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THE STREET RAILWAY COMPANY OF HAMBURG, GERMANY

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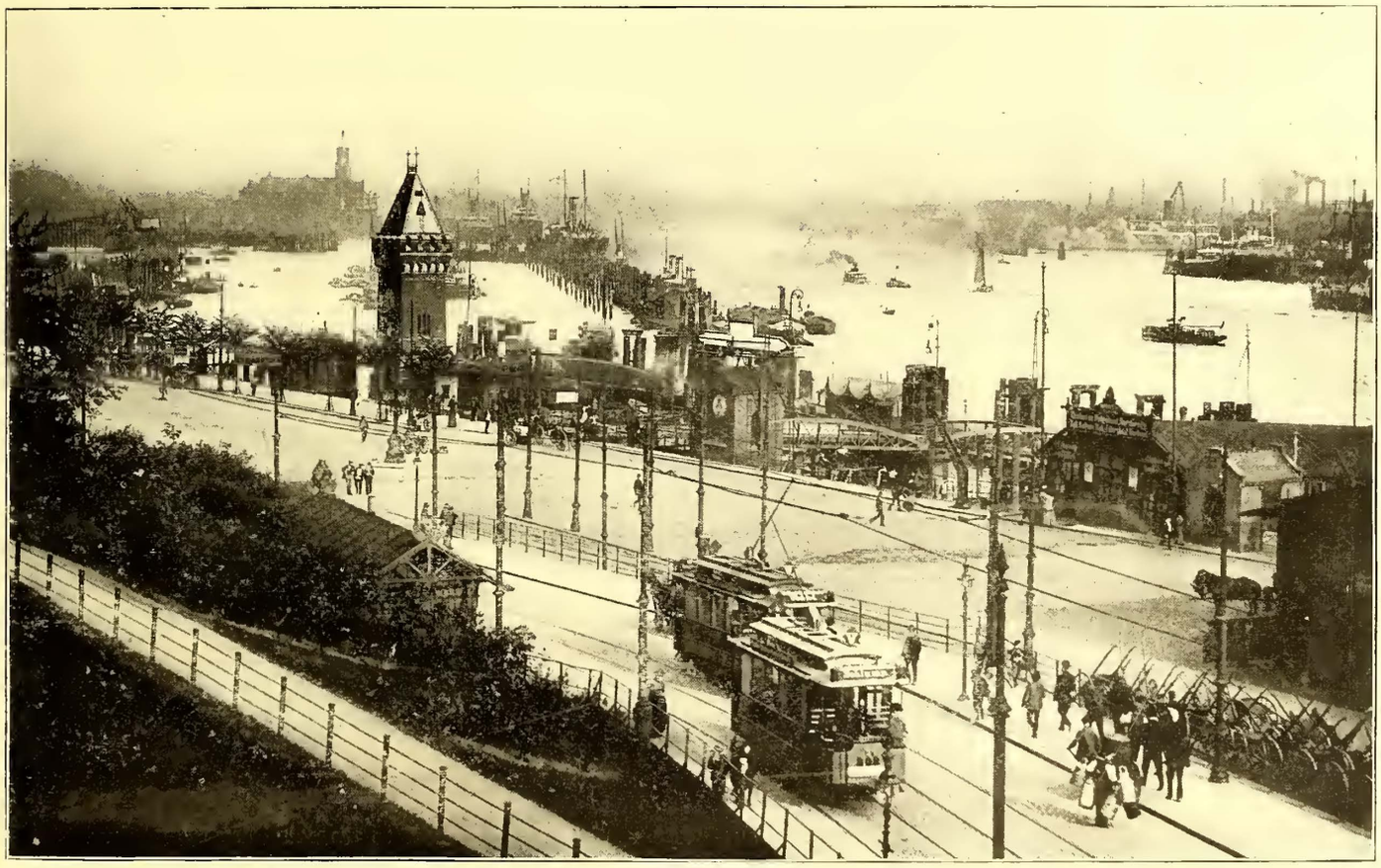
As has been the case with the majority of street railways, the extensive system of the Hamburg Street Railway Company is the result of evolution from a very small beginning. The growth has been due not only to the extension of the company's own lines, but also the absorption of a number of competitive roads. The original horse car line of Hamburg was owned by the Pferde-Eisenbahn-Gesellschaft, which was founded in 1864, and its first line was put in operation on Aug. 16, 1866. This road was in a prosperous condition up to 1877, which may be accounted for by the high fares which it was the practice at that time to collect. In 1877, on account of the increased traffic density, the main line was changed over to steam, which step proved a success from an engineering as well as financial standpoint.



VIEW OF THE ELBE RIVER AT HAMBURG

In 1870 the Hamburg-Altonaer Pferdebahn (the present Hamburg-Altonaer Centralbahn-Gesellschaft) was founded. This company, even up to the present time, is an independent company, and will probably remain so for a long time, because the company's financial and other conditions are not conducive to fusion with other roads. For some time past electricity has been the motive power on this road.

In 1881 the Strassen-Eisenbahn-Gesellschaft, the subject of this article, and which had been incorporated a short time previously, was consolidated with the Pferde-Eisenbahn-Gesellschaft. In 1884 an English syndicate formed the Hamburg-Altona-North-Western Tramway Company, Limited, which was later called the Hamburg-Altonaer Trambahn-Gesellschaft.

In 1886 the Strassen Eisenbahn-Gesellschaft, at the request of the municipality, carried on a series of experiments with two accumulator cars, designed by Engineer Hubert, and this service was continued until the end of that year. Fortunately for the company, as well as for the street railways of Germany in general, these experiments soon showed that this power was a complete failure for street railway service. The cars could not ascend the grades at all times, and frequently became stalled, so that the passengers were compelled to alight to relieve the motors. It may be confidently stated that if these experiments had

been successful, not only the Hamburg road, but those in many European cities, would have been equipped with the accumulator instead of the trolley system. The result of this, as evidenced by the failure of the accumulator system, would have been that the roads so equipped could not have met the demands of growing traffic, and many roads now in existence would never have been started, on account of the prohibitory initial cost. When, some years later, a few advocates of the accumulator system, desiring to bring it again to the front, denounced the trolley system as dangerous, the Hamburg officials took no heed of their arguments, because the Hubert trials of eight years ago were still fresh in their minds.

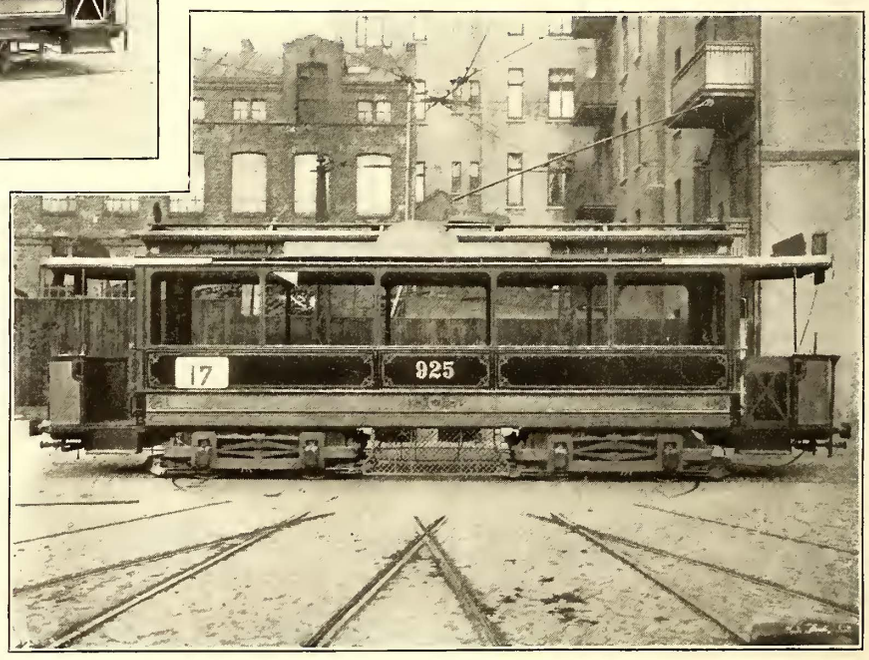
In 1887 another horse car line was started in Hamburg,

