, is a graduate of the Massachusetts Institute of Technology, and received his practical training in the works of the Westinghouse Electric & Manufacturing Company, of Pittsburgh. Mr. Hart, who is also located at the Havre shops, is a Technology graduate, as is also C. P. Smith.

Another highly important firm in France is the Compagnie Française pour l'Exploitation des Procédés Thomson-Houston, in which it is needless to say Americans are prominent. The managing director is Ernst Thurnauer, who, though European by birth, is an American by training. Mr. Thurnauer came to this country many years ago, and was a prominent member of the early engineering staff of the Thomson-Houston Company. By this company he was commissioned to install electric lighting plants in Europe, and was celebrated as having installed the lighting plant nearest the North Pole. The success which followed him in this work led to the establishment in France of the Compagnie Française pour l'Exploitation des Procédés Thomson-Houston, which has been in his hands ever since its inception. Also connected with this company is A. S. Garfield, who is a member of a family well known in Thomson-Houston annals. He has been very actively engaged in tramway work in Europe for the last few years, and is also in charge of the publishing department of the Compagnie Française pour l'Exploitation des Procédés Thomson-Houston, whose pamphlets on electric railway work are particularly complete and interesting.

Thus far, Europe only has been considered as a field of operation, but reference should be made to work of American engineers elsewhere. In South America, the Buenos-Aires tramway systems are largely in the hands of two Americans, Charles Bright and Theodore N. Vail. Although Mr. Bright has spent the greater part of the last twenty years abroad, he makes frequent visits to America, and believes in American methods of railway operation. Mr. Vail's name is familiar through his connection with the development of American electrical interests, particularly the telephone, and he now represents also a large amount of English and American capital. The electrical engineering work in the city has been largely in the hands of E. T. Birdsall, F. A. Wardlaw and P. A. Clisdell, all from America. The larger part of the electrical equipment of the lines in Rio de Janeiro, Brazil, has been carried out by James Mitchell, also an American. Mr. Mitchell was sent to Rio de Janeiro in 1890 by the Thomson-Houston Electric Company, after having installed electric railways in Des Moines, Omaha, Council Bluffs, Denver and other important points. Since he has been in Brazil, Mr. Mitchell has established a reputation of which anyone can be proud, being most influential with the government, having made a large fortune and having established at Rio de Janeiro one of the largest and handsomest electrical supply houses in any city. The electric tramway system of Sao Paulo, Brazil, was installed by and is in charge of R. C. Brown, formerly of Boston and later of Montreal, while that in San José, Costa Rica, Central America, is in charge of H. T. Purdy, formerly superintendent of the Georgetown & Tenallytown Railway, of Washington, D. C.

Much of the electrical work in the Republic of Mexico has been carried on by D. Mazanet, of New York. The management of the tramways of the City of Mexico was for a long time in the hands of H. P. Bradford, formerly of Cincinnati; and H. B. Niles, formerly of Indianapolis, still occupies an important position with the company. Mr. Bradford is now engaged as an expert by a London financial syndicate, and this business takes him all over the globe.

The West Indian Islands, formerly belonging to Spain, have, under their new political conditions, awakened to a period of industrial activity, in which tramway construction is a natural accompaniment. Thus, the extensive system of Havana, Cuba, is now being electrified under the direction of George F. Greenwood, formerly general manager of the Consolidated Traction Company, of Pittsburgh, and the tramway system of Ponce, Porto Rico, is being electrically equipped by John A. Wilson, of J. G. White & Company. Mr. Wilson has supervised the construction of a number of electric roads in the United States, notably the Niagara Falls & Buffalo Electric Railway.

In Australia, the general manager of the Brisbane Tramways is J. S. Badger. Mr. Badger was one of the early engineers of the Sprague Electric Railway & Motor Company, and installed a number of the first trolley railways in this country. Several years ago Mr. Badger was sent by the General Electric Company to carry on tramway construction in Australia. After finishing the Brisbane tramways, upon which he was engaged, he was appointed by the company manager of the system. Arthur Jones, who has also been largely instrumental in the development of electric railway matters in Australia, is a graduate of the Institute of Technology of Boston, and has spent the greater part of the last ten years in Australia. The tramway system of Perth was also built and is controlled by American capital. This system was equipped by W. E. Cooke, formerly chief engineer of the Peckham Truck Company, and until recently has been in charge of S. W. Childs, of New York.

In the Far East, Americans have been as prominent in tramway matters as in other parts of the globe. The Seoul Electric Railway Company, in Korea, is in the hands of H. R. Bostwick, formerly of San Francisco, and H. Raymond Crumm, of Columbus, Ohio, while in Japan are E. A. Carolan, formerly of New York, and the firm of Bagnall & Hilles. Both members of the latter firm are of Brush antecedents, and are in touch with all the important electric railway and light developments in that part of the world. Even in South Africa an American is found in charge of the principal tramways, *i. e.*, those in Cape Town and Port Elizabeth. This is John E. Lloyd, who was formerly connected with the Field Engineering Company, of New York, and in that capacity he assisted in the construction of the Buffalo Street Railway system and a number of other important electric railways in the early days.

Table Showing Cost of Operation for the First Seven Months of 1900 of the Central Avenue Power Station of the Metropolitan Street Railway Company, Kansas City, Mo.

	January 1900		February 1900		March 1900		April 1900		May 1900		June 1900		July 1900	
Output in kilowatt-hours	539,000 K. W. H.		572,187 K. W. H.		746,084 K. W. H.		812,789 K. W. H.		894,415 K. W. H.		878,604 K. W. H.		960,589 K. W. H.	
Cost of operating	Total Cost	Cost per K.W.H. cts	Total Cost	Cost per K.W.H. cts	Total Cost	Cost per K.W.H. cts	Total Cost	Cost per K.W.H. cts	Total Cost	Cost per K.W.H. cts	Total Cost	Cost per K.W.H cts	Total Cost	Cost per K.W.H. cts
	$	$	$	$	$	$	$	$	$	$	$	$	$	$
Engineers, firemen, oilers and other workmen	559.89	.001038	581.75	.001016	607.72	.000814	627.08	.000772	694.93	.000777	770.51	.000876	783.23	.000815
Repairs to engines and machinery	42.58	.000079	35.77	.000063	14.83	.000019	32.70	.000040	39.71	.000044	122.12	.000139	61.83	.000065
Oil and waste	8.10	.000015	71.85	.000126	42.09	.000056	56.33	.000069	69.88	.000078	48.03	.000054	115.77	.000121
Fuel	2,100.33	.003896	1,610.33	.002815	2,052.42	.002759	1,879.92	.002312	2,300.88	.002572	2,356.08	.002682	3,004.27	.003127
Water	66.29	.000124	66.53	.000115	59.90	.000090	53.10	.000065	42.77	.000048	46.12	.000053	49.26	.000052
Generator and switchboard attendance and rep's	103.53	.000193	98.84	.000173	59.99	.000091	29.79	.000037	139.97	.000156	102.85	.000117	117.79	.000122
Miscellaneous	51.45	.000095	4.00	.000007	.68	.000001	11.36	.000014	.48	.000001	6.40	.000008	18.14	.000018
Total	2,932.17	.005440	2,469.07	.004315	2,837.63	.003830	2,690.28	.003309	3,288.62	.003676	3,452.11	.003929	4,150.29	.004320
	Total Quantity	Quantity per K.W.H	Total Quantity	Quantity per K.W.H	Total Quantity	Quantity per K.W.H	Total Quantity	Quantity per K.W.H	Total Quantity	Quantity per K.W.H	Total Quantity	Quantity per K.W.H	Total Quantity	Quantity per K.W.H
Coal, number of tons purchased	$1,684^{2}$ tons	6.23 lbs.	$1,339^{550}$ tons	4.68 lbs.	$1,855^{15}$ tons	4.8 lbs.	$1,973^{225}$ tons	4.85 lbs.	$2,208^{050}$ tons	4.93 lbs.	$1,857^{25}$ tons	4 22 lbs.	$2,250^{2}$ tons	4.86 lbs.
Cylinder oil, number of gallons purchased	.... gals.	.. gls.	200^{5} gls.	3.5 gls.	152 gls.	2.3 gls.	151^{5} gls.	1.86 gls	300 gls.	3.35 gls.	100 gls.	1.14 gls.	402^{6} gls.	4.19 gls.
Engine oil, number of gallons purchased	.... gals.	.. gls.	300 gls.	5.24 gls.	....	.. gls.	95 gls.	1.17 gls.	152^{5} gls.	1.7 gls.	200 gls.	2.27 gls.	250 gls.	2.6 gls.

CONDUIT CONVERSION IN WASHINGTON

Washington, D. C., Sept. 13, 1900.

Editors Street Railway Journal:

An article on page 831 of the September Journal recites that the Third Avenue Railroad, of New York, was changed from cable to conduit-electric while in operation as a cable road, and adds: "On the other hand, the Capital Traction Company, of Washington, D. C., in altering over its Pennsylvania Avenue cable line to electricity, ran horse cars during the interruption."

Be pleased to observe that horse cars were necessarily run during the conversion of the Pennsylvania Avenue and Fourteenth Street lines of the Capital Traction Company because the power station of those lines had been totally destroyed by fire, and indeed this loss was the very occasion of the change of power.

Note also that immediately after the completion of the lines named the Seventh Street road of the same company (which had a power house of its own) was converted from cable to conduit-electric "rapidly, safely and with the minimum obstruction of street traffic (and none whatever of cable railway traffic) during the regular operation of the road by cable;" and further that this performance in Washington was, in the belief of the writer, then without precedent, and certain it is that it was completed long before the work on the Third Avenue line of New York was begun.

E. Saxton.

COST OF STATION OPERATION IN KANSAS CITY

Reference is made elsewhere in this issue to the cost of operation of the Central Avenue or Kaw River power station of the Metropolitan Street Railway Company, of Kansas City. The table in the adjoining column gives the detailed expenses, total and per kilowatt hour during the first seven months in 1900. As the supplies are charged to the month in which they are purchased, not when they are used, a slight difference in the items can be observed.

STREET CAR BUILDING

(Stephenson Practice)

BY CHARLES HENRY DAVIS, C. E.

IX.—Assembling—(Continued)

In the September issue of the Street Railway Journal we gave the details of the platforms for our two standard cars, namely, the Boston (closed) and the Brooklyn (open). Tables Nos. 39 and 40 give respectively the details of cabinet work, trimmings, etc., for these standard cars, while Plates XI and XII illustrate the various parts. As in Tables Nos. 31, 32, 33, 34, 35, 36, 37 and 38, each distinct part of the cabinet work, trimmings, etc., is described, giving the material, the general dimensions, how made, on what tools and how assembled, all in consecutive order as each car is built in the shop. In using these tables they are to be read across the page, line by line, as in the case of any book. Letters in column 4 are the same abbreviations of woodwork and metal work as used on Plates I and II. These tables are given on the following pages.

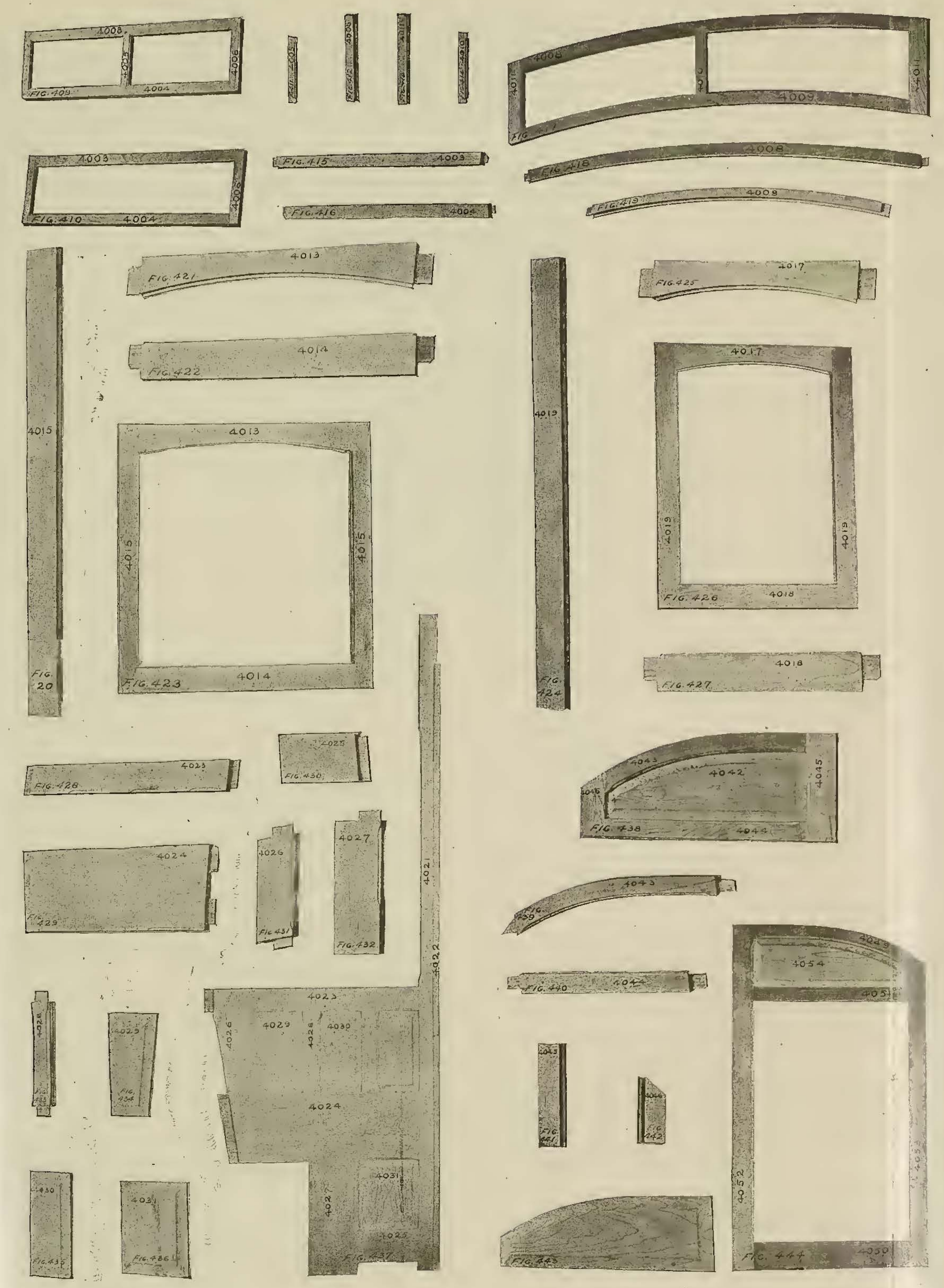
TABLE No. 39

DETAIL OF CABINET WORK, TRIMMINGS, ETC., OF BOSTON CLOSED CAR, IN THE ORDER OF ASSEMBLING

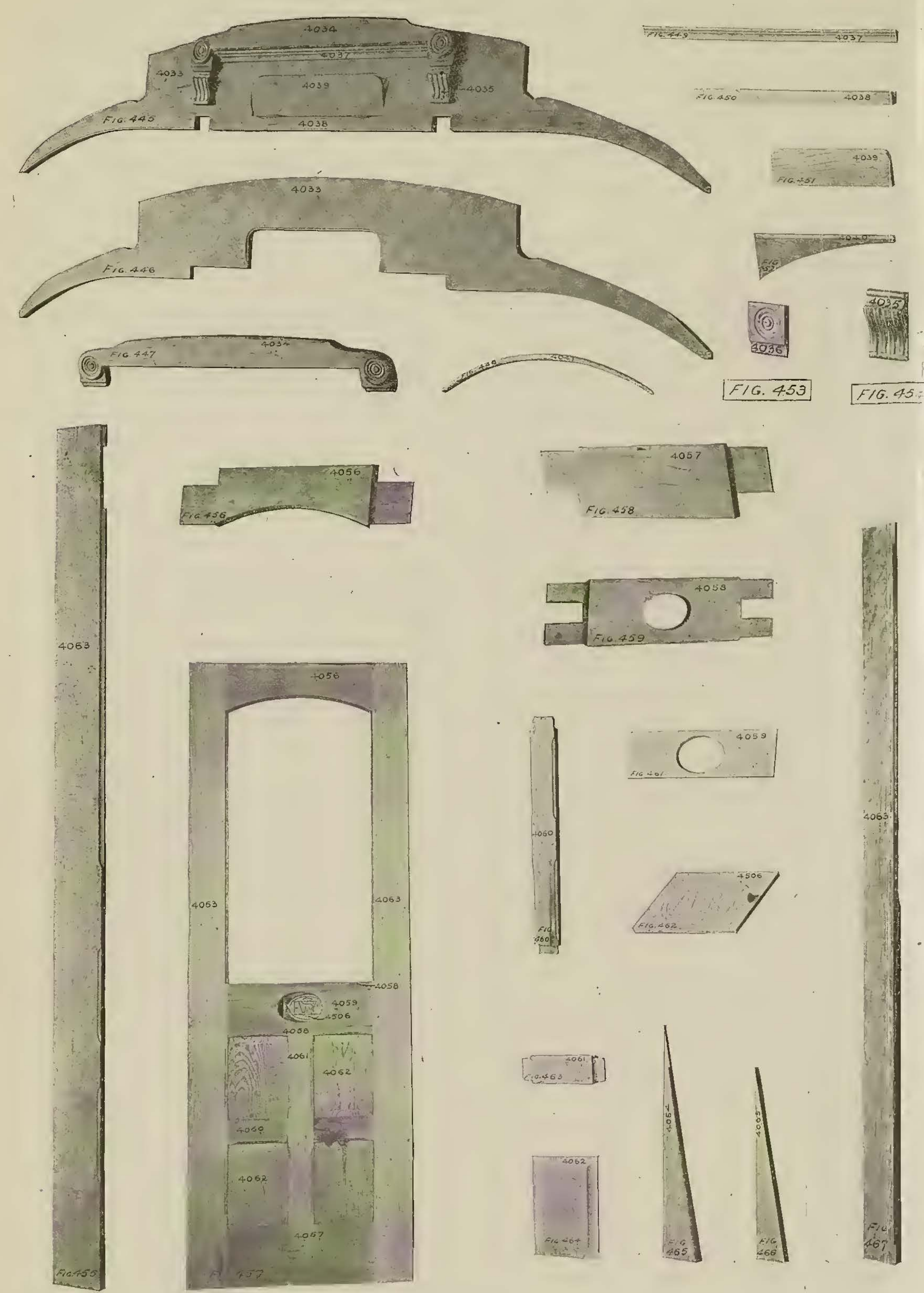
(25 ft. Body; Car No. 2; Fig. 3; Plates I., XI. and XII.)

Consecutive Number	Quantity	Name of Piece	Piece Number Plates I. and XI.	Material See Plates I. and II.	Details: Quantity	Details: Name	Details: Reference Letter Plate XI	Dimensions	Observations and Particulars of How Used	Tools Usually Employed (Others can be used if convenience or necessity requires)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
									The Cabinet Work, Trimmings, etc., are prepared during the assembling of the pieces already described, and after the platforms and platform-hoods are attached (*see Table No. 37 and Plate IX.*) they are put in place, adjusted and secured, much in the order of procedure here given, although in many cases several different pieces or parts are in hand at the same time. Fig. 525 on Plate XII. shows in position much of what is here described in detail, so that reference to it will often be useful	
234	168	**Floor-strips** (Not Ill.)	1064	Y. P.	--		--	¾ in. x ¾ in.	Clearly shown in Plates I. and II., are laid on the floor and screwed down with 648 No. 10 x 1½ in. steel screws	Molding machine
235	--	**8 Ventilator side-sashes** (Fig. 409)	4001	C.	--		--		Next the corner-posts, with center mullions, adjustable to open and close, composed of:—	
235a	8	**Top-rails** (Fig. 415)	4003	C.	--		--	2 ft. 4¼ in. x 1¼ in. x ¾ in.	All joints mortised, tenoned and glued, each having one edge rabbeted 7-16 in. x ¼ in. to receive the glass. *Note.*—The lengths of tenoned rails do not include the tenons	Variety machine, end tenoner and hollow-chisel mortiser
236	8	**Bottom-rails** (Fig. 416)	4004	C.	--		--	2 ft. 4¼ in. x 1½ in. x ¾ in.		
237	16	**Stiles** (Fig. 412)	4006	C.	--		--	8¼ in. x 1¼ in. x ¾ in.		
238	8	**Mullions** (Fig. 411)	4005	C.	--		--	5½ in. x 1¼ in. x ¾ in.		
239	16	**Ventilator sash-pivots** (Fig. 524)	4520	Bz.	--		--		Screwed to the sashes with 32 No. 5 x ⅝ in. bronze screws, the pivots being inserted in the ventilator side-posts	
240	4	**Ventilator sash-openers** (Fig. 497)	4519	Bz.	--		--		Screwed by the arms (a) to the top-rails of each pair of sashes with 24 No. 9 x 1¼ in. bronze screws, while the holding piece (b) in which the adjusting rod (c) slides is screwed to the ventilator bottom-rail facia (4104) Fig. 479 with 16 No. 10 x ⅝ bronze screws	
241	16	**Chipped-glass** (Not Ill.)	4226	----	--		--	1 ft. 2 in. x 6 in.	Set in putty all round and secured with	
242	64	**Glass-beads** (Not Ill.)	4073	C.	--		--	5-16 in. x ¼ in.	Same as shown on Plate XI. (9125) Figs. 593 and 594, screwed to the sash with 160 No. 5 x ⅝ in. bronze screws	Molding machine
243	--	**10 Ventilator side-sashes** (Fig. 410)	4001	C.	--		--		In the center of the body, stationary but removable, without mullions, composed of:—	
243a	10	**Top-rails** (Fig. 415)	4003	C.	--		--	2 ft. 4¼ in. x 1¼ in. x ¾ in.	All joints mortised, tenoned and glued, each having one edge rabbeted 7-16 in. x ¼ in. to receive the glass, fixed in position with	Variety machine, end tenoner and hollow-chisel mortiser
243b	10	**Bottom-rails** (Fig. 416)	4004	C.	--		--	2 ft. 4¼ in. x 1½ in. x ¾ in.		
243c	20	**Stiles** (Fig. 412)	4006	C.	--		--	8¼ in. x 1¼ in. x ¾ in.		
244	20	**Ventilator-sash buttons** (Fig. 524)	4521	Bz.	--		--		Screwed to the sash stiles with 20 No. 6 x ⅝ in. bronze screws, and	
245	20	**Ventilator-sash stops** (Fig. 509)	4522	Bz.	--		--		Screwed to the outside of the ventilator side-posts with 80 No. 6 x ⅝ in. bronze screws	
246	10	**Ground-glass** (Not Ill.)	4227	----	--		--	2 ft. 4¾ in. x 6 in.	Set in putty all round and screwed with	
246a	40	**Glass-beads** (Not Ill.)	4073	C.	--		--	5-16 in. x ¼ in.	Same as Con. No. 242, screwed to the sashes with 160 No. 5 x ⅝ in. bronze screws	Molding machine
247	--	**2 Ventilator end-sashes** (Fig. 417)	4007	C.	--		--	8 in. x 3 ft. 7¼ in.	Composed of:—	
247a	2	**Top-rails** (Fig. 418)	4008	C.	--		--	3 ft. 4¾ in. x 1¼ in. x ¾ in.	All joints mortised, tenoned and glued, each having one edge rabbeted 7-16 in. x ¼ in. to receive the glass, the sashes being set in putty and secured in the rabbets in the end top-rail (1006) and the upper-deck head-rafter (2006) with 20 No. 9 x 1¼ in. bronze screws	Variety machine, end tenoner and hollow chisel mortiser
248	2	**Bottom-rails** (Fig. 419)	4009	C.	--		--	3 ft. 4¾ in. x 1¼ in. x ¾ in.		
249	4	**Stiles** (Fig. 413)	4011	C.	--		--	8¼ in. x 1¼ in. x ¾ in.		
250	2	**Mullions** (Fig. 414)	4010	C.	--		--	5¾ in. x 1 in. x ¾ in.		
250a	4	**Ground-glass** (Not Ill.)	4227	----	--		--	3 ft. 5¼ in. x 6¼ in.	Set in putty all round and secured with	
250b	16	**Glass-beads** (Not Ill.)	4073	C.	--		--	5-16 in. x ¼ in.	Same as Con. No. 242, screwed to the sashes with 64 No. 5 x ⅝ in. bronze screws	Molding machine
251	--	**18 Side-sashes** (Fig. 423)	4012	C.	--		--	2 ft. 10⅛ in. x 2 ft. 7 in.	Composed of:—	
251a	18	**Top-rails** (Fig. 421)	4013	C.	--		--	2 ft. 2½ in. x 2⅝ in. x ¾ in.	All joints mortised, tenoned and glued, each having one edge rabbeted 7-16 x ¼ in. to receive the glass	Variety machine, end tenoner and hollow-chisel mortiser
252	18	**Bottom-rails** (Fig. 422)	4014	C.	--		--	2 ft. 2½ in. x 3½ in. x ¾ in.		
253	36	**Stiles** (Fig. 420)	4015	C.	--		--	2 ft. 10⅛ in. x 2¼ in. x ¾ in.		
254	18	**American plate-glass** (Not Ill.)	4225	----	--		--	2 ft. 4¾ in. x 2 ft. 3 in.	Set in putty all round and secured with	
254a	72	**Glass-beads** (Not Ill.)	4073	C.	--		--	5-16 in. x ¼ in.	Same as Con. No. 242, screwed to the sashes with 576 No. 5 x ⅝ in. bronze screws	Molding machine
255	36	**Sash anti-rattle springs** (Fig. 492)	4536	S. S.	--		--		Known as Scott springs, screwed to the stiles with 72 No. 8 x ⅝ in. nickel screws	
256	18	**Sash top-lifts** (Fig. 522)	4528	Bz.	--		--		Screwed to the sash top-rails with 54 No. 9 x ⅝ in. bronze screws	
257	18	**Sash leather-lifts** (Fig. 513)	4530	----	--		--		Secured to the sash bottom-rails with	
258	18	**Sash leather-lift plates** (Fig. 523)	4529	Bz.	--		--		Screwed with 54 No. 9 x ⅝ in. bronze screws	
258a	--	**Post-parting strips**	1035	C.	--		--		Described Con. Nos. 34, 37b and 45, Table No. 33 are now finally screwed in place. (See (f) Figs. 80, 81 and (t) Figs. 78, Plate V.)	
259	--	**4 End-sashes** (Fig. 426)	4016	C.	--		--	2 ft. 10⅛ in. x 2 ft. 0½ in.	Composed of:—	
259a	4	**Top-rails** (Fig. 425)	4017	C.	--		--	1 ft. 7½ in. x 2⅝ in. x ¾ in.	All joints mortised, tenoned and glued, each having one edge rabetted 7-16 in. x ¼ in. to receive the glass	Variety machine, end tenoner and hollow-chisel mortiser
260	4	**Bottom-rails** (Fig. 427)	4018	C.	--		--	1 ft. 7½ in. x 3½ in. x ¾ in.		
261	8	**Stiles** (Fig. 424)	4019	C.	--		--	2 ft. 10⅛ in. x 2½ in. x ¾ in.		
261a	4	**American plate-glass** (Not Ill.)	4225	----	--		--	2 ft. 4¾ in. x 1 ft. 8 in.	Set in putty all round and secured with	
261b	16	**Glass-beads** (Not Ill.)	4073	C.	--		--	5-16 in. x ¼ in.	Same as Con. No. 242, screwed to the sashes with 112 No. 5 x ⅝ in. bronze screws	Molding machine
262	--	**2 Doors** (Fig. 457)	4055	C.	--		--	6 ft. 4¼ in. x 2 ft. 3½ in.	Composed of:—	
262a	2	**Top-rails** (Fig. 456)	4056	C.	--		--	1 ft. 6 in. x 6 in. x 1⅛ in.	All joints mortised, tenoned and glued, panels adjusted and glued, edges of the rails rabetted 9-16 in. x 5-16 in. to receive the glass, and grooved 1 in. x 7-16 in. to receive the panels	Variety machine, end tenoner, hollow-chisel mortiser and panel raiser
263	2	**Bottom-rails** (Fig. 458)	4057	C.	--		--	1 ft. 6 in. x 7⅜ in. x 1⅛ in.		
264	2	**Middle-rails** (Fig. 459)	4058	C.	--		--	1 ft. 6 in. x 7 in. x 1⅛ in.		
265	2	**Change-slide caps** (Fig. 461)	4059	C.	--		--	1 ft. 6 in. x 4¾ in. x 1⅛ in.		
266	2	**Parting-rails** (Fig. 460)	4060	C.	--		--	1 ft. 11 in. x 3 ft. x 1⅛ in.		
267	2	**Mullions** (Fig. 463)	4061	C.	--		--	9 in. x 3 in. x 1⅛ in.		
268	8	**Panels** (Fig. 464)	4062	C.	--		--	10 in. x 7½ in. x ⅝ in.		
269	4	**Stiles** (Figs. 455, 467)	4063	C.	--		--	6 ft. 4¼ in. x 4¾ in. x 1⅛ in.		
269a	2	**American plate-glass** (Not Ill.)	4225	----	--		--	2 ft. 11½ in. x 1 ft. 6 in.	Set in putty all round and secured with	
269b	8	**Glass-beads** (Not Ill.)	4073	C.	--		--	7-16 in. x 5-16 in.	Screwed to the door frame with 46 No. 5 x ⅝ in. bronze screws	Molding machine
270	2	**Door change-slides** (Fig. 462)	4506	Bz.	--		--	6 1-16 in. x 4 1-16 in. x 9-32 in.	Adjusted in the wide channel in the door middle-rail, covered with the change-slide cap and prevented from rattling by	
271	2	**Door change-slide springs** (Fig. 517)	4507	S. S.	--				Screwed to the middle-rail with 2 No. 2 x ½ in. bronze screws	
272	2	**Door-bottom wear-plates** (Fig. 480)	4501	W. I.	--				Screwed to the bottom of the doors with 10 No. 12 x 1¼ in steel screws	
273	8	**Door wear-strips** (Fig. 481)	4502	Bz.	--				Screwed to the door bottom and middle-rails with 16 No. 6 and 14 No. 7 x ½ in. bronze screws. The doors are now ready for hanging from the tracks as follows:	
274	2	**Sliding-door top-tracks** (Fig. 482)	4508	W. I.	--		--		Screwed to the end top-rail through furring pieces (1038), Fig. 138, Plate V. (*See Con. No. 69, Table No. 33*) with 10 No. 12 x 1½ in. steel screws	
275	2	**Sliding-door rear-tracks** (Fig. 483)	4509	W. I.	..		--		Screwed to the end top-rail through furring pieces (1038), Fig. 139, Plate V. (See Con. No. 70, Table No. 33) with 10 No. 12 x 1¾ in. steel screws	
276	2	**Sliding-door top-sheaves** (Fig. 496)	4510	M. I.	--		--		With	
277	2	**do. do. holders** (Fig. 496)	4511	Bz.	--		--		And	
278	2	**do. do. plates** (Fig 501)	4512	Bz.	--		--		Screwed to the top of the doors with 8 No. 16 x ¾ in. machine screws	

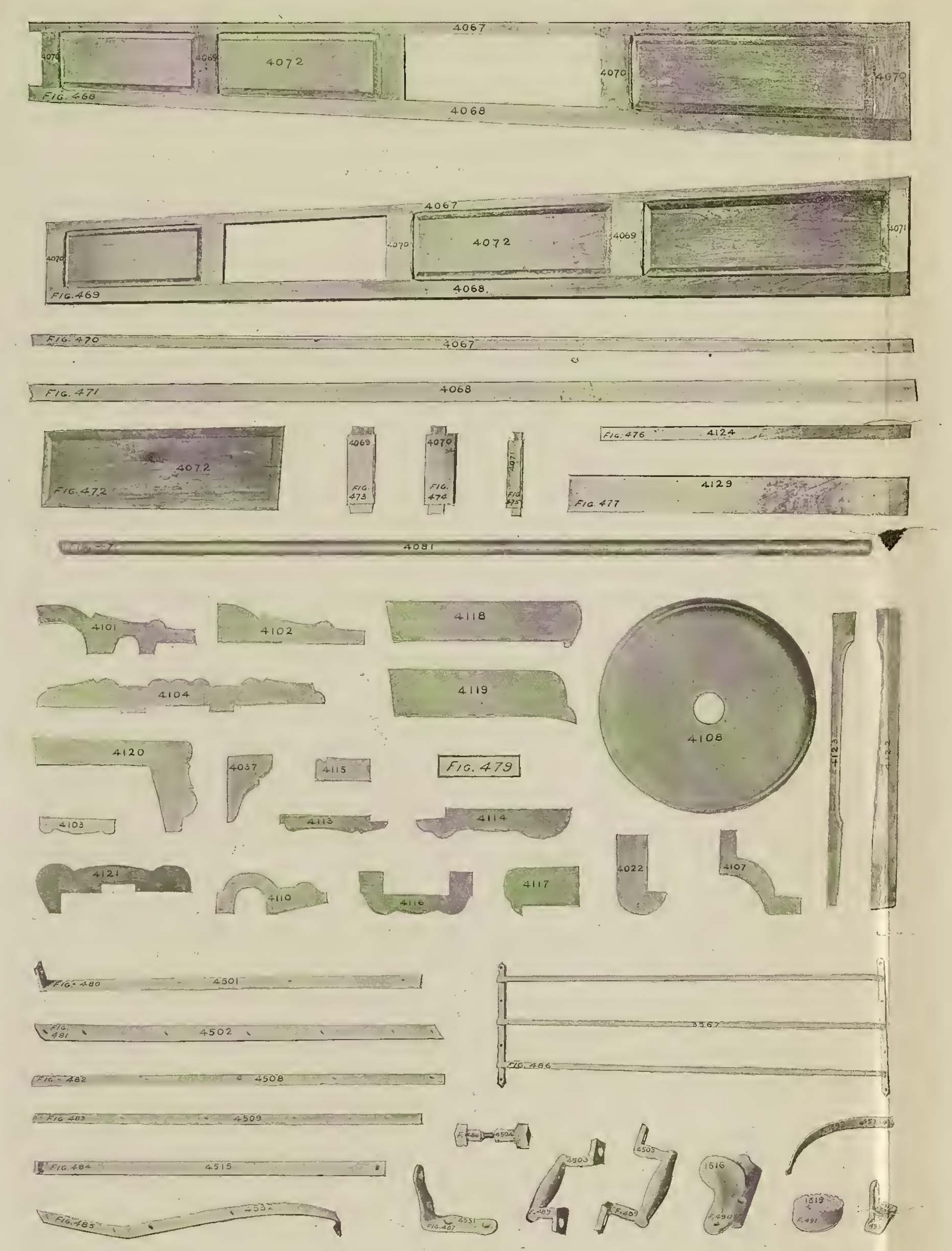
BOSTON CLOSED CAR. (Table No. 39.)



BOSTON CLOSED CAR. (Table No. 39.)



BOSTON CLOSED CAR. (Table No. 39.)



BOSTON CLOSED CAR. (Table No. 39.)

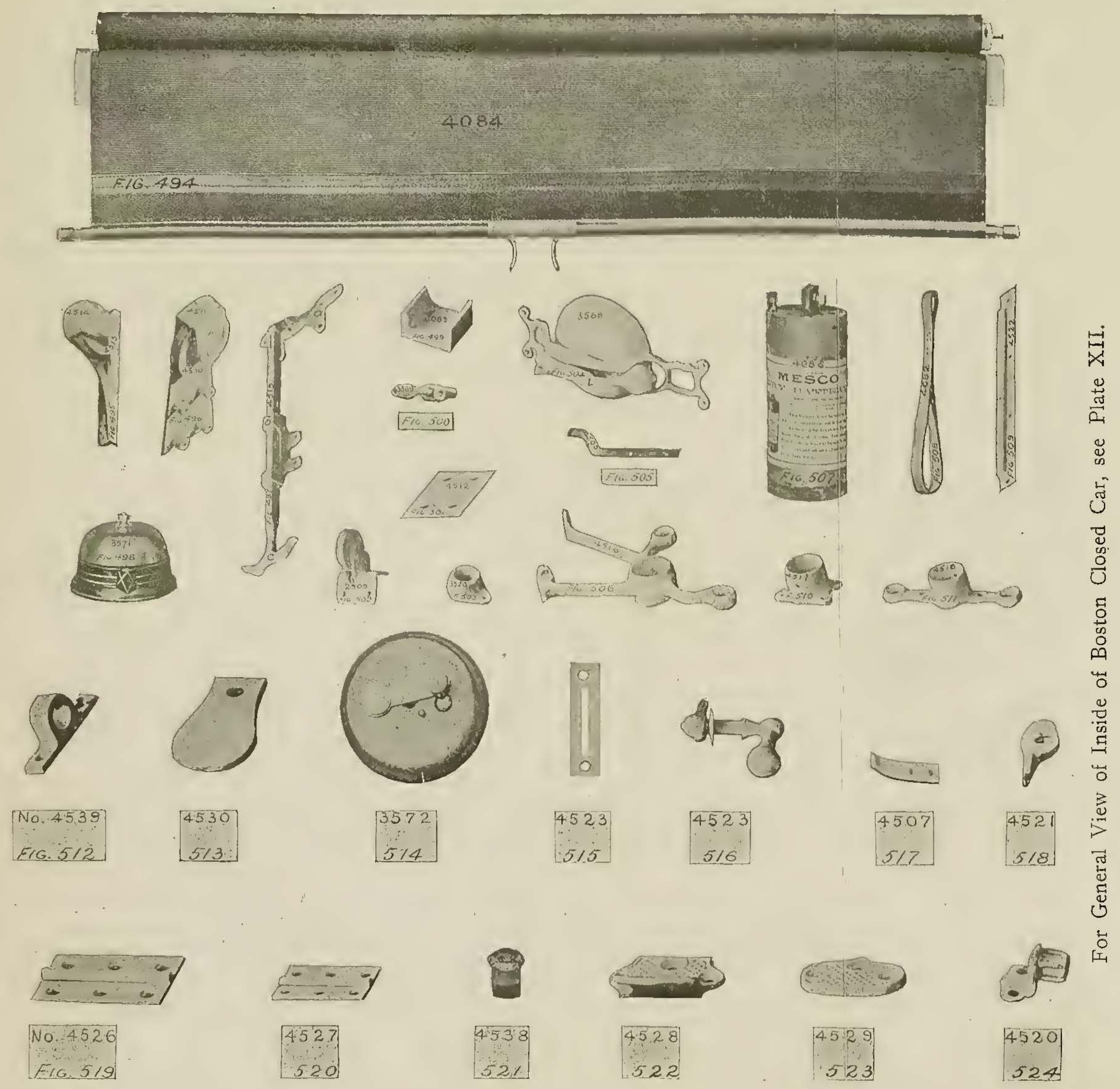


PLATE XI. [Figs. 409 to 524.]

DETAILS OF CABINET WORK, TRIMMINGS, ETC., OF

BOSTON CLOSED STANDARD CAR

ILLUSTRATING

STREET CAR BUILDING

(Stephenson Practice)

By

Charles Henry Davis, C. E.

For General View of Inside of Boston Closed Car, see Plate XII.

BOSTON CLOSED CAR. (Table No. 39.)

To Complete Plate XI.