STANDARD SINGLE TRUCK CAR, SHOWING SCRAPERS FOR CLEANING GROOVES OF RAILS

viz., the Grosse Hamburg-Altonaer-Strassenbahn-Gesellschaft, which was consolidated with the Strassen Eisenbahn-Gesellschaft in 1891. At this time the system, which embraced all the roads in the city, with the exception of the Centralbahn, underwent a considerable expansion, which, however, received a temporary check during the cholera year of 1892. During this time the officials carefully studied the subject of the application of electric power to street railway conditions, owing largely to the success of the experimental road operated by the Thomson-Houston Company, of America, at the industrial exhibition held in Bremen in 1890. The Hamburg Municipality was sufficiently broad-minded to permit the construction of an overhead line within the city's interior. This first trolley line was opened in March, 1894, and was an immediate financial success. The electrification of the entire system was concluded at the close of 1897, and to-day there are only two short suburban lines, about 6 km in length, which are not electrically equipped, and probably will not be for some time to come, on account of the franchise conditions which have been imposed. In June, 1897, the steam road was also electrically equipped, and the last steam train disappeared from the streets of Hamburg. In 1899 the Hamburg-Altonaer Trambahn-Gesellschaft founded in 1884 was absorbed, which road had in the meantime been electrically equipped, and embraced a considerable territory, especially in the adjoining town, Altona. It should be added here that many of the lines of the Strassen-Eisenbahn-Gesellschaft of Hamburg extend into Prussian territory, as well as to the Prussian town of Wandsbek, which adjoins Hamburg.

Besides the Hamburg Strassen-Eisenbahn-Gesellschaft, there still exists the Hamburg-Altonaer Centralbahn-Gesellschaft, founded in 1878. This company owns a single line about 7½ km in length, which runs through the heart of the district between Hamburg and Altona, a very favorable location. At present the Strassen-Eisenbahn-Gesellschaft of Hamburg owns 138.83 km of track, most of it being double-track. All of this track is used for through passenger traffic, and if we add to this all switching, depot and other tracks, the total will be 260 km. In addition, the company uses 5.67 km of the Central Company's tracks, while the latter makes use of some of that of the Strassen-Eisenbahn-Gesellschaft.

The franchise conditions in Hamburg, while they differ but little from those of other German companies, have served largely as a model for other cities, on account of the early introduction in Hamburg of electricity. There are, nevertheless, few cities which exact such large payments from a street railway company as Hamburg. At the termination of the franchise, in 1922, all tracks and buildings within the city limits of Hamburg will belong to the city, free of cost; in Altona even the trolley line and poles, as well, will lapse to the city. Up to within a few



STANDARD DOUBLE TRUCK CAR

years the company had to do considerable paving. This compensation was changed recently, however, to a percentage of the company's surplus after the payment of a 6 per cent dividend, beginning with 25 per cent, and for a 10 per cent dividend amounting to 50 per cent. Furthermore, for each passenger carried, whether he pays a 10 or 30 pfg. fare, the company is to give the city 1 pfg. As the average fare is 11½ pfg., this payment amounts to about 9 per cent of the gross receipts. The city also takes 5 per cent of all money received for season tickets.

These various taxes are by far the most onerous of any paid by any German company. The plan has its good and its bad side. The bad side is that the company has to pay a large sum of money. The good side is that the city, if it desires to give a franchise to a competitive road, must impose similar conditions, a circumstance which has prevented other roads from invading the field of the Hamburg Street Railway Company. The public in general, of course,

is not particularly pleased with the arrangement, as it prevents the railway company reducing its fares to that usual in German cities, viz., 10 pfg., and introducing other traffic facilities.

ORGANIZATION

The organization of the road is as follows: As with all German roads, there is first a supervising board (aufsichtsrat), composed of stockholders, mostly bankers. Such a board takes part in a company's management only in so far as it receives and passes on all recommendations of the board of directors. This action is nearly always favorable and pro forma, because most of the members of the board possess no technical knowledge. They are simply men who look after the financial interests of the stockholders and see that the laws are not violated. The responsible head of the company is the manager (direktor), or the general-direktor, in case there is a board of managers. His right-hand man is the general secretary. Directly beneath him are:

1—The oberingenieur, or chief engineer, of rolling stock and equipment.

amount of money invested in the Hamburg Company, on account of the consolidation with it of other lines, for which very little cash was required, an exchange of stock in certain ratios having been generally agreed upon. It may, however, be stated with considerable accuracy that the capital stock amounts to about 50,000,000 marks, of which about 8,500,000 marks have been expended on buildings and real estate, about 15,000,000 marks on cars and electrical equipments and about 26,500,000 marks on tracks and the company's share of street maintenance. In connection with this, it should be stated that the company does not generate its own current, but buys it from another company, which also owns the main feeder cables of the distribution system.

TRACK CONSTRUCTION

Although the Hamburg road was the first on the Continent to introduce the electric system on a large scale, it has not suffered from early mistakes, as have most other companies. This is due largely to the fact that, in spite of advice to the contrary and considerable ridicule, the company originally built a very heavy track and substructure.

VIEW ON JUNGFERNSTIEG, SHOWING ROW OF HANDSOME DOUBLE BRACKET POLES

2—The oberingenieur of the superstructure, which includes track and pavements.

3—The architect of new buildings, who also has the management of all buildings.

Directly under the ober or chief engineer, are (a) the technische inspektor, or superintendent of operation, and (b) the werkstattenchef, or shop foreman. The former is responsible for the operation of the road, for the new construction and maintenance of trolley lines and the electrical equipment of the cars. He gives orders to the repair men, who inspect the cars every morning before they start out, test the brakes and make slight repairs. The shop foreman (b) is the official who is responsible for the building of new cars, repairs to car bodies, trucks, wheels, etc. This official, as well as the architect, has an engineer assistant. The superintendent, mentioned under (a), has two assistants.

Reporting also to the general director, or manager, are also the cashiers and head bookkeeper, while the entire control of traffic comes under the charge of the general secretary.

CAPITALIZATION

It is a somewhat difficult matter to arrive at the exact

Low, broad rails, weighing as much as 53 kg per meter (about 106 lbs. per yard), are used throughout. The web of the rail is 16 mm (⅝ in.) thick, which permits the use of a substantial joint-plate.