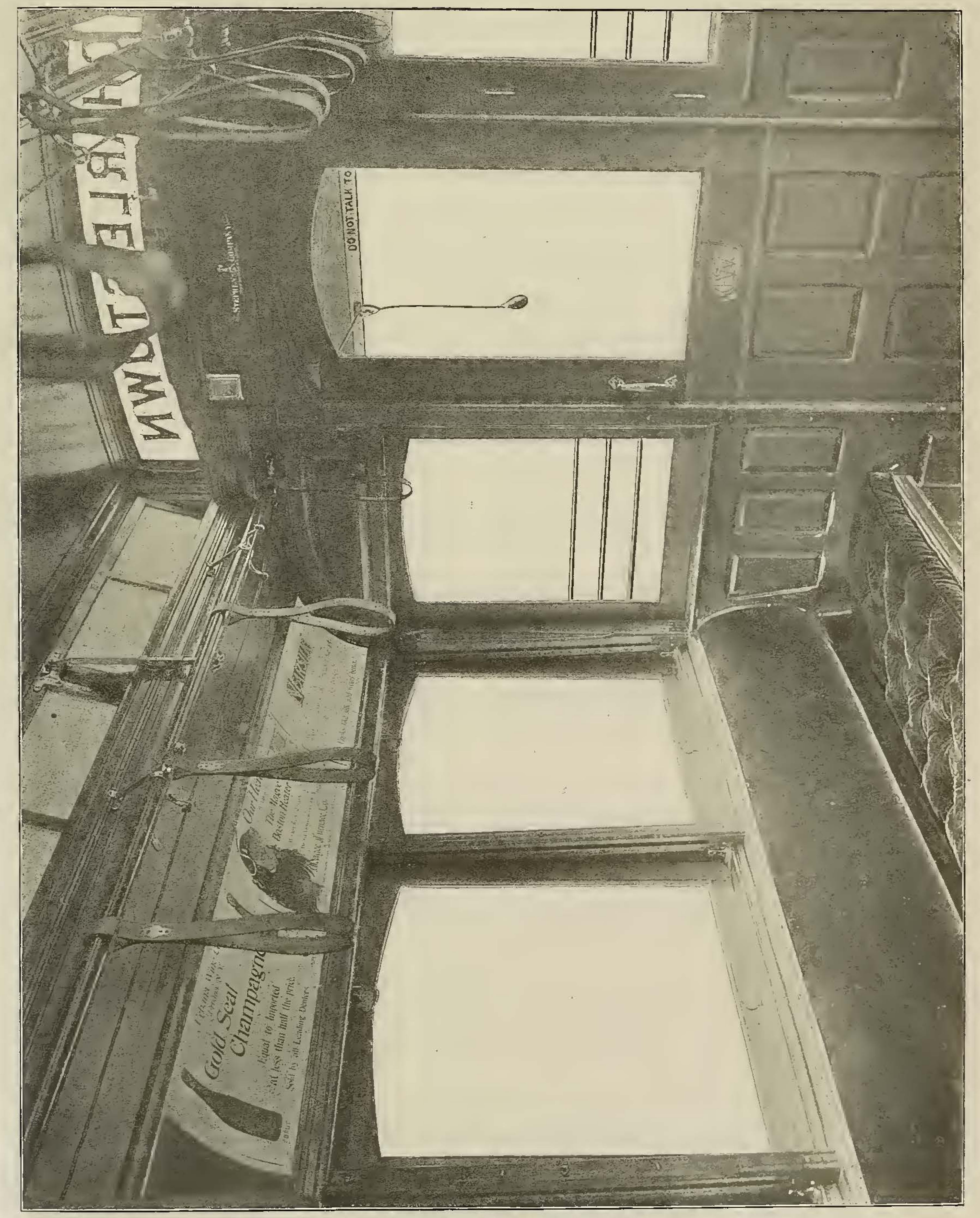
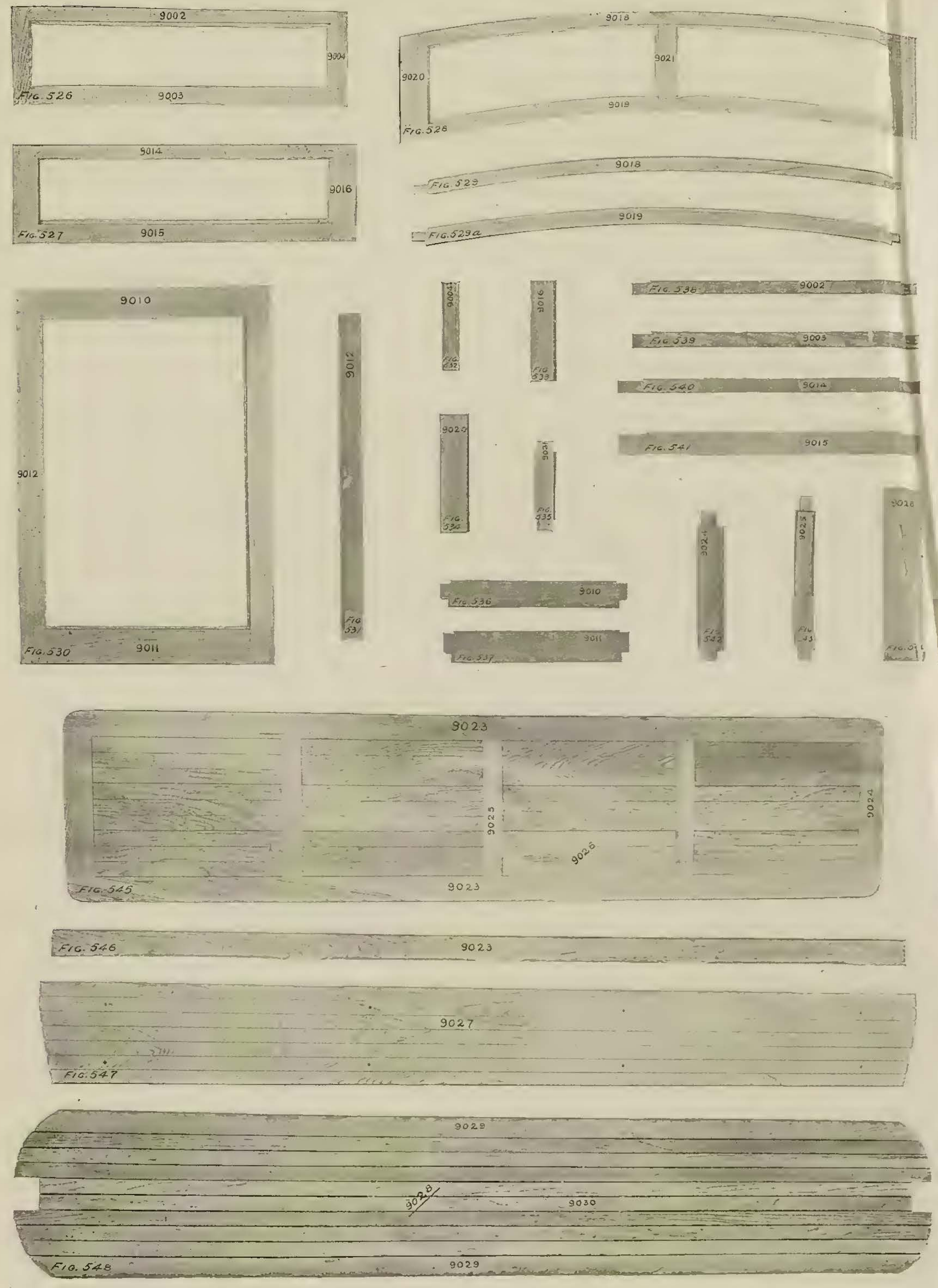
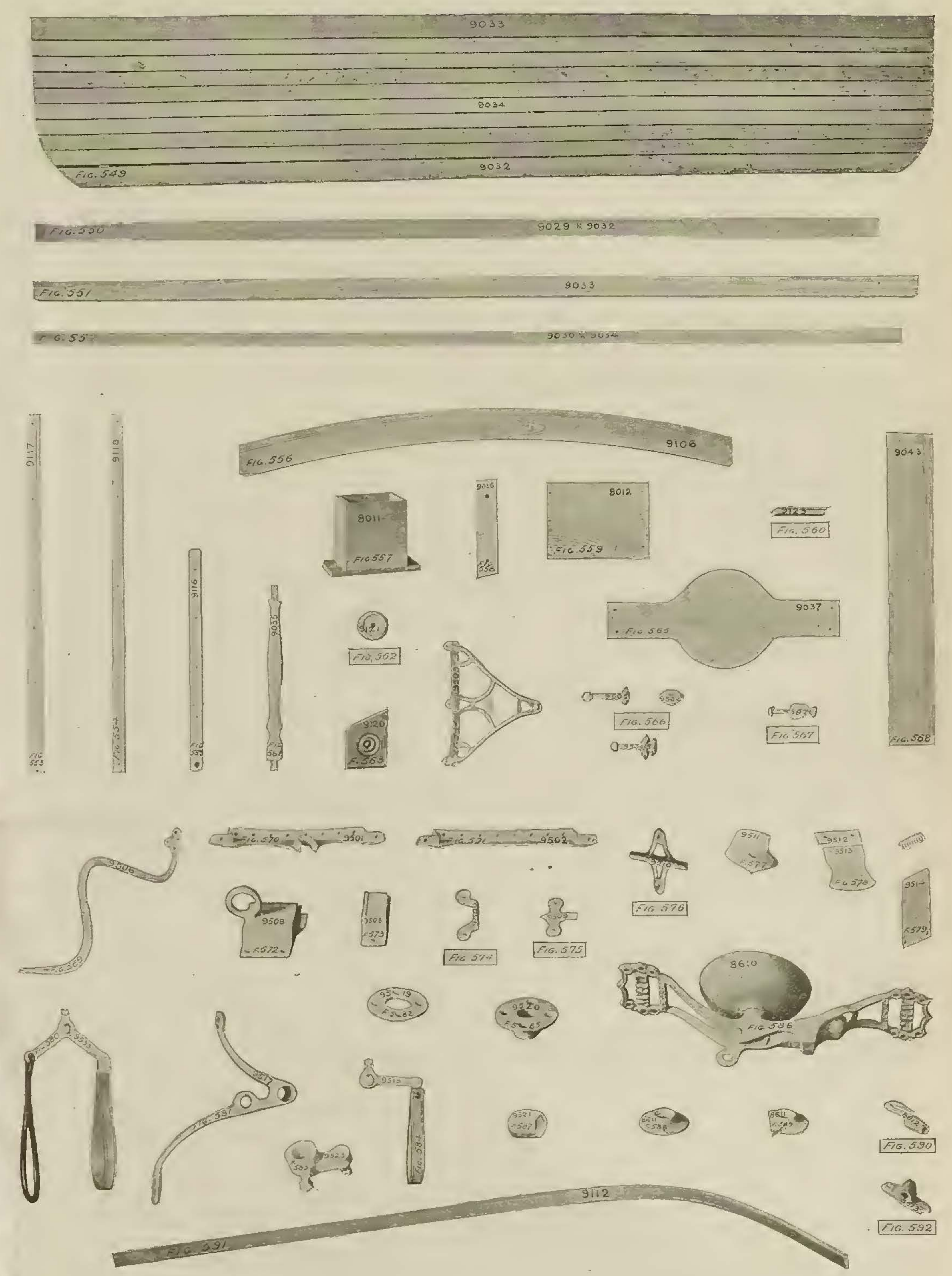


FIG. 525

BROOKLYN OPEN CAR. (Table No. 40.)



BROOKLYN OPEN CAR. (Table No. 40.)



BROOKLYN OPEN CAR. (Table No. 40.)

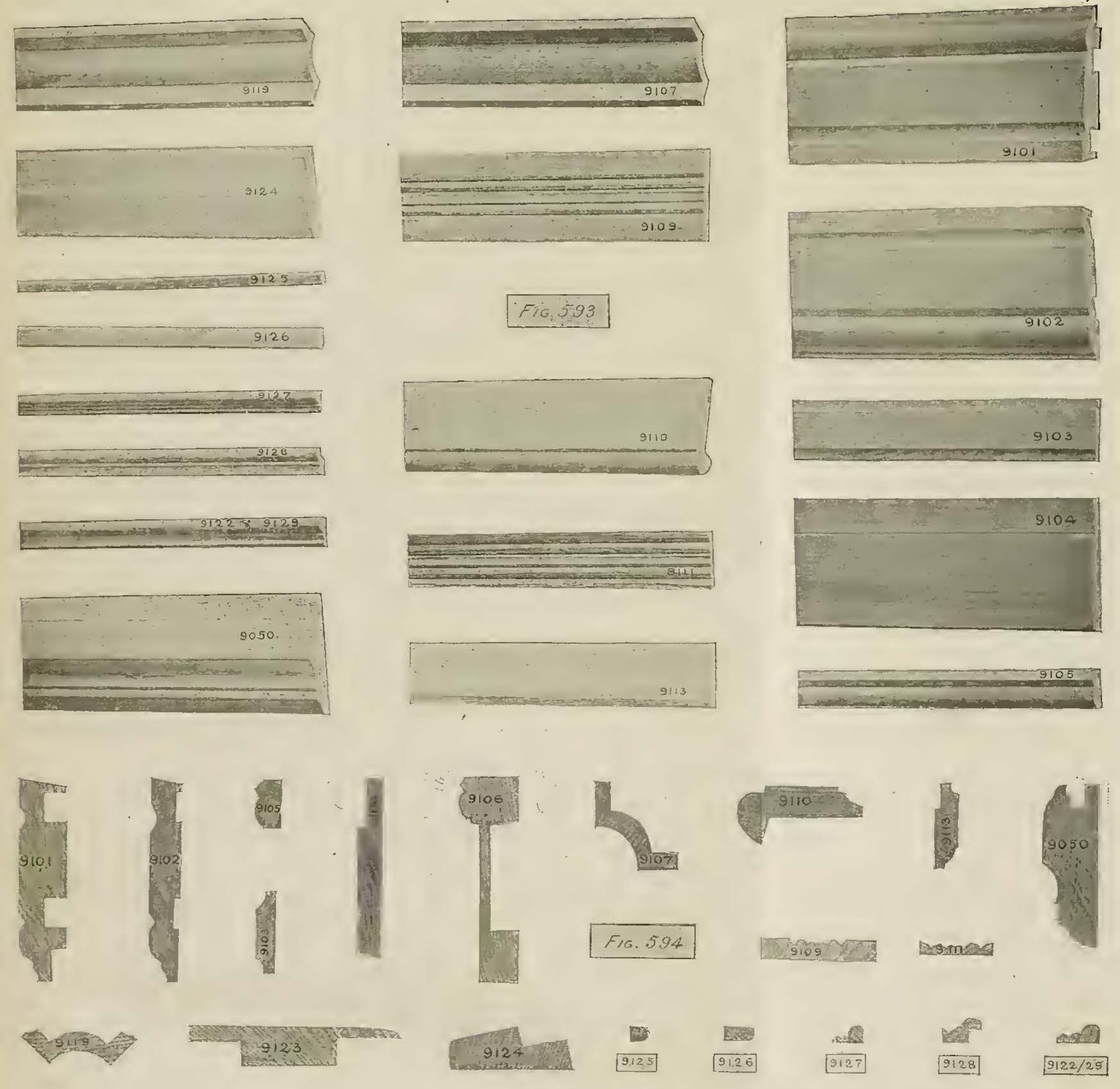


PLATE XII. [Figs. 525 to 594.]

DETAILS OF CABINET WORK, TRIMMINGS, ETC., OF

BROOKLYN OPEN STANDARD CAR

ILLUSTRATING

STREET CAR BUILDING

(Stephenson Practice)

By

Charles Henry Davis, C. E.

279	2	**Sliding-door rear-sheaves** (Fig. 495)	4513	M. I	--	--	--	--	And	
280	2	**do. do. bolders** (Fig. 495)	4514	Bz.	--	--	--	--	Screwed to the rear door-stile with 8 No. 10 x 1 in. steel screws	
281	2	**Sliding-door rear-sheave guides** (Fig. 484)	4515	W. I	--	--	--	--	Screwed to the corner and door-posts with 4 No. 12 x 1¼ in. steel screws (see 1004 j, Fig. 85, Plate V., and Con. No. 47, Table No. 33)	
282	4	**Rubber door-steps** (Fig. 499)	4083	----	--	--	--	--	Screwed to the door stop-blocks (1049), Fig. 140, Plate V., with 8 No. 6 x ¾ in. steel screws. (See Con. No. 100, Table No. 33)	
283	4	**Door-handles** (Fig. 489)	4503	Bz.	--	--	--	--	Secured one to each side of door with	
284	2	**Door-handle stub-bolts** (Fig. 488)	4504	Bz.	--	--	--	--	Securing the handles on each side of the door at same time	
285	--	**4 End-linings** (Fig. 437)	4020	C.	--	--	--	--	Composed of:—	
285a	4	**Stiles** (Fig. 437)	4021	C.	--	--	--	6 ft. 6⅛ in. x 2 in. x ⅞ in.	All joints mortised, tenoned and glued, panels adjusted and glued, edges of rails grooved ¼ in. x ¼ in. to receive the panels; the linings are secured as follows: Left-hand stiles screwed to end top-rail furring (1038), Fig. 111, Plate V., with 4 No. 10 x 1¼ in. steel screws, and to the left door-posts (thick, 1003), Fig. 75, Plate V., with 18 No. 10 x 1½ in. bronze screws; right-hand stiles screwed to end top-rail furring with 4 No. 10 x 1¼ in. steel screws; right and left-hand stiles fitted to mortises (o) in the end-sills (2), Fig. 36, Plate IV.; top-rails tenoned into mortises (k) of the corner-posts (1001), Fig. 79, Plate V., and screwed to door stop-blocks (1049), Fig. 140, Plate V., with 4 No. 10 x 1¼ in. bronze screws; middle-rails tenoned into mortises (l) of the corner-posts (1001), Fig. 79, Plate V.	Variety machine, end tenoner, hollow-chisel mortiser and panel raiser
286	4	**Top-rails** (Fig. 428)	4023	C.	--	--	--	2 ft. 0⅝ in. x 2¾ in. x ⅞ in.		
287	4	**Middle-rails** (Fig. 429)	4024	C.	--	--	--	1 ft. 10⅝ in. x 8⅜ in. x ⅞ in.		
288	4	**Bottom-rails** (Fig. 430)	4025	C.	--	--	--	7¼ in. x 3½ in. x ⅞ in.		
289	4	**Back-rails** (Fig. 431)	4026	C.	--	--	--	10 in. x 4⅝ in. x ⅞ in.		
290	4	**Upright-rails** (Fig. 432)	4027	C.	--	--	--	11⅛ in. x 4⅝ in. x ⅞ in.		
291	8	**Parting-rails** (Fig. 433)	4028	C.	--	--	--	10 in. x 2 in. x ⅞ in.		
292	4	**Back upper-panels** (Fig. 434)	4029	C.	--	--	--	10½ in. x 6¼" x 4⅝ in. x ½"		
293	8	**Upper-panels** (Fig. 435)	4030	C.	--	--	--	10½ in. x 5½ in. x ½ in.		
294	4	**Lower-panels** (Fig. 436)	4031	C.	--	--	--	9 in. x 7¾ in. x ½ in.		
295	..	**2 End-lining head-panels** (Fig. 438)	4042	C.	--	--	--	--	Composed of:—	
295a	2	**Top-rails** (Fig. 439)	4043	C.	--	--	--	1 ft. 7½ in. x 1¾ in. x ⅞ in.	All joints mortised, tenoned and glued, panels adjusted and glued, edges of the rails grooved ¼ in. x ¼ in. to receive the panels; they are secured to the end top-rail on the left side of the door with 8 No. 10 x 1½ in. bronze screws	Variety machine, end tenoner, hollow-chisel mortiser and panel raiser
296	2	**Bottom-rails** (Fig. 440)	4044	C.	--	--	--	1 ft. 7½ in. x 2 in. x ⅞ in.		
297	2	**Front-stiles** (Fig. 441)	4045	C.	--	--	--	10 in. x 2½ in. x ⅞ in.		
298	2	**Back-stiles** (Fig. 442)	4046	C.	--	--	--	6¼ in. x 2½ in. x ⅞ in.		
299	2	**Raised-panels** (Fig. 443)	4047	C.	--	--	--	1 ft. 8 in. x 6¾ in. x ½ in.		
300	--	**2 End-lining hinged-sashes** (Fig. 444)	4048	C.	--	--	--	--	Composed of:—	
300a	2	**Top-rails** (Fig. 444)	4049	C.	--	--	--	1 ft. 7½ in. x 1¾ in. x ⅞ in.	All joints mortised, tenoned and glued, edges of the rails grooved ¼ in. x ¼ in. to receive the panels and rabbeted 7-16 in. x ¼ in. to receive the glass	Variety machine, end tenoner, hollow-chisel mortiser and panel raiser
301	2	**Bottom-rails** (Fig. 444)	4050	C.	--	--	--	1 ft. 7½ in. x 3½ in. x ⅞ in.		
302	2	**Middle-rails** (Fig. 444)	4051	C.	--	--	--	1 ft. 7½ in x 2 in. x ⅞ in.		
303	2	**Front-stiles** (Fig. 444)	4052	C.	--	--	--	3 ft. 7½ in. x 2½ in. x ⅞ in.		
304	2	**Back-stiles** (Fig. 444)	4053	C.	--	--	--	3 ft. 3¾ in. x 2½ in. x ⅞ in.		
305	2	**Raised-panels** (Fig. 444)	4054	C.	--	--	--	1 ft. 8 in. x 6¾ in. x ½ in.		
305a	2	**American plate-glass** (Not Ill.)	4225	----	--	--	--	2 ft. 6½ in. x 1 ft. 8 in.	Set in putty all round and secured with	
305b	8	**Glass-beads** (Not Ill.)	4073	C.	--	--	--	7-16 in. x 5-16 in.	Secured to the sash frame with 42 No. 5 x ⅝ in. bronze screws	Molding machine
306	6	**Hinged-sash hinges** (Fig. 519)	4526	Bz.	--	--	--	--	Screwed to the hinged sashes and the end-lining stiles with 36 No. 7 x ⅞ in. bronze screws	
307	4	**Hinged-sash latches and keepers** (Figs. 515, 516)	4523	Bz.	--	--	--	--	Adjusted to the sashes and screwed to the end-lining stiles with 8 No. 7 x ⅞ in. bronze screws	
308	--	**2 Door-head linings complete** (Fig. 445)	4032	C.	--	--	--	--	Composed of:—	
308a	2	**Linings** (Fig. 446)	4033	C.	--	--	--	--	Screwed to end top-rail furring (1038), Fig. 111, Plate V., with 12 No. 10 x 2½ in. bronze screws	Variety machine
309	2	**Lining-cornices** (Fig. 447)	4034	C.	--	--	--	--	Screwed to the lining with 4 No. 10 x 2½ in. bronze screws	Variety machine and router
310	4	**Lining-pilasters** (Fig. 454)	4035	C.	--	--	--	--	Glued to the lining	Router
311	4	**Rosettes** (Fig. 453)	4036	C.	--	--	--	--	Screwed to the lining with 4 No. 7 x ⅞ in. bronze screws	Molding machine and router
312	2	**Cornice-moldings** (Fig. 449)	4037	C.	--	--	--	--	Nailed to the lining	Molding machine
313	2	**Door-sheave transom-sills** (Fig. 450)	4038	C.	--	--	--	--	Screwed to the lining	Molding machine & variety machine
314	2	**Door-sheave transoms** (Fig. 451)	4039	C.	--	--	--	1 ft. 4 in. x 4 in.	Hinged with	Variety machine
315	4	**Door-sheave transom-hinges** (Fig. 520)	4527	Bz.	--	--	--	--	Screwed to the transoms and transom-sills with 24 No. 4 x ½ in. bronze screws	Variety machine
316	2	**Door-sheave transom-latches** (Fig. 516)	4525	----	--	--	--	--	Same as (4523) Con. No. 307	
317	4	**Door-case corners** (Fig. 452)	4040	C.	--	--	--	--	Tongued and grooved to fit the bottom of the door-sheave transom-sills, and held in place with	Variety machine
318	2	**Door-case moldings** (Fig. 448)	4041	C.	--	--	--	--	The same as	Molding machine
319	2	**End-lining stile-moldings** (Fig. 479)	4022	C.	--	--	--	--	Shown in section, adjusted all round the door-case and secured with 44 No. 10 x 1¼ in. to 1¾ in. bronze screws	Molding machine
320	4	**Hinged-sash stops** (Fig. 476)	4124	C.	--	--	--	--	Are now screwed to the corner and right door-posts with 34 No. 7 x ⅞ in. bronze screws	Variety machine
321	2	**Inside crows-feet** (Fig. 465)	4064	C.	--	--	--	--	Tenoned into mortise (o) in the end-sills Fig. 36, Plate IV., nailed to the right end-lining stiles, and finished off with the end-lining stile-molding carried down to the floor	Variety machine
322	2	**Outside crows-feet** (Fig. 466)	4065	C.	--	--	--	--	Screwed to the right door-post (1004) with No. 10 x 1¾ in. to 2½ in. bronze screws	Variety machine
322a	4	**Rubber door-stops** (Fig. 499)	4083	----	--	--	--	--	Screwed to the left door-posts (1003) with 8 No. 6 x ¾ in. bronze screws	
323	2	**Corner-post end-facia** (Fig. 479)	4122	C.	--	--	--	⅜ in. thick	And	Variety machine
324	2	**Corner-post side-facia** (Fig. 479)	4123	C.	--	--	--	⅜ in. thick	Screwed to the left-hand corner-posts with 24 No. 7 x ⅞ in. bronze screws	Variety machine
325	2	**Electric dry-battery shelves** (Not Ill.)	----	P.	--	--	--	--	Screwed to the end top-rail furring at one end of the car behind the end-lining head-panel, with 4 No. 10 x 1¼ in. steel screws, and placed on it are	
326	2	**Electric dry-batteries** (Fig. 507)	4086	----	--	--	--	--	For supplying current to the electric-bells from the electric-bell push-buttons on the side-posts	
327	9	**Upper-deck panel-ceilings** (Not Ill.)	4074	O.	--	--	--	--	3-ply oak, screwed to the upper-deck furring (2021) with about 90 No. 6 x ¾ in. steel screws, and nailed to the upper-deck rafters	
328	2	**Lower-deck panel-ceilings** (Not Ill.)	4075	O.	--	--	--	--	3-ply oak, screwed to the ventilator bottom-rail and the plain advertising rack-rail with about 80 No. 6 x ¾ in. steel screws	
329	2	**Side crown-moldings** (Fig. 479)	4101	C.	--	--	--	--	And	Molding machine
330	4	**End crown-moldings** (Fig. 479)	4102	C.	--	--	--	--	Screwed on the sides and ends of the upper-deck panel-ceilings to the upper-deck furring with 64 No. 10 x 1¼ in. bronze screws, to secure the panels, add to the appearance and cover the electric wires	Molding machine
331	8	**Head-lining joint-moldings** (Fig. 479)	4103	C.	--	--	--	--	Bradded over joints of upper-deck panel-ceilings	Molding machine
332	4	**Ventilator corner-moldings** (Fig. 479)	4107	C.	--	--	--	--	Screwed to ventilator-posts with 16 No. 7 x ⅞ in. bronze screws	Molding machine
333	7	**Ceiling-rosettes** (Fig. 479)	4108	C.	--	--	--	--	For electric lamps, screwed to upper-deck rafters with 14 No. 7 x 1¼ in. steel screws	Lathe
334	2	**Ventilator bottom-rail facia** (Fig. 479)	4104	C.	--	--	--	--	Glued and nailed to the ventilator bottom-rail	Molding machine
335	4	**End top-rail facia** (Fig. 479)	4106	C.	--	--	--	--	Same molding as the ventilator bottom-rail facia (4104), screwed on each side of the door-head lining with 16 No. 7 x ¾ in. bronze screws	
336	2	**Side-ceiling moldings** (Fig. 479)	4110	C.	--	--	--	--	Screwed to under side of the ventilator bottom-rails with 54 No. 10 x 1¼ in. bronze screws	Molding machine
337	2	**Upper advertising-moldings** (Fig. 479)	4113	C.	--	--	--	--	Nailed to the lower-deck furring (2024)	Molding machine
338	2	**Lower advertising-moldings** (Fig. 479)	4114	C.	--	--	--	--	Screwed to the face of the plain advertising-rack rail (1069) with 54 No. 10 x 1¼ in. bronze screws	Molding machine
339	2	**Advertising rack-rail moldings** (Fig. 479)	4115	C.	--	--	--	--	Nailed to the under side of the advertising-rack rail	Molding machine
340	16	**Side-post caps** (Fig. 479)	4116	C.	--	--	--	--	Screwed to the side-posts with 64 No. 10 x 1¼ in. bronze screws, each one having a round hole in it for	Molding machine
341	16	**Electric-bell push-buttons** (Fig. 521)	4538	----	--	--	--	--	Adjusted to the side-post caps and connected by wires running from the electric dry-batteries to the electric-bells	
342	2	**Hinged-sash sills** (Fig. 479)	4117	C.	--	--	--	--	Screwed to the end-lining top-rails (4023) with 6 No. 10 x 1¼ in. bronze screws	Molding machine
343	2	**End-sash sills** (Fig. 479)	4118	C.	--	--	--	--	Screwed to the end-lining top-rails (4023) with 6 No. 10 x 1¼ in. bronze screws	Molding machine
344	--	**2 Seat-fronts** (Figs. 468, 469)	4066	C.	--	--	--	--	In two pieces, composed of:—	
344a	4	**Top-rails** (Fig. 470)	4067	C.	--	--	--	24 ft. 3⅞ in. x 1⅜ in. x ¾ in.	All joints mortised, tenoned and glued, edges of the rails rabbeted ¼ in. x ¼ in. to receive the panels, screwed to the seat-legs (1058) Fig. 134, Plate V., with 32 No. 12 x 1½ in. steel screws	Variety machine, end tenoner, hollow-chisel mortiser and panel raiser
345	4	**Bottom-rails** (Fig. 471)	4068	C.	--	--	--	24 ft. 3⅞ in. x 2¼ in. x ¾ in.		
346	4	**Mullions** (Fig. 473)	4069	C.	--	--	--	8½ in. x 4 in. x ¾ in.		
347	14	**Wide end-rails** (Fig. 474)	4070	C.	--	--	--	8½ in. x 4 in. x ¾ in.		
348	4	**Narrow end-rails** (Fig. 475)	4071	C.	--	--	--	8½ in. x 2 in. x ¾ in.		
349	12	**Raised-panels** (Fig. 472)	4072	C.	--	--	--	2 ft. 4½ in. x 9 in. x ½ in.		

TABLE NO. 39—*Continued*

Consecutive Number	Quantity	Name of Piece	Piece Number Plates I. and XI.	Material See Plates I. and II.	Details: Quantity	Details: Name	Details: Reference Letter Plate XI.	Dimensions	Observations and Particulars of How Used	Tools Usually Employed (Others can be used if convenience or necessity requires)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
349a	48	**Panel-beads** (Not Ill.)	4073	C.	--	----------	--	5-16 in. x ¼ in.	Screwed to the different rails	
350	2	**Front seat-supporting-rail facia** (Fig. 479)	4121	C.	--	----------	--	----------	Glued and nailed to the front seat-supporting-rail (1057)	Molding machine
351	2	**Front seat-rail knees** (Fig. 487)	4531	Bz.	--	----------	--	----------	Screwed to the front seat-supporting-rail and the end-lining middle-rail with 4 No. 10 x 1½ in. and 4 No. 10 x ¾ in. bronze screws	
352	--	**2 Plush seat-backs** (Not Ill.)	4076	----	--	----------		----------	Composed of:—	
352a	2	**Seat-back boards** (Not Ill.)	4077	A.	--	----------	--	----------	And	
353	6	**Seat-back battens** (Not Ill.)	4078	A.	--	----------	--	----------	Screwed to them with 46 No. 10 x 1 in. steel screws; to the seat-back boards are also screwed at the ends	
354	4	**Seat-back cleats** (Not Ill.)	4079	A.	--	----------	--	----------	With 12 No. 12 x 1½ in. steel screws to give the form of the seat-back which is of curled hair covered with crimson mohair plush; the seat-backs are then screwed to the side-posts with 32 No. 12 x 1¼ in. steel screws and to the seat-rail cleats (1056) Fig 132, Plate V., with 8 No. 12 x 1¼ in. and 2 in. steel screws	
355	4	**Seat-back end-straps** (Fig. 485)	4532	Bz.	--	----------	--	----------	Screwed to the seat-back cleats with 24 No. 7 x ⅞ bronze screws	
356	2	**Seat-back caps** (Fig. 479)	4119	C.	--	----------	--	----------	Screwed to the top of the seat-back boards with 54 No. 10 x 1¼ in. bronze screws	Molding machine
357	6	**Squab seat-cushions** (Not Ill.)	4080	----	--	----------	--	----------	Each filled with 18 lbs. of curled hair and covered with crimson mohair plush top, same as the seat-back, and duck bottom, are laid on the seat-lid boards (1062) Con. No. 97a, Table 33.	
358	18	**Sash winter-casings** (Fig. 479)	4120	----	--	----------	--	----------	Are secured against the side-sashes by	Molding machine
359	36	**Winter-casing knees** (Fig. 493)	4537	Bz.	--	----------	--	----------	Screwed to the side and corner-posts with 36 No. 12 x 1 in. bronze screws	
360	2	**Inside window-stops** (Fig. 477)	4129	C.	-	----------	--	----------	Screwed to the door-posts (1003) with 16 No. 7 x ⅞ in. bronze screws to secure the left-hand end-sashes (4016)	
361	18	**Spring-roller shades** (Fig. 494)	4084	----	--	----------	--	----------	With Burrowes' patent automatic shade-holding device, hung in sockets screwed to the side and corner-posts with 72 No. 4 x ½ in. steel screws	
362	2	**Hand-poles** (Fig. 478)	4081	C.	--	----------	--	1¼ in. diam.	Upon which are placed	Lathe
363	36	**Hand-pole straps** (Fig. 508)	4082	----	--	----------	--	----------	Of leather, the poles being secured with 4 No. 8 x ¾ in. bronze screws to	
364	2	**Hand-pole sockets** (Fig. 510)	4517	Bz.	--	----------	--	----------	Screwed to the door-head lining on the right side with 8 No. 8 x ¾ in. bronze screws, and	
365	2	**Hand-pole sockets with eyelets** (Fig. 511)	4518	Bz.	--	----------	--	----------	Screwed to the door-head lining on the left side with 6 No. 8 x ¾ in. bronze screws	
366	18	**Hand-pole brackets** (Fig. 506)	4516	Bz.	--	----------	--	----------	Are also screwed to the lower-deck rafters and the ventilator bottom-rail facia with 72 No. 8 x 1 in. bronze screws	
367	6	**Bell-cord bushes** (Fig. 503)	3570	Bz.	--	----------	--	----------	Secured to the end top-valance and door-head linings with 6 No. 5 x ⅝ in. bronze screws	
368	2	**Bell-cord sheaves** (Fig. 502)	2509	Bz.	--	----------	--	----------	Screwed to the platform-hood bow with 8 No. 8 x ¾ in. and 1 in. bronze screws	
369	2	**Signal-bells** (Fig. 504)	3568	Bz.	--	----------	--	----------	Screwed to the platform-hood with 8 No. 12 x 1¼ in. bronze screws	
370	2	**Bell-cord couplings** (Fig. 500)	3569	Bz.	--	----------	--	----------	For coupling and uncoupling the bell-cord	
371	2	**Electric-bells** (Fig. 498)	3571	----	--	----------	--	----------	"King" pattern operated by the electric-bell push-buttons on the side-posts, screwed to the end top-valance with 4 No. 7 x ⅞ in. steel screws	
372	1	**Electric-bell switch** (Fig. 514)	3572	----	--	----------	--	----------	Screwed to the door-head lining with 1 No. 7 x ⅞ in. bronze screw, to open and close the circuit from the batteries to the bells	
373	4	**Platform window-guards** (Fig. 486)	3567	Bz.	--	----------	--	----------	Screwed to the corner and door-post moldings with 32 No. 12 x 1½ in. bronze screws	
374	2	**Fender-rail trolley-steps** (Fig. 491)	1515	Bz.	--	----------	--	----------	Screwed to the fender-rails with 8 No. 10 x 1½ in. steel screws	
375	2	**Corner-post trolley-steps** (Fig. 493)	1516	Bz.	--	----------	--	----------	Screwed to the corner-posts with 8 No. 10 x 1½ in. steel screws	
376	2	**Door anti-rattle springs** (Fig. 505)	4505	S.S.	--	----------	--	----------	Screwed to end-lining with 4 No. 7 x ⅞ in. bronze screws	
377	1	**Sign-stick socket** (Fig. 512)	4539	M.I.	--	----------	--	----------	Screwed to the end-lining bottom-rail with 4 No. 10 x 1 in. steel screws.	

Number of Distinctive Pieces	144	(Column 1)
Total Number of Pieces	1338	(" 2)
Number of Bolts	None	(" 6 and 10)
Number of Screws (about)	3700	(" 6 and 10)
Number of Nails	?	
Total	5038 +	

While the assembling of the different parts and pieces of the Cabinet Work, Trimmings, etc., has been carried on, the painting of the cars is proceeded with from the point reached in Table No. 35, Con. No. 128, as follows:—10th day, Give a coat of lead tinted with the required color; 11th day, Second coat of color; 12th day, Third coat of color with enough varnish to make a gloss; 13th day, Rub with felt, powdered pumice stone and water, then wash with sponge and dry with chamois skin; 14th day, Stripe, letter and ornament; 15th day, Give a coat of Ry. Coach finishing varnish; 16th day, Second coat of varnish. This method is followed for other painted and ornamented parts besides the body, as platform-sills, step-hangers, fenders and dashers. All the iron-work is painted:—dasher-rail and posts, 2 coats of black; platform-hood supports, 3 coats black; buffer, 2 coats black then white numbers (of the car) and varnished. Iron-work under car, one coat Princes Metallic. Under side of platform-hood painted white. There are four transfers on the upper end-panels and two on the end sashes. The interior finish is natural cherry, no stain used, shellacked, 2 coats inside varnish rubbed to a flat finish. Ceiling-panels, flat finish and decorated, with one coat of lead and oil on the back. Sash and doors finished on the outside in natural wood with 2 coats inside varnish and 1 coat of body varnish. The ventilator sashes lettered in black on the ground side of the glass.

Table No. 40

Detail of Cabinet Work, Trimmings, Etc., of Brooklyn Open Car, in the Order of Assembling
(12 Benches; Car No. 4; Fig. 5; Plates II. and XII.)

Consecutive Number	Quantity	Name of Piece	Piece Number Plates II. and XII.	Material See Plates I. and II.	Details: Quantity	Details: Name	Details: Reference Letter Plate XII.	Dimensions	Observations and Particulars of How Used	Tools Usually Employed (Others can be used if convenience or necessity requires)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
									The Cabinet Work, Trimmings etc., are prepared during the assembling of the pieces already described, and after the platforms and platform-hoods are attached (*See Table No. 38 and Plate X*) they are put in place, adjusted and secured much in the order of procedure here given, although in many cases several different pieces or parts are in hand at the same time	
66	1	**Upper-deck panel-ceiling** (Not. Ill.)	9038	Q. O.	--	------	--	25 ft. 11¾ in. x 3 ft. 7 in. x ¼ in.	In 3 pieces, nailed and screwed to the upper-deck rafters with about 90 No. 6 x ⅝ in. steel screws	
167	2	**Side crown-moldings** (Figs. 593, 594)	9101	A.	--	------	--	------	Screwed to the upper-deck rafters with 54 No. 12 x 1¼ in. bronze screws	Molding machine
168	2	**End crown-moldings** (Figs. 593, 594)	9102	A.	--	------	--	------	Screwed to the upper-deck end-furring (7027) with 8 No. 12 x 1¼ in. bronze screws	Molding machine
169	5	**Head-lining joint-moldings** (Figs. 593, 594)	9.03	A.	--	------	--	------	Screwed to the upper-deck rafters with 20 No. 6 x 1 in. bronze screws	Molding machine
170	2	**Advertising rack-rails with facia** (Figs. 593, 594	9050	A.	--	------	--	------	Screwed to the side top-rails (6018) Fig. 163, Plate VI., with 20 No. 12 x 1¾ in. bronze screws	Molding machine
171	2	**Lower-deck panel-ceilings** (Not Ill.)	9039	Q. O.	--	------	--	25 ft. 8 in. x 1 ft. 3½ in. x ¼ in.	In 3 pieces each, nailed and screwed to the ventilator bottom-rail and lower-deck rafters with about 80 No. 6 x ⅝ in. steel screws	
172	2	**Side-ceiling moldings** (Figs. 593, 594)	9110	A.	--	------	--	------	Screwed to the ventilator bottom-rail with 38 No. 12 x 1¼ in. bronze screws	Molding machine
173	2	**Upper advertising-moldings** (Figs. 593, 594)	9113	A.	--	------	--	------	Screwed to the lower-deck rafters with 54 No. 6 x 1 in. bronze screws	Molding machine
174	6	**Side-ceiling joint-moldings** (Figs. 593, 594)	9111	A.	--	------	--	------	Nailed to the lower-deck rafters	Molding machine
175	4	**Side-ceiling end-moldings** (Fig. 591)	9112	A.	--	------	--	------	Steamed and bent to shape on a former and nailed to the end top-rail	Molding machine
176	4	**Ventilator corner-moldings** (Figs. 593, 594)	9107	A.	--	------	--	------	Nailed to the ventilator corner-posts	Molding machine
177	20	**Ventilator-post facia** (Figs. 593, 594)	9109	A.	--	------	--	------	Nailed to the ventilator side-posts	Molding machine
178	2	**Ventilator bottom-rail facia** (Figs. 593, 594)	9104	A.	--	------	--	------	Nailed to the face of the ventilator bottom-rail	Molding machine
179	2	**Ventilator bottom-rail facia molding** (Figs. 593, 594)	9105	A.	--	------	--	------	Nailed through the ventilator bottom-rail facia (Con. No. 178) to the ventilator bottom-rail	Molding machine
180	2	**End top-rail facia** (Figs. 556, 594)	9106	A.	--	------	--	------	Screwed to the end top-rail with 8 No. 12 x 1¼ in. bronze screws	Molding machine
181	4	**Bulkhead-panel rosettes** (Fig. 563)	9120	A.	--	------	--	------	Screwed to the end sub top-rail (6012) with 8 No. 12 x 1¾ in. bronze screws	Lathe
182	4	**Bulkhead-panels** (Fig. 568)	9043	A.	--	------	--	------	Secured with	Panel raiser
183	8	**Bulkhead-panel beads** (Figs. 593, 594)	9122	A.	--	------	--	------	Nailed to the corner and false end-posts	Molding machine
184	--	**14 Ventilator side-sashes** (Fig. 526)	9001	A.	--	------	--	------	Composed of	
184a	14	**Top-rails** (Fig. 538)	9002	A.	--	------	--	2 ft. 6⅛ in. x 1¼ in. x ¾ in.	All joints mortised, tenoned and glued, each piece having one edge rabbeted ½ in. x ¼ in. to receive the glass. *Note.*—The lengths of rails with tenons are from end to end of the sash	Variety machine, end tenoner and hollow-chisel mortiser
185	14	**Bottom-rails** (Fig. 539)	9003	A.	--	------	--	2 ft. 6⅛ in. x 1½ in. x ¾ in.		
186	28	**Stiles** (Fig. 532)	9004	A.	--	------	--	8½ in. x 1¾ in. x ¾ in.		
187	14	**Chipped-glass** (Not Ill.)	9207	----	--	------	--	2 ft. 3 in. x 6 in.	Set in putty all round and secured with	
188	56	**Glass-beads** (Figs. 593, 594)	9125	A.	--	------	--	------	Nailed to the sash	Molding machine
188a	--	**8 Ventilator side-sashes** (Fig. 526)	9001	A.	--	------	--	------	Composed of:—	
188b	8	**Top-rails** (Fig. 538)	9002	A.	--	------	--	1 ft. 7 9-16 in. x 1¼ in. x ¾ in.	All joints mortised, tenoned and glued, each piece having one edge rabbeted ½ in. x ¼ in. to receive the glass	Variety machine, end tenoner and hollow-chisel mortiser
188c	8	**Bottom-rails** (Fig. 539)	9003	A.	--	------	--	1 ft. 7 9-16 in. x 1¼ in. x ¾ in.		
188d	16	**Stiles** (Fig. 532)	9004	A.	--	------	--	8½ in. x 1¾ in. x ¾ in.		
188e	8	**Chipped-glass** (Not Ill.)	9207	----	--	------	--	1 ft. 4½ in. x 6 in.	Set in putty all round and secured with	
188f	32	**Glass-beads** (Figs. 593, 594)	9125	A.	--	------	--	------	Nailed to the sash	Molding machine
189	44	**Ventilator-sash pivots** (Fig. 575)	9509	Bz.	--	------	--	------	Screwed to above sash stiles with 88 No. 6 x ⅝ in. bronze screws and inserted in corresponding holes in the ventilator side and side-corner posts	
190	20	**Ventilator-sash steps** (Fig. 576)	9510	Bz.	--	------	--	------	Screwed to the ventilator side and side-corner-posts with 40 No. 6 x ⅝ in. bronze screws	
191	--	**6 Bulkhead sashes** (Fig. 530)	9009	A.	--	------	--	------	Composed of:—	
191a	6	**Top-rails** (Fig. 536)	9010	A.	--	------	--	1 ft. 10¼ in. x 2¾ in. x ½ in.	All joints mortised, tenoned and glued, each piece having one edge rabbeted 5-16 in. x ¼ in. to receive the glass	Variety machine, end tenoner and hollow-chisel mortiser
192	6	**Bottom-rails** (Fig. 537)	9011	A.	--	------	--	1 ft. 10½ in. x 3⅜ in. x ½ in.		
193	12	**Stiles** (Fig. 531)	9012	A.	--	------	--	2 ft. 9¾ in. x 2 5-16 in. x ½ in.		
194	6	**"Elmira" plate-glass** (Not Ill.)	9208	----	--	------	--	2 ft. 4 in. x 1 ft. 6 in.	Set in putty all round and secured with	
194a	24	**Glass-beads** (Figs. 593, 594)	9125	A.	--	------	--	------	Nailed to the sash	Molding machine
195	6	**Sash top-lifts** (Fig. 577)	9511	Bz.	--	------	--	------	Screwed to the sash top-rails with 6 No. 7 x ⅝ in. steel screws	
196	6	**Sash leather-lifts** (Fig. 578)	9513	----	--	------	--	------	Secured with	
197	6	**Sash leather-lift plates** (Fig. 578)	9512	Bz.	--	------	--	------	Screwed to the sash bottom-rails with 12 No. 7 x ⅝ in. bronze screws	
198	12	**Anti-rattle sash-plates and springs** (Fig. 579)	9514	Bz.	--	------	--	------	Stephenson pattern, screwed to the sash stiles with 24 No. 4 x ⅝ in. bronze screws	
199	4	**Corner-post corner-moldings** (Figs. 593, 594)	9119	A.	--	------	--	------	Screwed to the corner-posts with 32 No. 4 x ⅝ in. bronze screws	Molding machine
200	4	**Bulkhead-panel sills** (Figs. 560, 594)	9123	A.	--	------	--	------	Nailed to the inside end-belt-rail (6007)	Molding machine
201	--	**6 Ventilator sign-sashes** (Fig. 527)	9013	A.	--	------	--	------	Composed of:—	
201a	6	**Top-rails** (Fig. 540)	9014	A.	--	------	--	2 ft. 7⅝ in. x 1 9-16 in. x ¾ in.	All joints mortised, tenoned and glued, each piece having one edge rabbeted ½ in. x ¼ in. to receive the glass	Variety machine, end tenoner and hollow-chisel mortiser
202	6	**Bottom-rails** (Fig. 541)	9015	A.	--	------	--	2 ft. 7⅝ in. x 2⅛ in. x ¾ in.		
203	12	**Stiles** (Fig. 533)	9016	A.	--	------	--	9¼ in. x 2½ in. x ¾ in.		