The American engineer often wonders why the cross-tie construction is not in general use in Germany, the same being very reliable and not very costly. He may be answered by the fact that German roads are generally built through narrow city streets, where the municipality lays great stress on the excellence of the pavement. Cross-ties and well-paved streets, however, do not harmonize very well, because the foundation frequently becomes uneven, and a construction without the use of cross-ties must be adopted. Such a construction is more costly to maintain, and is responsible for the rail and track sections in use in Germany, which differ considerably from the American types. For the same reason the grooved girder rail (Rillenschiene) is used in Germany. It must, furthermore, be kept in mind that in Europe, on account of the narrowness of the streets, there is no law forbidding vehicles to use the car tracks, which also compels the use of the grooved rail. The groove is 32 mm (1¼ in.) in width and equally deep. The inner flange or lip is 15 mm (9-16 in.) wide,

and head of the rail is 60 mm (2⅜ in.) in width, so that the total width at the top is 107 mm (4 3-16 ins.). The base is 130 mm (5⅛ ins.) wide. The web, instead of being in the center of the rail, as is customary, is slightly to one side, so that the downward pressure of the wheel is in a vertical line with the center of the web. The pressure acts, therefore, directly over the center of the base, while in most other rails the pressure acts eccentrically, which results in a tilting of the rail. This, in turn, will loosen the rail and cause water to enter between the rail and pavement, destroying the railbed and entailing much expense.

For similar reasons the company has dispensed with the usual form of round or flat tie-rods, which do not prevent the tilting of the rail. Instead, the company uses a special section of flat rod, which is stood on its narrow edge, embraces the rail base by means of an extension and is secured by a wedge. It will be readily seen that by firmly holding the rail base at the center, directly below the line of maximum pressure, the rail is less liable to shift out of its original position.

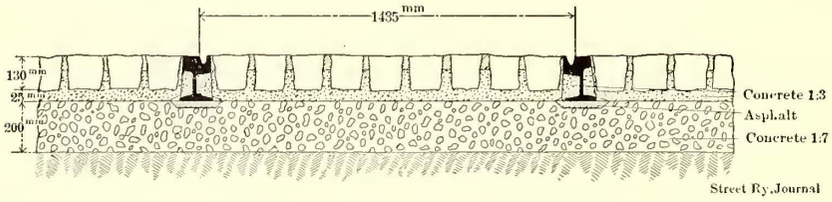
The joint-plate, see page 5, which is 850 mm (33 ins.) in length, is also carried under the base of the rail, and is tightened by means of six bolts. The fear expressed at the time these plates were introduced that a triple fit (below the rail base, above the same, and below the head) could not be simultaneously obtained, has not been borne out in practice. The results are so gratifying that other roads have adopted this construction.

The rails are rolled from what is known as Thomas-fluid steel, having a tensile strength of 72 kg per sq. mm (102,400 lbs. per sq. in.). The homogeneity of the material is determined by means of acid tests. The tie-rods used have a tensile strength of from 40 to 50 kg per sq. mm.

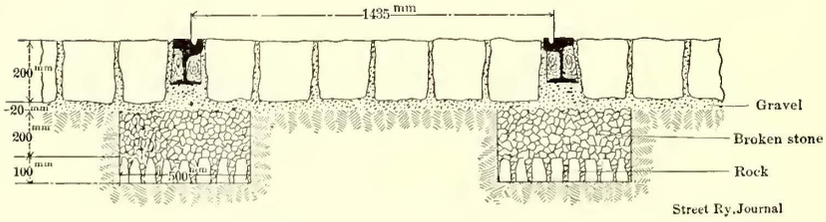
WHEEL TIRES AND CURVE CONSTRUCTION

Steel tired wheels are used throughout, the material being Excelsior steel, having a tensile strength of 80 kg. If has been found very satisfactory, and there is no case on record in Hamburg of a wheel flange having broken, no matter how much it has been worn. The only trouble experienced with the tires was that originally the treads wore much more rapidly than the flanges, which showed a tendency to become very long and thin at the edge, owing to the grooved rail used. To overcome this tendency, and obviate the frequent necessity of turning down, the company adopted the expedient of using for the outer rail of all curves of 30-m or less radius, shallow grooved rails, which differ from the grooved rails used elsewhere on the system, in having a groove only 8 mm in depth. This allows the wheels to run on the flanges, while the car depends mainly for guidance on the inner wheels. The diameter of the wheel, through the flanges, has such a relation to the diameter at the tread, that by the running of the outer wheels on the flanges, the axles naturally describe a curve of 35-m radius.

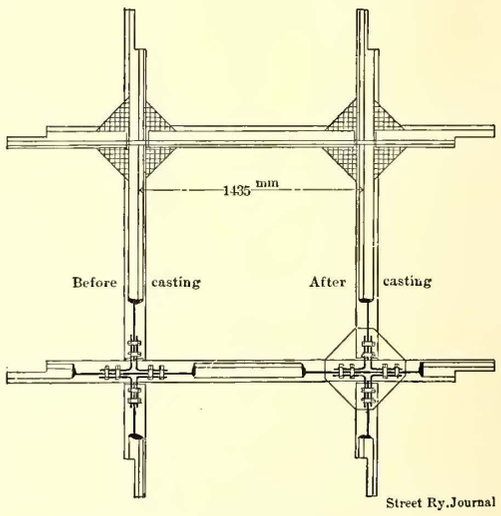
It was feared at first that the use of shallow rails at curves would cause the cars to jump the rails, but no such case is on record in Hamburg, where the traffic is very heavy, although the wheel flanges are 14 mm in depth. The company contends that owing to the binding effect of the ordinary grooved rail, and the unavoidable slight variations in gage, which are bound to occur in tracks laid in paved streets, the attempt to use a deep groove on both outside and inside rail is far less safe than to employ one guiding groove, because there can be no such binding of the wheel flanges. There is also no screeching around curves, and in consequence it has been found not necessary to grease the rails at curves. The rails on curves are laid with a super elevation of one in twenty. The only trouble experienced with the plan was that while the wear on flanges and treads was more equalized, it was not sufficiently so, so that the company is now using the shallow grooved rail on the outside of all curves up to 75 m; this has resulted in the uniform wear sought. These shallow rails are also used in the construction of built-up crossings, and this has the effect that the car runs over the crossing on its flanges, and there is no jumping across grooves. Finally, it should be stated that the gage on the curves where the shallow grooved rails is used is made tighter, and the rule is to make the gage 1432 mm, instead of 1435 mm.



STANDARD TRACK CONSTRUCTION IN PAVED STREETS ON CONCRETE FOUNDATION



STANDARD TRACK CONSTRUCTION ON PAVED STREETS WITHOUT CONCRETE FOUNDATION (PREFERRED TO THAT ON CONCRETE)



STANDARD BUILT UP CROSSING

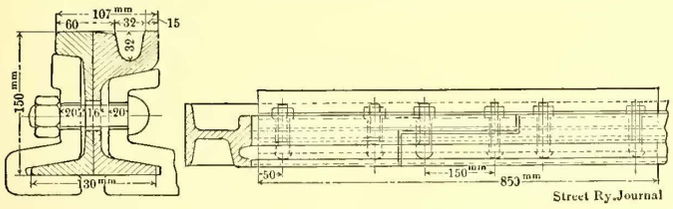
BONDING AND TRACK SUB-BASE

The rails are double bonded by channel pin bonds, with copper bond wire, 8.8 mm in diameter.

More than one-half of the entire track is laid on a ballast of coarse gravel or broken stone. The latter method has given the best satisfaction, has required the least maintenance, and has insured the easiest riding. Concrete foundations have not been found very satisfactory, although the company laid a cushioning material between the rail and the concrete, which insures easy riding and checks the wear on the concrete. Concrete has only been used when the entire street had such a foundation, and it was out of the question to use any other method. As an intermediate material between the concrete and rail, asphalt has been used, a layer being laid 2 cm (13-16 ins.) in thickness. It was of course impossible always to have

a space of 2 cm between rail and concrete, and in case the space was less, the asphalt was poured in. When the space available was 2 cm, powdered asphalt was mixed with sand, and the mixture was put into place by tamping. The depth of the concrete base below the rails is 20 cm (8 ins.), and consists of seven parts of broken stone and one part of cement. The paving blocks are laid in a mixture of three parts of stone and one part of cement. It should be remarked that Hamburg has very few asphalted streets, which makes the maintenance of the tracks a difficult matter. In the streets of heavy traffic concrete pavements are largely used, the cracks being filled with asphalt, the best quality costing 24 marks per sq. m.