TABLE NO. 40—*Continued*

Consecutive Number	Quantity	Name of Piece	Piece Number Plates II. and XII.	Material See Plates I. and II.	Details: Quantity	Details: Name	Details: Reference Letter Plate XII.	Dimensions	Observations and Particulars of How Used	Tools Usually Employed (Others can be used if convenience or necessity requires)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
204	6	**Ground-glass** (Not Ill.)	9209	----	--	----	--	2 ft. 3 in. x 6 in.	Set in putty all round and secured with	
205	24	**Sign-sash glass-beads** (Figs. 593, 594)	9126	A.	--	----	--	----	Nailed to the sash	Molding machine
206	12	**Ventilator sign-sash latches** (Fig. 572)	9508	Bz.	--	----	--	----	Screwed to the sign-sash bottom-rails with 48 No. 7 x ¾ in. bronze screws	
207	12	**Ventilator sign-sash keepers** (Fig. 574)	9508	Bz.	--	----	--	----	Screwed to the ventilator bottom-rail roof-molding with 24 No. 7 x ¾ in. bronze screws	
208	6	**Side sign sash moldings** (Figs. 593, 594)	9124	A.	--	----	--	----	Screwed to the ventilator top-rail (7001) with 24 No. 7 x 1 in. bronze screws	Molding machine
209	--	**2 Ventilator end-sign-sashes** (Fig. 528)	9017	A.	--	----	--	----	Composed of:—	
209a	2	**Top-rails** (Fig. 529)	9018	A.	--	----	--	3 ft. 11¼ in. x 1½ in. x ¾ in.		
210	2	**Bottom-rails** (Fig. 529a)	9019	A.	--	----	--	3 ft. 11¼ in. x 1½ in. x ¾in.	All joints mortised, tenoned and glued, each piece having one edge rabbeted ½ in. x ¼ in. to receive the glass	Variety machine, end tenoner and hollow-chisel mortiser
211	4	**Stiles** (Fig. 534)	9020	A.	--	----	--	9½ x 2¼ in. & 2½ in. x ¾ in.		
212	2	**Mullions** (Fig. 535)	9021	A.	--	----	--	9⅛ in. x 2 in. x ¾ in.		
212a	4	**Ground-glass** (Not Ill.)	9209	----	--	----	--	1 ft. 9½ in. x 7 in.	Set in putty all round and secured with	
212b	14	**Sign-sash glass-beads** (Figs. 593, 594)	9126	A.	--	----	--	----	Nailed to the sash	Molding machine
213	2	**Ventilator end-sign-sash holders** (Fig. 558)	9036	A.	--	----	--	9½ in. x 2 1-16 in. x ¾ in.	With one edge rabbeted to fit the sash stile, and	Variety machine
----	2	**Ventilator end-sign-sash holders** (Fig. 558)	9036	A.	--	----	--	9½ in. x 1¾ in. x ¾ in.	Screwed to the ventilator end-corner-posts (7004) with 8 No. 12 x 1½ in. bronze screws	Variety machine
213a	2	**Ventilator sign-sash latches** (Fig. 572)	9508	Bz.	--	----	--	----	Screwed to the sign-sash stile with 8 No. 7 x ¾ in. bronze screws	
214	2	**Ventilator sign-sash keepers** (Fig. 573)	9508	Bz.	--	----	--	----	Screwed to the sign-sash holders with 4 No. 7 x ¾ in. bronze screws	
215	4	**Bulkhead sash-guards** (Not Ill.)	6028	P.	--	----	--	6 ft. 4¼ in. x 1 ft. 3¾ in. x ½ in.	Screwed under the seats to the false-end and end-center posts with 48 No. 10 x 1 in. steel screws	
216	4	**Electric-wire furring** (Not Ill.)	6029	A.	--	----	--	1 ft. 3½ in. x 2 in. x 1¼ in.	Nailed to the end-bulkheads (6001)	
217	12	**Rubber sash-rests** (Not Ill.)	9040	----	--	----	--	3¼ in. x 1 in. x ⅜ in.	Nailed to the bottom false-sill	
218	--	**8 Reversible slat-seats** (Fig. 548)	9028	A.	--	----	--	----	Composed of:—	
218a	16	**Seat-rails** (Fig. 550)	9029	A.	--	----	--	6 ft. 11⅞ in. x 1⅞ in. x 1⅞ in.	And	Molding machine
219	64	**Seat-slats** (Fig. 552)	9030	A.	--	----	--	6 ft. 11⅞ in. x 1⅜ in. x ⅝ in.	Screwed to	Molding machine
220	32	**Reversible seat-brackets** (Fig. 570)	9501	M. I.	--	----	--	----	With 64 No. 10 x 1 in. and 256 No. 10 x ⅝ in. steel screws; these reversible slat-seats are secured in place by the seat-rails being bolted to the side-post seat-end iron-panels (6502), Fig. 188, Plate VI., through holes (e) with	
221	32	**Seat-bolts** (Fig. 567)	9507	W. I.	--	----	--	----	With beveled washers and nuts	
222	--	**4 Bulkhead slat-seats** (Fig. 549)	9031	A.	--	----	--	----	One on each side of the bulkheads, composed of	
222a	4	**Front-rails** (Fig. 550)	9032	A.	--	----	--	6 ft. 11⅞ in. x 1⅞ in. x 1⅞ in.		
223	4	**Back-rails** (Fig. 551)	9033	A.	--	----	--	6 ft. 11⅞ in. x 2 in. x 1⅞ in.	And	Molding machine
224	32	**Seat-slats** (Fig. 552)	9034	A.	--	----	--	6 ft. 11⅞ in. x 1⅜ in. x ⅝ in.	Screwed to	
225	16	**Bulkhead seat-brackets** (Fig. 571)	9502	M. I.	--	----	--	----	With 32 No. 10 x 1 in. and 128 No. 10 x ⅝ in. steel screws; the back-rails are screwed to the corner-posts with 8 No. 16 x 3 in. steel screws, and the seats are further secured by the front-rails being bolted to the corner-post seat-end iron-panels (6501), Fig. 187, Plate VI., through holes (e) with	
225a	8	**Seat-bolts** (Fig. 567)	9507	W. I.	--	----	--	----	With beveled washers and nuts	
226	6	**Bulkhead seat-legs** (Fig. 561)	9035	A.	--	----	--	1 ft. 7 in. x 1 9-16 in.	Adjusted to the front seat-rails and the flooring, two to each platform-seat and one to each inside-seat	Lathe
227	--	**8 Reversible seat-backs** (Fig. 545)	9022	A.	--	----	--	----	Composed of:—	
227a	16	**Rails** (Fig. 546)	9023	A.	--	----	--	6 ft. 2½ in. x 2½ in. x 1 in.		
228	16	**End-rails** (Fig. 542)	9024	A.	--	----	--	1 ft. 3¼ in. x 2½ in. x 1 in.	All joints mortised, tenoned and glued, each rail having one edge grooved to receive the panels, they are secured in position with	Molding machine
229	24	**Parting-rails** (Fig. 543)	9025	A.	--	----	--	1 ft. 3¼ in. x 1¾ in. x 1 in.		Variety machine
230	96	**Panels** (Fig. 544)	9026	A.	--	----	--	1 ft. 4½ in. x 4½ in. x 7-16 in.		Beading machine
231	16	**Reversible seat-back arms** (Fig. 564)	9503	Bz.	--	----	--	----	Screwed to the seat end-rails with 8 No. 12 x 1 in. bronze screws; the arms being pivoted to the side-posts (6003) through bolt-holes (h) Fig. 178, Plate VI., with	
232	16	**Reversible seat-back arm-plates** (Fig. 566)	9504	Bz.	--	----	--	----	And	
233	16	**Reversible seat-back arm-pivots and nuts** (Fig. 566)	9505	Bz.	--	----	--	----	Which also hold the pillar-handle middle-sockets (6512). *See Con. No. 43, Table No. 34*	
234	32	**Seat-back strike-rubbers** (Not Ill.)	9041	----	--	----	--	⅝ in. diam., 11-16 in. long	Let into the rails, varnished and nailed	
235	4	**Bulkhead seat-backs** (Fig. 547)	9027	A.	--	----	--	6 ft. 8¼ in. x 9 in. x 1 in.	One on each side of the bulkheads, screwed to the end-center and false end-posts with 32 No. 12 x 1¾ in. steel screws	Beading machine
236	8	**Bulkhead seat-arms** (Fig. 569)	9506	Bz.	--	----	--	----	Bolted and screwed to the bulkhead-seat front-rails (9032) with 8 bolts 2½ in. x ¼ in. and 8 No. 18 x 1¾ in. bronze screws, and bolted and screwed to the corner-posts with 4 bolts 5¼ in. x 5-16 in. each with 2 bronze nuts, and 8 No. 18 x 1¾ in. and 8 No. 14 x 1½ in. bronze screws	
237	14	**Spring-roller shades** (Not Ill.)	9042	----	--	----	--	7 ft. 1 in. x 2 ft. 5¼ in.	"Pantasote," with "Hartshorn" rollers and "Acme" fixtures, hung in sockets screwed in pockets (f) of the side-posts with 56 No. 4 x ½ in. steel screws, and	
----	4	**Spring-roller shades** (Not Ill.)	9042	----	--	----	--	7 ft. 1 in. x 3 ft. 4¾ in.	As above, screwed to the end side and corner-posts with 16 No. 4 x ½ in. steel screws, and	
----	4	**Spring-roller shades** (Not Ill.)	9042	----	--	----	--	3 ft. 6 in x 1 ft. 9 in.	As above, screwed to the false-end and end center-posts with 16 No. 4 x ½ in. steel screws	
238	16	**Side-post caps** (Fig. 555)	9116	A.	--	----	--	----	With holes for electric push-buttons, screwed to the face of the side-posts with 64 No. 6 x 1 in. bronze screws	Molding machine and router
239	4	**Center-post caps** (Fig. 553)	9117	A.	--	----	--	----	Screwed to the face of the end center-posts with 20 No. 9 x 1 in. bronze screws	Molding machine
240	4	**False-end-post caps** (Fig. 554)	9118	A.	--	----	--	----	Screwed to the face of the false-end-posts with 20 No. 9 x 1 in. bronze screws	Molding machine
241	6	**End top-valance lights** (Not Ill.)	9207	----	--	----	--	----	Chipped glass, secured to the end top-valances with	

242	16	**Side transom-glass beads** (Figs. 593, 594)	9127	A.					And	Molding machine
243	8	**Center transom-glass beads** (Figs. 593, 594)	9128	A.					Nailed to the end top-valances. *See Con. No. 40, Table No. 34*	Molding machine
244	2	**Transom-glass bottom-molding** (Figs. 593, 594)	9129	A.					Nailed all along the bottom inside edge of the end top-valance	Molding machine
245	2	**Platform electric-light rosettes** (Fig. 562)	9121	A.				3 in. x ⅞ in.	Screwed to the end top-valance with 4 No. 7 x ¾ in. steel screws	Lathe
246	2	**Trolley switch-blocks** (Fig. 559)	8012	A.				10⅞ in. x 8½ in. x ¾ in.	Screwed to the platform-hood rafters with 12 No. 12 x 1¼ in. bronze screws	
247	1	**Electric-battery box** (Fig. 557)	8011	P.				7 in. x 6½ in. x 6½ in.	Which with	
248	4	**Electric dry-batteries** (Not Ill.)	8617	----					Shown at Fig. 507, Plate XI., is screwed to the floor under the inside end seat with 2 No. 12 x 1¼ in. steel screws, and covered with a lid screwed down with 2 No. 8 x 1 in. steel screws	
249	2	**Electric-bells** (Not Ill.)	8614	----					Shown at Fig. 498, Plate XI., screwed to the end top-valance with 4 No. 7 x ⅞ in. steel screws	
250	2	**Electric-switches** (Not Ill.)	8615	----					Shown at Fig. 514, Plate XI., screwed to the end top-valance with 4 No. 8 x 1 in. bronze screws	
251	16	**Electric push-buttons** (Not Ill.)	8616	----					Shown by Fig. 521, Plate XI., secured in the holes of the side-post caps (9116), Fig. 555	
252	2	**Signal-bells** (Fig. 586)	8610	Bz.					Screwed to the platform-hood rafters with 8 No. 12 x 1 in. bronze screws	
253	8	**Bell-cord bushings** (Figs. 588, 589)	8611	Bz.					Screwed to the bulkhead-panel rosettes and the end top valances with 24 No. 4 x ½ in. bronze screws	
254	2	**Bell-cord hooks** (Fig. 590)	8612	Bz.					To connect the bell-cord to the signal-bells	
255	2	**Bell-cord end-fasteners** (Fig. 592)	8613	Bz.					Screwed to the platform-hood bows (7020) with 4 No. 12 x 1 in. bronze screws, to secure the end of the bell-cord	
256	2	**Corner-post trolley-steps** (Not Ill.)	6527	C. I.					Shown by Fig. 493, Plate IX., screwed to diagonally opposite corner-posts with 6 No. 14 x 1¾ in. steel screws	
257	1	**Register-block** (Fig. 565)	9037	A.					Screwed inside at one end of the car to the end center-posts with 4 No. 12 x 2½ in. bronze screws, for the fare-register to be fastened to	Variety machine
258	2	**Register-rods** (Not Ill.)	9516	W. S.					Held by	
259	16	**Register-rod brackets** (Fig. 581)	9517	Bz.					Screwed to the advertising-rack rail (9050) and side-post caps with 32 No. 12 x 1½ in. bronze screws, and operated by	
260	20	**Register-rod levers** (Fig. 580)	9533	Bz.					With the leather pull straps and secured to the register-rods with set-screws	
261	4	**Register-rod sleeves** (Fig. 582)	9519	Bz.					And	
262	4	**Register-rod bushings** (Fig. 585)	9520	Bz.					Screwed to the end sub-top-rail (6019) with 32 No. 9 x ½ in. bronze screws	
263	4	**Register-rod loose collars** (Fig. 587)	9521	Bz.					Put on the ends of the register-rod between the end of the car body and the levers on the platform	
264	2	**Register operating-cranks** (Fig. 583)	9523	Bz.					Adjusted to the register-rod and secured with the set-screw, to operate the register	

Number of Distinctive Pieces .... 99 (Column 1)
Total Number of Pieces .... 1182 (" 2)
Number of Bolts .... 12 (" 6 and 10)
Number of Screws, about .... 1668 (" 6 and 10)
Number of Nails .... (?)

Total .... 2862 +

During the assembling of the different pieces and parts of the Cabinet Work, Trimmings, etc., the painting of the cars is proceeded with from the point reached in Table No. 36, Con. No. 105, as follows:—7th day, Sanded with No. ½ paper and given a coat of color; 8th day, a coat of finishing color; 9th day, second coat of finishing color to dry with a little gloss; 10th day, stripe and letter; 11th day, A coat of Ry. coach finishing varnish on the entire exterior. Special parts are painted as follows:—Exterior of the sills and dasher receive 3 coats of flat color and one of gloss color applied on 4 consecutive days; Floors, steps and toe-guards, light gray; Dasher-posts, 2 coats color and varnish; Buffers, 2 coats Indian red; Iron work under car, metallic red; Sash signs, black block letters; Inside finish, natural wood with a coat of white shellac, one of Ry. coach rubbing and one of Ry. coach finishing varnish left in gloss, 24 hours between each coat.

A THREE-YEAR COMPARISON OF CABLE, ELECTRIC AND HORSE TRACTION IN NEW YORK CITY

The addition of the detailed earnings and operating expenses for the year ending June 30, 1900, to the two previous statements of the Metropolitan Street Railway Company of New York, which that company has generously allowed to be made public in these columns, makes a three-year record of the comparative cost and profits of cable, electric and horse railway operation of the largest city transportation system in the world, the value of which would be hard to overestimate. The total track mileage of the system during the last three years has remained practically unchanged. All three motive powers are used on the best streets and for the same kind of traffic, and the traffic density on the cable and electric lines is not greatly different. Comparisons could not possibly be made to better advantage except that it will, of course, be most interesting to know, a year or two hence, what is the actual cost of electric operation on the present cable system as compared with that of the cable, which electricity is about to replace.

It will be seen that there is little or no change in the conditions on the cable lines during the three years. The car mileage is almost the same, and the gross receipts, the operating expenses and the net earnings are surprisingly alike. The net earnings per car mile, however, are on a slightly decreasing scale, the range being from 18 cents in 1898 to 17.10 cents in 1900.

The horse railway car mileage has decreased from 15,994,912 miles in 1898 to 9,812,031 miles in 1900. The gross receipts per car mile have shown little change, but there has been a steady fall in net from 9.48 cents per car mile to 6.82 cents. Examination of the detailed report shows that this has been caused chiefly by an increase in the cost of provender and material with the much higher prices of the last eighteen months.

It is, of course, in the electric system that the greatest changes have taken place. The car mileage has increased from 7,110,090 in 1898 to 24,968,196 in 1900. During the same period the total passenger receipts were increased from $1,918,873, an average of 29.99 cents per car mile, to the enormous total of $8,125,112, an average of 32.54 cents per car mile. The operating expenses have increased from 10.23 cents per car mile to 13.16 cents; but the net earnings (from passenger operation) have increased from 16.76 cents to 19.38 cents, a sum equal to the gross of many roads, and a very satisfactory showing.

Examination of the detailed operating expenses shows an increase in each year in the main divisions as follows:

	1898	1899	1900
Maintenance of way	.33	.68	.81
Maintenance of equipment	.83	1.17	1.41
Power	1.70	1.77	1.99
Transportation	6.15	7.06	7.29
General expenses	1.22	1.27	1.66
Total	10.23	11.95	13.16

Some increase in these departments might readily have been expected because of the general condition of aging of plant and equipment, but there are two other elements which must not be lost sight of in making these comparisons. The first is that prices on coal, iron, steel and other material have been constantly increasing during the past three years. The other is that the "electric car mile" of 1900 is a very different thing from that of 1899 or 1898. due to the introduction, in the last two years, of longer cars, having much larger seating capacity. Such an increase in car capacity is inevitably felt more or less in every department of operation, and it is, on the whole, rather surprising that the increase in cost per car mile is not greater than is shown by the above figures.

The net (passenger) profits last year of the three different motive powers applicable to interest and dividend payments are as follows:

COMPARATIVE PROFITS IN 1900

	Per car mile	Percentage profits to gross receipts
Electric	19.38	59.5
Cable	17.10	49.0
Horse	6.82	26.4

It may be stated as an interesting fact that the horse railway portion of the Metropolitan Street Railway system. as it exists to-day, is a heavy financial drag upon the mechanical system, and it may be readily inferred, not only how important it is that horse traction should be replaced by some improved form of motive power, but what a tremendous future increment of earning power will come to this company when its horse railway mileage, now nearly half the entire system, shall be converted.

The great economy of the electric system over either cable or horses is but partly expressed by the accompanying tables and the above statements. The car mile unit is different in each case. The horse car will seat only sixteen to twenty passengers, the cable car about twenty-eight passengers, while nearly all the electric cars now in use will seat from thirty to fifty passengers. It will, therefore, be fairer in some respects to compare the three systems by the cost per passenger carried. This cost amounts to 2.02 cents for the electric cars, 2.55 cents for the cable cars (with greater density of travel than is found on any of the electric lines), and 3.67 cents for horse cars (with less average density of travel than on either cable or electric cars).

There is still another greater advantage of electricity over the cable or horse system, which cannot be expressed by figures, but is none the less reflected in increased earnings of a system, both gross and net. The electric system is far more "flexible" than is the cable system; a given number of cars can give a much larger service to the public through their greater speed and the ability which they have to make up lost time; paralysis of one or more complete lines, or of the system, is far less frequent than with the cable sytem; and, in short, a system can be handled from the operator's standpoint with far less friction and worry.

Taken as a whole, the Metropolitan system earned 31.63 cents per car mile in the year ending June 30, 1900, as against 29.70 cents in 1897, and its net profits from passenger operation were 16.13 cents as against 13.87. The percentages of operating expenses to gross receipts for the three motive powers and for the entire system have been as follows during the past three years:

PERCENTAGE OPERATING EXPENSES TO GROSS RECEIPTS

	1898	1899	1900
Cable	47.8	50.8	51.0
Electric	37.9	38.3	40.5
Horse	65.3	69.8	73.6
Total	53.3	49.4	49.0

The figures given in the accompanying table are for passenger receipts and operation only, irrespective of other operating receipts, fixed charges, etc. It may be interesting to present herewith a complete financial statement of the operation of the Metropolitan system for the last three years. In this statement the receipts from sources other than passengers include receipts from advertising, dividends on stock of other companies held in the treasury, income from rental of offices in the power station and other buildings owned by the company, etc.; while the operating expenses shown here are slightly larger than those in the accompanying table because of items covering cost of caring for office buildings and other real estate and a few other small charges.

GENERAL OPERATING REPORT

Earnings from all sources	$11,076,021	$13,525,524	$15,073,535
Operating expenses	5,620,484	6,408,711	7,104,607
Earnings from operation	5,455,537	7,116,813	7,968,928
Fixed charges	3,609,966	4,477,757	4,608,768
Surplus for dividends	1,845,571	2,639,056	3,360,160
Dividends paid (7 per cent)	1,500,000	2,471,675	3,145,891
Surplus over dividends	345,570	167,381	214,269

RECEIPTS AND EXPENSES OF THE METROPOLITAN STREET RAILWAY COMPANY, OF NEW YORK,

For the Years Ending June 30, 1898, June 30, 1899, and June 30, 1900,

SHOWING THE RELATIVE COSTS AND PROFITS OF CABLE, ELECTRIC AND HORSE RAILWAY OPERATION

Cable

ITEMS.	Amount 1898	Amount 1899	Amount 1900	Per Car Mile 1898	Per Car Mile 1899	Per Car Mile 1900
GENERAL EXHIBIT						
Total passenger receipts	4,130,225	3,690,615	3,698,672	34.42	35.43	34.86
Passenger operating expenses	1,970,486	1,874,422	1,884,723	16.42	18.00	17.76
Earnings from passenger operation	2,159,739	1,816,193	1,813,949	18.00	17.43	17.10
OPERATING EXPENSES IN DETAIL						
MAINTENANCE OF WAY						
1 Repairs roadbed—track, labor	41,447	44,894	37,630	.35	.43	.35
2 " " material	6,673	4,685	10,111	.06	.05	.09
3 " " steel rails	200	375	*35	..	....	....
4 " " switches, castings, spikes, etc	10,108	17,227	14,666	.08	.17	.14
5 " " ties and timber	287	14	75	....	....	....
6 Repairs overhead and underground construction	80,787	82,411	88,582	.67	.79	.84
7 Renewals of cable	189,391	239,481	262,992	1.58	2.30	2.48
8 Tube cleaners	11,758	11,824	11,216	.10	.11	.11
9 Oilers	40,708	41,511	42,108	.34	.40	.40
10 Gearsmen and splicers	21,240	21,339	20,397	.18	.20	.19
11 Repairs of buildings	4,099	7,783	10,350	.03	.08	.10
12 Removal of snow and ice, and street cleaning	15,328	17,045	14.968	.13	.16	.14
Total	422,027	488,590	513,061	3.54	4.69	4.84
MAINTENANCE OF EQUIPMENT						
13 Repairs of cars and vehicles	68,768	78,174	63,403	.57	.75	.60
14 " " electrical or cable equipment of cars.	42,287	37,380	36,348	.35	.36	.34
17 " " tools and machinery	1,714	1,974	1,053	.01	.02	....
Total	112,770	117,528	100,804	.94	1.13	0.94
POWER						
15 Repairs of steam plant	15,147	19,196	23,558	.13	.19	.22
16 " " electrical or cable plant	12,395	9,252	10,363	.10	.09	.10
18 " " harness	458	219	110	....	...	....
19 Stable equipment, supplies. etc	174	113	......	....	....	....
20 Renewals of horses	550	250	......	....	....	....
21 Horse shoeing	571	352	161	....	...	....
22 Cost of provender	3,432	4,081	3,933	.03	.04	.04
23 " " feedmen—wages	92	270	331	....	....	....
24 " " removing manure	60	75	70	....	....	....
27 Hostlers, hitchers and stable help	2,485	3,033	3.504	.02	.03	.03
28 Engineers, firemen and power service	65,262	64,342	59,896	.54	.62	57
32 Fuel, power houses	104,912	112,428	106,424	.88	1.08	1.00
33 Light and other supplies at power houses	15,471	16,383	17,967	.13	.16	.17
34 Water tax	21,775	19,383	21,408	.18	.19	.20
Total	242,784	249.577	247,727	2.02	2.39	2.33
TRANSPORTATION						
25 Conductors, drivers, gripmen and motormen	711,630	652,262	661,602	5.93	6.27	6.24
26 Inspectors, starters switchmen, etc	143,512	142,125	137,990	1.20	1.36	1.30
29 Car house exp. watchmen, car cleaners, oilers, etc	36,820	37,848	39,177	.31	.36	.37
30 Car service—car lighting	39,227	33,814	38,642	.33	.33	.36
31 " " oil, waste, etc	12,932	11,634	11,433	.11	.11	.11
Total	944,120	877,683	888,844	7.87	8 43	8.38
GENERAL EXPENSES						
35 Salaries of officers and clerks	30,359	28,123	25,583	.25	.27	.24
36-40 Injuries and damages	150,325	59,474	59,353	1.25	.57	.56
41-48 Other general expenses	68,099	53,446	49,351	.57	.51	.47
Total	248,784	141,043	134,287	2.07	1.35	1 27
Total operating expenses	1,970,486	1,874,422	1,884,723	16.42	17.99	17 76
Car mileage run	11,991,404	10,416,079	10,610,091	....	....	....

Electric

ITEMS.	Amount 1898	Amount 1899	Amount 1900	Per Car Mile 1898	Per Car Mile 1899	Per Car Mile 1900
GENERAL EXHIBIT						
Total passenger receipts	1,918,873	6,043,538	8,125,112	26.99	31 23	32.54
Passenger operating expenses	727,406	2.312,682	3,286,544	10.23	11.95	13.16
Earnings from passenger operation	1,191,467	3,730,856	4,838,568	16.76	19 28	19.38
OPERATING EXPENSES IN DETAIL						
MAINTENANCE OF WAY						
1 Repairs roadbed—track, labor	6,153	25,796	57,780	.09	.13	.23
2 " " material	*105	4,223	8.869	....	.02	.03
3 " " steel rails	954	28	*266	.01	....	....
4 " " switches, castings, spikes, etc	3,128	10,083	19.983	.04	.05	.08
5 " " ties and timber	148	746	702	....	....	....
6 Repairs overhead and underground construction	5,779	22 978	35.495	.08	.13	.14
7 Renewals of cable	......	......	......	....	....	....
8 Tube cleaners	4,230	30,818	43.711	.06	.16	.18
9 Oilers	12	......	......	....	....	....
10 Gearsmen and splicers	......	......	......	....	....	....
11 Repairs of buildings	821	11.853	16,516	.01	.06	.07
12 Removal of snow and ice, and street cleaning	2,731	25,413	19,925	.04	.13	.08
Total	23,851	131,938	202,084	.33	.68	.81
MAINTENANCE OF EQUIPMENT						
13 Repairs of cars and vehicles	28,687	134,339	197,873	.40	.69	.79
14 " " electrical or cable equipment of cars.	29,952	90,320	153.490	.42	.47	.62
17 " " tools and machinery	152	2,562	2,007	....	.01	....
Total	58,792	227,222	353,371	.83	1.17	1.41
POWER						
15 Repairs of steam plant	2,042	8,1.8	12,904	.03	.04	.05
16 " " electrical or cable plant	824	3,042	8,013	.01	.02	.04
18 " " harness	584	1,057	1,461	....	....	....
19 Stable equipment, supplies. etc	424	612	808	....	....	....
20 Renewals of horses	3.030	750	......	.04	....	....
21 Horse shoeing	2,477	3,175	4,034	.03	.02	.02
22 Cost of provender	14,010	15.575	20,120	.20	.08	.08
23 " " feedmen—wages	1,687	2.228	2,491	.02	.01	.01
24 " " removing manure	*85	*137	*154	....	....	....
27 Hostlers, hitchers and stable help	12,795	15,847	18,137	.18	.08	.08
28 Engineers, firemen and power service	20,662	63,480	100,605	.29	.33	.40
32 Fuel, power houses	51.015	188,455	270,644	.72	.98	1.08
33 Light and other supplies at power houses	5,370	13.414	19,355	.08	.07	.08
34 Water tax	5,842	27,300	37.438	.08	.14	.15
Total	120,675	342,974	495.856	1.70	1.77	1.99
TRANSPORTATION						
25 Conductors, drivers, gripmen and motormen	353,127	1,083,104	1,442,676	4.97	5.60	5.79
26 Inspectors, starters switchmen, etc	50,292	166,515	202,834	.71	.86	.81
29 Car house exp. watchmen, car cleaners, oilers, etc	27,392	93,205	136 722	.39	.48	.54
30 Car service—car lighting	1,142	2,306	5.144	.02	.01	.02
31 " " oil, waste, etc	5,158	19,991	32,331	.07	.10	.13
Total	437,111	1,365,121	1,819,708	6 15	7.06	7.29
GENERAL EXPENSES						
35 Salaries of officers and clerks	11,051	35,831	53,461	.16	.19	.21
36-40 Injuries and damages	43.829	101,968	179,753	.61	.53	.72
41-48 Other general expenses	32,100	107,628	182,311	.45	.56	.73
Total	86,978	245.428	415,525	1.22	1.27	1.66
Total operating expenses	727,406	2,312,682	3,286,544	10.23	11.95	13.16
Car mileage run	7,110,090	19,347,978	24,968,196	....	....	....

Horse

ITEMS.	Amount 1898	Amount 1899	Amount 1900	Per Car Mile 1898	Per Car Mile 1899	Per Car Mile 1900
GENERAL EXHIBIT						
Total passenger receipts	4,375,597	3,085,559	2,531,622	27.35	25 72	25.80
Passenger operating expenses	2,858,235	2,154,969	1,862,766	17.87	17.96	18 98
Earnings from passenger operation	1,517,362	930,590	668,856	9.48	7.76	6.82
OPERATING EXPENSES IN DETAIL						
MAINTENANCE OF WAY						
1 Repairs roadbed—track, labor	72,928	58,810	62,810	.46	.49	.64
2 " " material	7,549	14,462	26.085	.05	.12	.26
3 " " steel rails	705	711	*919	....	....	....
4 " " switches, castings, spikes, etc	5,567	4,936	4.583	.03	.04	.04
5 " " ties and timber	2,304	1,093	1,717	.01	.01	.02
6 Repairs overhead and underground construction	165	......	......	....	....	....
7 Renewals of cable	......	......	......	....	....	....
8 Tube cleaners	......	......	......	....	....	....
9 Oilers	......	......	......	....	....	....
10 Gearsmen and splicers	......	......	......	....	....	....
11 Repairs of buildings	17,262	13.695	23,659	.10	.11	.24
12 Removal of snow and ice, and street cleaning	9,666	24,864	10,159	.06	.21	.10
Total	116,145	118,572	128,095	.72	.99	1.30
MAINTENANCE OF EQUIPMENT						
13 Repairs of cars and vehicles	61,449	50,950	57,245	.38	.42	59
14 " " electrical or cable equipment of cars.	8	......	-	....	....	....
17 " " tools and machinery	328	74	266	...	....	....
Total	61,784	51,024	57,511	.39	.42	.59
POWER						
15 Repairs of steam plant	9	......	......	....	....	....
16 " " electrical or cable plant	3	......	......	....	....	....
18 " " harness	15,361	13,964	15,298	.10	.12	.15
19 Stable equipment, supplies. etc	12,206	8,594	8,555	.08	.07	.09
20 Renewals of horses	62,440	23,925	27,000	.39	.20	.27
21 Horse shoeing	80,933	62,737	53,191	.51	.52	.54
22 Cost of provender	445,183	377,736	357,129	2.78	3.15	3.64
23 " " feedmen—wages	40,419	28,516	24,293	.25	.24	.25
24 " " removing manure	7,109	6,637	6,526	.04	.06	.07
27 Hostlers, hitchers and stable help	347,855	271,283	222.874	2.18	2.26	2.27
28 Engineers, firemen and power service	240	......	......	....	...	....
32 Fuel, power houses	455	......	......	....	....	....
33 Light and other supplies at power houses	59	......	......	....	....	....
34 Water tax	11,138	8,691	6,823	.07	.07	.07
Total	1,023,408	802,082	721,690	6.40	6.69	7.35
TRANSPORTATION						
25 Conductors, drivers, gripmen and motormen	1,156,395	837,390	695,859	7.23	6.98	7.10
26 Inspectors, starters switchmen, etc	119,400	93,411	65,072	.74	.78	.67
29 Car house exp. watchmen, car cleaners, oilers, etc	63,245	44,829	35,029	.40	.37	.36
30 Car service—car lighting	11,690	9,305	8,667	.07	.08	.07
31 " " oil, waste, etc	7,191	3,574	3,849	.04	.03	.04
Total	1,357,921	988,508	808,476	8.49	8.24	8.24
GENERAL EXPENSES						
35 Salaries of officers and clerks	41,938	29,308	21,579	.26	.24	.22
36-40 Injuries and damages	79,076	50,711	38,392	.49	.42	.39
41-48 Other general expenses	177.962	114,764	87,024	1.11	.96	.89
Total	298,976	194,783	146,995	1 87	1 62	1.50
Total operating expenses	2,858,235	2,154,969	1,862,766	17.87	17.96	18.98
Car mileage run	15,994.912	11,996,799	9,812,031	....	....	....

Total

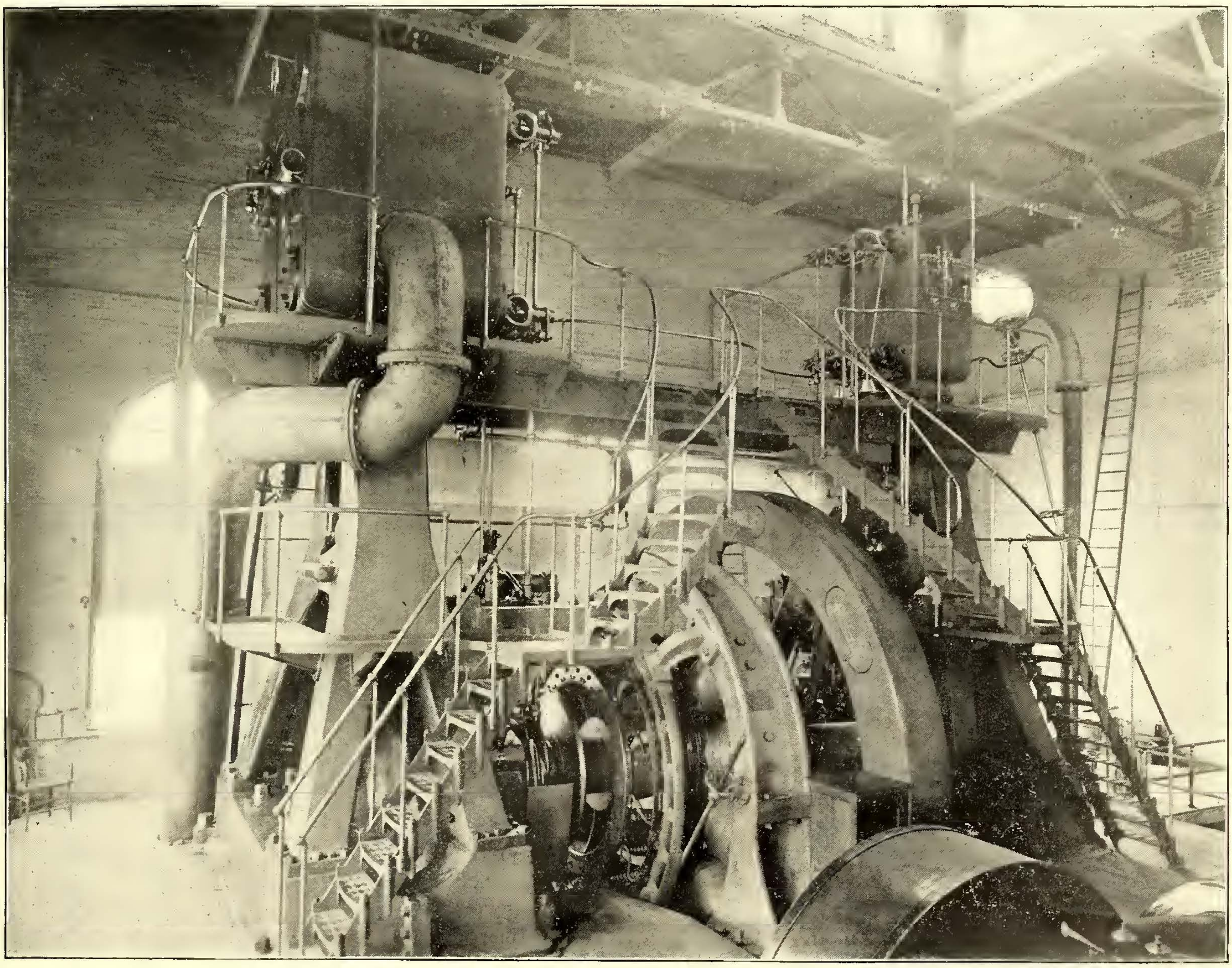
ITEMS.	Amount 1898	Amount 1899	Amount 1900	Per Car Mile 1898	Per Car Mile 1899	Per Car Mile 1900
GENERAL EXHIBIT						
Total passenger receipts	10 424,695	12,819,712	14,355,406	29.70	30.70	31.63
Passenger operating expenses	5.556,127	6,342,073	7,034,033	15.83	15.18	15.50
Earnings from passenger operation	4,868,568	6,477,639	7,321,373	13.87	15.50	16.13
OPERATING EXPENSES IN DETAIL						
MAINTENANCE OF WAY						
1 Repairs roadbed—track, labor	120,528	129,499	158,220	.34	.31	.35
2 " " material	14,117	23,370	45,065	.04	.06	.10
3 " " steel rails	1,859	1,114	*1,220	....	....	....
4 " " switches, castings, spikes, etc	18,804	32,247	39,232	.05	.08	.08
5 " " ties and timber	2,739	1,854	2.494	....	....	....
6 Repairs overhead and underground construction	86,731	105,389	124,078	.25	.25	.27
7 Renewals of cable	189,391	239,481	262.992	.54	.57	.58
8 Tube cleaners	15,988	42,642	54,927	.05	.10	.12
9 Oilers	40,720	41,511	42,108	.12	.10	.10
10 Gearsmen and splicers	21,240	21,339	20,397	.06	.05	.05
11 Repairs of buildings	22,182	33,331	50,525	.06	.08	.11
12 Removal of snow and ice, and street cleaning	27,725	67,322	44,422	.08	.16	.10
Total	562,024	739,099	843,239	1. 0	1.77	1.86
MAINTENANCE OF EQUIPMENT						
13 Repairs of cars and vehicles	158,904	263,463	318,521	.45	.63	.71
14 " " electrical or cable equipment of cars.	72,247	127,701	189,839	.21	.31	.42
17 " " tools and machinery	2,195	4,610	3.326	....	.01	....
Total	233,345	395,774	511,686	.66	.95	1.13
POWER						
15 Repairs of steam plant	17,197	27.543	36,462	.05	.07	.08
16 " " electrical or cable plant	13,221	12,293	18,376	.04	.03	.04
18 " " harness	16,404	15,240	16,868	.05	.04	.04
19 Stable equipment, supplies. etc	12,805	9.349	9,363	.04	.02	.02
20 Renewals of horses	66,020	24,925	27,000	.19	.06	.06
21 Horse shoeing	83,981	66,264	57,390	.24	.16	.12
22 Cost of provender	462,624	397,392	381,181	1.32	.95	.84
23 " " feedmen—wages	42,198	31,014	27,115	.12	.08	.06
24 " " removing manure	7,084	6,575	6,442	.02	.01	.01
27 Hostlers, hitchers and stable help	363,134	290,163	244,516	1.07	.70	.54
28 Engineers, firemen and power service	86,163	127,822	160,502	.25	.31	.35
32 Fuel, power houses	156,381	300.883	377,068	.45	.72	.85
33 Light and other supplies at power houses	20,900	29,797	37,322	.06	.07	.08
34 Water tax	38,754	55.374	65,669	.11	.13	.14
Total	1,386,867	1,394,634	1,465,273	3.95	3.34	3.23
TRANSPORTATION						
25 Conductors, drivers, gripmen and motormen	2,221,151	2,572,756	2,800,137	6.33	6.16	6.18
26 Inspectors, starters switchmen, etc	313,204	402,051	405,896	.89	.96	.89
29 Car house exp. watchmen, car cleaners, oilers, etc	127,457	175,882	210,929	.36	.42	.46
30 Car service—car lighting	52,059	45,425	52,454	.14	.11	.11
31 " " oil, waste, etc	25,281	35.198	47,612	.07	.08	.10
Total	2,739,153	3,231,312	3,517,027	7.81	7.73	7.74
GENERAL EXPENSES						
35 Salaries of officers and clerks	83,348	93,262	100,624	.24	.22	.22
36-40 Injuries and damages	273,229	212,154	277,498	.78	.51	.61
41-48 Other general expenses	278,162	275,837	318,686	.79	.66	.70
Total	634,738	581,253	696,808	1.81	1.39	1.53
Total operating expenses	5,556,127	6,342,073	7,034,033	15 83	15.18	15.49
Car mileage run	35,096,406	41,760,856	45,390,318	....	....	....

* Credit balances.

A 1500-HP Vertical Engine at Portland, Maine

A new unit of power has recently been installed in the Forest Avenue power house of the Portland Railroad Company, consisting of a 1500-hp, vertical, cross-compound, Rice & Sargent engine, direct-connected to a 1050-kw General Electric railway generator. The engine has cylinders 28 ins. and 50 ins. in diameter by 42-in. stroke, and runs at 100 r. p. m. with 120 lbs. boiler pressure. The piston rods extend as tail rods through the heads of the cylinders; the receiver between the cylinders is cylindrical, extending across the frame, and mounted behind it, as shown in the illustration; the exhaust pipe curves around the frame, and passes down beneath the floor to the condensers. The throttle is controlled from three positions by means of hand wheels attached to a shaft, one at the floor and one at each platform. The valve gear is of the Rice & Sargent type, and has silent vacuum dash-pots. The main shaft is 22 ins. in diameter at the armature. The fly-wheel weighs about 85,000 lbs.

The valves and valve mechanism of these machines are of special interest. All the valves have double ports, and the exhaust valves are set nearer the piston than the steam valves, so that the clearance is largely reduced. They are operated by direct motion from the eccentrics without the medium of wrist-plates, there being two eccentrics, one for the inlet valves and one for the exhaust on each cylinder. The range of cut-off is from zero to three-quarter stroke, which gives the engine great capacity for overloads, and insures perfect regulation under any condition of load. Proper motion for the exhaust valve is secured by means of a toggle joint on each exhaust bonnet without the intervention of wrist-plates. A further advantage of this construction is that the moving parts have small mass, and are, therefore, fitted to operate quietly at comparatively high speeds. The cut-off latches operate without springs, dropping by their own weight, and are so constructed that the pressure from the eccentrics is on a line below the pivotal point, so that the latch cannot jump up. The wearing contact plates on the latches are square, and are made of hardened steel, so that by shifting a plate and turning it over, there are eight corners for wear. The point of cut-off is determined by a rod from the governor which actuates a yoke behind the latch, operating by means of rollers on a curved lever attached to the cut-off toe. The mechanism is so balanced that it requires very little power, and there is consequently little stress on the governor at the instant of cut-off. The entire design is so disposed that the utmost quietness in operation is secured, and, in fact, at a short distance from the engine, while in operation, it would be almost impossible to tell whether the parts were in motion or not. The intermediate rocker mechanism is supported by means of box-brackets and girders bolted to the engine frames. The governor is so designed that a centrifugal effect combined with an inertia effect is obtained. The governing wheel is about 3 ft. in



1500-HP GENERATING SET AT PORTLAND, MAINE diameter, and is located, as shown in the illustration, on the first gallery. The governor is extremely sensitive and rapid in its operation, and the regulation of the engine, under varying loads, is very satisfactory. In connection with the governor is a safety device, designed to shut off the steam in case the governor belt should break or fail to work properly. The connecting rod is so designed that by removing one bolt it can be detached from the crank-pin, and being swung to one side, through an opening in the frame, the engine can, if necessary, be run by one cylinder only.

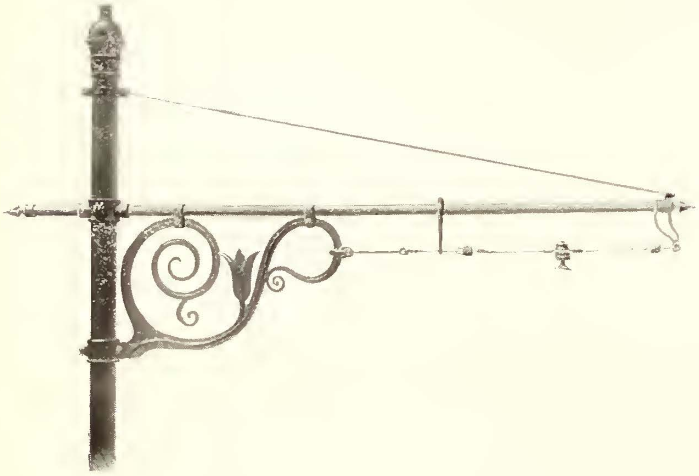
The fly-wheel weighs 95,000 lbs. and is built in eight sections, each section consisting of a piece of the rim and an arm. The rim joints are made by arrow-head, steel keepers, and the arms are bolted to an octagonal, box-section hub by means of pads which are perpendicular to the axes of the arms. The bolting is done by through bolts, which are reamed fit in their holes. The main bearing caps are adjusted by means of set screws, against which the ordinary cap bolts act, this construction giving a very accurate adjustment of the main bearings.

The parts are oiled by chains on the shaft, of which there are three on each bearing, leading the oil from large reservoirs in the pillow blocks. There are also four sight-feed oil cups on each bearing. On the crank side, the waste oil from the bearing is led out into the crank-pin, and on the other side there are channels which convey it back to the bearings. Drip pans are provided at each end under the crank disc, from which the oil is led to the filter.

The platforms about the machine are so arranged that any part can be reached and inspected without any danger to the attendant. The stairs are not spiral, but bend slightly and are not very steep, so that they are easily traversed, and the frame is very strong, the outlines, as seen from the illustration, being pleasing to the eye. The engine was built and installed by the Providence Engineering Works, of Providence, R. I.

An Ornamental Bracket

The handsome trolley bracket illustrated herewith is one of the many new designs made by the Creaghead Engineering Company, Cincinnati, Ohio, for export trade. The pole and arm are made of standard steel tubing, the smaller ornaments being made of malleable iron. As seen from the illustration, double insulation is used between the trolley wire and the arm of the bracket. The Creaghead Company has had great success with its ornamental brackets, its object having always been to combine strength with beauty.

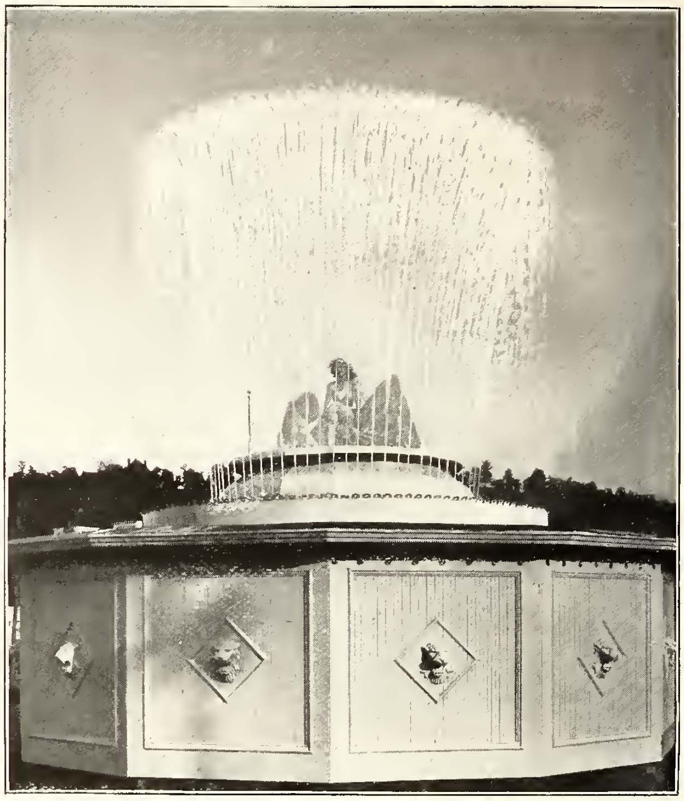


A HANDSOME BRACKET

A Novel Illuminated Fountain

The electric illuminated fountain, illustrated on this page, opens a new field of attractions for trolley parks and other summer resorts. The original idea of combining *tableaux vivants* with a display of brilliantly illuminated falling water is one that has already taken the fancy of the amusement-seeking public wherever it has been introduced.

The fountain shown in the engraving occupies a central position in Heine Park, Kansas City. It is strongly illuminated by electric lights, whose color can be changed at will. The figure, which, in a first glance at the picture, would be taken for a statue, is in reality flesh and blood. While the fountain is in operation, therefore, various poses, or even dances, can be introduced, and the beautiful effect of the graceful, handsomely attired performer, moving amidst a shower of brilliantly sparkling water, can be imagined.



ELECTRIC ILLUMINATED FOUNTAIN

This novelty is the invention of C. A. Dunlap, Providence, R. I., who is supplying it to parks and private individuals. Many of the designs are of quite a pretentious character, floor space being provided for the staging of an entire *corps du ballet*. The space in the center, which is occupied by the performers, is perfectly dry, and permits of a pyrotechnic display in conjunction with the acquatic features.

A Large Chemical Company

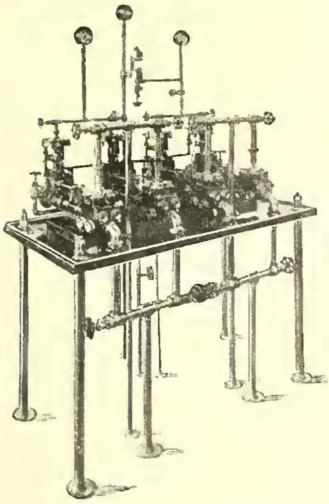
The Dearborn Drug & Chemical Works, Chicago, have recently increased their offices and laboratories. The latter are to-day among the most thoroughly and completely equipped for carrying on all kinds of testing and general analytical work to be found in the country. Coal, oil and water analysis, and any testing work pertaining to the steam plant, is done for the steam user. The laboratories are constantly open to the public.

The Dearborn Drug & Chemical Works have been in business some twelve years, and are to-day incorporated for $250,000. The numerous reports that they have made to the managers of power plants have made their name familiar in connection with engineering undertakings. The company has branch offices at St. Louis, Denver, San Francisco and St. Paul. The officers are: William H. Edgar, president; Robert F. Carr, vice-president and general manager, and Charles M. Eddy, secretary and treasurer.

This company is possibly best known to the mechanical world as a manufacturer of boiler feed water treatment. It analyzes the water and proportions to suit the requirements, preparations that remove scale from boilers, prevent new formation, and overcome the various deleterious actions that are produced in the boilers from feed waters. The methods pursued in manufacturing these boiler compounds are scientific, and appeal to the reason of the thinking buyer. Some five years ago the company went into the production of high-class lubricating oils, and is to-day furnishing many of the largest street railway and lighting power stations with some of the very best lubricants that can be produced.

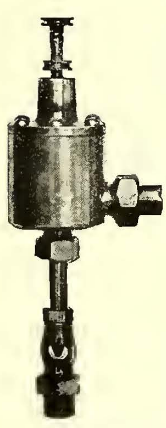
Automatic Lubrication

Probably no better illustration of the perfection of details in modern power-station work is afforded than by the state of refinement to which methods of lubrication have been brought. One of the best automatic oiling systems is, perhaps, the one furnished by the Siegrist Lubricator Company, of St. Louis, and illustrated in the accompanying cuts. This system is proving not only a great saving over hand lubrication, both in labor and oil, but the company claims for it greater safety and more positive action.

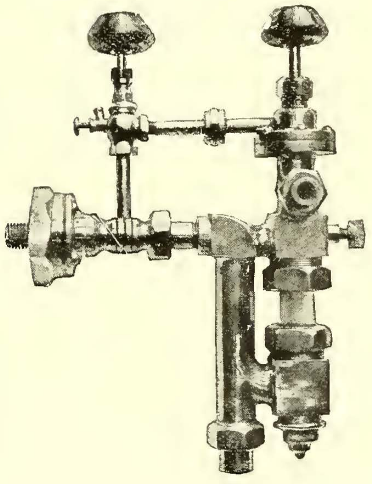


FOUR-PUMP TABLE

In the Siegrist system the oil is forced through the pipes by small steam pumps, the pumps being so constructed as to keep it at a constant pressure. The heart, so to speak, of the system is the oiling table, which contains the pumps. The usual form of table has four pumps, two for cylinder oil and two for engine oil. Ordinarily only one pump is kept running for one kind of oil, and the other is held as a reserve. They are direct-acting duplex pumps, and on the top of each steam-chest is a special governor for individual, automatic control. There is a gage for both engine and cylinder oils, so that the engineer can see from a distance whether the proper pressure is being maintained. The steam for the pumps is supplied by a ¼-in. pipe in which is a steam gage. The piping on the table and the legs and pipes underneath



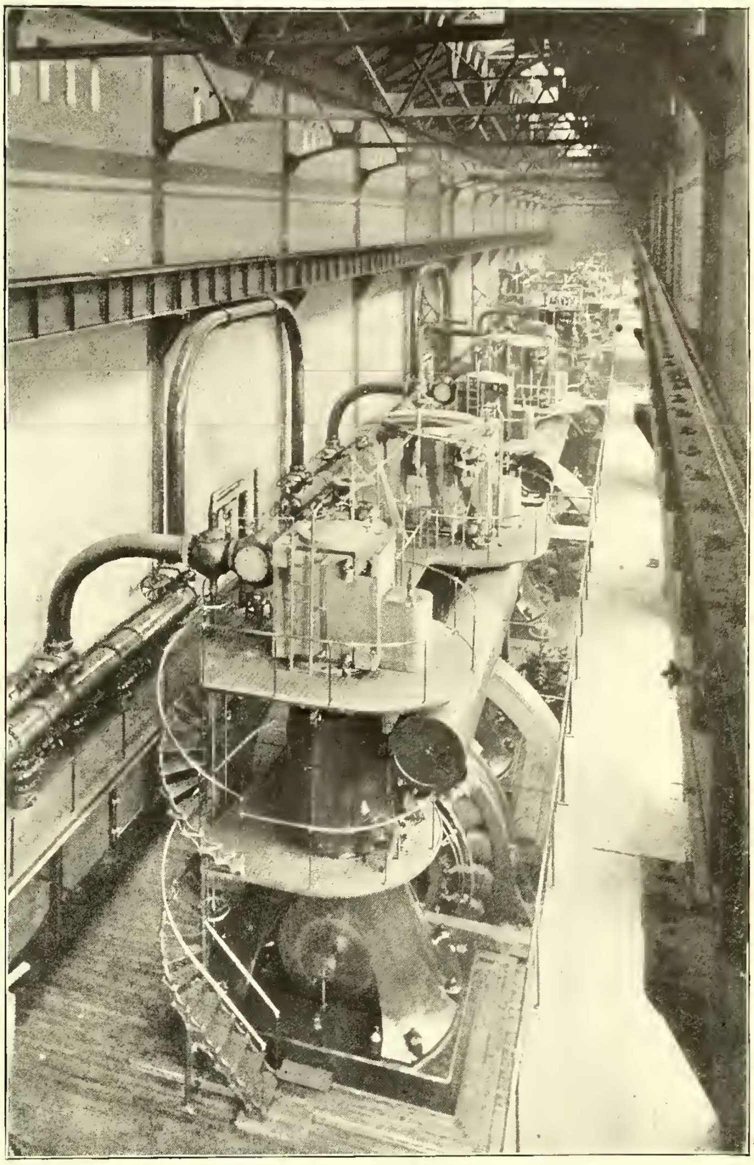
AUTOMATIC OIL CUP



CYLINDER LUBRICATOR

are all polished brass, giving a fine appearance to the installation. The table itself is made of polished and japanned iron with a raised edge to prevent oil, in case of accident, from running on the floor. The table just spoken of with four pumps is 65 ins. x 27 ins. and stands 3 ft. from the floor. The company also makes a table containing only three pumps, one for engine oil and one for cylinder oil and one to be used as a reserve on either engine or cylinder oil. A two-pump table is made for plants which run only a part of the time, and opportunity is afforded to pack pumps between runs.

In connection with these oiling tables the company makes a complete line of oil cups for use in connection with its oiling system. These oil cups are furnished with sight-feed and regulating valves, and provided with a flexible diaphragm, so that when the oil pressure falls below 30 lbs. per square inch the feed in the cup will be immediately shut off by the diaphragm. The object of this is to stop the flow as soon as the main valve supplying the engine with oil is shut off. All the engine oil on an engine is controlled by one valve and all the cylinder oil by another valve, so that it is not necessary to open and set or close cups or lubricators each time an engine is started or stopped. The usual



OILING SYSTEM IN METROPOLITAN WEST SIDE ELEVATED RAILWAY STATION, CHICAGO

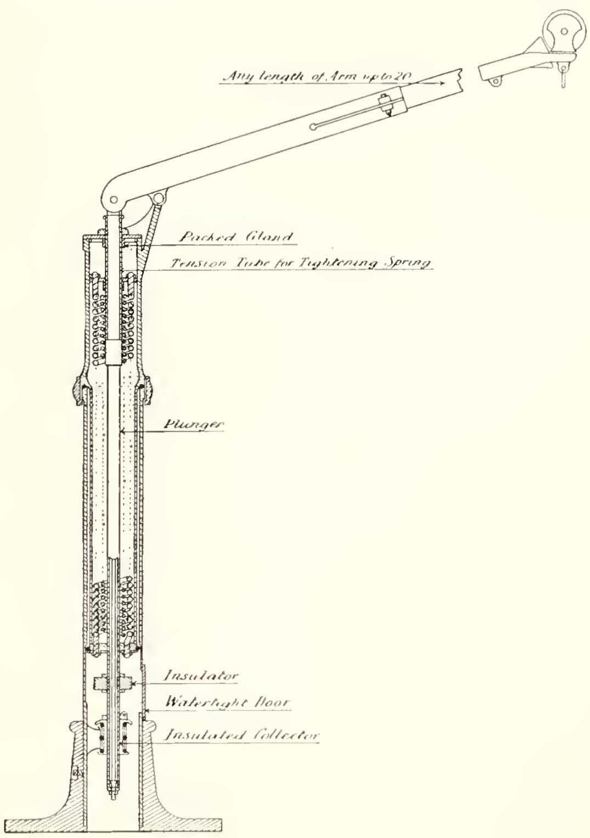
pressure kept on the oiling system is 80 lbs. per square inch, though, of course, any pressure can be used and it can be varied to allow for changes in temperature, or where a flood of oil is needed, as in the case of hot bearings. One of the advantages of this method of oiling is the ease with which any bearing can be flooded in case of trouble from heating. On the cylinder-oil pipes a pressure of 25 lbs. per square inch above the steam pressure is maintained. The cylinder lubricator is automatic, with 1-in. sight-feed, and has a flexible diaphragm so arranged that steam cannot back up into the oil pipes if the oil pressure falls below that of the steam pressure.

With the Siegrist automatic oiling system there is no handling of oil about the stations, save from barrel to tank. This means a large saving in both oil, labor and fire risk, to say nothing of the insurance against danger with hot bearings afforded by being able to use large quantities of oil and to get a flood on a bearing promptly. This is done without loss, as all oil not actually consumed is caught and returned automatically to filters, where it is refiltered, pumped to original tank and repumped over the machinery, thus making a perpetual circuit until it is actually consumed.

Those going to the Kansas City convention can see the Siegrist system in use at the power plants both of the Armour and Cudahy packing houses. It is also installed in the Metropolitan West Side Elevated Railway power house at Chicago.

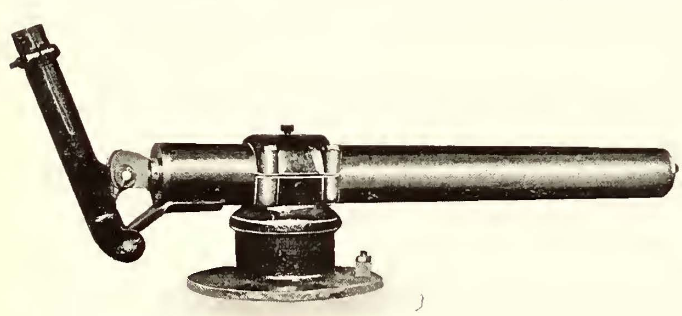
An Improved Trolley Standard

One of the latest types of trolley standards with inclosed springs is shown in the accompanying illustrations. The manufacturers are Lowdon Brothers & Company, but the apparatus is being placed on the market by Estler Brothers, of London, England.



SECTION OF TROLLEY STANDARD

These standards were, in the first instance, specially constructed to meet a special case presenting particularly severe requirements which existing types were unable to fulfil, and, as a result of their successful operation on this road, the manufacture has been taken up on a large scale. The standards have now been adopted by a number of railways, and have given great satisfaction. They are most substantially constructed, and, with the exception of the base, no cast iron whatever is used. To meet the necessities of all kinds of lines, three types are made, viz.: No. 1, the heavy pattern suitable for poles up to 20 ft. in length; No. 2, the medium pattern suitable for poles up to 16 ft. in length, and No. 3, the light pattern suitable for poles up to 14 ft. 6 in. in length. The construction of the three patterns is, in the main, identical, the difference being for the most part in the outside diameter and the weight generally, while the springs are, in each case, specially selected for the length of pole to be used.



STANDARD FOR SINGLE-DECK CARS

The sectional illustration represents a No. 1, heavy pattern trolley standard for double-deck cars, suitable for poles up to 20 ft. in length, and from this the main features will be at once apparent. It consists of a heavy cast-iron base, which is bolted onto the roof of the car, and a steel tube forming the body of the apparatus fits into this base. In this tube again, and projecting above it, there is the spring container, resting on ball bearings in a ball race at the top of the tube, while it is kept in alignment by ball bearings at the lower end. The spring container is a malleable iron casting, and has plates at its upper and lower end to which the springs are bolted. The top end of the container is closed, and has a gland through which the center tube for the cable, and also the sleeve for adjusting the springs, passes. The trolley-pole holder is fixed to, and is pivoted on, the spring-container casting, and the trolley pole is firmly gripped by the holder as shown. The center tube passes through the container to an ebonite insulator, and is continued to the insulated collector by a brass tube, to the lower end of which the cable from the trolley wheel is fixed by means of a cone. The collecting device is an important feature of the standard, and it is very strongly made and well insulated. A three-arm web bracket is screwed into the body of the apparatus, and carries a porcelain petticoat insulator. Rubber rings are inserted between the casting and the insulator to protect the porcelain from jars and shocks. A split tube is fixed in the insulator having a cone connection at the top, while at the bottom it firmly grips the center brass tube to form a good connection. It is clear, therefore, that the cable connection from the trolley wheel is in no way subjected to a twisting strain, and consequently the trolley arm can be turned round and round any number of times without damaging the cable in the slightest.

The upward pressure of the trolley wheel on the wire is very easily adjusted, without opening up any part, by turning the sleeve mentioned above, which is screwed into the top plate of the container, finally pressing on a collar on the center tube. By this means the top plate is raised or lowered, putting more or less tension on the springs, the pressure on the wire being adjusted to a nicety. The springs used are covered by patents. They are double wound in a peculiar manner, that insures a uniform tension on the wire.

Great care has been taken to combine utility with neatness of appearance in this standard, and the electrical insulation has received special attention. Designs are made for both single and double-deck cars, the only practical difference being that those intended for single-deck cars are of a horizontal pattern, as shown.

A New Water Purifying System

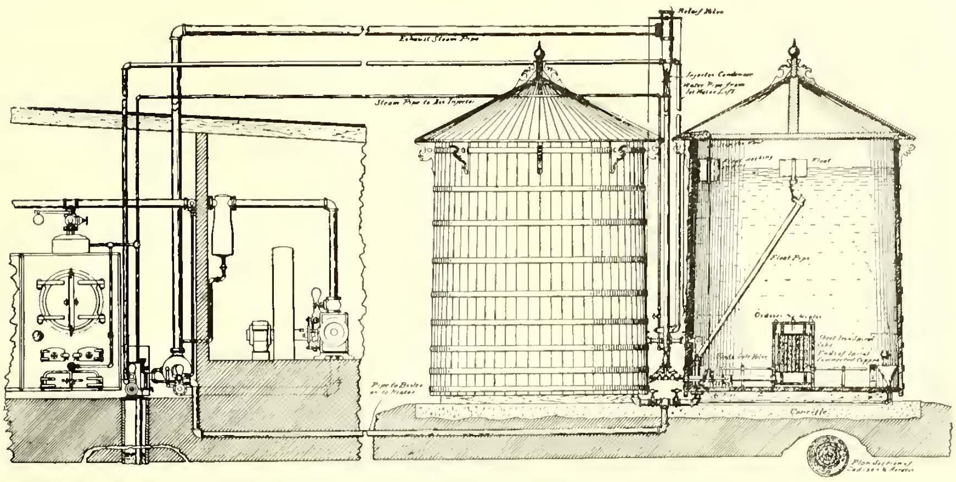
Even a small accumulation of scale in boilers will greatly increase the fuel and repair bills of a power station, reduce the capacity and efficiency of the plant and cause the burning out of boiler tubes. In many districts this scale proves so troublesome that it is difficult to keep a plant in operation without frequent interruptions for the purpose of cleansing and repairing the boilers and replacing the tubes. The system about to be described is claimed to remove from the feed-water all scale forming and other foreign ingredients. It is called the Tweeddale system, and is based upon the principle that all foreign substances, whether held in solution or suspension, can be released by electrical and chemical action and precipitated to the bottom of the tank.

The apparatus itself consists of a pair of tanks which hold water supply sufficient for six hours' run. In the bottom of each tank is located an aerater and oxidizer combined. This device contains a system of metallic plates filled in with coke, which set up a chemical and galvanic action in the water, separating its ingredients and forcing it to release its hold upon all foreign matter. A strong jet of air is also forced through the oxidizer and aerater pipes, producing an agitation and aeration, which, combined with the electrical action and chemical reagents, cause first a thorough mixture of all the contents of the tank, and then a releasing of the impurities held by the water. At the proper time a small quantity of reagent is injected, and when the disturbance ceases a coagulated mixture is formed which seizes upon the released impurities and carries them down to the bottom of the tank by ordinary precipitation at the rate of about 12 ft. per hour.

No mechanical filter is required, the only filter employed being that which forms in the water itself and carries the released impurities to the bottom of the tank by ordinary sedimentation.

At the end of the process water which was cloudy and muddy before becomes clear, and not only is it clarified, but it is purified and softened.

The purified water is drawn from the surface by a pipe suspended from a float so as to have its opening always a little below the surface, while the percipitated impurities are carried away by waste pipes located at the bottom of the tank. While one tank

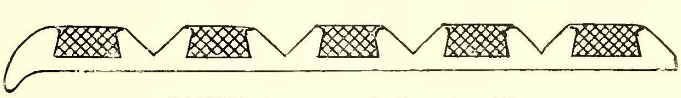


ELEVATION OF WATER PURIFYING PLANT

is being treated as described above the water supply is taken from the companion tank. The whole process is simple, effective and economical, and the apparatus and reagents employed are quickly understood and easily handled by the ordinary engineer. Water treated by the system will not only leave the boilers in good condition, but can be used to advantage in laundries, breweries, etc., where a clear, soft water is desirable. Purifying plants which work upon the above principle are being installed by the Chicago Boiler Cleaner Company, of Chicago.

A Safe Car Step.

The advantage of a car step upon which it is impossible to slip is apparent to all, and especially to managers who have to meet frequent suits for damages from this cause. The Mason Safety Tread, illustrated herewith, is claimed to be a sure safeguard



SAFETY TREAD FOR CAR STEPS

against slipping, and has been in successful operation on many roads. Added to the immunity from slipping the safety treads take all the wear, and as the lead, which constitutes the non-slipping surface, is protected by a steel back and ribs, the treads will last for many years. Moisture, frost or light snow is said to have no effect on their safety-securing properties.

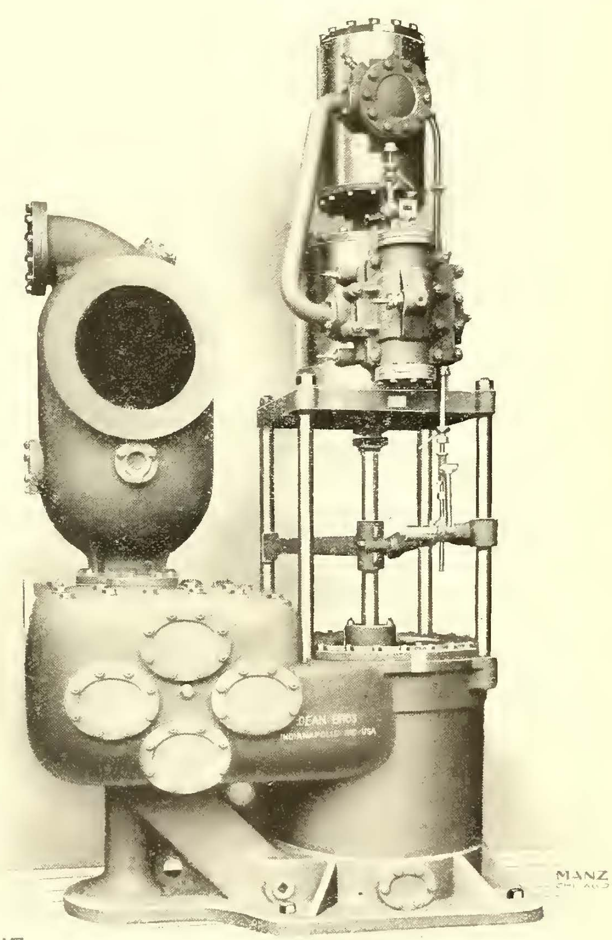
The safety tread can be used upon stairs, like those of the elevated stations in New York, Chicago and Boston, public buildings, railroad stations, school houses, etc., and upon ship ladders in the navy, but during the past two years a large demand, which is constantly increasing, has been developed from the street railway companies. The American Mason Safety Tread Company, of Boston, manufactures these treads, and has agencies in all the larger cities.

Vertical Air Pump and Condenser with Compound Steam Cylinder

The condensing apparatus shown in the accompanying illustration is designed for the engines of street railway plants and other places where economy of fuel or increase of power is desired. It is manufactured by the Dean Brothers' Steam Pump Works, Indianapolis, Ind., and combines several special advantages with the general features of this company's output.

The vertical type of air pump is said to be much more durable than the horizontal type, because there is so little side wear in the cylinder and stuffing boxes. In horizontal pumps especially large sizes, there is a constant downward wear of piston and rods, due to their weight. Any sediment in the water will settle on the lower side of cylinder, where this pressure is greatest, causing the piston and cylinder to wear rapidly. The vertical air pump occupies but little floor space, and it is much more convenient to set down into a pit, should it be necessary to lower the air pump in order to reduce the vertical lift of injection water. The steam cylinders are steeple compound with the high-pressure cylinder on top. The high-pressure steam chest is circular and contains a plain slide valve that is operated from the chest piston on the low-pressure cylinder.

The apparatus has Dean Brothers' noiseless valve gear, the valve-actuating mechanism being on the low-pressure cylinder. The auxiliary slide valve has extra long travel, and the stroke of pump may be lengthened or shortened, even while running, by moving a stud in a segmental slot. The piston rod between the high- and low-pressure cylinders is fitted with automatically adjusting metal packing that will always keep tight. The low-pressure cylinder is fitted with valves for regulating the steam passing to each end of cylinder. The air pump being double acting, the same amount of work is done in the down stroke as in the up stroke. The lower head of low-pressure cylinder is removable, so that the cylinder and packing may be inspected at any time. The piston rods are separable at the cross-heads, the



513

VERTICAL AIR PUMP AND CONDENSER

cross-head being of steel, and the rods fitted in on a taper and held by flat keys.

The air-pump cylinder head may be taken entirely out of the way by unkeying the piston rod. The stuffing box and all valves are water sealed, there being no valves in the air piston.

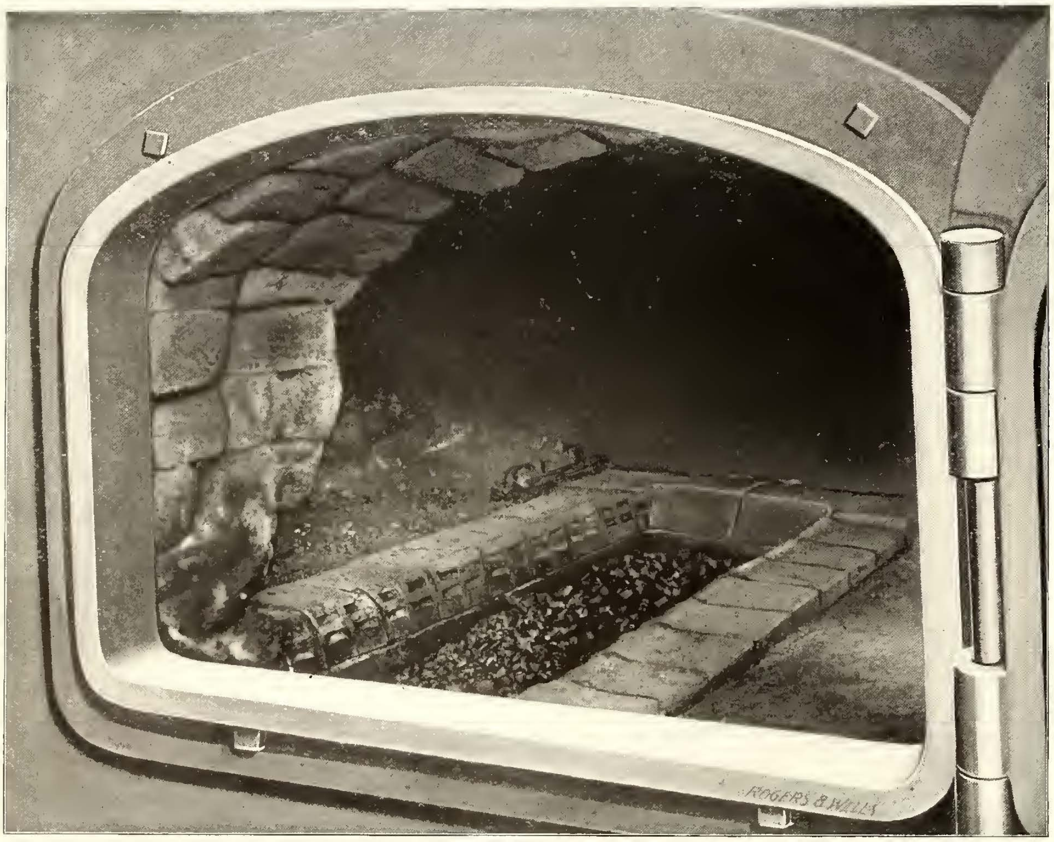
The dimensions of the apparatus shown are as follows: 14-in.

high-pressure steam cylinder, 20-in. low-pressure steam cylinder, 38-in. air cylinder, 18-in. stroke.

For electric traction or electric light plants this apparatus is claimed to be especially adapted, as it can be operated on ½ per cent of the steam used by the engine, and will save from 20 per cent to 30 per cent of the total steam consumed by the engine.

Long Life of an Underfeed Stoker

The Jones underfeed stoker, in its present form, has been on the market since 1895, and the merits of the device have been well tried and tested. An extended technical description of the stoker is not, perhaps, necessary here, but it will be of considerable interest, however, to note some of the practical results that have been attained in the way of lasting qualities and economy of fuel as well as smokelessness. In the Jones underfeed stoker the coal is burned over a long retort. The coal is fed in from beneath by a ram with a reciprocating movement, and is gradually forced up over the edges of the retort. Around the edges of the retort are a row of tuyere blocks through which an artificial blast of air is forced. The combustion of the fuel, which takes place over its surface above the retort, is supported by the blast of air coming through these tuyeres at a low pressure. The tuyere blocks are made of heavy cast iron. The only moving part about the furnace is the ram which supplies the "underfeed" of coal, and which, being down in the cold fuel, will manifestly last a long time. The tuyere blocks are nearer to the hot fire, and it might at first thought be expected that they would be burned out rapidly, although on further consideration it is evident that since the air blast is constantly going through them they are kept comparatively cool. Practical demonstration is more convincing than theory, however, and the accompanying engraving from a photograph of one of the La Grange, Ill., Light & Water Company's furnaces is a striking proof of the way it stands up under use. It shows the condition of the furnace after an eleven months' run, day and night, without repairs, and is certified to by C. T. Moffitt, secretary and treasurer of the company.



FURNACE AFTER ELEVEN MONTHS' SERVICE

An interesting illustration of the way this stoker burns the gases producing smoke was furnished by the Northwestern Straw Works at Milwaukee, where it was necessary, formerly, to burn hard coal because the practice was to bleach straw on the roof and soot was not desirable. The Jones underfeed stoker was put in, and not only was the plant able to burn low-grade bituminous screenings without smoke, but the steaming capacity of the boilers was greatly increased. This is, however, the natural result with a stoker of this type, as the coal comes up from underneath and the volatile matter which makes smoke and which is given off when first the coal is heated up must pass through the bed of hot coked coal on top before it can go up the flues.

The Underfeed Stoker Company of America has been organized within the past year, and has a strong financial backing. Fred A. Daley, who has been connected with the manufacture of the stoker ever since its invention, is manager of the company. The Toronto Railway Company has this stoker under eight 160-hp boilers.

A Traveling Link Grate

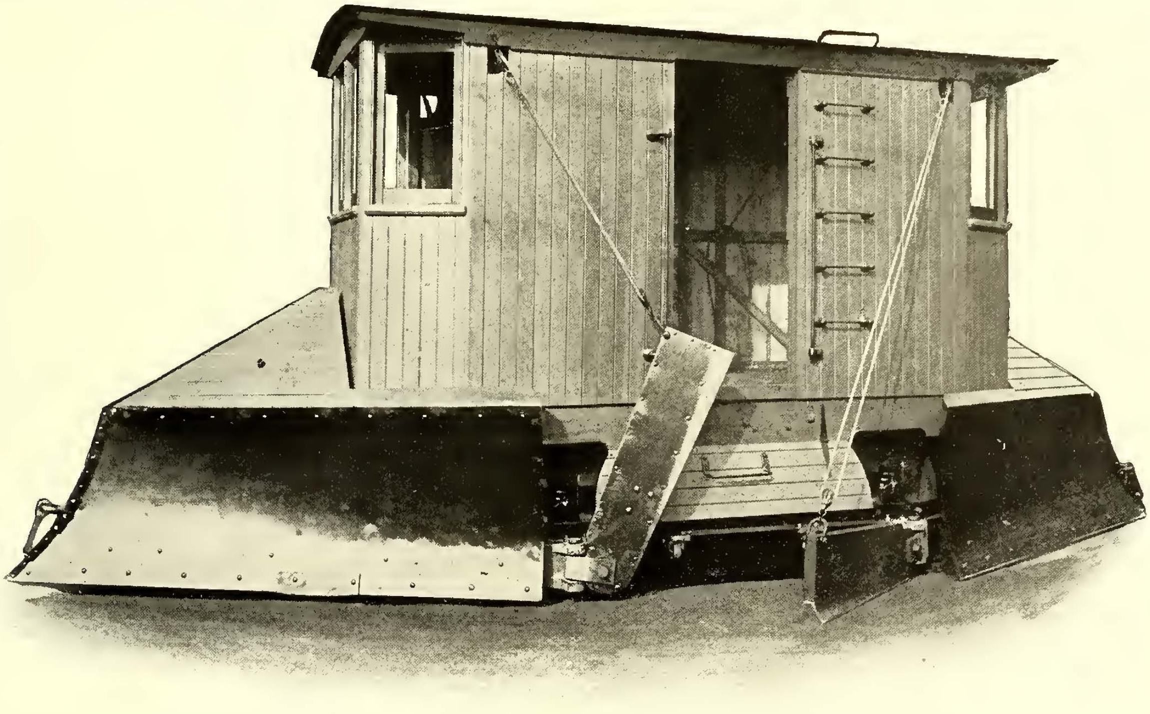
The traveling link grates made by the Green Engineering Company, of Chicago, have met with remarkable success in the short time they have been on the market. It is now only about three years since the company started making these grates, and in that time many of the best contracts in the field have been secured, and numerous second orders received. Among the most important installations may be mentioned two orders from the Milwaukee Electric Railway & Light Company aggregating 11,000 hp, two orders from the Chicago Union Traction Company amounting to 8000 hp, and two orders from the St. Louis Transit Company amounting to 13,000 hp. The Metropolitan Street Railway, of Kansas City, has 3000-hp capacity in these grates at its Riverside station. Two of these grates at Kansas City were put under two 500-hp boilers two years ago, and at the time were notable as being the widest moving grates ever built, being 10 ft. 2 ins. wide. The Armour packing plant in the same city has since put in some grates 11 ft. wide. The construction of the Green traveling link grate is such that there is practically no limit to the size of the grates that can be built, the limit being the size of the boiler. By means of a peculiar form of clip the grates can be repaired without withdrawing the connecting rods which hold the sections together. The clips are of five different designs, and any one can be removed without disturbing the rest of the grate. Their form is such as to allow plenty of air for good combustion, and the result is an almost perfect combustion with exceedingly little smoke. This claim of the makers is fully demonstrated by the operation of the plants equipped with the grate. A serious drawback to automatic stoking when first introduced was that the repairs on the apparatus and the expense of throwing the stokers out of service for repairs almost amounted to more than the resultant saving in firemens' wages. Since then marked improvements in the lasting qualities of automatic stoker grates have been made, and in the present instance the repairs are comparatively quickly and easily made, making an important step in advance. As an illustration of the saving in labor effected by the use of Green chain grate mechanical stokers, the case of the Cincinnati Edison Company, where there are six 750-hp boilers and the boiler-room force is only four men in twenty-four hours, may be cited.

The Green Engineering Company now devotes its entire time to making and selling grates. The main offices are in Chicago and the officers are: W. M. Green, president; John R. Gent, vice-president; P. Albert Poppenhusen, treasurer; Herman A. Poppenhusen, secretary, all of whom, through previous experience, are familiar with steam engineering work.

A Powerful Snow Plow

A description was published last month of the new snow plow brought out this season by the Taunton Locomotive Manufacturing Company, but the illustration given was of a plow built by the company for very heavy service. The accompanying engraving shows a correct view of the plow described last month. For convenience of reference some particulars of this plow are republished from the last monthly issue.

The plow weighs 5 tons without motors, and is thus somewhat lighter than the Taunton standard plow of last year. This reduction in weight has been secured entirely by dispensing with cast iron, especially in the shape of the two heavy counterbalance weights. The manufacturers have also substituted wrought iron and timbering for a large amount of cast iron used in last year's plow, and the noses are now raised and lowered by a chain, operated by worm and gear mechanism. The whole weight of the nose rests on the rail, although the height of the nose can be adjusted to suit any condition. This renders the plow especially valuable in light snows, and guarantees a clean rail under these circumstances. At the same time the shape of the nose and heavy oaken backing give sufficient strength for heavy drift work.



A POWERFUL SNOW PLOW

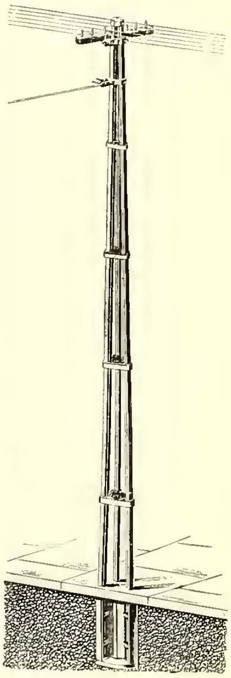
The wings are also a departure from former Taunton practice, and are believed to be an improvement, inasmuch as they dispense with the wing hinge pin, always difficult to keep in shape when the plow is sent against frozen ground or hummocks of ice. The nose is carried so far back on each side that the wheels are thoroughly protected, and the sides of the plow are also protected from snow without in the least interfering with accessibility to the running gear. The hood or overhang part of the roof has been practically taken away to make perfectly easy the manipulation of the trolley rope. The effective Taunton digger is applied to this plow, and, as now built, the manufacturers, who have had many years of experience in electric plow building, state that they can see no opportunity for further improvement in a plow for all-round single track work. The changes made this year, as stated, are not in design, but are mainly in the substitution of timber and wrought iron in place of cast iron. For ordinary work the excessive weight is not often necessary.

A Tripartite Steel Pole

The steel pole illustrated herewith has recently been placed on the market by the Electric Tripartite Steel Pole Company, of New York, and is designed especially for trolley-wire service, though similar poles are also manufactured for electric light and power lines and telegraph and telephone wires. It consists essentially of three high-carbon rolled-steel T's or U's, formed in a tripod shape, and set in a cast-iron base in which they are keyed. At the head is a cap in which each of the three members is riveted, and between the cap and base are cast-iron spreaders, making a positively rigid pole.