Ample provision has been made for the drainage of the tracks and switches. Wherever there is a change of grade, the flange of the rail and bottom of the groove are cut away for a distance of 20 cm (8 ins.), and a cast-steel piece is inserted with an outlet, which terminates below in a pipe connecting with the city drainage system. The insertion of such a device costs about 300 marks ($75) per double track, and along the entire 266 cm (166 miles) of track there are, in all, more than 300 such drains.

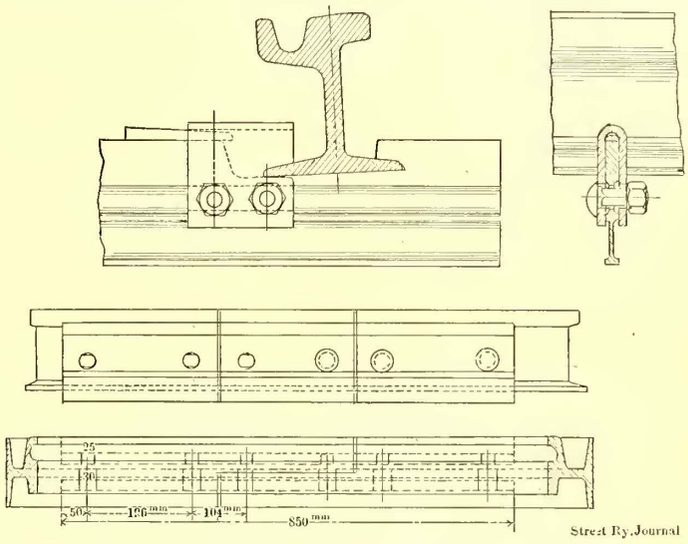


STANDARD RAIL AND MITERED JOINT

Switch tongues are constructed of Siemens-Martin cast steel in one piece, and the material has a tensile strength of at least 65 kg per sq. mm. Movable tongues are counterweighted. The counterweight case is not drained and the accumulated water is removed by means of a hand pump. The switch-boxes, which are controlled by levers, however, are connected to the city drainage system. The company is opposed to the use of those switches which are automatically set by the cars, and prefers either those set by the motormen, or those operated by switchmen. In 1899 the company tried switches having two tongues, a common type in Germany, but they were not found satisfactory, and only one-tongued switches are in use at present. At only two points along the lines, where traffic is very dense (216 scheduled cars every hour), are switchmen used. The tongues of the switches are 4 m (13 ft. 1 in.) long, and the fact that their length is considerable, probably accounts for their successful working.

Crossings are made up of service rails, with their joints cast together, after the usual style, with cast iron.

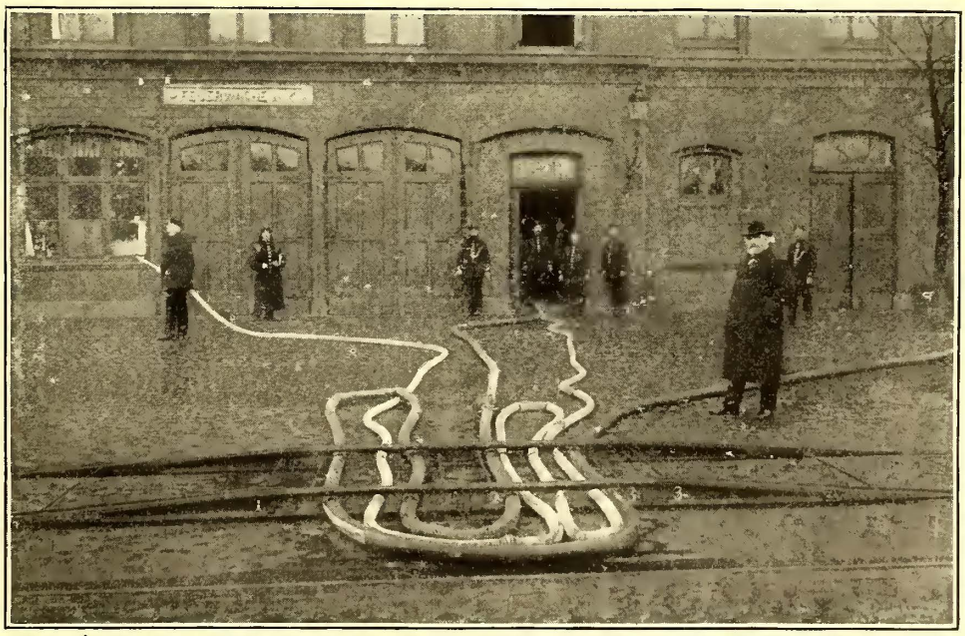
The tracks are always laid in the center of the streets. The distance between double-track centers is 2.65 m (8 ft. 8 ins.), so that there is a space of .65 m (26 ins.) between two passing cars, which are 2 m (6 ft. 6 ins.) in width. This space allows a stout policeman to stand between the two cars. A double track is permitted on the streets only where sufficient room is left at each side to allow an ordinary vehicle to pass alongside of the car. This rule also holds for side streets, and has often necessitated the reduction of the width of sidewalks at the railway company's expense. For a distance between rail centers of 2.65 m the street must be 9.65 m wide in order to comply with the above regulation. This has been found feasible in all the suburbs, not always, however, in the city itself, and very seldom in Altona.



SECTION AND PLAN OF TIE ROD USED IN HAMBURG

OVERHEAD CONSTRUCTION

The trolley system is used throughout. In the narrow streets the trolley wire is suspended from wall rosettes, fastened to the houses; wherever such a rosette was not permitted, poles were erected. In the suburbs poles are used almost exclusively, set 35 m apart. Stranded span wires, 6 mm in diameter (No. 2 wire), carry the trolley wire. Only Mannesman steel tube poles are used, and are capped on top by an ornamental hood. The poles used on tangents are designed to have a tensile strength of 200 kg, while 1000 kg is the figure prescribed for the poles used at curves.



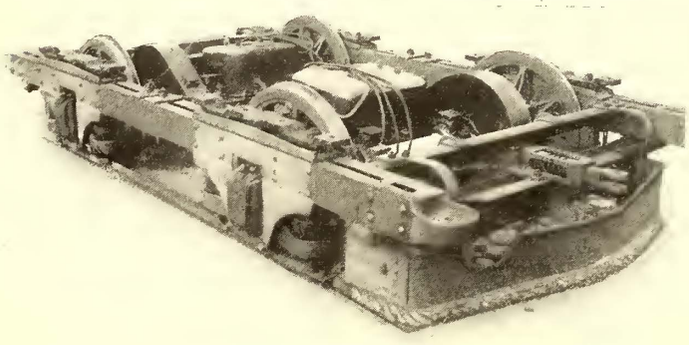
HOSE BRIDGE

On Jungfernstieg, a view of which is shown in the illustration on page 3, and which is one of the finest streets in Hamburg, some special and very attractive double bracket

poles have been used. They are 6½ m high and 17 m wide, that is, the brackets extend out on each side 8½ m, and the ornamentation and scrolls are beautiful specimens of coppersmith work. The cost of these poles, installed, was about 10,000 marks each. On account of their appearance, the people in Hamburg have nicknamed the street Galgen Allee (Gallows Alley). The tops of the poles are surmounted by arc lights.