Several advantages are claimed for this kind of pole. One is, that as the base is broad and contains a great proportion of the weight, the excavation required for setting is not as deep as that needed with a tubular pole. In fact it is stated that ample rigidity for this pole in railway work is secured by setting it 3 ft. deep in concrete. Again, the pole can be shipped and distributed unassembled, and can be put together at the point of use.

The tripartite poles were tested at Stevens' Institute, Hoboken, N. J., September, 1899, with following results as an average of twelve tests:



TRIPARTITE POLE

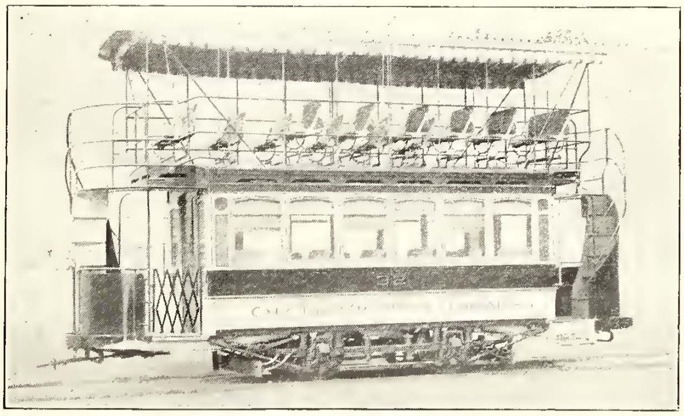
300-lb. strain, double reading....................1.73-in. declivity
400-lb. strain, double reading....................2.37-in. declivity
500-lb. strain, double reading....................3.00-in. declivity

In every instance when the load was released the pole came back to its original position. The weight of the poles is from 350 lbs. to 700 lbs.

New Cars for Cape Town Tramways

The handsome car shown in the cut on the next page is one of a lot which the Cape Town Tramways have purchased from the J. G. Brill Company, and which has just been shipped. The details of construction embody the latest improvements in cars of double-deck type. The bodies are 17 ft. long with 5-ft. platforms making the car 27 ft. over the dashers. The width at the sills is 6 ft. 10 ins., and at the posts a fraction over 7 ft. 4 ins. Stairways leading to the upper deck are of the Brill pattern, which in connection with the hood protect the motorman, while they discharge the passengers on the lower deck directly at the entrance. There are twelve reversible back seats on the upper deck and the same number of spring cane seats and backs in the body. The lower seats are reversible excepting those in the corners, which have stationary backs.

One valuable feature in construction of the canopy is found in the fact that it is braced in all directions, thus giving a much greater stiffness and durability to this part of car which is always subjected to severe strains. The truck is the Brill No. 21-E, with the usual double journal springs and half elliptic on the extreme ends. The trim inside is of white ash with three-ply veneer head linings. The Brill practice of using a very high railing around the upper deck is followed in this case, thus insuring the safety of the passenger when alighting even though the car be in motion.



DOUBLE-DECKED CAR FOR CAPE TOWN

The height of the car inside is 6 ft. 8 ins., ample for men of rather more than the average height. There are two oil headlights, radial draw-bars, angle iron buffers, a pair of Brill sand-boxes and two "Dedenda" gongs. The upper deck is defended by heavy curtains at both sides and ends.

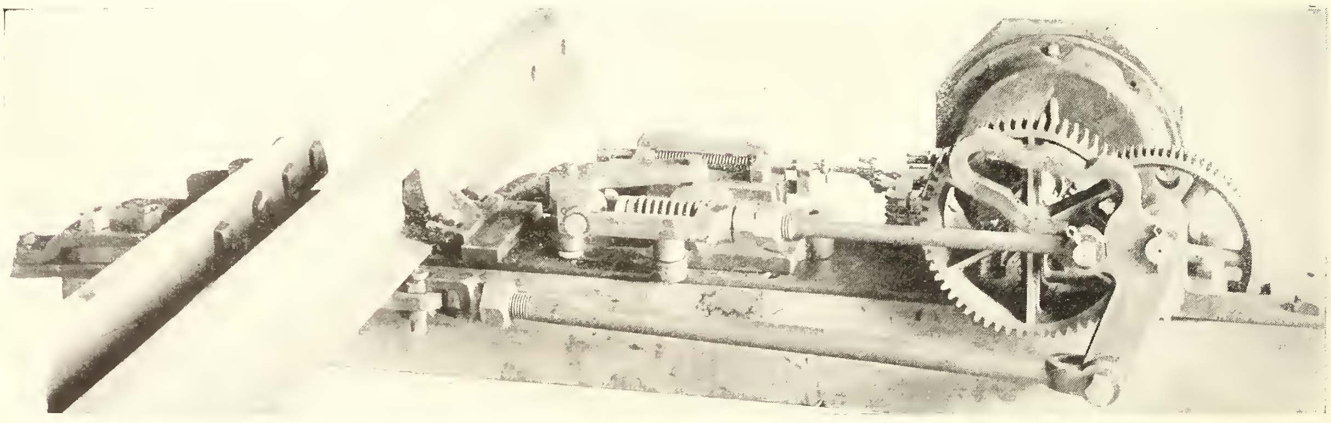
In connection with this order a pair of cars 22 ft. in length, of the same general type were also purchased. The principal difference is that they are mounted upon a pair of "Eureka" maximum traction trucks fitted each with a G. E. 1000 motor. The larger cars are capable of making a much higher rate of speed, and will be valuable in the city and suburban service.

An Interlocking System Applied to Grade Crossings

The interlocking apparatus of the Taylor Signal Company, which is finding favor with steam railroad men for large interlocking plants in switchyards and station terminals is also being applied to the protection of grade crossings of steam and electric roads. Two such applications have been made on the main line of the Lake Shore & Michigan Southern at Fremont, and at Genoa, Ohio, where the Toledo, Fremont & Norwalk Electric Railway crosses it. Before describing this crossing in particular it will be well to explain some of the details of the Taylor Signal Company's apparatus. The equipment uses electricity entirely for the working of both switches and signals instead of compressed air or mechanical connection to the tower by rods and wires. To operate the switches and derailing switches a 1-hp electric motor is employed. One of these motors, with accompanying mechanism, connected to a derailing switch, as used on the interlocking grade crossing is shown in the illustration. The mechanism operates as follows: When the motor starts to open the switch the first part of the movement pulls a pin that unlocks the switch. The next part of the movement opens the switch itself, after which the locking mechanism is again thrown in. The motor is automatically stopped at the end of the cycle of operations by the throwing of a quick break switch, which reverses the armature connections, shuts off current supply and connects the motor to act as a dynamo. Three purposes are accomplished in this operation. The motor connections are reversed so that the motor is ready to close the track switch again upon the closing of the supply circuit; the dynamo action of the motor helps to stop it; and the locking is released so that the signals can be set at "clear." Furthermore the current obtained from the motor when acting as a dynamo is used to energize indication coils in the interlocking machine, which show that the switch has been completely thrown, and permit the lever to complete the balance of its stroke. Until this takes place the signals cannot be set.

To work the semaphore signals on both the steam and electric roads a 1-6-hp motor is used. This motor is placed upon a platform attached to the semaphore pole, and by means of a set of double reduction gears pulls the signal to a horizontal position against the force of gravity. When the motor has pulled the semaphore to position a switch automatically throws in series with the motor a pair of magnet coils, acting against a disc on the armature shaft. The disc is held by the magnets, so that it cannot revolve, and the signal is held set as long as current is maintained in the clutch magnets. The current for working the switch and signal motors is obtained from a 60-volt storage battery, which is charged at intervals by a gasoline engine and dynamo. The current at 60 volts required to throw a switch in two seconds is about 7 amps. To set a semaphore signal in two and one-half seconds 2 amps. is taken.

The crossing at Fremont, Ohio, which is protected by this apparatus, is provided with a derailing switch on the electric road at the crossing approach, and a low semaphore signal indicating its position, and two semaphore signals (home and distant) on the steam road approach to the crossing. There is also an outlying derail on the electric road, which a car encounters after leaving the crossing, the object of which will be explained later. The home signals on the steam road are 600 ft. from the crossing, and the distant signals 1800 ft. These signals stand normally at safety. When a train gets within 2300 ft. of a crossing it enters a track circuit section, which locks out any attempt to change the signals and let an electric car on the crossing when a steam train is within 2300 ft. When an electric car approaches the crossing the steam road signals are set at danger, the derail on the electric road is closed, and its signals set at clear. At the same time the derail in the electric track on the far side of the crossing is opened. After an electric car has gone over the crossing it cannot proceed until the steam road signals have all been cleared and the electric road approach put back at danger. This is to prevent the steam road signals being left so as to block the road. These signals are designed to be operated either by a towerman or by the conductor of



SWITCH-OPERATING MOTOR AND MECHANISM

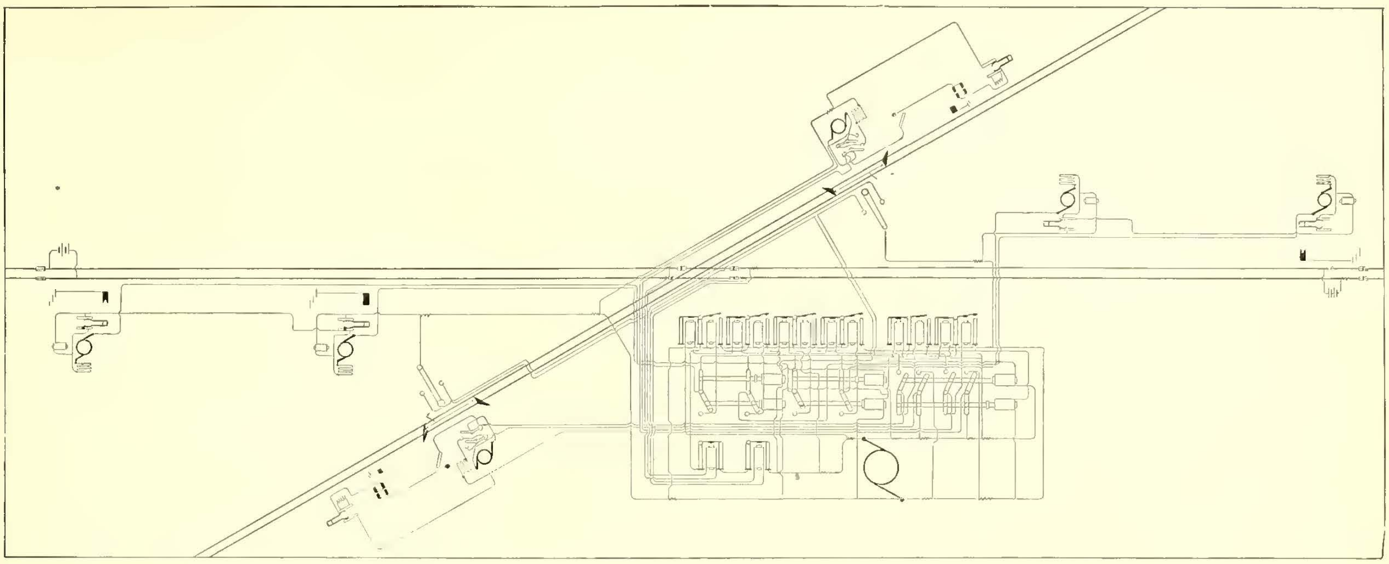
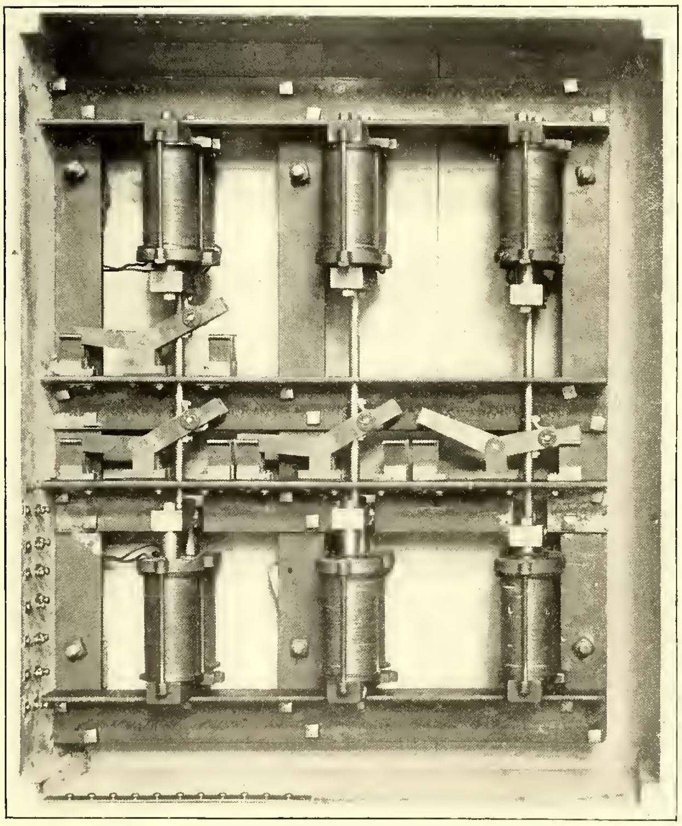


DIAGRAM OF SIGNAL AND INTERLOCKING SYSTEM

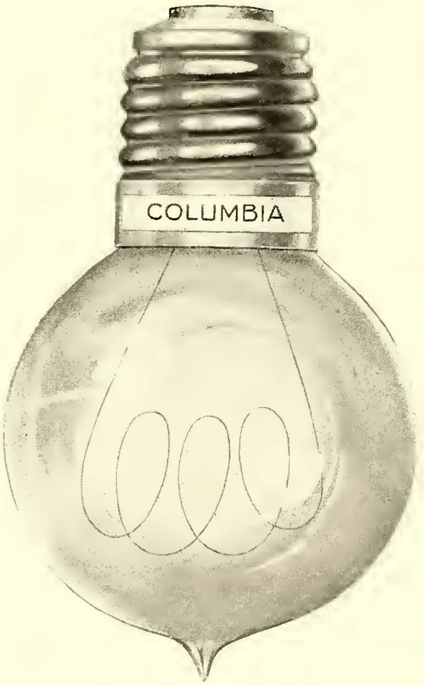
the electric car from a locked box near the track. The signals being entirely automatic and interlocking this can safely be done. When the towerman is absent the interlocking machine is worked by solenoids, the solenoid circuits being controlled by a small switch in the conductor's switchbox beside the track. The same switchbox is used for both approaching and leaving cars, the switch being thrown in one direction for a car going one way and in the other direction for a car going the other way. The conductor has simply to hold the switch closed for a short period, a spring holding the switch normally in a central position. The possibility of doing away with a regular towerman at the crossing is one that recommends it strongly to street and interurban roads, and the interlocking feature makes it absolutely safe. The factory of the Taylor Signal Company is at Buffalo, and headquarters are also maintained at Monadnock Block, Chicago.



SOLENOIDS FOR INTERLOCKING SYSTEMS

Incandescent Lamp for Railway Use

The Columbia Incandescent Lamp Company, St. Louis, Mo., is now entering on its tenth year. During this time the firm has been in continuous operation, and can, therefore, well claim to be one of the oldest lamp houses in the country. By the inauguration of such methods and changes from time to time as to keep abreast of the business and by the use of the latest and most improved machinery, the company has striven to give satisfaction to its customers. As a result of this in the railway field it now holds several yearly contracts with roads throughout the country for supplying their cars with lamps. One style of these successful lamps is illustrated in the accompanying engraving. The filament of the lamp is carefully made at the company's own factory, and its brilliancy is practically maintained throughout its long life. As seen from the cut, the filament is made heavy enough to withstand the shocks of railway service without anchoring.



RAILWAY LAMP

Another form of lamp which has given great satisfaction wherever introduced is made with the standard size of bulb. The spiral form of filament is used in this lamp, and it is found to be strong enough to work admirably without anchoring.

The "Kansas City Special" Short Wheel Base Truck

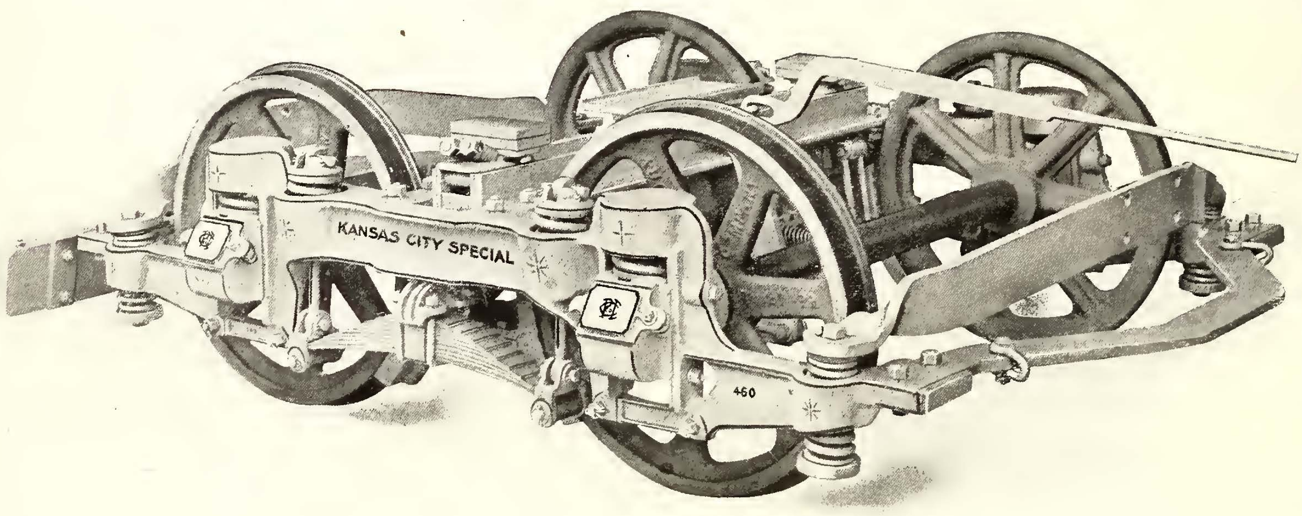
The accompanying engraving shows the "Kansas City Special" short wheel base truck, manufactured by the Peckham Truck Company. This truck has proved very popular in Kansas City, as is shown by the fact that the Peckham Company has already furnished the Metropolitan Street Railway Company, of that city, with 102 pairs of these trucks, and has orders for 148 pairs in addition.

This truck is constructed on the same general lines as the Peckham regular 14 B-3 short wheel base truck, the difference being in the construction of the cast-steel side frames, which are modified to suit the requirements of the master mechanic of the Metropolitan Street Railway Company, of Kansas City. The changes made are mainly in the construction of the end extensions for supporting the motors, which in this truck are made lower, and are provided with pockets for the motor suspension springs. These are located nearer the axle than in the regular 14 B-3 construction, so that the weight of the motors is carried nearer the axles.

The end cross-bars connecting the two side frames are made flat in this construction, while in the 14 B-3 trucks they are of angle bar construction.

The bolster of this truck, as in the 14 B-3, is a center bearing swing bolster, carried upon two half elliptical springs, which, in turn, are carried by coil equalizer springs. Large coil springs are also placed over the journal boxes, thus making three separate sets of springs between the car body and rail, insuring a very easy and steady riding car under all conditions of load.

In this truck, as in the regular 14 B-3, the motors are placed outside of the axles, and the brakes are constructed with inside brake shoes.

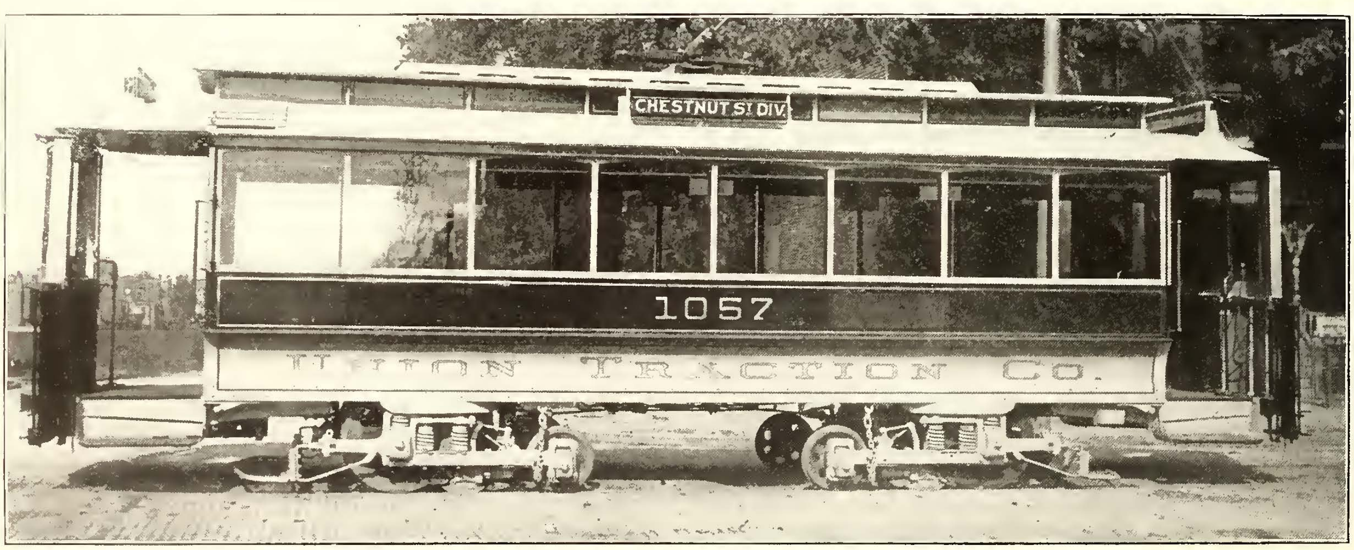


"KANSAS CITY SPECIAL" TRUCK

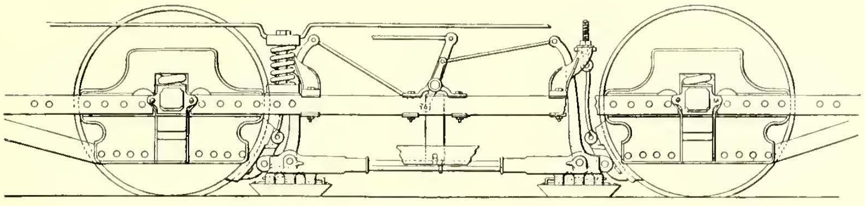
Combined Track and Wheel Brake

The accompanying engravings illustrate a new track and wheel brake which has been lately put upon the market. The brake presents several novel features, and has been giving satisfactory service upon some of the cars of the Union Traction Company, Philadelphia, where it has been installed. The inventor of the device, Charles V. Rote, claims that it is exceedingly efficient and easy of application. Its simplicity adds to its safety, and the ingenious mechanical arrangement facilitates the making of quick stops with very little inconvenience to the passengers. The principle upon which the Rote brake operates is quite simple, and there is nothing in the mechanism which can easily get out of adjustment. There is a flat shoe about 1 ft. long suspended over the rail. This is so adjusted as to barely clear the rail, with which it can be brought into contact by a slight turn of the brake handle. An ingenious mechanical device, somewhat analogous in principle to the cantilever, allows the brake to be applied with great power. It is so made that the grip and release of the brake are rendered elastic, thus obviating the unpleasant jolt occasioned by the sudden application of a wheel brake.

On an eight-wheel car it is evident that the shoe surface is sufficient to cover a large length of rail, thus giving great power for stopping the movement of the car. The pressure of the wheels

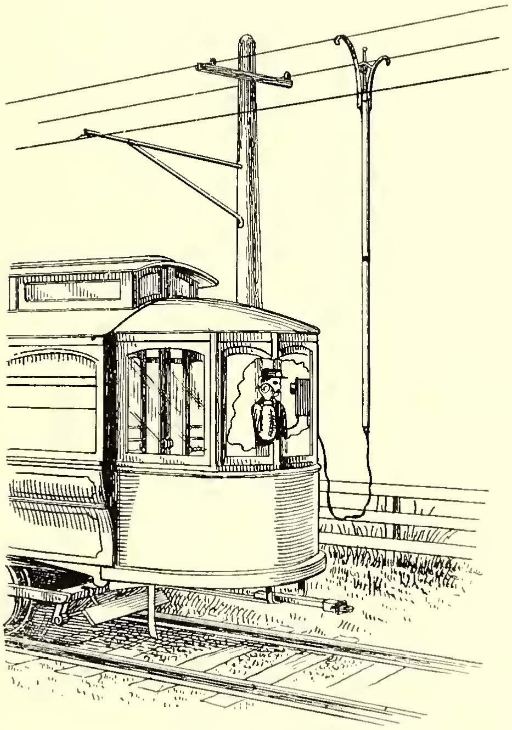


TRACK AND WHEEL BRAKE ON MAXIMUM TRACTION TRUCKS on the track at the same time is largely diminished, so that should they by any chance become locked, the sliding would not be disastrous to their tread. The shape of the shoe is such that it will pass easily over uneven joints in rails and cross-frogs, and provision is made for adjusting to wear. It is, however, close enough



DETAILS OF TRACK BRAKE

to the track to keep it clear of ice or snow, any coating of ice that the front wheels may crush being removed by the shoe following. The mechanism can be worked from either end of the car by an ordinary hand-brake spindle or by air, but the amount of pressure required is so slight that the hand-brake gives sufficient power in all cases. One of the illustrations shows the brake as applied to a maximum traction truck; in this case but one shoe is used between each pair of wheels. In the ordinary bogie truck, where both wheels have a separate brake shoe, two track shoes are also used, as shown by the detail drawing.



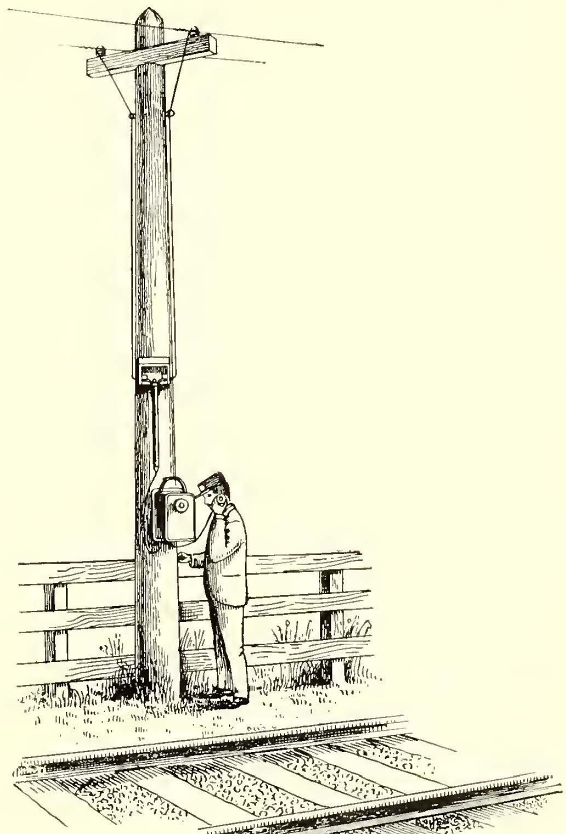
TELEPHONE IN USE ON CAR

The brake is being manufactured by the Rote Track Brake Company, Lancaster, Pa.

A Portable Telephone for Trolley Cars

The accompanying cuts illustrate a device by means of which the conductor of a car is at all times able to communicate with the office or power station. The system comprises many ingenious features, as every precaution has been taken to make it thoroughly reliable, and its extreme simplicity, both of construction and operation, will do much toward recommending it to the managers of street railways in general, but especially of those roads which traverse long stretches of open country.

The mode of application is well shown in the engravings. A jointed pole, through the center of which passes the double telephone cord, is provided at one end with wide-spreading hooks, and at the other end with short-contact pins. The hooks are electrically connected to their respective contact pins by means of the enclosed cord, and cylindrical terminals on the end of the flexible cord connecting with the car make the circuit complete between the telephone and the overhead telephone wires. Each telephone is furnished with a holder, which is placed in the car in any convenient place. This holder is stationary, but the telephone can be removed from the car, as shown in the second illustration, where the line is too far from the track to be reached by the connecting cord, or where, for any reason, this method is thought preferable, as, for example, in a crowded street. The field box shown in this cut has a sloping roof protecting the terminals of the telephone circuit, which receive the hooks on the portable pole, and, being much nearer the ground, does not require the use of such a long pole It is evident that with the telephone remaining in the car connection could be made to the field box in the same manner as to be the overhead wires themselves. This is of service where the wires are suspended at a distance above the track too great for the length of the pole, although the much simpler expedient of dropping wire hooks down from the line to the required level is adopted where



TELEPHONE TRANSFERRED TO POLE

many of these cases occur. Cleats are provided on the portable pole on which the flexible cord is wound when not in use.

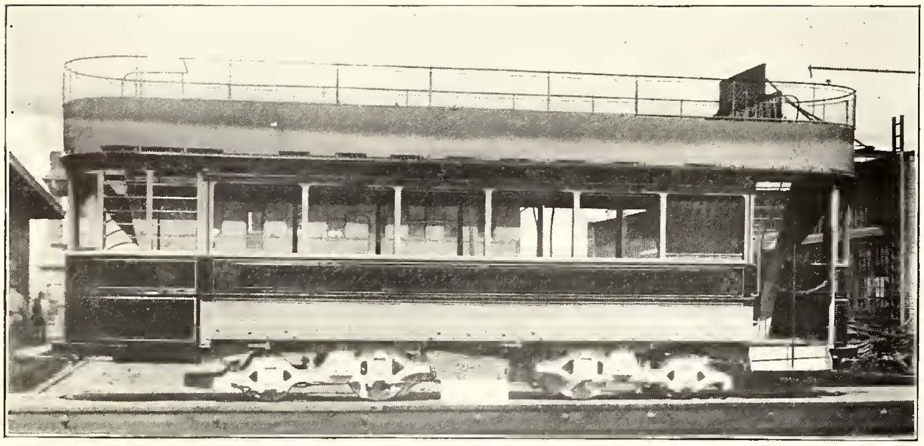
After the connection is made the telephone is used in the ordinary manner. Its application to this service, as described above, is due to M. Garl, who has secured patents on the novel features employed. The system is being put on the market by the Garl Electric Company, Akron, Ohio.

New Power Station at Portsmouth, England

The Corporation of Portsmouth has just awarded the contract for the complete equipment of the power station to Dick, Kerr & Company, which already has orders for supplying eighty motor cars. The initial installation will consist of about 2000-hp capacity, and engines of slow-speed Corliss type will be used, direct coupled to generators supplied by the English Electric Manufacturing Company.

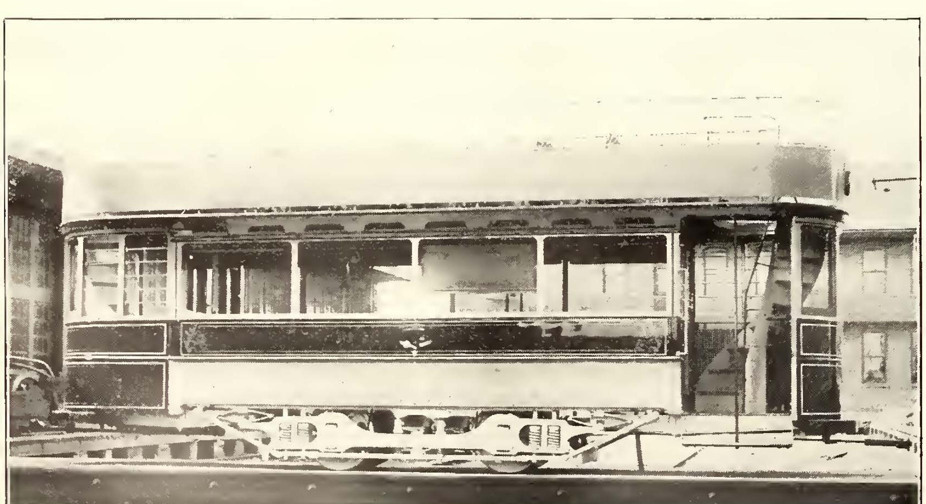
Cars for the Isle of Thanet

The first illustration herewith shows a 21-ft. double-deck box car built for the Isle of Thanet Railways Company, Ltd., by the St. Louis Car Company. This car is mounted on two St. Louis Car Company's No. 13 trucks. The total length of the car body is 32 ft. 4 ins. over all; the clear height inside of the center is 6 ft. 4½ ins.; the width of the car is 6 ft. 6 ins. and the length of each platform is 5 ft. 3 ins. The interior of the car is finished in quartered sawed oak, with longitudinal seats upholstered, and the second story is equipped with garden "walk-over" seats. All trimmings are of bronze. The cars were built complete and then taken apart, boxed and shipped.



DOUBLE-TRUCK CAR FOR ISLE OF THANET

The second illustration shows a 17-ft. car mounted on a St. Louis Car Company's No. 8 single truck. This car is 28 ft. 4 ins. over all, 6 ft. 6 ins. wide, and the platform is the same length as the long car. The car is similar in every respect to the car mounted on double trucks, shown here.

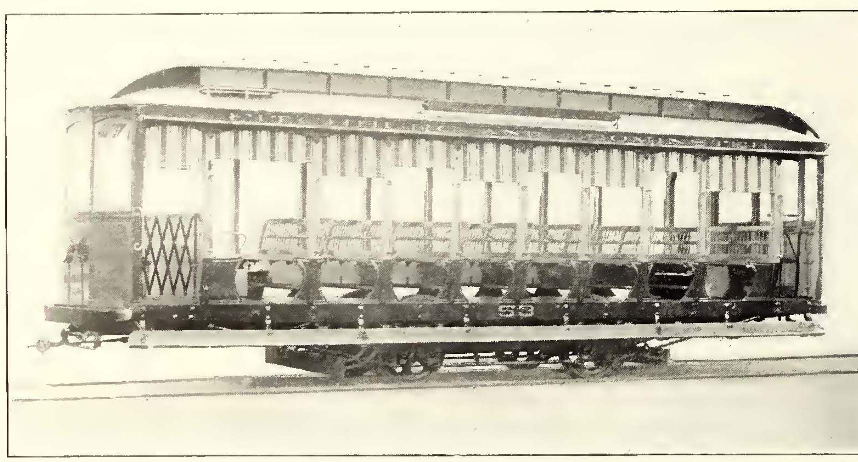


SINGLE-TRUCK CAR FOR ISLE OF THANET

Open Vestibuled Car

The Fitchburg & Leominister Street Railway has just received from the J. G. Brill Company a number of open cars of a novel design. One of these cars which was shipped to road last week is shown in the illustration given herewith. It is 31 ft. long over the bumpers, has a 3-ft. platform, and is 6 ft. 2 ins. wide at the sills. From the bottom of the sill over the top of the trolley board the car is 8 ft 9 ins. high. The first point of novelty which strikes the observer is the fact that the car has a regular steam car roof; in this case the framing of the car runs out to the vestibule. The vestibule itself is of the standard three-window type, and is closed at the sides by gates and by curtains which come all the way to the floor. The platforms are not intended for passengers and are without seats. The car is also built without bulkheads, so that the platform and interior of the car are all in one compartment except for the low partition and spindle back of the stationary seats at the end of the car. There are seven seats with reversible spindle backs.

The arrangement of the car without the bulkhead to some extent necessitates the use of a steam car roof, because the vestibule takes the place of the bulkhead as a member of the framing and must be connected with the plates and frame of the monitor in such a way as to make a solid structure. In the arrangement described, the motorman in stormy weather is as completely protected as the passengers. When the curtains are drawn down on the platform the gates fold against the stationary seat. The trimming throughout is of bronze, the head lining of decorated three-ply white birch. The wheel boxes are of metal.



OPEN CAR WITH VESTIBULES

The seats are fitted with the round-corner seat end panels. There are radial draw-bars, two Brill sand-boxes, two Dedenda gongs and two electric headlights. The wheel base is 7 ft. and the wheels are 33 ins. in diameter with 2¼-in. tread and ⅞-in. flange.

New English Works

W. A. McGuire, president of the McGuire Manufacturing Company, Chicago, has returned from a two months' trip in England, where he has been making arrangements for the manufacture of the McGuire trucks and other specialties. Although the company's material can thus be supplied to the English trade at a less cost, the move was not taken for economical reasons alone, but because, in Mr. McGuire's opinion, the English people prefer, wherever possible, to purchase articles of home manufacture. A factory is to be built, and until its completion all orders which require immediate attention will be filled from Chicago, as it is thought more advisable to get the business into activity at once, and sacrifice the large freight expense, than to lose the time which would be required for the building of the plant. The railway men of England are already conversant with the company's products, but its genial leading salesman, W. J. Cooke, will spend six months in the country making their acquaintance. The London offices are at present located at 5 Warwick Court, High Holborn, W. C.

An Automatic Air Brake for Electric Cars

In the Knell air-brake system several good points are manifested. The construction of the apparatus is simple, and there is nothing that is liable to become damaged, get out of order or wear out. The durability of the brake is further insured by having the moving parts run in oil. The accompanying half-tone illustrates the compressor with the upper half of the dust-proof gear case removed. Since the compressor works only when the car is in motion, the action is practically noiseless, and special precautions have been taken to muffle the exhaust.

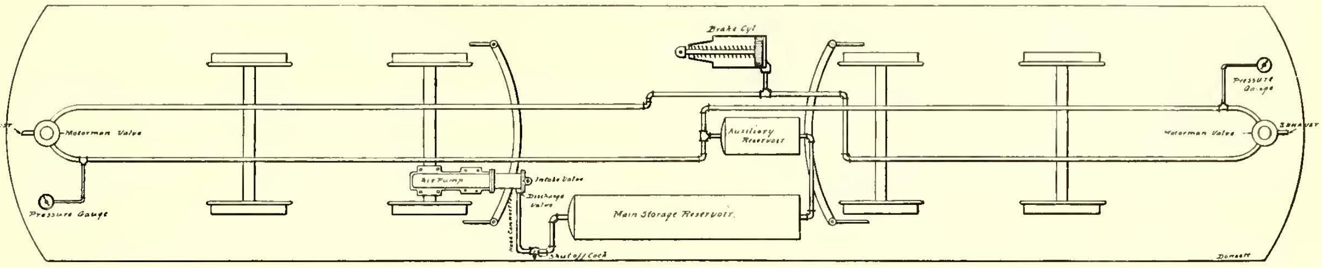
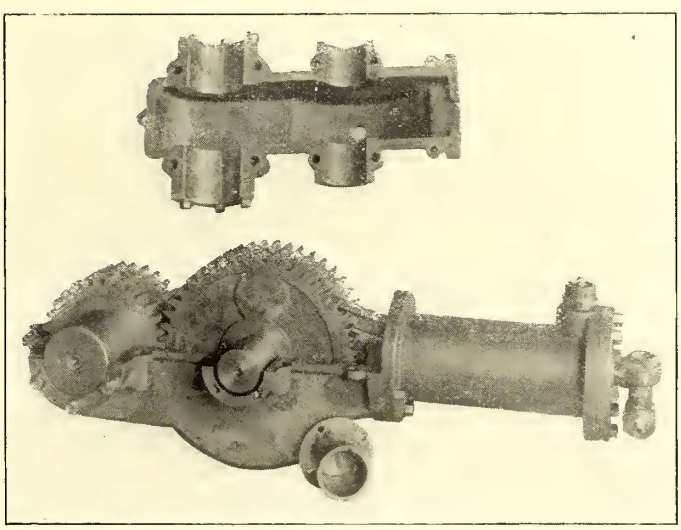


DIAGRAM OF BRAKE APPLIED TO CAR

A diagram showing the application to a car is also given. The hose is attached to the upper end of the compressor, and the air is piped in the ordinary manner to the reservoir, from which it is released through a pipe to the brake cylinder by an ingenious device under the control of the motorman. The force is applied from the brake rod to the brake shoe in the same way as with the ordinary hand-brake. The brake rod is attached to the same chain that operates the hand-brake, and does not interfere with the use of the hand-brake. When the brake is applied with air the hand-brake chain loops down, and when the brake is applied by hand the air-brake chain loops down.



AIR COMPRESSOR WITH GEAR CASE REMOVED

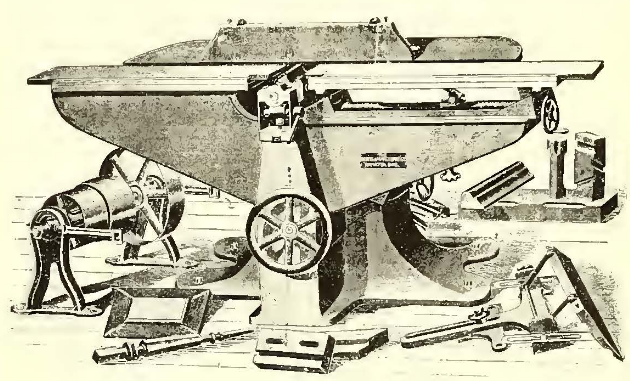
The device shown at the front end of the compressor contains an automatic cut-off valve. The mechanism of this valve is such that a uniform pressure is maintained in the reservoir. When the pressure in the reservoir attains the desired amount, usually from 60 lbs. to 80 lbs., the automatic valve goes into operation and holds the pressure in the reservoir at that point until air is released from the reservoir and carried to the cylinder operating the brake.

During the time that the air from the reservoir is maintained at the desired pressure by the action of the valve the compressor is released from all duty, simply working back and forth, but exerting no pressure against the air as maintained in the reservoir. The compressor is, during this time, simply pumping into the atmosphere through an open port in the automatic valve and sustains no appreciable amount of wear. As soon as the pressure in the reservoir has been reduced by an application of air to the pipes leading to the brake cylinder, the automatic valve is released, and immediately the compressor goes into operation and in a few revolutions raises the pressure to the maximum amount, when the valve again acts and the pressure is maintained in the reservoir until it is again reduced by another application of air to the brake cylinder. There is thus a constant supply of air always at the motorman's command requiring no attention on his part.

Brakes of this design have been in use in Battle Creek, Mich., Indianapolis, Ind., and Buffalo and Rochester, N. Y., and a number have been purchased for use on interurban lines running into the former city and Elmira, N. Y. They are manufactured by the Knell Air Brake Company, Battle Creek.

An Improved Universal Wood Worker

The accompanying engraving illustrates a solid universal wood worker, which is one of the latest forms brought out by the Bentel & Margedant Company, Hamilton, Ohio. The machine is supplied with three adjustable working tables, which can be raised or lowered by means of screws and hand-wheels in a most satisfactory manner. Three bearings are provided for the mandrel, so that the driving pulley may be placed between the last two, and does not overhang. This gives much better service, and saves the journals. The mandrel in the 9-in. machine is 1½ ins. in diameter, and made of hammered crucible tool steel. It is not filed, but is turned down and ground to a perfect surface. The firm, square column which rises from the heavy base is cast in one piece with the frame. The front of this column is provided with two vertical dove-tail slides and adjusting gibs. The table bracket carries two tables, which raise and lower simultaneously by means of the raising screw, and thus greatly facilitates the adjustment. The third table moves independently, and is used principally for resting the adjustable planing fence and bevel rest. At the back of the supporting column, when so desired, is placed a horizontal boring and routing machine, with the necessary supporting table. The boring tools are chucked onto the protruding end of the mandrel.

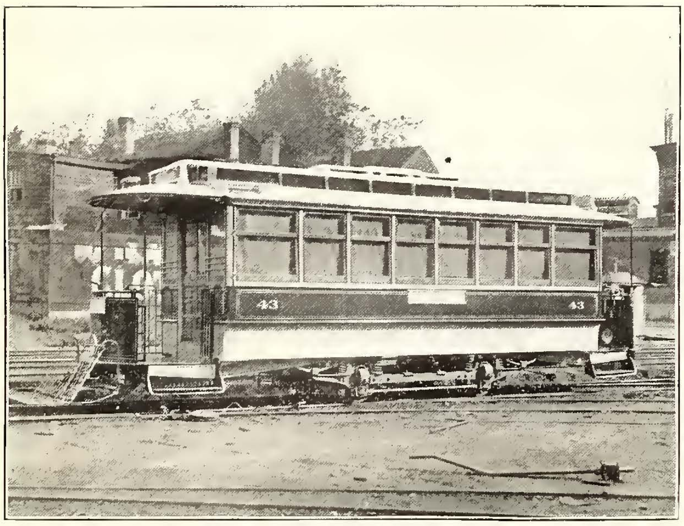


UNIVERSAL WOOD WORKER

This machine is one of eighteen varieties made by the Bentel & Margedant Company. It is a labor saver, and can be used on all kinds of wood working, such as rip or cross-cut sawing, gaining, plowing, panel raising, cornering between ends, etc., etc., so that it is not likely to stand idle in a shop. The front tables are 12½ ins. wide, including the recessed slide-way, and 6 ft. 10 ins. long, and will plane a board 9 ins. wide.

Cars for the Havana Electric Railway

The Jackson & Sharp Company, Wilmington, Del., are making weekly shipments of closed-car bodies to Havana for the Havana Electric Railway. Through its general manager, G. F. Greenwood, the railway company placed an order some weeks ago with



NEW HAVANA CARS, EXTERIOR

the Jackson & Sharp Company for sixty car bodies, and later on for fifty more, to be delivered at the rate of ten per week. Nearly all the cars have been shipped, and the balance are now awaiting shipment, or rapidly approaching completion.

The interior and exterior views, which are given herewith, will give a good idea of these cars. They are 20 ft. long in frame, and 29 ft. 6 ins. over platforms. The sash in each window is double,

NEW HAVANA CARS, INTERIOR

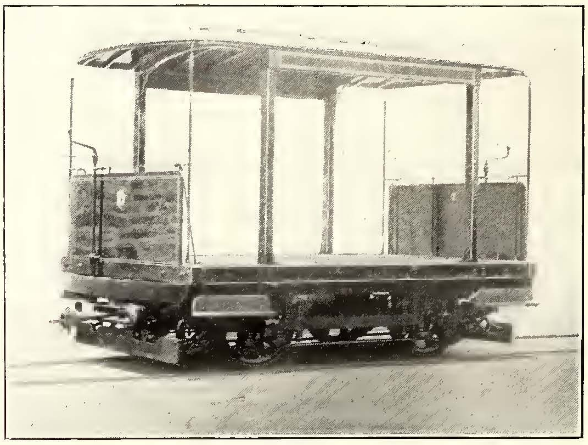
the upper sash being permanent and the lower sash made to drop, thus affording a very large opening. The interior is finished in cherry in neat design. The seats are of the Walkover type, covered in rattan, and are arranged eight on each side, thus giving a seating capacity of thirty-two passengers. Open platforms are used, fitted with the Wood gates. The under frame of the car, as well as all platform timber, is made of yellow pine, and the bracing is done in the most substantial manner. The exterior is painted with English vermillion and cream decorated in gold, making a very showy and handsome appearance.

When the cars are completed the platforms, dashers and canopies are taken off and placed inside, and the car is then boxed whole, and shipped by steamer to Havana. As the boxes are so large they have to be carried on the deck of the steamer, and ten cars are all the largest ones can take, even by greatly crowding the deck space. The Jackson & Sharp Company expects to make the final shipment in about two months.

Second-Class Funeral Car

The popularity of funeral cars in Mexico and the attention which is being paid to them in this country shows that the subject is one that deserves the attention of street railway managers. The car illustrated is one of a large order shipped within the present month to one of the Mexican railways from the works of the J. G. Brill Company.

It is 13 ft. long by 8 ft. 2 ins. wide, and is mounted on a No.

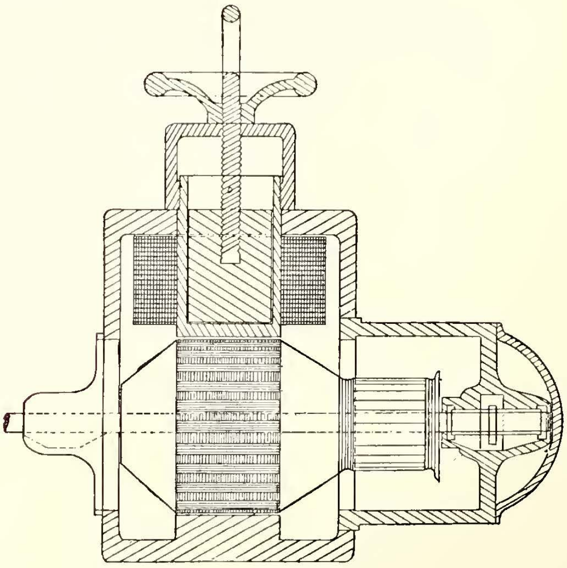


SECOND-CLASS FUNERAL CAR

21-E truck with a 6-ft. 6-in. wheel base. The road is standard gage, 4 ft. 8½ ins.; the cars are fitted with two G. E. 1000 motors so that they could haul a considerable number of trailers if necessary. The weight of the car without the motors is 7860 lbs. Radial draw-bars are used with angle-iron buffers. A step is placed at each corner of the car. The roof is supported by four stout corner posts, which are strengthened by wrought iron corner braces. The decorations for the car consist of black curtains, draperies, etc., which are furnished and put on by the company. There are also crucifixes and other religious decorations. These cars take the place of the hearse in American cities, and as the company furnishes transportation for the mourners as well as for the coffin, the revenue derived from this source is a large one.

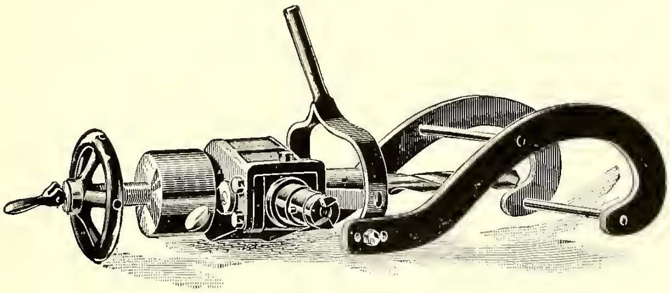
Electric Street Railway Track Drill

A tool of this kind, taking its power from the trolley wire and doing the work in a fraction of the time required by hand, should certainly appeal to everyone interested in street railway construction.



SECTION OF MULTI-SPEED MOTOR

From the fact that this device is used on a grounded circuit and usually handled by unskilled workmen, the motor requirements are very exacting. It must be practically dust and water proof and unbreakable, simple in construction, but of high efficiency; in fact, constructed specially for this kind of service. The Stow Manufacturing Company, of Binghamton, has been working along this line for years, some of its earlier designs having been previously illustrated in these columns. Several of the more primitive type have been in active service for the past four years, and are still in good working order, but practical use has from time to time developed faults in construction which, as fast as discovered, have been corrected. The invention of the



AUTOMATIC TRACK DRILL PRESS

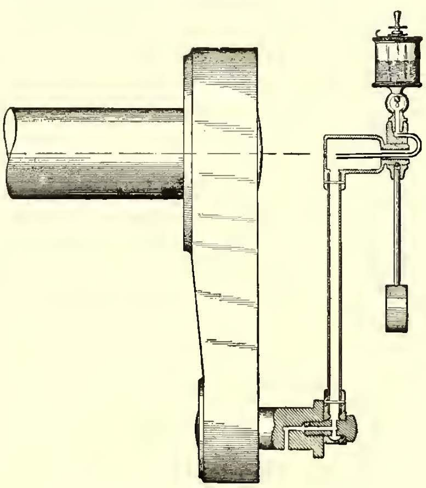
multi-speed motor has aided greatly in perfecting this apparatus, and while no doubt further improvements will suggest themselves, the company has no hesitation in stating that in its present form the combination of Stow flexible shaft and iron clad electric motor is as near "fool proof" as any electrical device on the market, and that no appliance used in street railway construction will pay a larger dividend than this.

The cut showing a cross section of the motor illustrates the extreme simplicity of its construction, and also the method of speed regulation. By simply raising and lowering the soft iron plunger in the hollow field by means of the hand wheel on top of the motor, the speed can be varied even to the fraction of a revolution. The motor is self contained, no outside speed regulator or starting box being required, a most desirable quality in a portable motor.

The automatic track drill press is a most valuable tool to use for rebonding. As shown in the illustration, it consists of a double hook, from the end of which the drill is thrust forward. This hook can be adjusted to the track or detached therefrom in a moment, which allows it to be used while the road is in operation with but little interference to traffic.

A Pendulum Crank-Pin Oiler

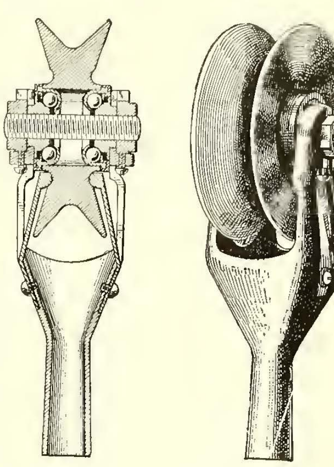
The Nugent patent pendulum crank-pin center oiler accomplishes its purpose without stuffing-boxes or packing of any kind. Neither is there a mechanical connection with the floor, wall, railing or any stationary part of the engine, as seen by reference to the accompanying cut. The tube through which the oil runs from the cup to the crank-pin is fixed on the crank-pin, so that one end is always central to the engine shaft. On this latter end is journaled an oil-cup support weighted with a pendulum bob which keeps the oil cup always stationary and right side up. In case it is desired to flood the crank-pin with water or cylinder oil, as in the case of a hot bearing, the oil cup can be taken off while the engine is running at full speed and the nozzle of a hose applied. It is claimed by the manufacturer, with apparently good foundation, that water applied to the outside of a hot bearing contracts the brasses so that they bind and make matters worse. By pouring water into the regular lubricating channels, the crank-pin is cooled first and there is less tendency to bind. Where a pressure oiling system is in use the connection can be made directly to the pendulum to which the oil cup is normally attached. The E. P. Allis Company, C. & G. Cooper Company, Filer & Stowell Company, Newburgh Ice Machinery & Engine Company, I. & E. Greenwald Company, St. Louis Iron & Machine Works, Ingersoll-Sergeant Drill Company, Vilter Manufacturing Company, William Tod & Company, Bass Foundry & Machine Works, Fraser & Chalmers, Griffith & Wedge Company, and a great many others use the Nugent center oiler exclusively. The device is made by William W. Nugent & Company, Chicago.



IMPROVED CRANK-PIN OILER

The Ball-Bearing Trolley Wheel

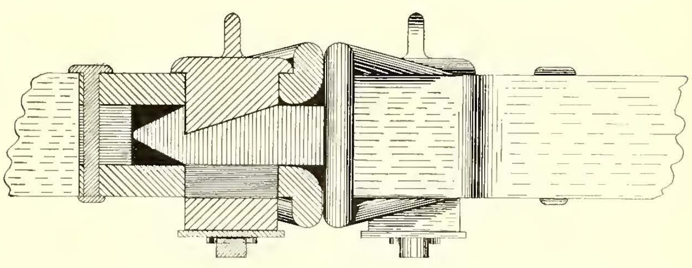
The trolley wheel illustrated in the accompanying cut is designed to transmit the current in an efficient manner with as little resistance of rotation as possible. The friction of the wheel on its axle is greatly reduced by the introduction of a ball bearing within the two arms of the harp. The balls are held in place by cups made of steel stampings, and revolve against cones of hardened steel, which are screwed upon the axle. Locking nuts are provided at either end of the axle, which provide against the bearing becoming loose. Springs are screwed in the bottom of the harp and press against the wheel to better facilitate the passing of the current, but the pressure of these springs against the surface of the wheel is too light to materially detract from the easy-running qualities of the ball bearings. This device is made by the Akron Trolley Wheel Company, Akron, Ohio.



BALL-BEARING TROLLEY WHEEL

A New Automatic Coupler

An extremely simple, practical and substantial automatic coupler for electric railway service of all kinds is about to be put out by the Auto Appliance Company, of Chicago. It would be hard to imagine anything more simple than the design of this coupler. There are only two parts to the coupler proper. As seen in the



A SIMPLE CAR COUPLER

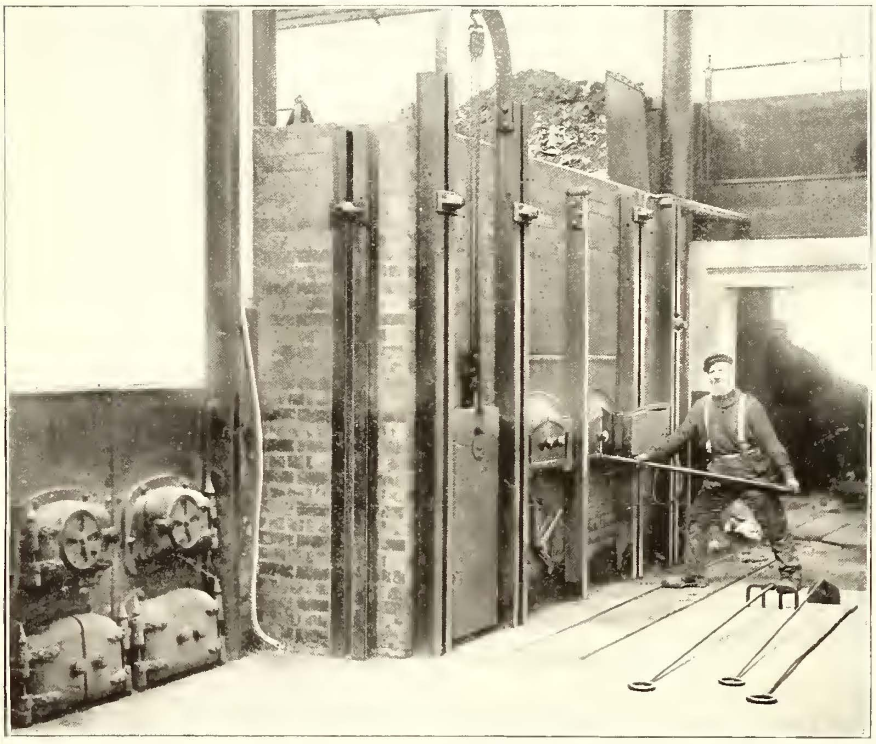
accompanying illustration, which represents a vertical section through the coupler, the draw-bar head, instead of being provided with a pin as in most couplers, has a slotted block through which the link passes. This link has a catch on each end, and as soon as it has fully entered, the slotted block drops down by gravity and the coupling is made. The parts are machined so that the clearance is small between draw-heads when the cars are attached together. The links are cut from bar steel and the draw-heads and locking blocks are of malleable cast iron. The simplicity of the coupler renders its action easily understood by a glance at the illustration. It is the invention of T. I. Duffy, of the Auto Appliance Company, and will be exhibited at the National Street Railway Convention.

Refuse Destructor at Llandudno, Wales

One of the most interesting features about the recent installation of an electrical plant at the beautiful health resort of Llandudno, in Wales, is the refuse destructor that has been adopted by the Urban District Council. An illustration is shown of a destructor cell, which, though it looks to all intents and purposes like an ordinary furnace, is specially constructed to burn the refuse from the town. The particular form of destructor used is the Beaman & Deas destructor, now controlled and manufactured by Meldrum Brothers, Limited, of Manchester.

The entire scheme may be described in a few sentences. The refuse of the town, upon arrival at the works, is charged into the destructor cells, where it is burned by the aid of forced draft; the flames and hot gases resulting from the combustion of the refuse in these cells are led under large water tube boilers; the steam generated in these boilers is conveyed to high-speed steam engines coupled direct to powerful dynamos by which the electricity is generated; the current thus produced is distributed as required throughout the town, serving arc lamps of 1200 cp on the promenade and other parts of the town, and incandescent lamps in the hotels and private residences.

In the destructor cells now in operation at Llandudno the difficulty of burning the refuse without creating a nuisance has been overcome by a novel and compact combination of simple elements. The charging opening and the drying hearths of the cells are as far removed as possible from the entrance to the flue, in order that the green gases arising from the drying process must pass over the fire itself. Ample space is also provided for the mixing of the gases, while finally the double construction of the furnaces—that is the arrangement of the cells in pairs—and the alternative system of working are calculated to make assurance doubly sure in regard to the destruction of any fumes of a noxious character which might otherwise possibly escape into the flues. It is impossible with any destructor cell to ensure a continuous high temperature in the cell proper. The cell must be more or less open to be charged and clinkered and the charge must be started from a comparatively cool condition. The Beaman & Deas destructor is no exception in this respect; therefore, unless special provision is made to prevent them, comparatively green gases must pass into the atmosphere. In this destructor each cell of a pair acts alternately as a fume cremator to the other; when the one cell is comparatively green the gases from the other are at their hottest, and with ordinary refuse a minimum temperature of 2000 degs. F. is maintained in the combustion chamber where the gases unite, provided only that a reasonable supply of refuse is maintained. Finally the combustion of the refuse is aided by forced draft generated by a special type of fan, the object being to destroy the refuse quickly and at the highest convenient attainable temperature; that is to say, a temperature calculated to decompose and render harmless and innocuous all the products of combustion.



REFUSE DESTRUCTOR AT LLANDUDNO

It is interesting to note that the whole scheme was examined and reported on by A. H. Preece, of the firm of Preece & Cardew, who stated that the destructor was doing its work in a most satisfactory manner, and had frequently to get rid of such unpromising material as fish and horses. Even with such refuse to use as fuel the cost, per Board of Trade unit, had been reduced to under ½d., while all noxious gases had been entirely consumed, and, though the destructor had been working for six months, at the time of the report, no complaint of any kind from adjacent property owners had been received.

Recent Rail Bond Tests Made in Paris

To determine which was the best method of rail bonding, very careful and thorough tests of the leading types of rail bonds were made in July by experts of the French Government at the Ecole d'Electricité in Paris, and the formal report has just been issued. To insure fairness each bond was applied by a representative of the manufacturing company who was present at the test. In each case the current and potential difference was measured, from which the resistance was calculated. In each test the same pair of grooved girder rails were used, weighing about 80 lbs. to the yard, and point plates were not used.

Following is a detailed description of tests:

Test No. 1.—Edison-Brown plastic copper rail bond of 0000 size; length, 76 mm; height, 38 mm; thickness, 3.2 mm. This bond was merely laid by its own weight, so that one half touched the amalgamated spot upon one rail and the other half a similar spot upon the other rail. A current of 1915 amperes was passed from rail to rail through this bond with a potential difference of 0.0234 volts; calculated resistance, 0.0000122 ohms. After five minutes the current was 1806 amperes, potential difference, 0.0233 volts, and calculated resistance, 0.0000129 ohms. After the passage of the current for five minutes through this bond, the finger could be held upon it without discomfort.

Test No. 2.—Conditions the same as in the first except that two 0000 Edison-Brown plastic copper rail bonds were used. In this case the current was 1915 amps.; difference of potential, 0.0127 volts, and calculated resistance, 0.00000666 ohms. No apparent heating above temperature of room.

Test No. 3.—Conditions the same as before except that one Edison-Brown plastic copper rail bond 000000 size was used. Length, 89 mm; height, 44.5 mm; thickness, 4.7 mm. The current was 1910 amperes; the difference of potential, 0.0114 volts, and the calculated resistance, 0.00000598 ohms. No appreciable heating above temperature of room after five minutes' passage of current through the bond.

Test No. 4—Conditions the same as in No. 3, except that two Edison-Brown plastic copper bonds 000000 size were used. The current was 1880 amperes; the difference of potential, 0.00678 volts; calculated resistance, 0.0000036 ohms.

Test No. 5.—Copper bond of 00 size set in rails by driving steel pin in the longitudinal hole in the terminals. Diameter of conductor 9.3 mm; diameter of terminals, 16 mm. In this case the current was 1610 amperes; difference of potential, 0.75 volts, and calculated resistance, 0.00046 ohms when the circuit was closed. After five minutes the current was 1530 amperes; difference of potential, 0.83 volts, and calculated resistance, 0.00054 ohms. After the current had passed for two minutes it heated the bond to redness.

Test No. 6.—Two copper bonds aggregating the same section as in test No. 1; these bonds were set by driving a steel pin in the longitudinal hole in the terminals. The diameter of each bond was 9.3 mm; diameter of bond terminals, 16 mm. In this case the current was 1805 amperes; difference of potential, 0.278 volts, and calculated resistance, 0.000154 ohms at the start. After five minutes and twenty seconds the current was 1620 amperes; difference of potential 0.37 volts, and calculated resistance, 0.000219 ohms. After the passage of the current during two minutes and five seconds the temperature of the bonds was at steam heat.

Test No. 7.—In this test a certain type of flexible copper bond with solid terminals was used, which had exactly the same section as the bond in test No. 1, viz.: 0000; diameter of terminals, 22 mm. The current was 1830 amperes; the difference of potential, 0.119 volts, and the calculated resistance, 0.000065 ohms when the circuit was closed. After five minutes the current was 1750 amperes; difference of potential, 0.1213 volts, and calculated resistance, 0.0000659 ohms; temperature, steam heat.

Test No. 8.—One end of a permanent copper bus-bar on the switchboard in the laboratory of Ecole d'Electricité was connected to an adjoining bar by the experts of the school, in the best French manner. The other end of the same bus-bar with contact of the same area and with same number and size of bolts, was made up with the Edison-Brown contact alloys. With a current of 1760 amperes the loss at the first joint was 0.048 volts; the loss at the plastic alloy joint in series with the first was 0.0008 volts, or sixty times as good.

Test No. 9.—A current of 202 amperes was passed through a copper rod 11 mm in diameter. Difference of potential measured between two points about 10 cm apart on the rod was 0.0038 volts; calculated resistance, 0.0000188 ohms. The rod was then sawed in two, the ends were amalgamated and a small amount of plastic alloy was placed between the ends in contact with each other. With a current of 206 amperes the difference of potential was .0045 volts, and the calculated resistance, 0.0000218 ohms. The length of a bar of unbroken copper, to give the same resistance, measured 11.5 cm. Resistance of the rail per meter, 0.0000564 ohms.

Overhead Material for Electric Railways

The growing demand existing for overhead material has caused many concerns to specialize this branch of the electrical railway supply business. This has naturally raised the standard of excellence in regard to the apparatus in question, and the imposed conditions have been met by the older firms in the trade by a quality of output that can hardly be bettered. This excellence of quality includes not only improvement in the metal and insulation used, but the invention of new machinery and the employment of skilled labor has rendered practicable the securing of the best possible workmanship and finish.

A large and well known firm which has recently begun to pay special attention to overhead construction is that of F. H. Lovell & Company, New York and London. In its business dealings regard is always had for the effect of first cost on electric installation, but it never subordinates quality to price. Having its own foundry and machine shops the company is dependent upon no outside sources for its supply of castings. It is enabled thus to follow through, from start to finish, the making of its goods, and also to give intelligent and exact promises regarding the delivery of material. The factory is situated in Brooklyn. The entire plant, including machinery, apparatus, recipes, etc., of the New York Electrical Works, has been purchased, which enables the Lovell Company to make the same insulation as was used by the former occupants. This insulation has stood all tests, including those of time and use. It has given satisfaction wherever introduced, and has been employed extensively on many large systems, such as the Brooklyn Heights Railroad Company's. Overhead material, in which this insulation is used, is claimed to be always reliable, the dependence which can be placed upon it being undoubtedly due to the great care taken in its manufacture and the strictness of the inspections and tests to which each piece is subjected.

That promptness in acknowledging and executing orders is absolutely essential, especially in cases where material is desired for export, has always been recognized by the company. Its customers may, therefore, rely upon its despatch and reliability. From the thorough knowledge of overhead work possessed by the men in the company's employ it is assured that its products will continue to be manufactured along the most modern lines, and by thus keeping abreast of the times it will be enabled to advise in all improvements which are taking place from time to time in overhead construction.

An Efficient Electric Arc Headlight

That a headlight giving greater illumination than the best forms of oil headlight is a necessity on interurban and suburban lines operated along public highways is now admitted by the majority

PHOTOGRAPH TAKEN BY LIGHT FROM ARC HEADLIGHT

of the railway men in charge of such lines. The interesting illustration on this page is a reproduction of a night photograph taken by the Wagenhals Arc Headlight. The headlight was on one of the cars of the Southern Ohio Traction Company, which connects the cities of Cincinnati, Dayton and Hamilton, and the view shows a position of one of the interurban tracks of the company. Where a motorman can have as well lighted a track by night as by day there is little or no excuse for collisions or similar accidents, and a glance at the engraving will show the flood of light which is constantly in front of the car when this headlight is used. It is claimed that on straight track the road is illuminated for sometimes half a mile in advance. The arc lamps in these headlights are easily operated and not liable to get out of order. The voltage is regulated by a German silver resistance substantially built and placed out of the way under the car. The current required by the lamp is from 3 amperes to 4 amperes, which is quite low for this class of apparatus.

The Wagenhals Electric Arc Headlight is made by the Dayton Manufacturing Company, Dayton, Ohio.

New English Car Company

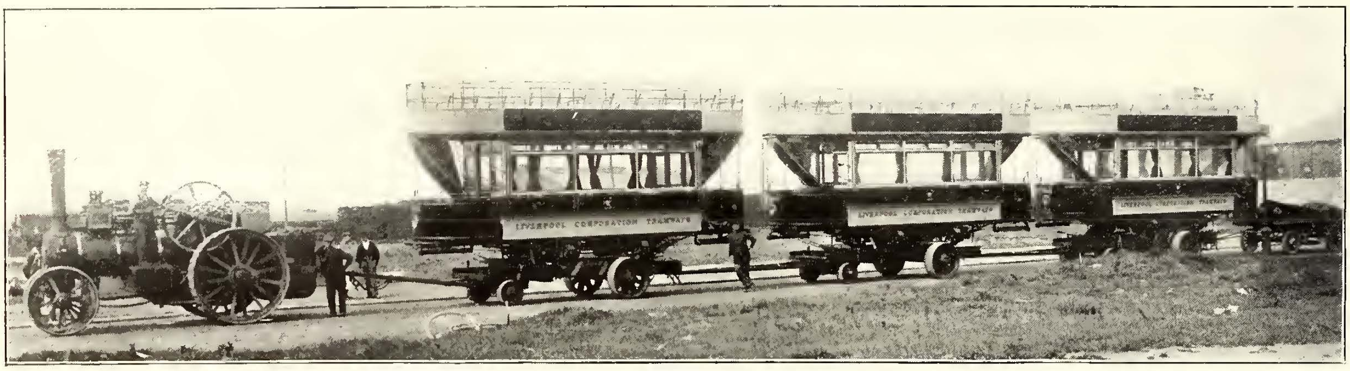
The British Electric Car Company, Limited, with a capital of £50,000, has just been organized with the following directors: A. K. Baylor (chairman), William M. Murphy, George J. Jackson, Jervis W. Barber and W. S. Laycock. The company has been formed with a view of carrying on the business of manufacturers of and dealers in electric cars and other rolling stock, having its headquarters in London. It is intended to devote special attention to the supplying of cars for electric tramways and light railways.

The company has secured a site for the erection of works at Trafford Park, Manchester. The location is a particularly suitable one for its purposes, as it is in direct communication with the various railways serving Manchester, and is at the same time on the banks of the Manchester ship canal. It is proposed to place the building contracts at once so that manufacturing or assembling facilities will be ready in a short time.

A. K. Baylor, the chairman of the company, is well known in both England and America, having been for several years manager of the traction department of the British Thomson-Houston Company, before which time he was associated with the General Electric Company, of New York. The other directors are also well known in electrical and railway work in England, the whole forming a particularly strong board for the purposes in view.

Traction Engines for Shipping Electric Cars

The interesting photograph which is presented herewith shows the method in which electric motor cars are shipped by the Electric Railway & Tramway Carriage Works, Limited, Preston, England, to fill the contracts of Dick, Kerr & Company, Limited, with the Corporations of Liverpool and other towns within a radius of 40 miles to 50 miles from the works. It will strike American readers as curious that such a method should be at once much cheaper and more expeditious than shipment by rail. The fact of the matter is that, although these works have excellent railroad connection with the tracks of two of the great English railroad systems, the magnificent country roads which exist throughout Great Britain enable them to ship by road-traction engine with considerable advantage. As will be noted from the illustration, the cars are mounted on small, special, wide-wheel road trucks complete, with the exception of the upper deck trolleys, the road bridges permitting the passage under them of any article not more than 15 ft. to 16 ft. in height above the roadway. These cars, tested on the company's tracks after being completely equipped at Preston, simply have the trolley stands and poles removed before being run on to the road trucks. After their arrival at their destination, all that is necessary is to run them down on the tramway track, replace the trolley and start off under current. The ordinary rate of shipment under these conditions is about three complete cars per day. It cannot be said that this appreciation of existing facilities shows any lack of enterprise on the part of the English engineers.



SHIPPING ELECTRIC CARS BY TRACTION ENGINE

A Prosperous New England Car Company

The Laconia Car Company Works, of Laconia, N. H., with principal offices in Boston, Mass., has, under the efficient management of Col. E. H. Gilmour, gained a most enviable reputation for the handsome types of electric cars built by this company, and particularly for the excellence of the work in every detail. Laconia cars have a reputation in New England second to none, and, although the company's plant at Laconia is the largest and most complete car-building works in New England, its capacity has been continually taxed for the past year in filling orders for that section alone. In taking charge of the Laconia plant the first move made by Col. Gilmour was to equip it throughout with the very best and latest types of machine tools. The company is enlarging its factory very considerably, and with a largely increased capacity hopes to be able to extend its business beyond its present limits. The double truck designed and made by it is said to have given unqualified satisfaction wherever introduced. These trucks are equipped with double-plate wheels of the company's own make, the wheels being practically of the steam-car type, much stronger and more durable than the ordinary wheel and better adapted for high speed.

Lythite for Power Stations, Car Houses, Etc.

Lythite is the title of a cold-water paint now being put on the market by the Frank S. De Ronde Company, of New York. It is a dry powder, which, when simply mixed with cold water, produces a perfectly pure liquid paint. It is especially recommended for coating the walls, ceilings, etc., of power houses, engine rooms, car houses, storage rooms, and hosts of other purposes. Lythite is made in a pure, lustrous white and in twenty-four handsome colors. It is claimed to last ten times as long as whitewash and is guaranteed not to crock, rub or peel off. It also gives a fine, firm, hard surface, that will last for years, and is both fire- and weatherproof. Another important advantage claimed for it is that it sets very quickly and when dry is extremely hard, at the same time retaining its elastic properties. To large surfaces this paint can be most economically applied with De Ronde's ideal painting machine. This is a unique apparatus, having the power air compressor, tank and all combined, ready for use; at the same time it is compact and simple in construction.

Another very valuable use for Lythite is as a priming surface over which oil paint and varnish are to be applied. It makes an excellent foundation and base for a priming or rubbing down coat. Recent tests have also shown its value for rubbing down. One railway company which had used the material for this purpose reports that Lythite takes the place, without a filler, of two coats of rough stuff and one of filler rubbed down with pumice, and that it gives a remarkably smooth finish under the action of pumice stone and water. The colored Lythites have been used extensively for the outside coat of car houses and buildings of every description.

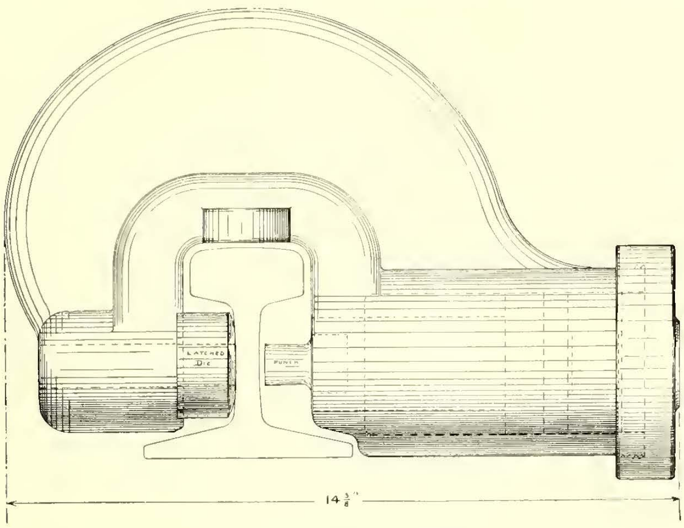
Where a cheaper sanitary coating than Lythite is required, the De Ronde Company supplies National Wall Coating. This latter material is only adapted for inside work, while the Lythite can be used for either inside or outside purposes. The Wall Coating possesses many of the good properties of Lythite, however, has the same intense whiteness, and is also fire resisting. This product is also made in twelve delicate tints, as well as white.

The treasurer and general manager of the company is Frank S. De Ronde, who is well known in electrical circles and is an authority on insulating materials and paints of every description. The other officers are: John A. Hall, president; Col. Sheffield Phelps, vice-president, and Charles D. Bailey, assistant manager.

The Sunderland (England) Corporation Electric Tramways were formally opened on Aug. 15. This is one of the most important undertakings in the North of England, Sunderland having a population of from 150,000 to 175,000. The present scheme, upon which work was commenced a year ago, included the construction and equipment of 15 miles of track. The contract for the complete equipment of the lines, amounting to about $700,000 in the present case, was placed in the hands of Dick, Kerr & Company, who constructed the permanent way and overhead systems and supplied the feeders and rolling stock, which consist of cars of the standard Preston type.

A New Hydraulic Rail Punch

The apparatus illustrated on this page is designed to furnish street railways with a convenient and efficient means of punching the rails. The device is but little over a foot in length, and is



HYDRAULIC RAIL PUNCH

used in conjunction with a small portable hand-pump. The entire weight of the complete equipment is about 80 lbs. The hand-pump or compressor is joined to the press by a flexible hose connection, which is attached to the end of the press cylinder by an ordinary coupler. The hardened steel die of the punch is made removable, and is dove-tailed, or latched, into the steel backing. This enables the frame of the punch to be conveniently placed over the head of the rail, while the die is removed, and allows of its easy adjustment. The punches and dies can be easily changed, and the machine thus readily adapted for installing bonds by pressure.

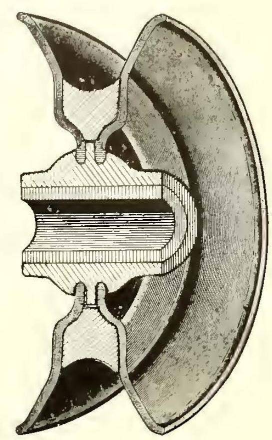
This improved form of hydraulic punch is controlled by the Morris Electric Company, of New York, and is being put upon the market by that company.

Electrical Traction in Liverpool

The Corporation of Liverpool has been proceeding very rapidly with the equipment of its electric installation, and by the end of this year will have reconstructed at least 100 miles of tramway route, and will thus be the first large city in Great Britain to be thoroughly equipped electrically. The current for the lines is obtained principally from the two large new generating stations which have been built for lighting and power, each having a capacity of 1200 hp. A very interesting feature of these new power stations lies in the fact that high-speed engines have been adopted, each engine having a nominal capacity of 1200 hp and 1500 actual hp. The engines were built by Willans & Robinson, of Rugby. They are direct coupled to 220-volt, 800-kw Siemens' multipoler generators, which are shunt-wound, so that they can be used for either lighting or power. These new power stations may be taken as excellent examples of English electrical engineering practice. There will probably be much comparison between them and the American practice, adopted in Glasgow, where the principle of joint supply at 500 volts is used both for lighting and tramway purposes and where both circuits are taken directly from the same generating sources. The use of these high-speed engines, which, to American ideas, seem abnormal for such large units, is also distinctly English, and the economy in this Liverpool system as compared with the Glasgow system will undoubtedly be watched with a great deal of interest on both sides of the water. The cities are practically of the same size, both under municipal control and resembling each other in many aspects. So fast has the Corporation been extending its lines in Liverpool that it has just extended the existing contract with Dick, Kerr & Company, Limited, for another hundred completely equipped motor cars of the improved Preston top-seat type, making a total of 425 which it has had from this firm.

An Economical Trolley Wheel

In designing the trolley wheel illustrated on this page the manufacturers have attempted to combine the merits of existing forms with some added improvements of their own. It was their intention to produce a wheel constructed on mathematical lines, which would have a maximum strength and a minimum weight, and which, while remaining inexpensive, would have a long life, without being destructive to the wire. The result of these attempts is the "Ideal" trolley wheel herewith shown.



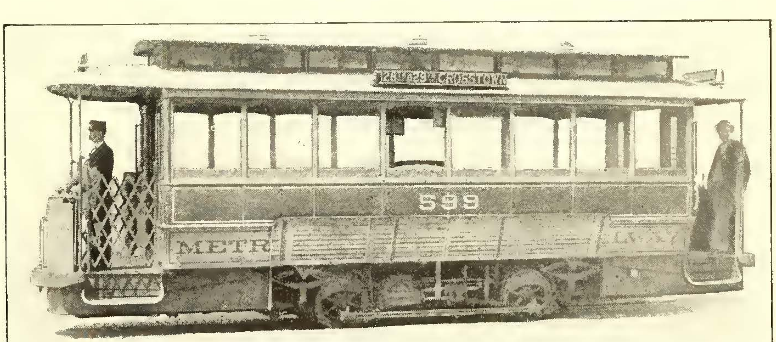
IMPROVED TROLLEY WHEEL

The flanges of the "Ideal" wheel are made of a special, soft, cold-rolled and pickled steel. It is claimed that this steel will not become hardened or blistered by the electric arc or current, and will, therefore, wear the wire no more than if made of a soft bronze. These flanges are securely held in the hub, which is cast around them, as shown in the cut. As there are no screw threads to wear out, or nuts to work loose, there is no danger of the wheel collapsing. The material used in this hub is "Lumen" bronze, a patented alloy, controlled by the manufacturing company. Standard graphite bushings are employed as a bearing for the hub, the wearing tread of the wheel being of pure copper.

The "Ideal" trolley wheel is made by the Bierbaum & Merrick Metal Company, Buffalo, N. Y., and is extensively used on many railways. Its peculiar construction, recommending it to both theoretical and practical engineers, has led to its introduction, and its efficient service has retained it in favor wherever installed.

Compressed Air Cars in New York

The new type of compressed air cars being used by the Metropolitan Street Railway Company, of New York, and manufactured by the Compressed Air Company, under the Hardie patents, have been put in operation on the Twenty-Eighth and Twenty-Ninth Streets line. The cars differ considerably in appearance from



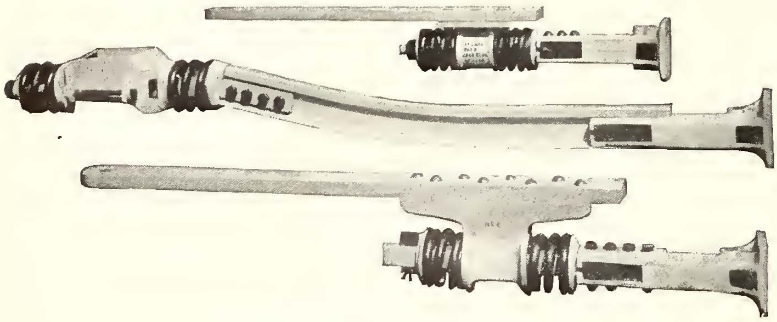
AIR MOTOR CAR IN NEW YORK

those formerly used, as will be seen from the engraving herewith. The chief feature of difference to the ordinary observer is the use of connecting rods. The motors, however, as well as the general method of using the air, is quite different from that formerly employed, as was fully described in the Street Railway Journal for August.

In actual service on the street a wooden screen, shown raised in the cut, covers the upper part of the truck and connecting rod, this having been considered more desirable for city service.

An Efficient Car Coupler

In elevated railway service, where cars are run in trains, and on those roads where trailers are operated, the question of car couplers is of considerable importance. The accompanying illustrations show some forms of coupler which have been in successful operation for a considerable length of time, and which are especially adapted to this class of service. The styles shown are



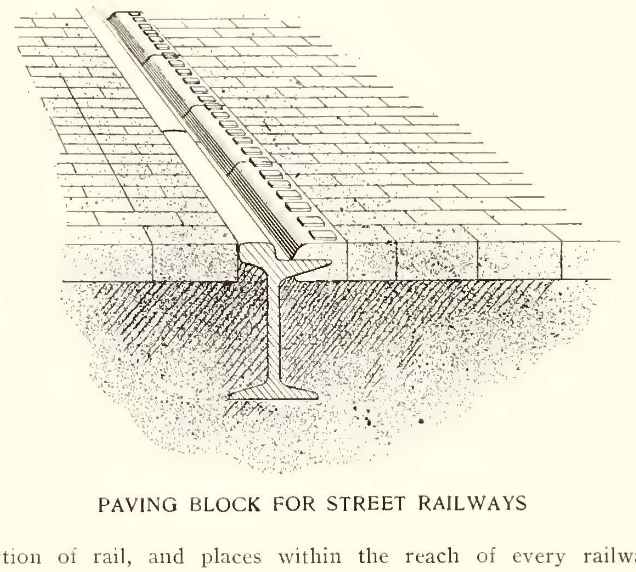
COUPLINGS FOR ELECTIRC CARS

three of the thirteen distinct patterns of automatic couplers made by the W. T. Van Dorn Company, Chicago, and represent the type used on the new Northwestern Elevated and the Lake Street Elevated of that city on trailer cars, the kind used on the same roads on motor cars, and a special form designed particularly for interurban service.

The Van Dorn couplers are giving satisfaction in many parts of the world. The company has lately been favored by orders from Yokohama, Japan, and Glasgow, Scotland, as well as from the Continent of Europe. Recently the Manhattan Elevated, of New York, and new elevated roads of Boston have begun the installation of this form of coupler on their cars.

An Improved Paving Block

The large number of roads now laid with the ordinary trainhead girder rail have long experienced the troubles accompanying its use both from the wearing out of the adjacent pavement and from the damage to vehicle wheels. The device illustrated on this page converts the old-style rail into the standard full-groove



PAVING BLOCK FOR STREET RAILWAYS

section of rail, and places within the reach of every railway manager the means of making his track conform to the most modern practice. The application of the paving block to existing roads entails very little more work than the mere repaving of the street, no skilled labor being required or bolts used.

The engraving shows the invention used on brick-paved streets, although it is, of course, equally applicable to granite block or asphalt pavement. It is called the "Buckland Paving Block," and consists of an iron casting, grooved to receive the lip of the rail, and finished with ridges on the upper surface to give a foothold for horse traffic. By arranging the blocks so that they break joints with the rail an efficient secondary rail-joint is provided, and this property increases the value of the paving block to a very great extent.

These blocks have been extensively used in Springfield, Mass., for more than two years, and the result has been most satisfactory. The rail-joints have remained in most perfect condition, and the entire track has to-day the appearance of having been but recently laid.