The trolley wire used in the suburbs is a No. 0, 8.3 mm in diameter, while within city limits a No. 000 wire, having a figure 8 section, with cross section of 80 sq. mm, is used Recently a wire having a rectangular shape, but rounded at the four corners, has been introduced. The thickness of this wire is 8 mm (5-16 in.), and the area is 90 sq. mm (157,880 circ. mils). Experience has shown that it is a simple matter to string this wire.

To guard against contact between fallen telephone and



STANDARD DOUBLE TRUCK

trolley wires, wooden strips are secured above the wire, and are covered by a roofiing of thin tin. They are mounted on metal pins, soldered to the trolley wire every meter. These devices, however, have not given thorough protection in the past. The telephone wires, in the act of falling, roll up and frequently make contact with the trolley wire from below. The device has to be employed, however, because the government prescribes its use, in order to protect its telephone system. It is useless and costly, and makes the otherwise sightly trolley wires look cumbersome and objectionable.

Out of the ten cases of broken wires which have occurred on the system since it was put in operation, seven were caused by the wires parting, two were caused by breakage of the span wires, and one was due to the burning out of an insulating support. The number of wire breakages is the smallest in Germany, taking into account the extent of the system and the traffic, which, since 1894, has been over 100 million motor car kilometers. It is due to the careful inspection and maintenance of the line. The technical inspector has worked out a plan, according to which each point of a wire is inspected within a period of 14 days.

The tension on an 8.3 mm trolley wire is 400 kg, which is measured by means of a dynamometer. When the warm weather approaches, small pieces are cut out of the trolley wire at convenient points, so as to make the wire shorter. These pieces are replaced when the cold weather sets in. The trolley wires passing along streets where the traffic is very heavy are replaced every three years, because they are worn out in about that time, especially at the curves and switches. At certain points the wire is subject to the wear of the trolley wheels of 108 cars every hour, not counting any extra cars during rush hours.

POWER STATION

Current for the Hamburg lines was supplied up to within a half-year ago by one of the power stations belonging to the Hamburg Electricitäts Werken Aktiengesellschaft, from which company the current was purchased. The current for the Altona lines was supplied from a second station belonging to the same company. The territory furnished from the Altona station is not very large, but that from the Hamburg station is very extensive. The contract calls for a minimum voltage of 490 and a maximum of 540. The distance between the station and the furthest feeding point is 8 km, and to the end of the trolley wire even 10 km (6.2 miles). The point where the greatest amount of current passes into the trolley system has passing through it 800 amps., and recently no new feeding points have been selected which do not require at least 500 amps. A larger number of smaller feeding points might be more economical, but the frequent burning-out of the feeder fuses would cause many disturbances in traffic.

The current is measured, not at the switchboard, but at the feeding points, and payment is made accordingly. The cables and return wires belong to the company furnishing the current, which is also responsible for any damages due to electrolysis, a point which was probably not thought of when the contract was made. Both companies have at each feeding point wattmeters, which are placed in a small house on the street. There are in all thirty-three feeding points, which, for economical reasons, are all interconnected. The connections may thus be altered at will. In case there is a fair or race in some suburban town, occasioning heavy traffic, then all the neighboring feeding points are connected into this particular line. The wattmeters are read every two days.

Some time ago a new central station belonging to the same company, was opened near the other end of the city, which somewhat reduced the difficulty of returning the current to a single central station. A third station is now being built, and will supply the southern portion of the system with current. The several circuits leading to the various feeding points can be increased or diminished by means of section insulators, which are inserted into the trolley line every 300 m. These insulators also serve to limit an accident occurring on any line, such as the breaking of a wire, etc., to a section only 300 m in length, a precaution which is essential for the continuity of the service.

ROLLING STOCK

The rolling stock consists of fifty double-truck cars, twenty-six equipped with two G. E.-800, and twenty-four with G. E.-52 motors; one three-axle car, with two G. E.-800 motors; 181 single-truck, double-motor cars, seventy-nine with G. E.-800, 21 with the old W. P. motors, and eighty-one with Shuckert motors; 280 single-truck, single-motor cars, with G. E.-800 motors, one parlor car, and one experimental car, a total of 524 motor cars. A larger number of motor cars are now being constructed. There are, in addition, 300 trailers, fifty of which were specially constructed for electric service (those which belonged to the former tramcar company), while 250 were the old horse cars transformed into trailers. The transformation consisted in the lighting installation, the mounting of a magnetic brake on one axle, and a coupler. They seat fourteen persons, and six persons can stand in front and five in back, a total of twenty-five persons. The cars are very light, weighing from 2.5 to 2.8 tons, and could easily be drawn by a one-motor car, although there are grades as steep as 5 per cent. The double-truck cars seat thirty persons, each seat being 50 cm wide; four persons can stand in front, and five in back. In connection with this statement it should be said that in Hamburg, as in all German cities, the police watch closely that only

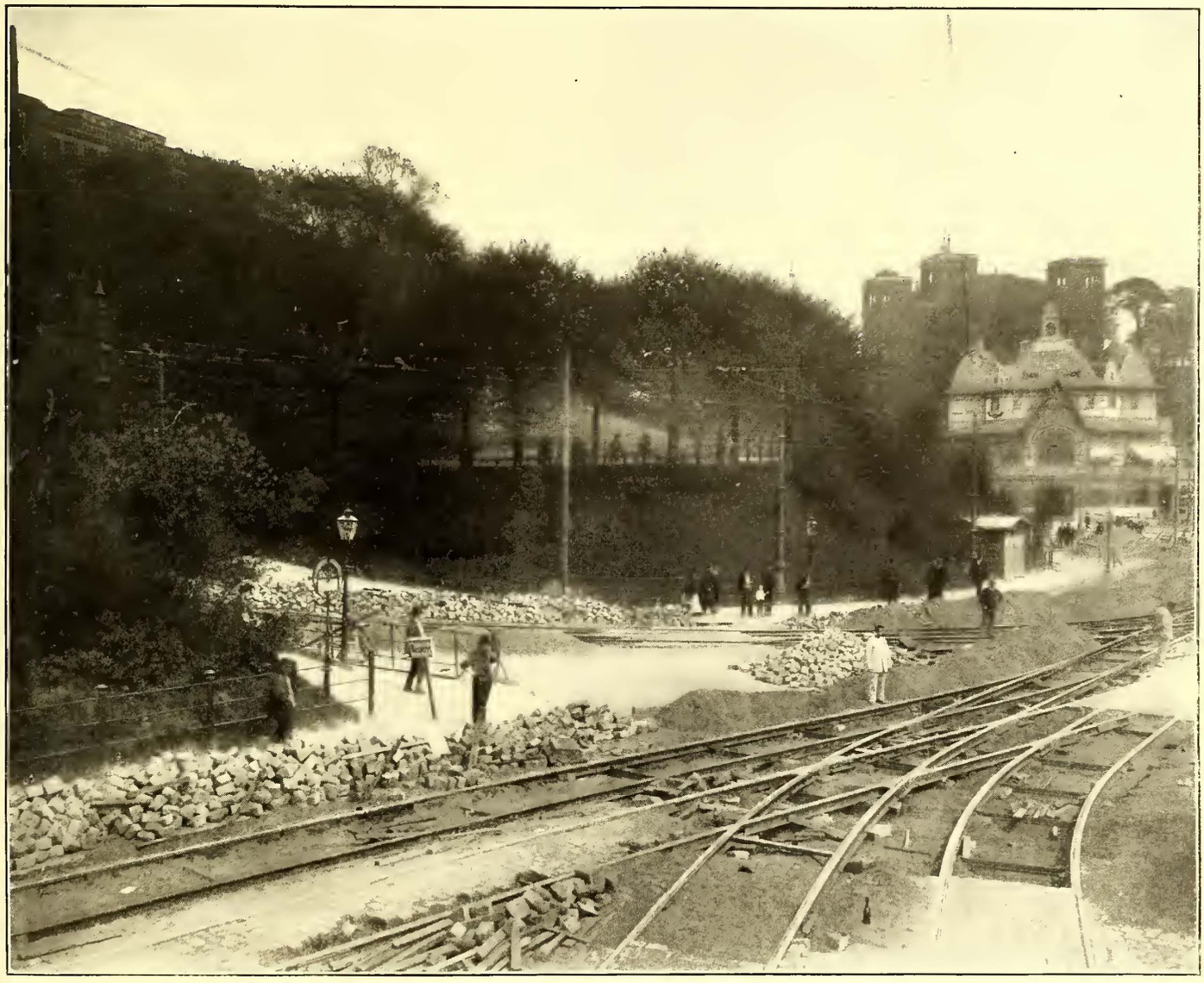
the prescribed number of persons is carried. To this regulation we will return later.