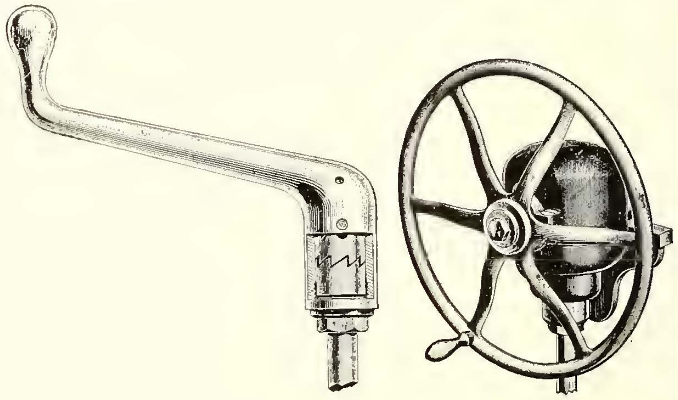
Considerable public indignation had been produced before its installation by the dangerous condition of the old girder rail, and it became necessary for the railway management to improve the condition of the track. The conversion of a section of the road to grooved rails by the application of the Buckland device was so successful that its general adoption soon followed.

A company has been organized in Springfield for the manufacture and sale of the Buckland paving block, and for contracting to do paving between the rails of street railways or general paving throughout the different cities and towns of the United States and Canada. It is called the American Street Railway Paving & Improvement Company, and is capitalized at $150,000, divided into shares of $100 each. The officers are: William P. Wood, Pittsfield, Mass., president; James D. Hunter, North Adams, Mass., vice-president; and C. Fred Smith, Adams, Mass., manager.

Ratchet Brake Handles for Street Cars

The "Beverly" ratchet-clutch brake handles and ratchet-clutch vertical brake wheels, which are herewith illustrated, have been manufactured by the Beverly Engine & Machine Company, of Beverly, Mass., for a number of years past, and have been in successful operation on many roads. The "Beverly" brake handles are simple, strong and reliable, and are made of the very best composition. The clutches are made of steel, and are machine cut, the workmanship and finish being of the best.

The ratchet brake handle resembles an ordinary, rigid brake handle. In the butt of the handle a steel ratchet clutch is held, and



RATCHET BRAKE HANDLE AND WHEEL

on the upper end of the brake staff the other engaging member is secured. The upper part of the clutch is movable, and the members of the clutch are held together, and the handle is secured to the staff by a lock-nut, screwed into the bottom of the handle butt. This is illustrated in the accompanying figure.

The ratchet-clutch brake wheels are intended for use on vestibule cars, and are, therefore, designed to be simple and powerful, while taking up but little room on the platform. The whole wheel projects only 10 ins. from the front of the vestibule. They are a combination of the ratchet of the brake handle and the brake wheel, placed so as to get the best results. The gearing gives a leverage equal to the diameter of the wheel used. Like the handles, they are made of the very best material throughout, the clutches being of machine-cut steel, and the gears of the finest quality.

These handles and wheels are in use by a number of the larger street car builders, including the Jackson-Sharp Company, Wason Car Manufacturing Company, Woeber Carriage Company, Briggs Carriage Company, Laconia Car Manufacturing Company, Duplex Car Company, and by the street railways in the cities of Boston, Philadelphia, Baltimore, Richmond, Brooklyn, Springfield, Providence and a large number of smaller towns.

The Price Friction Brake

The Price friction brake, which is manufactured by the Peckham Motor Truck & Wheel Company, is being rapidly introduced upon a number of electric railways. As its name implies, the application of the brakes is accomplished by means of the frictional resistance of two discs that are pressed together. Briefly, the device consists in having a friction disc *A* cast on one of the wheels, a corresponding disc *C*, provided with a sleeve *D*, mounted loosely upon the axle, a second sleeve *N*, secured firmly, and keyed to the axle, and a friction clutch, located between the down *M*. This pushes against the disc *F* at the point *H*. This forces the loose sleeve against the wheel disc, and makes it turn with the axle, winding up the chain. The wear between the sleeves and the circular disc and yoke levers is taken up by the brass plates *Q Q*. Only one pressure piston is used, as at *K* the opposite fulcrum is held by a surplus of light springs. As the parts wear, an adjustment is made by turning the screw bolt *O*. The springs *I* serve as a cushion that softens the application of the brake, and tends to the avoidance of sudden gripping by causing the application of the pressure between the two discs to be gradual.

The brake, as thus constructed, is exceedingly sensitive, and

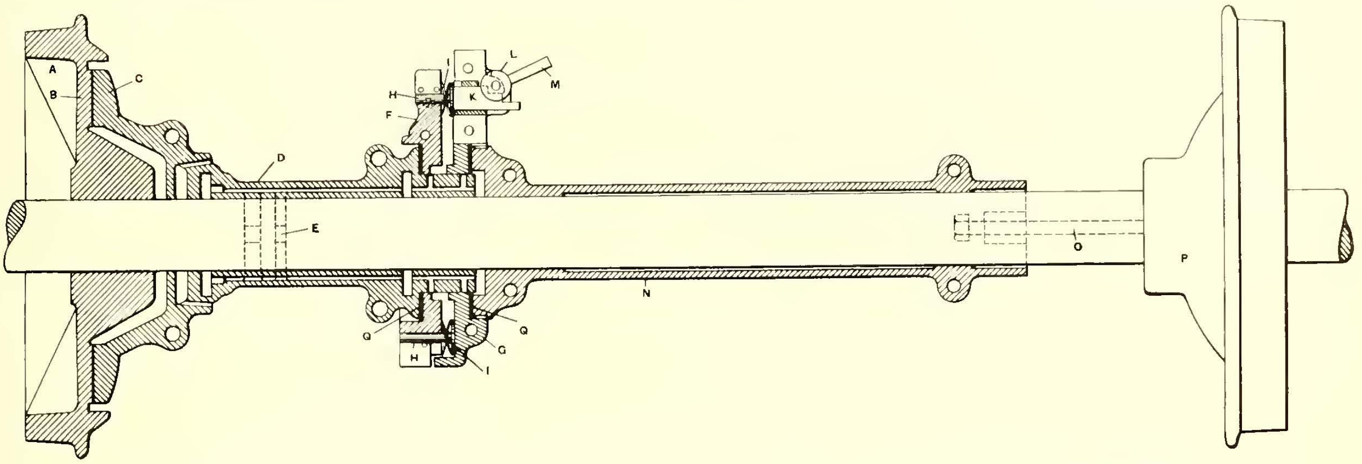


FIG. 1.—PLAN VIEW OF AXLE OF MAXIMUM TRACTION TRUCK, SHOWING BRAKE MECHANISM

two sleeves. The loose sleeve is provided with lugs, to which is secured a chain, which leads to the brake sway-bar, attached to the car body. As the wheels revolve, and as the pressure is applied to the end of the sleeve *D*, of the disc *C*, the chain winds around the sleeve and applies the pressure to both brake-shoes by means of the brake connecting rods. The power is applied to the friction discs, which are machine faced, by means of the clutch, which is operated by the motorman by means of a wire rope connecting the clutch with the brake staff.

The mechanism of the brake is clearly shown in Figs. 1 and 2, which show it as applied to one of the trailing axles of a maximum traction truck. Referring to the plan, Fig. 1, the engraving represents the parts in section, whereas, in reality, the surfaces so sectioned are the flat parting surfaces of one of the halves. The section lines are used in order that the eye of the reader may quickly and easily distinguish the metal surfaces from the open spaces.

can be so applied as to produce any desired amount of tension on the brake chain. At the same time this tension can be made very severe by a hard pull upon the staff lever. In some tests that have recently been made, the pull on the chain was raised to 2500 lbs., a tension that is far in excess of anything that the brake would ever be called upon to do. For ordinary working the intention is so to proportion the leverage that for a sudden emergency application of the brake, the pull on this chain should be from 800 lbs. to 1100 lbs., according to the weight and speed of the car and the load that is being carried.

The advantages claimed for this brake are, first, that the amount of brake-shoe pressure can be varied, so that it is properly proportioned to the weight on the wheels, using a higher pressure for a loaded than for an empty car. In this way it becomes quite possible to make as short a stop with a loaded as with an empty car, a condition that is quite impossible to meet in the case of a car upon which the brake-shoe pressure is constant under all variations of load.

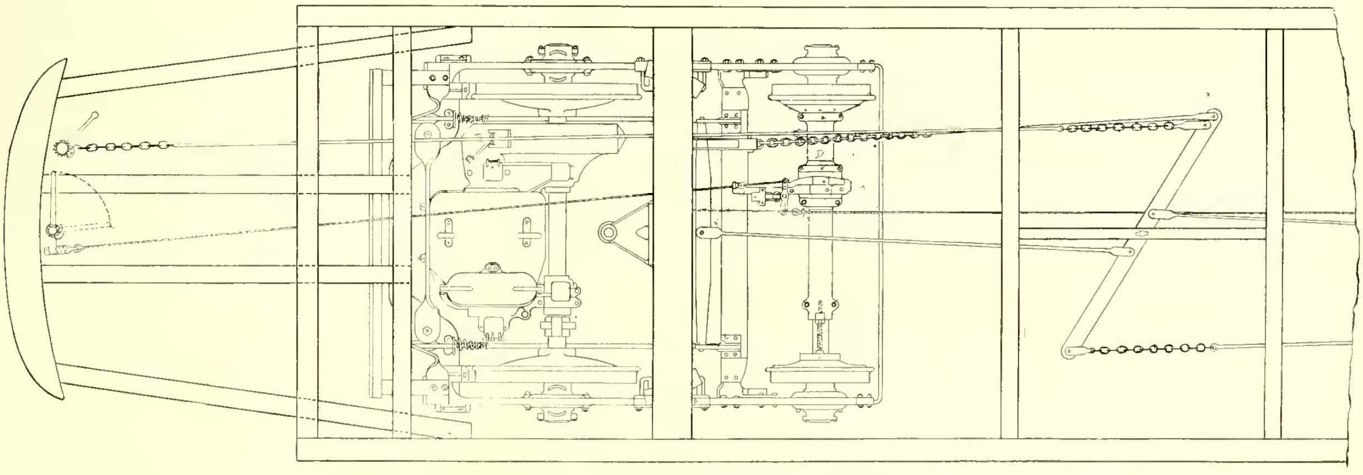


FIG. 2.—PLAN SHOWING APPLICATION OF BRAKE TO MAXIMUM TRACTION TRUCK

The method employed to force the two discs together is extremely simple. The sleeve *N* is, of course, fixed on the axle, and turns with it. It is adjusted to the proper position longitudinally with the axle by means of the screw bolt *O*, that bears against the inside of the hub of the wheel *P*.

One end of the wire cable for setting the brake is attached to the brake staff. The other end is attached to the lever *M*. One quarter turn of the handle serves to apply the brake by drawing

Secondly, the simplicity of the mechanism used is such that it is not likely to get out of order, and can be easily and quickly understood by the men who are to have charge and operate it. It requires no especial skill to apply it or to operate it, and hence the cost of maintenance is reduced to a minimum. In fact it has been found that one ordinary, unskilled man can easily take care of and properly maintain fifty or more of these brakes, and that, too, when they are running on different divisions, so that a considerable amount of time is lost in going from one car house to another.

Thirdly, the power consumed in the application of the brake is taken from the momentum of the car itself, and thus assists in the stopping, and does not in any way call upon the electric generating machinery to do the work. It, therefore, avoids all the charges for operating expenses that fall upon those systems of brakes that are driven by a current taken from the main current, either directly or indirectly.

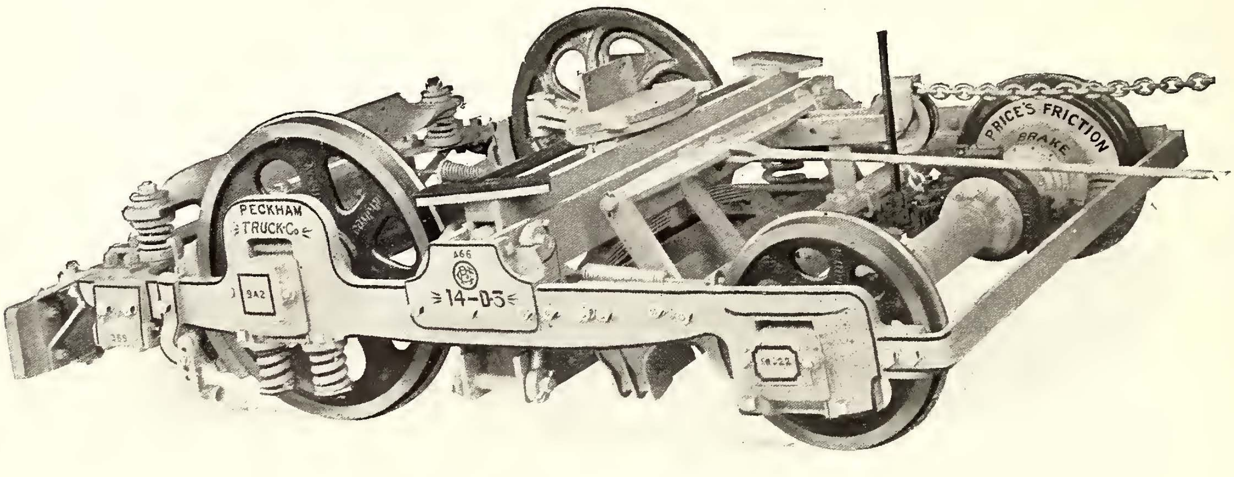


FIG. 3.—GENERAL VIEW OF BRAKE ON MAXIMUM TRACTION TRUCK

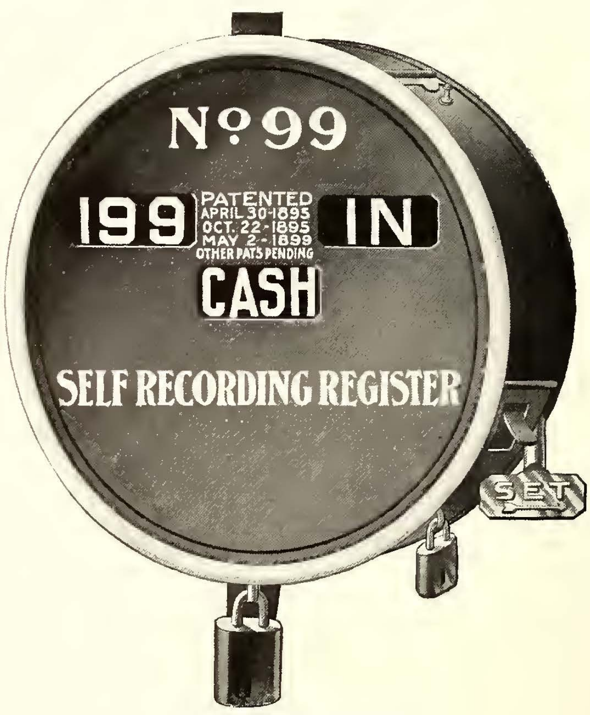
And, finally, it is extremely rapid in application. It has been proved, by repeated tests, that the brake can be fully applied within one-quarter of a second from the time that the motorman starts to move the brake handle. With these advantages in its favor the mechanism is proving itself to be thoroughly efficient and reliable for the work that it is intended to do.

To adapt it to different styles of cars and service, this brake is constructed of three different styles—styles A, B and C. Style A is designed for use on maximum traction trucks, which use only one motor per truck. Style B is designed for single-truck cars, where the motors are attached to both axles. Style C is designed for double trucks, used for heavy, high-speed service. Among the roads which have used these brakes for several months are the Brooklyn Heights Railroad Company, of Brooklyn, which has forty equipments on maximum traction trucks, and the New Jersey & Hudson River Railway & Ferry Company, of Bergen County, N. J., which is operating ten 45-ft., fourteen-bench open cars, mounted upon Peckham 14-B 3 short wheel-base trucks, and equipped with four G. E. 57 motors. The grades of this road run from 6 per cent to 10½ per cent, with sharp curves. People's Tramway Company, of Putnam, Conn., is also using this brake, operating six cars, mounted upon Peckham 14-B 6 trucks, equipped with two Westinghouse 49 motors; as is also the Meriden, Southington & Compounce Railroad Company, of Meriden, Conn., which has four cars, mounted upon Peckham 14-B 6 trucks, with four Westinghouse 49 motors.

A Self Recording Cash Register

Street railway managers always welcome a device that tends to do away with or lessen clerical labor or lessen the liability of error in clerical work. For this reason the new self-recording register, herewith illustrated, which is being put out for the first time, should meet with success. This register does not depend on the accuracy of clerks or conductors in noting register readings, but furnishes printed slips to both conductor and company with the register reading thereon. At the end of his run each conductor may draw from the register a slip showing the register totals at the end of each trip during his run. On another slip, drawn from a long roll of paper in the register, is printed a duplicate of the conductor's record, this duplicate being under padlock, and accessible only to the company. As the register totals at the end of each trip are printed in plain figures, there can be no dispute between conductors and clerks as to register readings.

The operation of the register will be understood by reference to the accompanying engraving, together with the following. The number of fares and transfers rung up on a trip is shown by the numerals at the left. These numerals are claimed to be the largest in use on any register, and are 1¼ ins. high and 1 in. wide. The cash fares and transfers are, however, separate on the totalized records furnished on the printed slips. The direction of the trip is indicated at the right, and the kind of fare rung up shown in the center, the target showing kind of fare last recorded. The cord running to the right rings cash fares and sounds a loud bell, while that running to the left rings transfers and sounds a muffled bell. At the end of each trip the conductor turns the key on the right-hand under-side of the case, which automatically brings the register back to zero. In so do-



NEW RECORDING REGISTER

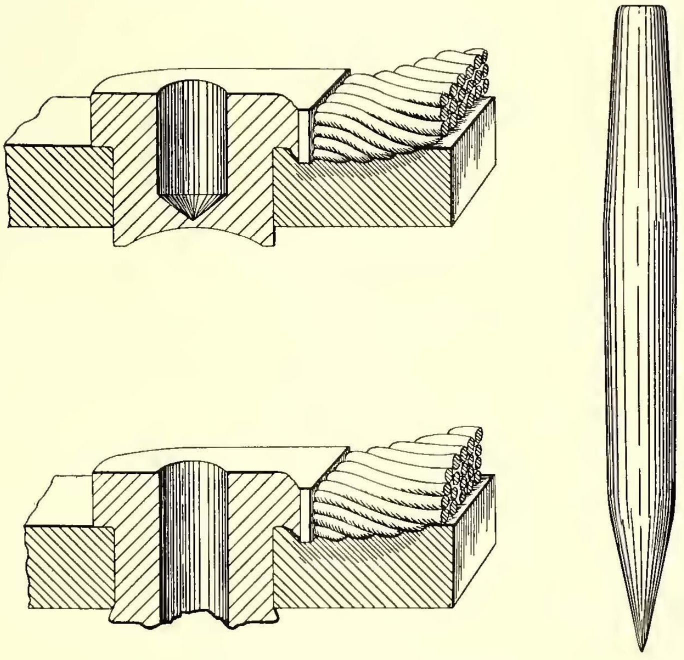
ing he works a cam, which prints the totalized cash fare and transfer readings on the slips, by the impression of steel type on the paper. The company paper roll is of rather thin paper, and the impression of the steel type letters prints partly through the company paper and into the conductor slip, which is of thicker and softer paper. No fares can be rung unless the trip changing and printing key has been turned a full turn, and until the conductor inserts his strip. The conductor puts in and takes out his strips through a door in the side of the case, but this door does not give him access to the company paper, which latter can only be taken out by the door which is locked with the padlock. There is sufficient paper on the company roll inside the register to last one hundred days with proper handling. It is claimed that it takes less time to take out a conductor's strip or a company's strip than it does to note down a register reading in the usual way. As to the disposition to be made of the company and conductor strips there are a variety of plans open. The conductor may keep his slip as a check, for his own protection, or he may turn it in to the company. In any case, the register furnishes two positive printed records of every trip made, and that alone is enough to commend it, whatever the particular disposition of the records decided on. The mechanical parts are all made of steel, and are entirely interchangeable. The description above applies to the register recording two classes of fares, or double register. The single type records only one class of fares, but is operated with the conductor's strip and company paper, as in the double register.

The self-recording register will be on exhibition at the October convention. It is made by the St. Louis Register Company, and will be shown at the convention with the exhibit of that company.

An Improved Method of Attaching Rail Bonds

The accompanying illustrations show a rail bond which has recently been put on the market, and which is not only easily applied to the track but is very efficient. The application of the bond to the track is well shown in the cuts. A hole is punched through the web of the rail in the ordinary manner, and the cylinder-shaped projection on the terminal of the bond is placed in the hole. A hardened steel punch, shown on the right, is then driven through the thin copper web in the bond end by means of an ordinary heavy hammer. This punch, as will be noticed, tapers slightly to a little more than one-half its length, and after the sharpened end has broken through the solid copper, the tapering sides force the sides of the projection on the bond closely into contact with the iron of the rail. A cold riveted joint is thus produced, the peculiar shape of the bond head causing it to lap over the end of the hole in the rail web, thus locking it permanently in position.

It is evident that the bond cannot be left when improperly applied or only half riveted, as the steel pin, not being a part of the bond proper, must be forced entirely through before the workmen can go to the next bond, or the fish-plate attached. The bond is made in several forms, the ordinary flattened cable connection being shown in the illustration. It is the invention of Robert E. Benning, chief engineer of the Union Railway Company, New York, and is manufactured and sold by the Morris Electric Company, of New York.



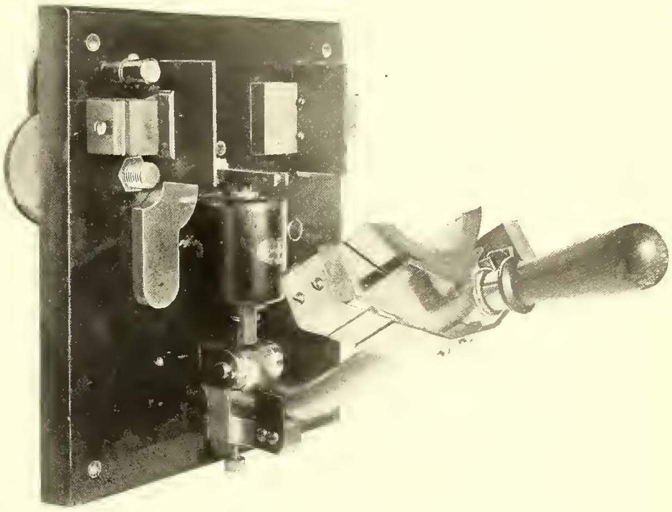
SECTIONS OF BONDS AND PUNCH

Magnetic Blow-Out Circuit-Breakers

The Cutler-Hammer Manufacturing Company, well known as manufacturers of rheostats and electric motor controlling devices, will exhibit for the first time, at the Kansas City Street Railway Convention, a line of magnetic blow-out circuit-breakers, which possess several features of value in railway work. The accompanying cut gives a good idea of its construction and appearance.

The main contacts of these breakers are made of multiple leaf copper strips, pressing firmly against brass or copper surfaces, parallel to the plane of the switchboard. The arcing is taken from very heavy carbon blocks, which are easily renewable, and the opening of the breaker is sufficiently great to break the arc. In addition to this long break, however, two powerful magnets are used to blow out the arc, which they do so effectively that the breakers are guaranteed to open the circuit at their rated capacity 500 times without requiring repairs.

The pressure of the carbons and copper leaves is utilized to open the breaker, thereby eliminating extra push-off springs, which would require extra manual exertion to close the breaker. This heavy pressure on the carbons also insures such a good contact that absolutely no arcing occurs at the copper brushes when they break contact. The blow-out magnets make a sharp, clean break of the arc, thereby eliminating the sheet of flame which occurs on breakers not provided with the blow-out feature, which flame is liable to injure both the breaker and surrounding instruments. The breakers are held closed by a hair trigger, which cannot be jarred loose, but will open with a very light blow, struck by the plunger of the tripping coil.



MAGNETIC BLOW-OUT CIRCUIT-BREAKERS

A feature of special interest is the time limit attachment, which allows the breaker to remain closed during the flow of an abnormal current which lasts but a few seconds, but will open the circuit if this abnormal current lasts long enough to endanger the apparatus. The breaker will open instantly, however, on short-circuits or dangerously abnormal currents. This result is accomplished by shunting a portion of the current around the tripping coil through strips of iron ribbon, whose cross section is so small that they are heated by the current. As these strips heat up their resistance increases, and more current is consequently sent through the tripping coil, eventually causing this coil to trip the breaker. It will thus be seen that abnormal currents that last but a few seconds will not have sufficient time to heat up the iron strips, but dangerously abnormal currents will shunt enough current through the tripping coil to cause it to act immediately without waiting for the iron strips to heat.

A very large range of adjustment of the breaker is obtained both by varying the lift of the plunger and the number of iron shunt strips, which are made easily renewable. The breaker can also be adjusted so as to make it sensitive or sluggish to moderate overloads, as may be desired. These breakers will be known to the trade by the letters W. T. L., which are the initials of the words "with time limit."

Motors for the Metropolitan Underground, Paris

The newly inaugurated Metropolitan Underground Railway system of Paris is probably the most notable instance of the application of the electric motor to high-speed underground railway service that has thus far been developed. This railway extends underground from Porte Maillot to the Porte de Vincennes, and 14 miles of track are in operation; but the route that is now open is only a small fraction of the projected Metropolitan system. When this enormous undertaking is finished its electric trains will reach practically every corner of Paris and its immediate suburbs.

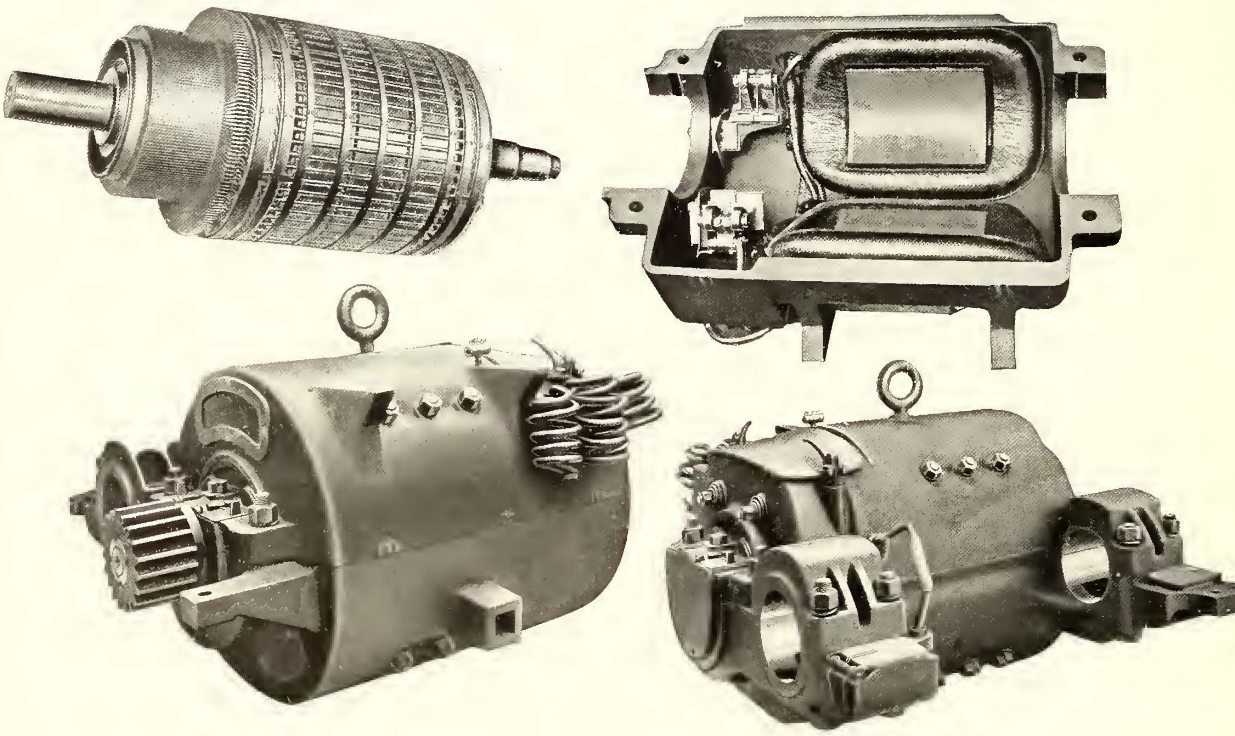
It would be difficult to find a greater contrast in transportation methods than that afforded between the present electric system and the ordinary street railway service of the French capital. Americans traveling abroad have been amazed at the inadequacy of the Parisian transportation systems, and the tiresome officialism associated with it. The omnibuses and street cars, as a rule, stop only at officially designated "stations," at each of which the waiting passengers are supplied with tickets, numbered in the order in which they were purchased. Upon the arrival of a particular omnibus the tickets that have been sold are called out in order, and only those passengers are allowed upon the bus whose tickets come first in order—provided, of course, the omnibus is not large enough for the entire number. This fits in nicely with the French idea of equality, but it has always proved very tiresome to American tourists.

The Metropolitan Underground has brought the first real relief to this condition of things. In October, 1898, seventy Westinghouse motors were ordered from the Societe Industrielle d'Electricite, Procedes Westinghouse for the new road. These motors are of the type designated by the makers as the Westinghouse No. 70, which are in regular service on some of the most prominent street railways of the United States, excepting, of course, that the motors for Paris were slightly modified to conform to the special designs of car and truck which are used in France.

There are presented herewith a number of illustrations showing the general appearance of this motor. It has a cast-steel frame, into which the pole pieces are bolted, the latter pieces carrying projections which keep the field coils in place. The frame is divided horizontally in such a way that the top half may be lifted off for inspection, or the under half similarly removed. It is adapted to the familiar side-bar suspension, and is equipped with a single train of gears, the gear ratio being 1 to 2.4. The motors have been guaranteed to give their full output for one hour of continuous running without excessive heating, and furthermore they are guaranteed to carry 50 per cent overload for twenty minutes, and 75 per cent overload for shorter periods.

The specifications of the Metropolitan Company were very exacting, and the motors represent the very highest possible practice in electrical construction. Each Westinghouse car equipment for the Paris underground includes two complete motors with gears, gear casings and suspension springs; two controllers, automatic safety circuit-breakers, safety fuse blocks and lightning arresters; also contact shoes, a complete car wiring for light and power, and electric couplers for supplying current to the trailer cars.

The armatures are of the slotted drum type with two-circuit windings. The core is of sheet steel of the highest magnetic quality. The armature is wound with copper bars, nearly rectangular in section, forged into shape without joints. Ventilation of the armature is adequate to stand very heavy overloads, and the motor frame is designed in such a way as to allow ample circulation of air through the motor windings, the openings for this purpose being provided with lids which may be closed when necessary.



WESTINGHOUSE NO. 70 MOTOR

The field coils are wound on curved molds, fitted to the shape of the motor. The best quality of copper wire, double cotton covered, and of round cross section, is used. The several layers of wire are insulated with mica and fibrous material, all being covered in with strong tape and treated with moisture-proof compound. All the coils are subjected to an insulation test at 3000 volts, alternating current.

The motors themselves were tested very thoroughly as to running qualities, the method being to couple the motors together; one, running as a motor, driving the other as a generator. In this way the motors were run for a period of one hour at a small overload, the direction of rotation being changed every twenty minutes. The insulation of the motor as a whole was furthermore tested at 3000 volts, alternating current. Insulation between two adjacent segments of the commutator was tested to 500 volts.

The motors were constructed by the French Westinghouse Company, and were guaranteed to give the train an acceleration of 3 ft. per second when starting from rest upon the level, and to maintain a speed of 22 miles per hour, assuming a 32-ton train, and sufficient weight on the driving wheels to secure the necessary adhesion.

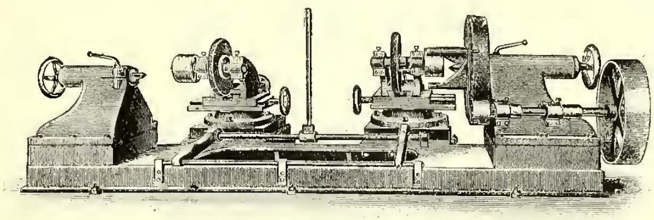
Trains on the Metropolitan underground consist of one motor car, equipped with two motors, and drawing one or more trailers. The motor car is double-ended, having a motorman's compartment at each end, in which is placed a series-parallel controller. The train is also equipped with air brakes, operated by an electric air compressor.

On the present line there are eighteen stations, the average distance being about 700 yards. The average speed of the trains is 15 miles an hour, including stops. The average length of the stop is approximately twenty seconds, and the run between termini, a distance of about 7 miles, is, therefore, made in about half an hour. Thus far, a ten-minute service has been employed, but the control of the electrical equipment is so complete that the intervals between trains may be as short as desired.

Electric Car Wheel Grinder

The car wheel grinder, illustrated herewith, is intended for use in railway repair shops, where efficient and rapid work is required. The machine is equipped with 18-in. x 1½-in. emery wheels. The head and tail stocks and emery wheel heads are on one solid base, which prevents vibration and secures accurate work. The emery wheel head is practically upon a compound slide rest, which is on a swivel head admitting of any desired angle. The machines are so arranged that one operator can grind two wheels at a time.

The spindles are ground and lapped and run in bronze boxes,



CAR WHEEL GRINDER

with dust-proof collars, and are arranged to take up the wear. There is a short track attached to a lever and a cam; the wheels are run upon this track, and by bringing the lever down the track is lifted and the wheels brought to center, making a simple device for centering the wheels before grinding. The head and tail stock spindles are arranged to give a variation of 8 ins. between centers and the machine is arranged for either extremely wide or narrow gage, as desired.

This improved car wheel grinder is made by the Springfield Manufacturing Company, Bridgeport, Conn.

Water-Wheel Governors

The whole subject of governing water-wheels is so obscure and of such a difficult nature that it is almost impossible for the ordinary engineer or operator of a water power to predetermine what degree of speed regulation can be obtained, how the governor should be connected up, or what changes in the plant, if any, will be necessary to obtain the best results. He is, therefore, more or less at the mercy of the manufaeturer, and it becomes more advisable than in any other department of hydraulic engineering to choose a reliable house.

The Lombard Water-Wheel Governing Company, Boston, Mass., is having decided success with its apparatus, and has a force of consulting engineers, who are constantly employed on just such problems. The company manufactures governors for all makes of turbines and impulse wheels on practical, novel designs, which are broadly covered by letters patent. They are simple in operation, regulate closely, and are in successful operation in many water power plants throughout the country.

The chief engineer of the company, Allan V. Garratt, is well known in engineering circles, and especially in conneetion with the development of hydraulic installations. The work of the company is under his careful superintendence, and its excellence is thus assured.

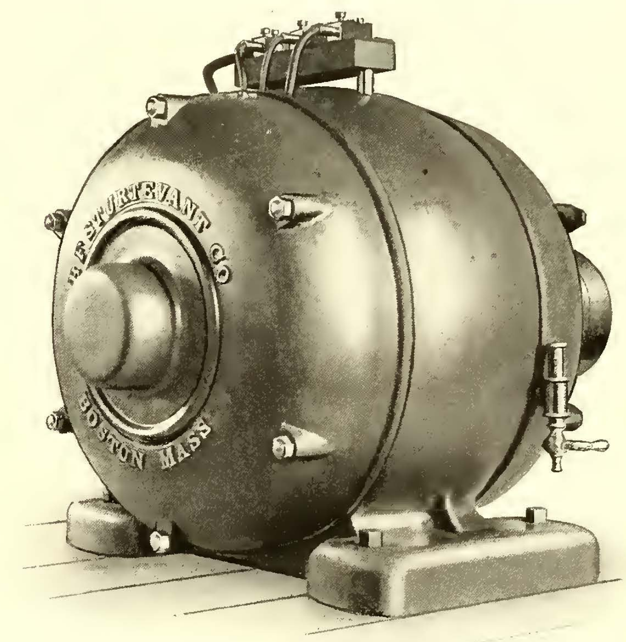
A New Type of Enclosed Electric Motor

This type of motor, built by the B. F. Sturtevant Company, Boston, Mass., being inclosed and readily portable, in the small and medium sizes, is specially adapted for driving small machines, such as machine tools, blowers, etc. For certain classes of work, where the conditions are favorable, the motor may be direct-connected to the machine which is to be driven. Cased fans of the centrifugal type may be thus equipped, and if desired the fan casing itself may be supported by the motor frame and made adjustable about it, so that any direction of the air discharged may be provided.

In order to avoid the excessive temperature which is incident to the operation of most inclosed motors, this type has been very carefully designed, so that a low temperature rise can be maintained without greatly increasing the size and weight above that of the ordinary open type.

This machine is capable of continuous operation for ten hours, with a maximum temperature rise not exceeding 60 degs. F. Yokes extending out from the field ring support the armature shaft. The end casings are entirely independent and can be instantly removed to give access to the entire interior. The bearings and brushes can be reached by simply removing the caps in the center of the casings.

The brushes are of hard carbon, in holders of a modified reaction type, which allows of easy adjustment when it becomes neces-



ENCLOSED ELECTRIC MOTOR

sary to reverse the direction of rotation of the motor. The bearings are self-oiling and self-aligning, and fitted with eomposition sleeves, which are removable from the outer ends of the boxes. These motors are built in this type in seven sizes, ranging from 1-6 hp to 5 hp.

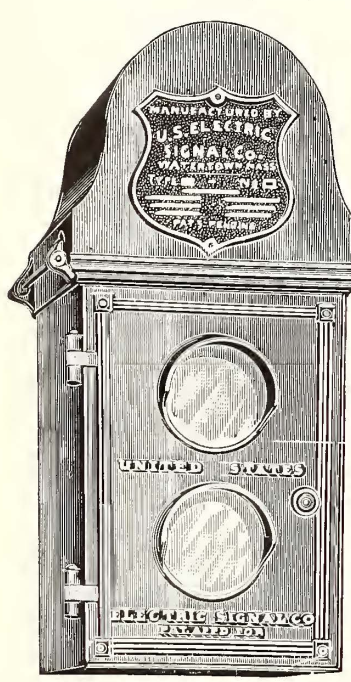
Manager for an Air Brake Company

Anthony H. Metzelaar has lately resigned his position with the Magann Air Brake Company, Detroit, Mich., with which company he has been for the last two years, to assume the position of general manager for the Knell Air Brake Company, Battle Creek, Mieh. Mr. Metzelaar is a graduate of the Engineering College of the city of Amsterdam and took one year's post-graduate work at the Michigan Agricultural College, Lansing, Mich. He has made a speeial study of compressed-air apparatus and begins his new work with the best wishes of his friends.

Dick, Kerr & Company has commenced work on the construction of 20 miles of permanent way for the Gateshead (England) Electric Tramways for the British Electric Traction Company, and the same company has just completed its contracts for the construction of the permanent way for the British Electric Traction Company for its extensive system in the Potteries District. This is by long odds the most important interurban tramway system so far undertaken in Great Britain, connecting as it does a series of towns of considerable population lying close together throughout the working districts of the Midlands.

A New Automatic Block Signal for Electric Railways

This signal is designed especially for use on single track trolley roads, to show positively whether the section to the next turnout is free, or whether occupied by another car. The signals are operated by the trolley wheel of the car coming in contact with an automatic switch placed on the trolley wire. The signal proper consists of a signal box, usually placed a short distance beyond a turnout, and made of a substantial cast-iron case containing the mechanism. In the front of the signal box are placed two windows, one covered by a red glass and the other by a green or white glass, and behind each of these windows are two incandescent lamps. The boxes are always used in pairs, and are electrically connected by two wires. In each box are two operating magnets, the power developed being five or six times as great as required, giving a large margin of safety. When a car enters the block section, one set of signals is operated, showing a white or green light at the entering point, and a red light at the other end of the section. The armature of the lighting magnet is mechanically locked in place after it has operated the proper contact, and if the lamps are extinguished through failure of the current, they will immediately be relighted when the current returns. They can thus be permanently extinguished only by the action of the putting-out magnet, which cannot be operated until the car has reached the further end of the section. In the same manner, when a signal is set for either direction, a signal for the opposite direction is mechanically locked out of service. The lamps in the two signal boxes being in series, one signal cannot be set without the other being set, and the motorman entering the block and seeing the green or white light, knows the red or danger signal at the other end is lighted.



CASE OF SIGNAL

This ingenious system is the invention of J. J. Ruddick, and is manufactured by the United States Electric Signal Company, of Watertown, Mass. For nearly two years the members of this company have been developing and completing it, and have produced a system which is not only simple and reliable, but which can be applied with but small expense to existing roads.

An Interesting Wire Exhibit at Paris

John A. Roebling's Sons Company had a most interesting exhibit at the Paris Exposition. It was practically two exhibits, as it was divided into two entirely distinct sections, each of which received an award of a grand prize. One of these was a general collection of samples, specimens and models of wires, cables, etc., and contained many results of the company's capabilities. The other was of more interest to street railway men, however, as it represented the electrical department of the Roebling Company. The principal feature of this section consisted of a full-sized model of a section of underground trolley track, illustrating the arrangement of the feeders, ducts, etc. Besides this main attraction there were innumerable examples of the Roebling wire which is manufactured especially for electrical uses.

A Well-Tested Cash Register

The New Haven Car Register Company, of New Haven, Conn., will make a full exhibit at the Kansas City Convention of the various styles of its widely known single, double and triple-fare registers, both round and square. The company has been doing a very large business during the present year, and has added a large number of roads to its already long list of customers among the leading roads of both this and foreign countries. It will place on exhibition one of its machines, which has a record of upward of 10,000,000 registrations, made in actual use on rapidly moving machinery in a large wood working factory. The register has withstood the test, which is equivalent to over one hundred years constant use on street railways, in a remarkable manner, it being still unimpaired for regular service. This machine will undoubtedly attract much attention at the convention, and will certainly be taken as conclusive evidence of the good wearing qualities of these registers.

AMONG THE MANUFACTURERS

BABCOCK & WILCOX BOILERS have been awarded the grand prix at the Paris International Exposition of 1900.

THE SNOW PLOW BUSINESS is again commencing. Arthur W. Field, Boston, reports a number of sales of rotary snow plows in New England this fall.

THE AMERICAN BRIDGE COMPANY announces that August Ziesing has been appointed general Western representative of the company, with headquarters at Chicago, Ill.

THE UNITED STATES ELECTRIC COMPANY, of Watertown, Mass., has recently purchased the Bancroft & Sullivan patents, consisting of United States and foreign patents for electric street railway block signalling.

THE LITOFUGE MANUFACTURING COMPANY, formerly at 1710 Market Street, Philadelphia, Pa., has removed to 2240 and 2242 North Ninth Street, where it has secured larger and more commodious quarters.

GEORGE A. PARMENTER, Cambridgeport, Mass., manufacturer of the well known Parmenter fender and wheel-guard, reports some very good orders lately. The most important of these is one embracing all the street cars of Havana, Cuba.

A MEDAL FOR THE BRISTOL COMPANY.—The jury of award at the Paris Exposition has granted the Bristol Company, of Waterbury, Conn., a silver medal for its exhibit of recording electrical instruments, and has also given honorary mention to its recording steam and pressure gages.

THE BURT MANUFACTURING COMPANY, Akron, Ohio, maker of the Cross oil filters, has recently commenced to advertise the Burt exhaust head. Mr. Warden, manager of the company, reports that orders are crowding in in a most satisfactory manner, and a busy season is expected.

EDWARD P. SHARP has been appointed manager of the street railway department of the Bierbaum & Mervick Metal Company, Buffalo, N. Y., exclusive manufacturers of Lumen bronze for bearings, and also of the Ideal trolley wheel, two high-class specialties that Mr. Sharp firmly believes will make many new friends for him.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, was awarded a gold medal at the Paris Exposition covering its line of elevating, conveying and mining machinery. The company's new and complete catalogue describing its extensive line of chains, etc., is now ready for distribution, and will be gladly sent to all who ask for it.

THE EUREKA TEMPERED COPPER WORKS recently booked one of the largest orders for drop forged commutator bars ever placed in this country. The company is naturally greatly pleased at this recognition of the superior quality of its goods, and in the future will attempt to maintain the high standard attained by its drop-forged segments.

AN INTERESTING FEATURE OF THE PARIS EXPOSITION, especially to electrical men, was the exhibit of electrical measuring instruments made by James White, Glasgow, Scotland. The many persons who admired this exhibit, as well as the numerous friends of the concern, will be glad to learn that it was awarded the grand prix.

THE AULTMAN COMPANY, CANTON, OHIO, has arranged with the C. T. Patterson Company, Ltd., of New Orleans, to represent it in the sale of its complete line of elevating conveying and power transmission machinery. A competent force of engineers is at hand to give prompt and intelligent attention to all inquiries received for this class of machinery.

"LIGHT ON THE JOINT QUESTION."—A little book has been issued with this title, by the American Improved Rail-Joint Company, Chicago, giving the recent decision in the United States Court of Appeals on the subject of cast-welded rail-joints. Since the decision is necessarily of interest to all users of this type of joints, the pamphlet will probably be widely read.

THE ELECTRICAL POWER STORAGE COMPANY, LTD., of London, has been awarded a gold medal at the Paris Exposition, which has been granted to it chiefly on account of its new Faure-King model for auto-car work. H. W. Butler, chief engineer of the company, was, in addition, personally awarded a silver medal for the general excellence of the company's manufactures.

H. W. JOHNS MANUFACTURING COMPANY, New York city, recently secured a contract from the Pittsburgh Plate Glass Company, Ford City, Pa., for furnishing and applying asbestos fire felt covering for its factory No. 3, in which plant the Pittsburgh company is now installing twelve new boilers and the necessary steam pipes. The contract in question will amount to over $2,000.

THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, London, has recently opened a branch office in Manchester, in the Trevelyan

Building, Corporation Street, where local inquiries will receive every attention. To meet the increasing business of the company in the Northern Provinces, it has, in addition to the other branch offices, opened a branch at Newcastle-on-Tyne.

LARGE CONTRACT FOR THE AMERICAN BRIDGE COMPANY.—The new ship-building plant for the Risdon Iron Works, at San Francisco, Cal., will be built by the American Bridge Company, of New York, and will consist of a boiler shop, machine shop and foundry, all of the latest design and most modern description.

THE STANDARD AIR BRAKE COMPANY, New York, is being kept busy by the large number of duplicate orders and new business that it is getting. This company has been particularly successful with its axle-geared compressor, which is run without the use of an auxiliary motor. The good points of this device are rapidly pushing it into favor with the managers of railways throughout the country.

"GROOVED TROLLEY WIRE" is the subject of Bulletin No. 4228, of the General Electric Company. The ears used to hold this wire have the form of longitudinal clamps, which are tightened by transverse screws. The wire is made in three sizes, equivalent to No. 00, No. 000 and No. 0000 round wire, the actual diameter of the grooved wire being sufficiently great to allow for the metal taken out by the grooves.

THE FRANK RIDLON COMPANY, OF BOSTON, which is the New England agent for the Mayer & England Company, of Philadelphia, and which represents the Protected Rail Bond Company in the East, has obtained the entire rail bonding for the elevated work in Boston, including both wheel rail and third rail. This is one of the largest and most exacting rail-bonding orders that has ever been placed.

PHOSPHOR BRONZE in many forms is described in a little pamphlet issued by the Phosphor Bronze Smelting Company, Ltd., Philadelphia. The company is one of the original manufacturers of this material, and is the sole maker of the well known "Elephant" brand. Besides being a catalogue and price list the book contains much valuable and interesting information regarding phosphor bronze and other alloys, as well as numerous useful tables.

A MAMMOTH CATALOGUE.—The General Electric Company, Limited, of London, England, has distributed what is probably the most comprehensive list of electrical apparatus and supplies ever placed before the public. The volume is handsomely bound, and contains 1000 pages of closely printed matter. It is divided into sections, and covers dynamos, motors, wiremen's sundries, fixtures, heating, telephone bells, electro-medical supplies, etc.

AN UNEXPECTED PARIS AWARD.—The Triumph Electric Company, Cincinnati, Ohio, reports the receipt by it of a medal from the Paris Exposition for the excellence of its machines. The company is especially gratified at this recognition of its product, as it was not a regular exhibitor, but had merely loaned its apparatus to other companies for the purpose of operating their exhibits. The award, therefore, came as a great surprise to the Triumph Company.

GENERAL ELECTRIC LINE MATERIAL is described in catalogue and price list No. 7530. In the pamphlet will be found everything in the way of materials for overhead construction, such as insulators, strain and bracket suspensions, curve suspensions, plain trolley ears, clamping ears, splicing sleeves, crossings, etc. So many articles are mentioned that without the index, which concludes the book, one would have difficulty in finding any particular thing desired.

A. O. SCHOONMAKER, New York, importer of mica for electrical and other purposes, is having a large trade in India and amber mica, both cut and uncut. A specialty is made, however, of stamped solid sheet segments and washers. The uncut sheet, or block, mica is always carefully selected as to size, so that as little waste as possible will result when articles are being manufactured from it. Among the numerous lines carried may be mentioned mica plate, flexible mica, mica cloth, mica paper and mica tubing.

THE LEONHARDT WAGON MANUFACTURING COMPANY, Baltimore, Md., reports that 1900 has been one of its busiest years. The company has put out more of its easily operated, revolving tower wagons than ever before. These wagons are built with large and roomy tool compartments, and can be raised and lowered by one man. Their operation has been so satisfactory to the users that much of the business done by the Leonhardt Company has been the filling of duplicate orders.

ARTHUR KOPPEL, Berlin, Germany, has issued a large volume containing a collection of views taken at installations of industrial railways put in by this firm in all parts of the world. The descriptive text is written in six languages, which shows the wide distribution expected to be made of the publication. The cover is highly illuminated, and shows a scene in a forge, while the illustrations within give a comprehensive idea of the widespread adaptation of the narrow-gage railway to manufacturing and other industrial purposes.

THE BRITISH SCHUCKERT ELECTRIC COMPANY, LTD., of London, England, states that the Schuckert Company was represented at the Paris Exposition in the four following sections: Section 23, electrical machinery and motors; Section 25, electric lighting plant; Section 29, general plant; Section 118, electrical apparatus for marine and naval purposes. In all four cases the grand prix has been awarded. The engineers and representatives of the firm have also received nine gold medals and eight silver and bronze medals.

THE CRANE COMPANY, New York, is distributing a handsome metal sign which will undoubtedly prove sufficiently handsome to commend a share of the wall space of many engineering offices. The sign is over a foot long and is decorated in colors. The design represents an 18-in., extra heavy, iron body gate valve, with outside screw and yoke and by-pass. Numerous gates of this style have been installed, it having been extensively used in the equipment of power plants. A representation of wrought-iron pipe makes an effective border.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY.—In a recent communication to this firm, the George A. Fuller Company, contractor for the Broadway Chambers Building, New York City, a model of which is exhibited at the Paris Exposition, states: "Your dynamo forms a prominent feature in our exhibit, and helped to obtain the grand prize and gold medals which have been awarded to this exhibit." Prospective purchasers would serve their own interests by investigating the Bullock dynamos and motors before placing their orders.

THE H. W. JOHNS MANUFACTURING COMPANY, of New York, has secured a contract for supplying and applying asbestos fire felt covering for the steam pipes, boilers and brine pipes at the Havana Brewery, Havana, Cuba. The company is sending skilled labor from New York to carry out this contract, and it is the first instance of this kind that is on record. There are a number of new power plants being constructed in Havana, and the Johns Manufacturing Company believes in being on the field with its skilled labor and materials to insure getting the work.

THE MEYERCORD COMPANY, Chicago, has made such a good showing at the Paris Exposition that it has received the highest and only award given in the company's department. The decalcomania transfers which were placed in competition with the foreign manufacturers attracted much attention, and many thousand dollars' worth of business was placed abroad. To attend to this business and keep it active, a large number of permanent agencies have been established in Europe. One of the company's specialties which elicited much praise was its new opalescent window signs.

AUTOMATIC LUBRICATION.—The Siegrist Lubricator Company, St. Louis, Mo., has received a duplicate order from the Imperial Electric Light, Heat & Power Company, of the same city, for the Siegrist automatic oiling system, to be used in connection with some new units now being installed in the Imperial Company's plant. The Siegrist system has been under practical test in the Imperial plant for the past year, and the fact that the Imperial Company has given a duplicate order is evidence that the system has given satisfaction. A description of this system is given in the reading columns of this issue.

WESTERN ELECTRIC SUPPLY COMPANY, St. Louis, Mo.—In a supplement to its catalogue No. 22, this company describes the G. I. circuit breakers. These circuit breakers are made largely for railway use, and their fine finish and simplicity give a handsome appearance to the switchboard, as well as insuring efficient operation. They are easily closed and quick to open, roller latches of hardened steel being used to give a frictionless design. The laminated contacts are well made and protected from arcing. The Paragon bipolar power motors are also described in this supplement, as well as starting boxes for the same.

TRIUMPH MOTORS.—The Triumph Electric Company, of Cincinnati, Ohio, has received the following from C. P. Alterberg, manager of the foreign department of the J. A. Fay-Egan Company, Paris Exposition: "We have used five of your 220-volt motors, aggregating 100 hp, to operate our exhibits at the Paris Exposition. Up to date we have not expended 1 cent in repairs of any kind; our operators give the motors no attention beyond keeping them clean and the bearings supplied with oil. I feel highly gratified with their performance, and take pleasure in so advising you." As the communication came entirely unsolicited, the Triumph Company is naturally highly gratified at its receipt.

EFFICIENT TUBE CLEANERS.—The Lagonda Manufacturing Company, of Springfield, Ohio, recently sent one of its "water power turbine cleaners" to the Warren Water Company. C. E. Inman, superintendent of the company, writes that after cleaning one boiler and part of another, he is more than pleased with the machine. He states that it has removed scale that was really a surprise to him, as he did not suppose it would be possible for such a machine to remove scale as thick and hard as found in their boilers. It is such a curiosity that he has several pieces which he keeps for exhibition. This is only one of numerous reports of this kind that the Lagonda Company is constantly getting from users of its machines.

THE BETHLEHEM STEEL COMPANY reports that among the orders recently booked are spare propeller shafts for the steamers "Ponce" and "San Juan," of the New York & Porto Rico Line, which are being furnished to Harlan & Hollingsworth Company, of Wilmington, Del. The company is also supplying eight forged hollow shafts of fluid-compressed, open-hearth steel, for use in Cuban sugar mills, and, in addition to these, it is making a large number of gun barrels for the Winchester Repeating Arms Company and Colt's Patent Fire Arms Company. These latter forgings are to be made of Bethlehem nickel steel, which is peculiarly adapted to the purpose on account of its ability to withstand severe strains.

THE WEINLAND TUBE CLEANERS.—The Lagonda Manufacturing Company, Springfield, Ohio, is having great success with the Weinland Mechanical Tube Cleaners, which are being widely introduced. The operation of these tube cleaners is extremely simple, a belt being used to revolve the series of cleaner heads with cutter-wheels attached, which make up the cutting apparatus. This belt can be driven by steam, gas or gasoline engine, electric motor or any suitable power, so that the machines can be used under almost any conditions. This class of apparatus is peculiarly adapted for giving proof of its efficiency, and the Lagonda Company is constantly in receipt of testimonials telling of relief to boilers that were filled with scale.

THE MORRIS ELECTRIC COMPANY, of New York, has had a most successful summer and fall, and is looking forward to a much larger increase of business in the future. It has sold a great many rail bonds, 6000 having been included in a recent European order, and seven different roads are using electric heaters obtained through the company. Five complete cars have recently been built in the company's own shops for Mexico, and Costa Rica has received three carloads of iron poles, one carload of car wheels and 4000 rail bonds. Large shipments have been made to Cuba, including seventy-six carloads of Mason Potomac terra-cotta conduit, 1000 iron poles, 20 miles of line material and trolley wire, as well as the complete installation of a 500-light incandescent electric plant. The European orders comprise 20,000 carbon brushes, among many other supplies and tools.

FLEXIBLE MICANITE PLATE, STYLE C, is the name of the latest addition to the line of high-grade insulators manufactured by the Mica Insulator Company, New York and Chicago. The company has been experimenting and working for many months to perfect this material, and believes it will prove one of the most important of the many original contributions it has made to the electrical industries. Flexible micanite plate, style C, will stand a high temperature without losing its mechanical strength. It will also remain flexible indefinitely, and can therefore be safely carried in stock. For all general insulating purposes, insulating transformers, armature and field magnet cores, armature slots and commutator shells, etc., it will be found of great value.

A LIST OF SALES OF MECHANICAL STOKERS has been issued by the Westinghouse Company. The list gives the names of some recent purchasers of the Roney mechanical stokers with the total boiler horse-power which will be installed when the present orders are completed. This, of course, represents a much larger engine horse-power, but it gives some idea of the number of large stations using the Roney stoker. Among the larger ones may be mentioned the Manhattan Railway Company, 34,000 hp; the Third Avenue Railroad Company, two stations, 36,000 hp, and the Metropolitan Street Railway Company, all of New York. Eight orders, aggregating 12,500 hp, from the United Railways & Electric Company, Baltimore, Md., are also recorded.

AGING OF TRANSFORMER IRON.—The General Electric Company is distributing a ninety-two page pamphlet on the subject of "Aging of Transformer Iron," containing five important articles that have been issued regarding this subject, as follows: "The Aging of Transformer Iron," by Prof. W. Elwell Goldsborough; "On Slow Changes in the Magnetic Permeability of Iron," by W. Mordey; "Effects of Prolonged Heating on the Magnetic Properties of Iron," by S. R. Roget, B. A.; "Hysteresis in Sheet Iron and Steel," by Arthur Hillyer Ford, and "The Aging of Transformer Iron and Steel," by J. A. Capp. This pamphlet is one that should be in the hands of every central station manager, and will be gladly furnished to all who apply for it to the General Electric Company.

DEOXIDIZED BABBITT METAL, as manufactured by the Bridgeport Deoxidized Bronze & Metal Company, can be easily distinguished from inferior metals by its silver-like appearance. It is clean and smooth, and contains no lead, so that it cannot "be used for a pencil." This fact is taken advantage of in getting out a novel little pamphlet, on the front page of which appears the surprising information that the recipient cannot write his name. The investigation of the "why?" which this naturally produces discloses the remainder of the statement on the last page, and shows that it is, when Deoxidized Babbitt Metal is employed, that the inability exists. The little book contains several testimonials in the form of facsimile reproductions of the original letters, which show that for other purposes the metal is most satisfactory.

THE LARGEST ELECTRICAL POWER PLANT IN THE WEST, that of Armour & Company, Chicago, is equipped with gate valves and other steam fittings made by Crane & Company, of that city. The piping system of this installation was carefully worked out in order to secure both mobility and simplicity. The main header connecting the twelve boilers with the engine-room is 172 ft. long and is fitted with Crane extra heavy cast-iron flanges and divided into three sections by two Crane high-pressure gate valves. The same style of valve is used on the boiler-leads to the main header and on the engine-leads. This installation serves as a good example of the kind of engineering work the Crane Company is doing. This branch of its business is becoming a very important one, 250 complete piping equipments being a conservative estimate of the work it has done during the last five years.

TRACK SANDING.—Whether shoveled onto the track by hand or allowed to pour out of the sand box in a stream the application of sand has long been a source of annoyance. Both methods have some advantages and many disadvantages. The Frank Ridlon Company, Boston, Mass., claims for a track-sanding apparatus which it is putting on the market all of the advantages and none of the disadvantages of the old methods. The device, which weighs but 18 lbs., takes the sand from the box in small scoopfuls, and deposits it in a tube, which transmits it to the track at exactly the right place. Any kind of sand may be used, the apparatus working equally well, whether it is fine or coarse, wet or dry. A depression of a button placed conveniently near the motorman's foot deposits but one portion of sand on the track, so that there is no wasteful flow or such an excess used as to render liable the production of flat wheels.

SOME LARGE ELECTRICAL CONTRACTS.—Kohler Brothers, contracting engineers, Chicago, Ill., report the following contracts on hand: Southside Alley L installation of 48,000 ft. of 1,500,000 circ. mils feeder wire, just completed; Southside Alley L, removing 29,000 ft. of feeder wire, now in progress; Chicago & Alton Railroad Company, complete equipment of power plant, Bloomington shops; Illinois Central Railroad Company, complete underground and overhead and interior construction for lighting right of way and suburban stations; *Chicago Tribune*, complete equipment of press-room with patented mechanical and electrical devices; Illinois Asylum for Feeble Minded Children, Lincoln, Ill., complete steam heating and lighting contract; Coliseum, entire lighting and switchboard contract; McCormick Harvesting Machine Works, Chicago, wiring foundry and installing trolley line.

A MOST INTERESTING AND HANDSOME SOUVENIR of the Paris Exposition has just been issued by Witting Brothers & Company, Limited, of London, who represent in England Electricité et Hydraulique, of Charleroi, Belgium. The souvenir consists of an album about 14 ins. long by 9 ins. wide, which contains a number of very beautiful photographs of the exhibition, in addition to a few particular photographs of their own exhibits. There are beautiful pictures of the Chateau d'Eau, the Trocadero, various views of the Seine in the vicinity of the Exposition, showing the Belgian government house in the Street of Nations, the new Alexander III Bridge, opera house, etc., which are neatly interspersed with views of the various exhibits of Electricité et Hydraulique, in which Witting Brothers are interested. There will doubteless be a great demand for this handsome souvenir, and we feel sure that every engineer ought to endeavor to procure one.

THE WESTERN ELECTRICAL SUPPLY COMPANY, of St. Louis, Mo., will be represented at the Street Railway Convention by Charles Scudder, Jr., manager of its electric railway department. He will make his headquarters at the exhibit of the Ohio Brass Company in the Convention Hall, although he will also have a display and be glad to see electric railway men at the Baltimore Hotel. This company has gradually enlarged its electric railway department so that to-day it carries one of the largest stocks of electric railway supplies in the West, and is prepared to equip electric railways complete with anything pertaining to their construction, maintenance or operation. A catalogue devoted exclusively to electric railway supplies has recently been published, which is about the only one covering everything pertaining to electric railways from a bonding cap to a complete electric railway. The company will mail this catalogue on application.

IDEAL ENGINES FOR STREET RAILWAY SERVICE.—A. L. Ide & Sons, Springfield, Ill., are making a modified design of their Ideal four-ported engine especially intended for use in street railway power houses. Like all Ideal engines, its construction is reduced to the simplest forms available, and embodies the well known original self-oiling system. The liberal proportions of the working parts, the use of special material for each of such parts, and the constant flush of oil over all the bearing surfaces, are features which qualify the Ideal engine for continuous and severe service. The valves and valve-gearing, while producing results in efficient steam distribution approaching the performance of a Corliss valve equipment, are of the simplest form, and are capable of operating with the utmost smoothness and ease at any speeds up to the highest. Thus, a highly efficient engine devoid of all complicated mechanisms is offered, and will undoubtedly find favor among the managers of those roads where the kind of service for which the engine is built is required.

HEAT INSULATION ON OCEAN STEAMERS.—The P. & B. Giant Insulating Papers manufactured by the Standard Paint Company, whose main office is in New York, with factories in New Jersey and at Hamburg, Germany, have been used in the construction of the cold-storage rooms and the insulation of the freezing tanks of the "Deutschland," as well as on many of the other large ocean grayhounds and freight-carrying vessels. The list embraces the "St. Louis" and "St. Paul," of the American Line; "Kaiser Wilhelm der Grosse," "Friedrich der Grosse," "Barbarossa" and "Koenigen Luise," of the North German Lloyd; and the principal steamers of the Cunard Line, White Star Line, Red Star Line, Furness Line, Elder Dempster Line, and many others. The experience had with P. & B. insulation on the vessels mentioned has proved that this material gives most excellent results. The temperature in their cold-storage rooms is easily regulated on account of the efficient insulation obtained, and the manufacturers claim that no other material could give as great satisfaction.

WITTING BROTHERS & COMPANY, LIMITED, of London, England, have in hand one of the largest contracts that has ever been placed for polyphase motor-generators. The order in question has been placed with Witting Brothers by the Metropolitan Electric Supply Company, of London, and includes the supply and erection of six 500-kw polyphase motor-generators and three smaller sets for exciting, making a total of 9000 hp in electrical machinery. The motor-generators, which are of the synchronous type, will be placed in the Manchester Square station of the company, deriving current from the new Willesden station, distant about 3 miles. The Westinghouse generators in this station generate two-phase current at 500 volts per phase, which is raised to about 10,000 volts for the line; at Manchester Square this will be stepped down to 1000 volts per phase for the motor-generators. Each of the large motor-generators consists of a 900-hp synchronous two-phase motor coupled to a 500-kw generator, both machines being of Witting Brothers' standard pattern. Each machine has two bearings, and each bed-plate is provided with flanges and faced seatings for bolting together, the combination running at 212 r. p. m. at 60 cycles.

THE EMPLOYMENT OF HIGH-PRESSURE ALTERNATING CURRENTS has of late given a great impetus to the growth of electrical undertakings for the transmission of power over extended areas, and the consequent rapidity with which new designs of generators, motors, switchboards, etc., for this service had to be made, as well as the enormous amount of apparatus that has been supplied, has kept the manufacturers busy. The active development of this industry and the exceptional demands made on the different departments owing to the large increase of orders has prevented the firm of Brown, Boveri & Company, Ltd., Baden, Germany, from laying before those interested an account of its recent operations. In a report on the more important installations carried out during the last few years the company presents a pleasing description of many plants in which it has been interested, well illustrated by large engravings and bound in an attractive manner. Much interesting matter is devoted to general remarks about the Brown-Boveri apparatus, for both alternating and direct-current, but the larger part of the book is made up of a partial list of installations made during the eight years the company has been in existence. The list is arranged geographically, and a short, technical description of each plant is given. The copy which reached this office was written in English, but editions in German and French have probably been printed for use in other countries.

COCHRANE FEED-WATER HEATERS.—In every steam plant a properly designed exhaust steam feed-water heater will effect a saving, according to the conditions, of from 5 per cent to over 20 per cent. This will take place whether the plant is operated high pressure, exhausting free to the atmosphere; whether operated under back pressure, using the waste steam for heating or drying; or whether it is operated condensing. The saving will be made even though these plants are equipped with economizers and provided with live steam purifiers; and while making it the exhaust steam feed-water heater will eliminate the strains caused by introducing cold water into boilers, economizers and live steam purifiers, which strains are chiefly recognizable in repair bills and stoppages. Besides insuring the benefits referred to above, the right kind of a feed-water heater will very materially improve any feed-water supply—no matter how bad—by eliminating some, or all, of the scale-forming matter present in the water, and by saving the exhaust condensed in accomplishing the heating. The Harrison Safety Boiler Works, Philadelphia, have collected a large amount of material on this subject, and in an attractive pamphlet which they have issued devote considerable space to the "deadly parallel" method of proving the excellence of the Cochrane Heaters. The remainder of the book is devoted to illustrated descriptions of various forms and different modes of installation, and the whole will prove of interest to all steam users.

SOME DICK, KERR & COMPANY CONTRACTS.—The Grimsby & Cleethorpes Tramways have just commenced work on the re-equipment of their lines for electric traction, and have placed the contract for the power house equipment, for the construction of the lines and for the supply of the rolling stock in the hands of Dick, Kerr & Company. The Nottingham (England) corporation tramways will very shortly commence operation. The scheme is an extensive one, involving the conversion of a considerable mileage now in operation with horse traction, and numerous extensions of the existing system which are being undertaken by the corporation. The current for the operation of the line will be taken from the existing 500-volt supply of the Corporation Electricity Works. Orders for fifty-seven completely equipped motor cars of the improved Preston type were placed some time ago with Dick, Kerr & Company, and these will be manufactured, together with the motor equipments, at the Preston Works. The Leeds (England) corporation tramways, one of the first and most important of electric traction undertakings in Great Britain, has had an important function in showing the essentially profitable nature of the conversion from horse and steam to traction by electricity. The corporation is rapidly extending its lines, and has now an order with Dick, Kerr & Company for one hundred completely equipped motor cars, to be manufactured at Preston, all of which will be in operation by the end of the present year.

"CROWN" RAIL BONDS.—The simplicity of the "Crown" bonds furnished by the Washburn & Moen department of the American Steel & Wire Company, Chicago, is doubtless the key to their widespread adoption in the construction of electric railways and tramways. Taken for granted that the copper of which they are made is of standard conductivity, and that the company is able to furnish every style of bond, solid or flexible, for bonding over or under the fish-plates, under rails, or for cross-bonding, the simplicity of application must account for the popularity these bonds have attained. When it is noted that the work of applying "Crown" bonds is all done on one side of the rail, and that only one man is required to handle and properly attach the bond, the economy effected on the score of labor alone is a very considerable item in every mile of bonding. Perhaps one of the greatest labor-saving points in connection with the "Crown" bonds is in rebonding work, which is the ability to dispense with all helpers. The ability of one man to handle the rebonding without assistants is a point in economy which cannot be overlooked by street railway superintendents and contractors. A catalogue, or little booklet, on "Crown" bonds will be sent free to anyone writing for same to the American Steel & Wire Company, at either the Worcester, New York or Chicago offices, and the company will be glad to extend the services of its expert electrical engineers to facilitate by suggestions the settlement of all questions regarding either bonding, line wires, feeders, or any electrical work for light or power plants, whether aerial, underground or submarine.

THE PARTICULAR FEATURES OF THE BLOWER SYSTEM of mechanical ventilation and heating are thus summarized in a recent lecture by Walter B. Snow of the engineering staff of the B. F. Sturtevant Company, Boston, Mass.: "The entire heating surface is centrally located, inclosed in a fireproof casing, and placed under the control of a single individual, thereby avoiding the possibility of damage by leakage or freezing incident to a scattered system of steam piping and radiators. The heater itself is adapted for the use of either live or exhaust steam, and provision is made for utilizing the exhaust of the fan engine, thereby reducing the cost of operation to practically nothing. At all times ample and positive ventilation may be provided with air tempered to the desired degree. Absolute control may be had over the quality and quantity of air supplied. It may be filtered and cleansed, heated or cooled, dried or moistened at will. By means of the hot and cold system the temperature of the air admitted to any given apartment may be instantly and radically changed without the employment of supplementary heating surface. The pressure created within the building is sufficient to cause all leakage to be outward, preventing cold inward drafts and avoiding the possibility of drawing air from any polluting source within the building itself. By returning the air, using live steam in the heater and operating the fan at maximum speed, a building may be heated up with rapidity, as is usually desirable in the morning. The area of heating surface is only one-third to one-fifth that required with direct radiation, while the primary cost and operating expense of a fan is far less than that of any other device for moving the same amount of air."

THE CHLORIDE ELECTRICAL STORAGE SYNDICATE, LTD., London, England.—The syndicate shows a large and varied assortment of its manufactures at the Paris Exposition. It includes large cells of perhaps 4,000,000 watt-hours or 5,000,000 watt-hours' capacity, such as are used by corporations, electric light and power companies, large private installations, as well as the very small cells used in the most delicate surgical operations. The exhibit of larger cells comprises similar ones to those employed by the Manchester, Halifax, Bolton, Newport, Leigh and Saint Helens corporations and at Arundel Castle (probably the largest battery in the world for private mansion lighting). Chloride cells have been adopted by upward of 200 central light and power stations, making a total of more than 45,000 cells, and having 150,000,000 watt-hours' capacity. There are also specimens of the special Admiralty type cells manufactured by the syndicate for yacht lighting, which has been installed on H. M. Queen Victoria's yacht, H. R. H. the Prince of Wales' yacht and H. I. H. the ex-Empress Eugenie's yacht. A wooden tray contains a set of cells of the type and size used on the Birmingham Central Tramways. The chloride cell is the only one that has been able to stand the arduous work of this system, 900,000 miles having been covered by the cells. The average life of each set of cells in this service is about 25,000 miles. Various sizes of cells in glass and lead boxes are erected on one of the syndicate's standard two-tier wood stands, large central station type cells in lead boxes are erected upon a standard single tier stand, and a complete battery of thirty-three cells in glass boxes is erected complete upon a three-tier wooden stand. There are also shown numerous examples of the accessories and instruments necessary for the storage battery, comprising trays, insulators, supports, separators, bolt connectors, clips, hydrometers, voltmeters, etc. The syndicate has made great effort to have an attractive and instructive exhibit of storage batteries and fixtures, and that its endeavors have been appreciated by the judges is shown by the award of a gold medal which they have received.

"DIRIGO" is the distinguishing name given by the Ohio Brass Company, Mansfield, Ohio, U. S. A., to the insulating material which they employ in the manufacture of their overhead electric railway materials. It was first made commercially seven years ago, and much of the original output produced in the first few months of its manufacture is now in use; a service which, both long and severe, has done much to establish its present reputation. The ingredients, which are prepared from a formula adopted after much experiment, as well as the methods of handling them, in the course of making the completed insulation, have been so carefully guarded that although many attempts have been made to duplicate the Dirigo none has been as yet successful. In appearance the insulation is a dark green, and the word "Dirigo" appears in raised letters on the surface of each piece, thus plainly distinguishing it. The characteristics, which are those qualities pre-eminently required for the use to which it is put, are toughness, elasticity, non-conductivity of heat or electricity, imperviousness to moisture, and, most important of all, great durability when exposed to the elements. It has been tested in nearly every climate of the world, and is alike unaffected by the intense cold of Canada or the high temperatures of the tropics, the dryness of high altitudes or the fogs and dampness of the seashore. It was perfected, especially, as an insulating material for overhead trolley systems, and in that capacity fills every requirement, but is equally fitted for other purposes where a good insulator is necessary, such as for controllers, motors and dynamos. As yet, however, this is an undeveloped field, for the Ohio Brass Company, although its plant has been operated both day and night almost steadily, has not been able to fill orders promptly for its regular line of railway materials during the past year. The testing of the finished product plays a most important part in its handling, and is carefully and accurately conducted. All articles are given an electrical test ranging from 5000 volts to 10,000 volts, depending upon the use they will be put to, and those whose shape and size will permit are subjected to a mechanical test. For the high voltage a special alternating-current transformer, with the aid of a water rheostat, gives a graduated pressure from zero to 10,000 volts; the readings being taken from a voltmeter connected in the circuit. A Reihlé Brothers' machine is used for making the mechanical tests, and, if the device will stand as much, pressures up to 10,000 lbs. can be obtained. The severity of the tests and the care with which they are made is largely accountable for the high standard of excellence of Dirigo insulation and those articles in the construction of which it enters.

"MULTIPLEX" ELECTRIC HEADLIGHTS.—It is recognized by many that the use of electric headlights is much more convenient and economical for street railway purposes than is the use of the oil headlight, and it is also claimed by many that the efficiency of an electric headlight consisting of a 16-cp lamp and a parabolic reflector is not much more than the light obtained from the lamp alone. The reason given for this is, that a true parabolic reflector requires the source of the light to be practically a point, such as an arc light produces, or as is produced in less degree by a brilliant oil light. Therefore a regular locomotive headlight with an oil lamp will always be more efficient than the same headlight would be, fitted with an incandescent electric lamp of equal candle-power, because the reflected image of the latter is very much distorted and out of focus. The light of the oil lamp is more condensed, and consequently most of it is in proper focus with the parabola, while but a very small portion of the light of the incandescent lamp is in focus. It is for these reasons that the inventor of the "Multiplex" reflector conceived the idea of making a reflector which is adapted to the requirements of the incandescent lamp. The general form of the "Multiplex" reflectors is on the lines of a true parabola, and the multiplex improvement consists of so altering the form of the parabola reflector as to form a number of annular and concentric separate reflectors, which illuminate the distortion of the reflected image of the incandescent lamp, and the result is a reflector which is several times as efficient as an ordinary parabolic reflector. "Multiplex" reflectors have now been on the market little more than one year and have attracted the attention of street railway managers everywhere. Their introduction and adoption have been extremely rapid. The cost of headlights fitted with these popular reflectors being on a par with that of ordinary headlights, they are very naturally preferred and adopted in competition with the latter. "Multiplex" reflectors for railway headlights are constructed in accordance with scientific principles. They are spun out of a heavy gage of brass, and their form consists of a series of convex and concave corrugations of shape, size and radius varying with the style and kind of light to be used in combination therewith. They are polished, heavily silver plated, and then burnished, or nickle buffed, and are finished in such a manner as to maintain a lasting brilliancy. Each one of the concave corrugations performs the functions of a separate and distinct reflector, reproducing the light in a greatly magnified and intensified beam, the beams from each corrugation merging into those of the other corrugations, and this multiplication of separate beams of light is the secret of the intense light produced by the "Multiplex" reflector headlights. Two kinds of rays are projected from this reflector. One set of rays forms a bright beam of great intensity, projected in a comparatively small field and penetrating to a great distance, while the other set of rays has a much larger field of less intensity. This feature makes the "Multiplex" headlights especially desirable for street railway purposes. The Multiplex Reflector Company makes a specialty of furnishing reflector shells to parties who may desire to substitute "Multiplex" reflectors in the cases which they now have.

The factory of the Multiplex Reflector Company is located at Cleveland, Ohio, a convenient and centrally located shipping point for all parts of the United States. The selling agents for these headlights and reflectors are: The W. R. Garton Company, Chicago; Western Electrical Supply Company, St. Louis; Morris Electric Company, New York, and Percy Hodges, Boston, Mass.

NEWS NOTES

CHICAGO, ILL.—The Suburban Service Company, of Chicago, has just been incorporated, with a nominal capital of $100,000. It is chartered to operate street railways. Gordon J. Murray, Harry H. Phillips and F. M. Walter are the incorporators.

CHICAGO, ILL.—The South Side Elevated Railroad has recently increased its equipment by the addition of thirty new cars.

CHICAGO, ILL.—The Metropolitan Elevated has received fifty-six new coaches, which will be put on at once.

FT. WAYNE, IND.—The promoters of the Decatur & Ft. Wayne Electric Railway have applied to the Board of Works for permission to enter the city. The company has already secured franchises in Adams and Allen Counties.

SOUTH McALESTER, I. T.—The Union Electric Railway Company, which was incorporated on Sept. 8, has completed its organization and elected the following officers: Eugene E. White, president; W. E. Browne, vice-president; J. F. Craig, secretary; W. G. Wiemer, treasurer. The company is now arranging for a survey of its proposed line. It will extend from South McAlester to Hartshorn via Krebs, Alderson, Buck and Cherryville, a distance of 25 miles. The capital stock of the company is $125,000, fully subscribed.

WORCESTER, MASS.—The Railroad Commissioners, after careful consideration, hold that the officials of the Webster & Dudley Street Railway and the Worcester & Webster Street Railway are responsible for the collision of cars of the two lines, which occurred at Webster July 4. The Board found that the Worcester & Webster Street Railway was operating its cars on the line of the Webster & Dudley Street Railway on the day of the collision under an oral understanding, which is against the law, and that no comparison of time tables or arrangement of a special schedule for that day had been made. The cars collided head-on, and two persons were killed and about thirty-five persons injured.

BOSTON, MASS.—The petition of the Boston Elevated Railway Company for permission to remove its tracks from Marlboro Street, on the Back Bay, has raised an interesting question. This is a fine residential street, and the abutters have always prevented the use of electric cars, so that it is the only place, except Onset, where there are horse cars. The cars do not pay, and a majority of the residents, as well as the company, favor the idea of removing the tracks. The general law provides, however, that a line shall not be given up unless equal facilities are furnished in some other way, and at the hearing on the matter the chairman of the Railroad Commission declined to rule that the question of electric cars was finally settled, hinting that it might be that the Board would have to recommend electrics as the only way of furnishing equal facilities, though he did not appear to think this course probable. The matter has gone over to Oct. 31 for further hearing.

ST. LOUIS, MO.—The Wellston, Creve Coeur Lake & Western Railroad Company has filed its acceptance of the order made by the County Court on June 26 last, and was given an extension of thirty days' time in which to furnish bond. The orders of the court granted the company a franchise for a branch line to Bridgeton. The work on the new line will begin immediately.

TRENTON, N. J.—It is officially announced that the New Jersey & Philadelphia Railway Company has secured entire right of way for its new electric railway to extend from Trenton to Philadelphia. Some portions of the system are already in operation, and the work of construction is proceeding as rapidly as possible on the remainder. The cars will run from Trenton to Morrisville over the Calhoun Street Bridge, from Morrisville to Fallsington over the Lower Falls Road, thence to Emilie, the connecting point with the Philadelphia & Bristol line, and by tracks and franchises of the latter to Holmesburg, where connection is made with the Holmesburg, Tacony & Frankford Electric Railway. The Union Traction cars run direct from Frankford to the center of the city.

DUNKIRK, N. Y.—The Dunkirk & Point Gratiot Traction Company has made application to the Council for a franchise for the construction of a number of new lines here.

NYACK, N. Y.—The Rockland County Traction Company, recently incorporated to construct an electric railway in Nyack, Upper Nyack and nearby towns, has elected the following officers: C. W. Reeve, president; F. H. Reeve, vice-president; E. B. Harris, secretary and treasurer.

CLEVELAND, OHIO.—The Cleveland, Elyria & Western Electric Railway Company has decided to extend its Berea branch to Medina, a distance of 17 miles. An effort will be made to secure a franchise granted some time ago to Joseph Roof for a line along the Wooster Pike from Cleveland to Medina, passing through Strongsville and Brunswick. If this cannot be secured a private right of way will be purchased.

CINCINNATI, OHIO.—Tom Johnson is said to be interested in a company which is seeking a franchise for an electric railway from Cincinnati to Red Bank. Another company is after the same right of way, but thus far Johnson's company seems to have the advantage, having offered to build a double-track railway and to sell ten tickets for 25 cents, or a single fare for 3 cents.

BEDFORD, OHIO.—V. A. Taylor, of Bedford, the chief promoter of the Bedford-Ravenna Electric Railway, has made application to the County Commissioners for a franchise for the construction of an electric railway through Twinsburg and Hudson Townships, on a route from Bedford to Ravenna. The company desires a fifty-year grant and the right to lay a double track.

XENIA, OHIO.—The Dayton, Springfield & Urbana Electric Railway Company and the Springfield & Hillsboro Traction Company have both applied to the Commissioners of Green County for a franchise through the county from Jamestown to Cedarville. The Commissioners want a line through Xenia, but neither company will agree to this provision.

AKRON, OHIO.—The Portage Lakes Traction Company has applied to the County Commissioners for a fifty-year franchise. The Commissioners demand that several changes be made in the conditions, and they are not willing to grant more than a twenty-five year franchise.

COLUMBUS, OHIO.—The Columbus, Mount Sterling & Chillicothe Electric Railway Company has applied to the County Commissioners of Franklin County for an extension of time in which work must commence under the company's franchise. The company has been unable thus far to secure a city franchise.

MANSFIELD, OHIO.—The new Shelby-Mansfield Electric Railway has been placed in operation. The portion of the road from Mansfield to Rocky Run will be operated for the present.

NEW KENSINGTON, PA.—The Creighton, New Kensington & Springdale Street Railway Company has awarded the contract for the construction of its proposed road to the Tennis Construction Company, of Philadelphia. The new line will connect with the Tarentum & Natrona trolley line, and extend south, with a loop across the Allegheny River to New Kensington and Aspinwall, where connections will be made with the Consolidated Traction Company's lines to Pittsburgh.

CONNELLSVILLE, PA.—Work has been begun at Dunbar on the Mount Pleasant, Connellsville & Uniontown Street Railway Company's line, and the connection between Graham's Crossing, the terminal of the Connellsville, New Haven & Leisenring Street Railway and the Uniontown line will be rushed to completion. A gang of workmen are putting down the girder rails in Connellsville. The girder-rails and paving are being laid on Main Street, and it is currently reported that the new line will be built out as far as Moyer, and possibly Pennsville, this fall.

McKEESPORT, PA.—It is announced that the McKeesport & Youghiogheny Street Railway Company, which now operates a line between McKeesport and Buena Vista, and which the company intended to extend to West Newton, will, during the coming year, extend its road to New Haven, opposite Connellsville. The company has arranged to put in a number of aluminum feeder lines.

CHARLOTTESVILLE, VA.—The Charlottesville City & Suburban Railway Company has been reorganized, and the following officers elected: R. P. Valentine, president; H. C. Marchant, vice-president; F. A. Massie, secretary and treasurer; R. R. Case, general superintendent. Having acquired more property, including a park and hotel, it is the intention of the company to make improvements both on the line and the property acquired.

SEATTLE, WASH.—For several weeks past the Seattle Electric Company has been losing copper wire, and the thefts are said to have amounted to several hundred dollars. The officers of the company have made every effort to apprehend the miscreants and believe that they have at last run down the offenders. Four linemen in the employ of the company are charged with the offense.

TWO RIVERS, WIS.—Thomas Higgins, of Neenah, has been successful in his efforts to obtain a franchise here. The Council granted him the right to construct an electric railway to Manitowoc, on Sept. 21. Mr. Higgins expects to have the line in operation by July 3, 1901.

WAPAKONETA, WIS.—L. M. Coe, F. D. Carpenter and Jacob Mayer, of Cleveland, have been granted a franchise for the construction of an electric railway here. It is the ultimate intention of the promoters to extend the line to Lima, Minster and Cridersville. The franchise requires that the line be in operation by December, 1901.

CANADIAN NOTES

WELLAND, ONT.—The Niagara, St. Catharines & Toronto Railway Company has been granted an extension of time to May 1, 1901, in which to complete the Niagara Falls, Westley Park & Clifton Electric Railway on Murray Street.

SELKIRK, ONT.—The Selkirk Electric Railway Company has been very successful in securing franchises and right of way from the municipalities along its proposed route from Winnipeg to Selkirk. The overhead trolley system will be used, and the company will shortly be in the market for rails, cars, etc.

OTTAWA, ONT.—The Ottawa Electric Railway Company is about to extend its present system from the Rockcliffe Ranges to Besserer Grove.

NIAGARA FALLS, ONT.—The Niagara, St. Catharines & Toronto Electric Railway Company inaugurated through service between Niagara Falls and St. Catharines Sept. 24. A dozen round trips were made, and the cars were well filled.

SARNIA, ONT.—The Sarnia Street Railway Company has elected new officers as follows: J. D. Beatty, president; James Flintoft, vice-president; H. W. Mills, secretary, treasurer, purchasing agent, manager and superintendent. The company is now equipping its lines with electricity.