The single-truck motor cars have twenty seats, there is standing room for nine persons, while the above-mentioned fifty trailers have eighteen seats, and there is standing room for nine persons. As the cars are only permitted by law to be 2 m wide, it is impossible to provide three seats across the car, with a longitudinal aisle. The seating arrangement thus provided is not an ideal one, especially during the rush hours; nevertheless these cars are liked better than those having longitudinal seats. All cars are made at the company's own works at Hamburg-Falkenried, and the company's long and varied experience in car building is of great value to it. Its works are the largest of their kind on the continent. During the last few years over 500 cars were turned out for other companies.

As will be seen in one of the engravings, the single-truck cars are supported by spiral springs, which insure smooth running, but have the disadvantage that their elasticity weakens in time, and that they have to be replaced frequently. The cars taken over from the Tramway Company have elliptic springs. The wheelbase of the single-truck cars is 1.7 m; that of the trailers 1.53 m. The wheel diameter of the motor cars is 780 mm; that of the trailers 760 mm. The double-truck wheelbase is 1.3 and 1.5 m, and it has been found that the 1.3 m trucks derail much more frequently than the 1.5 m trucks, probably because the wheelbase is smaller than the gage.

The Union E. G. (G. E.) controllers are used throughout, but recently controllers designed by the company's engineers have been built. They have six operating and six braking steps. The last braking point furnishes the current direct from the trolley wire for emergency purposes. Contrary to German custom, the short-circuit and magnetic brake, operated by means of the controller, are employed simultaneously with the hand brake, for operating purposes. On most roads they are only employed in cases of emergency, because of the consequent wear and strain on the gearing. The motormen have instructions, however, to use the last notch, already referred to, only when there is danger of accident, and every time this last notch is used, it is indicated on a register, which is attached to the controller. It registers eleven times before it has to be set back to zero. The company has also patented a device which is attached to the axle, and registers the number of revolutions of the axle whenever the current is on. In that manner a careless and wasteful motorman can be easily detected.

As already stated, all motor car wheel tires lately installed have been of Excelsior steel, having a tensile strength of 80 kg. The material is 40 per cent more expensive than the steel usually employed, but it possesses the property, always to remain rough on the surface, so as to provide good adhesion between wheel and rail. Furthermore the wear is uniform, uneven spots only being visible after long service, so that the tires need only be turned off



TRACK CONSTRUCTION NEAR THE HAMBURG HARBOR SIGNALING STATION

after an average travel of 60,000 km (38,000 miles). This may be done two or three times before discarding the tire, so that the average life of a tire is about 200,000 km (125,000 miles). All axles have a diameter of 110 mm (4 5-16 ins.), experience having shown that smaller axles are liable to break.

The motor pinion is made of cast steel, the gear of gray cast iron. This material was chosen, because the company thought it advisable to replace both gear and pinion at one

PAINT ROOM

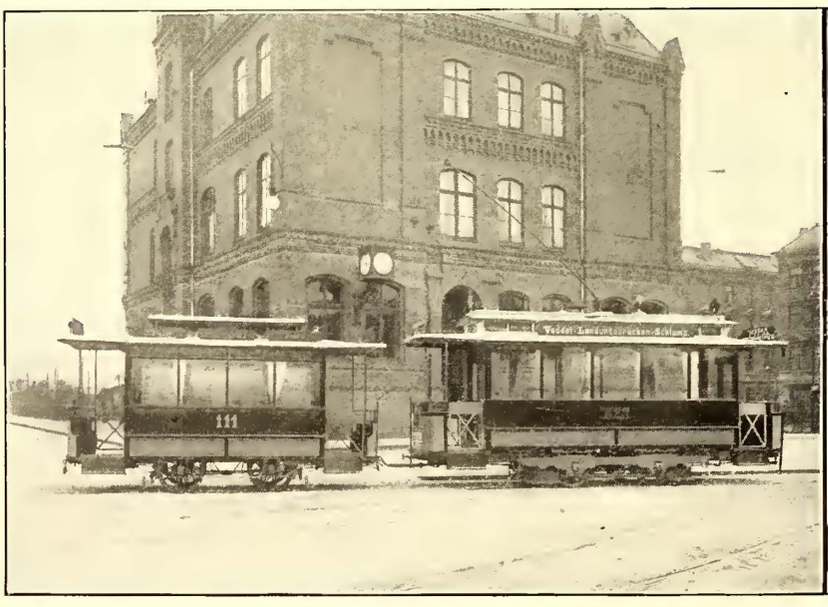
and the same time, and not, as is generally done, replace a worn gear or pinion by a new one, and have it work with a worn wheel, with which it will certainly not mesh. In 1897, when the hand brake only, and not the short-circuit brake, was used for operating purposes, the pinion had a life of 175,000 km, and the gear 215,000 km. These figures were reduced to 110,000 and 125,000 km respectively when traffic became heavier, and the short-circuit brake was used for operating purposes. These favorable results are due to the careful cleaning and watching of axle bearings, by which perfect meshing of the gears for long periods is insured. It must be kept in mind that over one-half of the cars are equipped with only one motor, and that the cars make many stops, sometimes every 50 m. Furthermore, many cars have trailers attached. As a result the motorman must frequently keep the current on until he almost reaches the stopping place, so that the controller handle may often be thrown from a running point on to the short-circuiting brake point. A more severe test can hardly be conceived. The insulation has stood these trials well, there having been very few cases of armature and field coil burnouts. This may be gathered from the fact that the entire winding force consists of four machinists and four other workmen, who take care of 520 motor cars.

The cars, as has been stated, are manufactured at the company's work at Falkenried. Although the system has been considerably extended during the past few years, and the traffic has increased, the company has built no cars for its own use during the past four years, because the works have been fully occupied building cars for other roads. The cars needed during the company's growth have been taken from the reserve stock, which was quite large some years ago.

Special mention should be made of the track cleaners, which are attached beneath the platforms, and which are let down on to the tracks by the motorman turning a small handle located next to the controller. This device cleans the groove in the rails, and has saved the company considerable money in dispensing with the services of men employed especially for this purpose. Only a few track cleaners are now employed for cleaning the switches, which obviously cannot be kept clean by the device mentioned.

The cleaner consists of a specially shaped piece of cast iron, having considerable weight, which is attached to a rod and can be lowered into the groove. The first cars leaving in the morning lower the cleaner, and during the day several motormen are ordered by the inspector to do likewise. The saving due to the use of this device was 85,000 marks in wages during the first year of its use. At first a number of cleaners were destroyed by careless motormen, who did not lift them up when they passed over a switch or crossing, but as soon as the company announced that the motorman would have to pay for damaged cleaners, in case they did not follow instructions, the number of damaged cleaners was considerably decreased.

To guard against accidents to pedestrians the company has equipped its cars with the wheel guards or track clearers, used almost exclusively in Germany. This device consists of a board mounted on the truck frames just in front of the wheels. The public did not, at first, consider this device ample protection, but experience has shown that roads, on which other so-called protective devices are in use, have had many more accidents to record



STANDARD TRAIN. CONSISTING OF ONE MOTOR CAR AND ONE TRAILER

ARMATURE REPAIR ROOM

than those on which the above wheel guard has been adopted.

Even in Germany it is conceded that the far-protruding American fenders may lessen a person's injuries under favorable conditions, that is, if the person is caught in the fender while in a standing position, or if he is lying on the ground with legs and arms pulled closely to the body, or is hit in the back by the fender, so that the latter picks him up. If the person falls, however, as is often the case, with outstretched arms and legs, then nine times out of ten the first part of the body struck will be a hand or a foot, over which the fender will pass, maiming the person, without catching him. Cases have also been recorded in which one limb was caught above and the rest of the body below the fender. These protruding fenders, however, cannot be used in Germany, because there are many crooked streets and curves, and with single-truck cars the fender will not follow the curve, but project outside of it. Moreover they have the disadvantage that they shorten the distance in which a car can be braked after a collision is imminent. For these reasons the Hamburg Company, after having had twenty cars equipped with fenders during the past four years, has decided, in conjunction with the municipal authorities, to use no other protective device than the flat wheel guard, and to carefully inspect and maintain in perfect condition all brakes on the cars.

NEW WAITING STATION IN HAMBURG

REPAIRS

All repairs to the cars are made at the several depots of the company, and, as stated above, are in charge of the technical inspector. For the making of these repairs, including cleaning and lubrication of motors and trucks, but exclusive of the care of the car bodies, one workman is employed for each five motor cars in daily service, besides one helper for twelve motor cars, and one machinist for twelve trailers. In the main repair shops, in which the commutators are repaired, five workmen are employed. There is, furthermore, a main shop for the repair of trucks and inspection of wheel tires, but repairs to trucks which cannot be made at the local depots are not of very frequent occurrence. The repairs in the central shops are made under the supervision of the factory foreman. In the small shop shown on page 8 all the armature repairs are made.

OPERATION

The entire traffic of the road, as stated, is under the direction of the traffic manager, who has under him the superintendent and his two assistant superintendents. Each of the latter controls a district of which there are two. The traffic manager decides all questions of general character relating to the traffic, the superintendent and the two assistants solving the actual problems which come up in daily operation, and which do not require the personal attention of the chief. The manager plans the hours of service for the employees, there being 914 conductors, 809 motormen, 113 male, and 147 female car cleaners, and 48 road inspectors. The two assistant superintendents transmit the orders of their chief to the depot foreman, who in turn transmits them to the other employees under his direction. The assistant superintendents also examine employees and witnesses in case there are any complaints or accidents, and report on any observation and deficiencies of the service. The immediate superior of the motormen, conductors and road inspectors is the depot foreman, whose duty it is to see to it that the service schedule is strictly adhered to. This embraces the cleaning of the car bodies, the starting and return of the cars, receipts of money from the conductors, giving and receiving of tickets, and the general care of the depots, while, as stated above, the machinists and other technical men are under the direction of the technical inspector. The depot foreman reports to the central office as to the number of cars in service, distances traveled, receipts, etc. He reports also all accidents and traffic disturbances to his assistant superintendent, and in order to save time, he reports such

accidents and disturbances to the traffic manager in person.

The motormen are taught how to handle their controllers and brakes and insert fuses, but are not instructed as to the other mechanism of the car, as the company has found that it is better not to allow the motorman to attempt to make any repairs. It has found that the best men to train as motormen are the former horse-car drivers, who are well acquainted with the street car traffic. The candidate at first accompanies an experienced motorman for a few days. The latter points out to him the stopping places, the special features of that particular route, the section insulators, the points where he has to cut off his current, etc. After a few days he is brought before one of the head motormen, of whom there is one for each type of car in use, *i. e.*, one-motor car, two-motor car, double-truck car, cars with and without the line pressure used at the last braking contact, etc. The men are taught the handling of the cars by accompanying this man on a schedule trip. This is continued for three weeks in company with a head motorman or his assistant, after which the assistant superintendent examines the candidate, and if he is successful in his examination, he is examined finally by the superintendent himself. If after the three weeks, the candidate exhibits no aptness for the position, no more time is wasted on him, and he is sent away, because it has been found that if a man does not grasp the problem in three weeks he probably never will. After the candidate has passed his examination, he has issued to him a certificate, which he takes to police, where he is given his official permit to operate a car. He is then only used as a substitute or reserve, and is made use of only on Sundays, or during the busiest hours of the day, otherwise being employed with the washing of the cars, or in some other work. Any man who intends to become either motorman or conductor must first wash cars. He is then graduated to the position of motorman, and only after then can he reach the position of conductor. All motormen can act as conductors, and, conversely, all conductors can act as motormen, so that they can always help each other out. This is of great value at the time of strikes. The total number of uniformed employees of the company (exclusive of the female car cleaners) is 2400 men.

The company also has a force of ticket inspectors who examine the tickets given to the passengers, and determine whether the conductors have made their entries correctly. There are also the usual inspectors, who interfere in case there is any disturbance, and must attempt to run cars as they are scheduled; they also have to report to the superintendent. The car-cleaning is done at night by the men and women referred to above.

VARIOUS TYPES OF WAITING STATIONS USED IN HAMBURG

Hamburg is fortunately so laid out that the traffic is densest in the center of the city. Radial lines emanate from this point. In the most frequented streets of the city 108 cars pass a given point every hour in each direction, not counting extra cars run during rush hours. The maximum permissible speed is 18 km per hour, but the mean speed through the narrower streets of the city is only 10 km, the same as that of the old horse cars. Through one of the streets where the traffic is exceptionally heavy the speed has to be reduced to 7 km, but this line is very short. The mean speed in the suburbs is 12 km per hour, and on two lines 14 and 16 km.

For the convenience of the public, waiting pavilions have been erected at very congested points, as shown on pages 9 and 10. The company is obliged to construct these

pavilions whenever ordered to do so by the municipality, and must pay for maintenance and lighting. At the termination of the franchise, these pavilions will revert to the city without compensation. In these houses, the company posts all time-tables, regulations and notices. No advertisements are placed in them, as the small return would not warrant keeping the advertisements up to date, and they are apt to divert the attention of the public from the time-tables and the other notices. For the same reason all advertisements have recently been removed from the cars. It costs from 3000 marks to 5000 marks to construct one of these pavilions. They have a stone foundation, are built of wood, and in the better quarters of the city are very handsomely decorated. The conductor of the last car passing such a pavilion at night must extinguish the lights and lock up.

over which a passenger travels, and for this purpose the entire system is divided into districts. In the first two zones the fare is 10 pf. (2½ cents), for each two zones further 5 pf. (1¼ cents) more, so that the fare for four zones is 15 pf., six zones 20 pf., etc. The longest trip includes ten zones, the fare for which is 30 pf. (6 cents). The zones within the interior of the city are shortest, and toward the exterior of the city, as the traffic becomes less, they become larger. The shortest is 800 m (0.558 mile), and the longest 3500 m (1.87 miles). In general whenever a passenger alights to go in a new direction, a new fare must be paid, but in a few special cases the company provides a free transfer, on which the conductor marks the necessary data with lead pencil. The passenger, in order to transfer, must do so at very definite corners, and must make immediate connection. In case the first car is filled,

LEHMWEG CAR HOUSE

One of the fundamental regulations prescribed for the motorman is that before he begins his work he must have slept eight hours. In order that he may surely get the benefit of this time, he is not allowed to live further away than twenty minutes from the depot. When a motorman ends his work, therefore, at 1.30, he will not be asked to return before 9.30. No motorman is allowed to work longer than ten hours, including stops at the terminals. The conductors work one hour longer than the motormen. The entire force receives from the company, in addition to their wages, uniforms, caps, gloves, overcoats and mackintoshes free of charge. All articles of apparel are manufactured in the company's own shops. The tailors who make the clothes also repair the window shades of the cars, which are used in summer to keep out the sun, and are removed in winter.

FARES

The amount of fare charged is regulated by the distance

the passenger must take the one following, or his transfer ticket will be invalid. These rules produce considerable complications, and the company is not inclined to extend this system, although it has found great favor with the public. The conductors carry all tickets in rolls of 500, which are contained in tin boxes carried on a chain around the neck.

In addition to the tickets, time tickets are issued, which are good for 24 minutes, and can be bought at a reduced price, so that each trip, which usually costs 15 pf., will only cost 7½ pf.

The fare has been reduced constantly. The last big reduction was made at the close of 1896, and has shown that a reduction of fare does not always mean increased gross receipts, as seems to be the general opinion. The Hamburg Company has always held out firmly against uniform fares; firstly, because it has to give up 1 pf. for each ticket sold, whether the ticket costs 10 pf. or 25 pf., but mainly because, under the present system, certain

fare zones are established at which the passengers must vacate the cars, making room for other passengers, or else pay another fare. In this way it is possible to maintain the service with a minimum number of cars. After the reduction of fare, the receipts per car-kilometer decreased considerably, namely, from 40 pf. to 31 pf. per car-kilometer in a very few years.

Last year 70,000,000 persons bought single tickets, and about 10,000,000 time tickets. It might be of interest to learn what percentage of the total receipts is to be ascribed to the 10-pf. tickets.

Seventy and eight-tenths per cent, or 60.5 per cent of the receipts were from 10-pf. tickets.

Twenty-six per cent, or 33 per cent of the receipts were from 15-pf. tickets.

The small remainder is divided among the more expensive tickets.

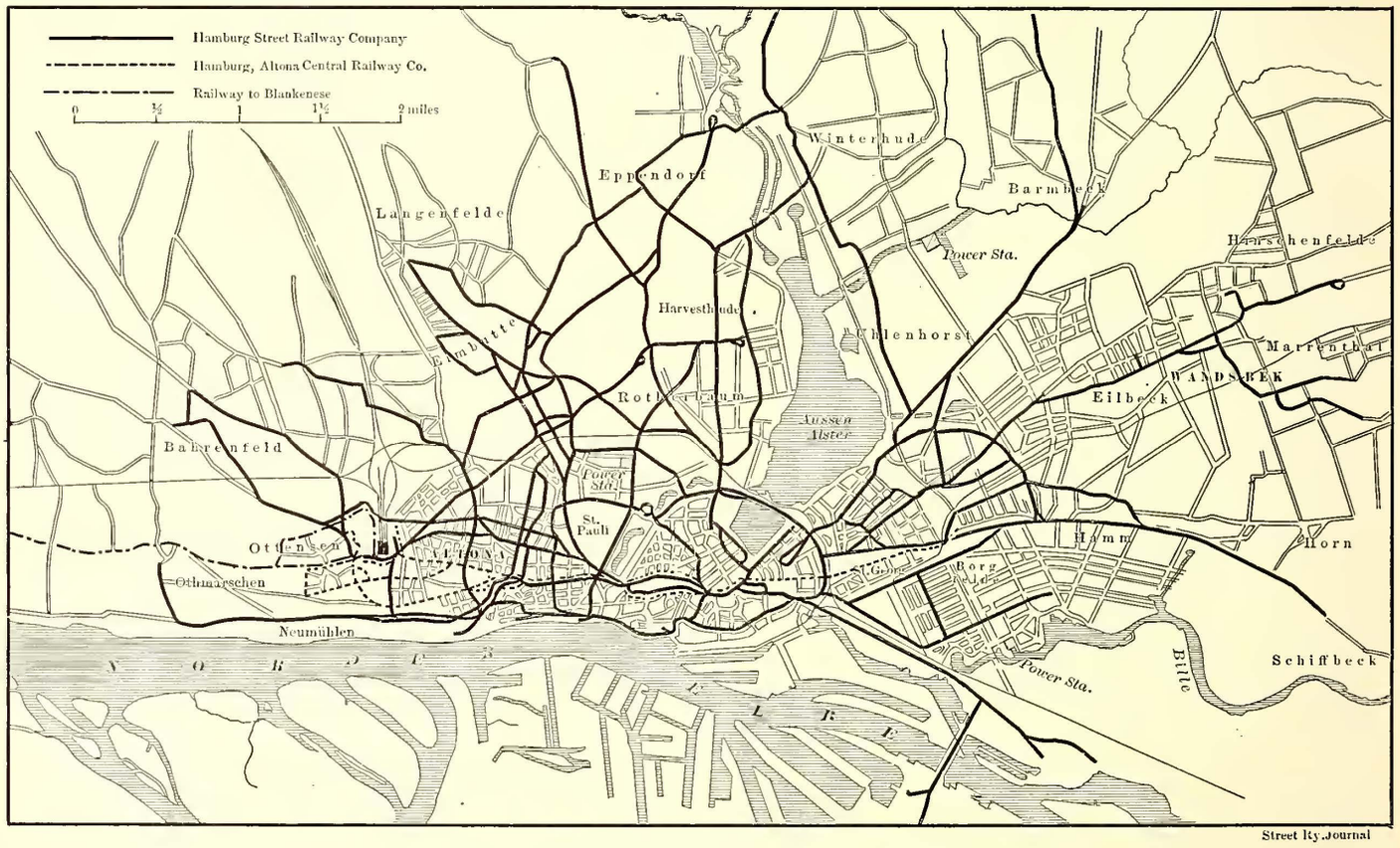
During the year 1900, 9,150,000 marks were paid for single tickets, and 675,000 marks for time tickets. The average price for single ticket was 11.52 pf., while the average price paid per person, including the time tickets, was 10.9 pf.

A total of 29.36 million car-km were traveled, 7.5 million by trailers, 1.25 million by single-truck cars, and 20.51 million by double-truck motor cars, while the horse cars traveled about 100,000 car-km. Greater Hamburg, including Altona and other towns from which revenue is collected by the street car company, has a population of about 900,000.

During the last few years 20,000 marks have been paid out to injured persons each year, or about 2 per cent of the receipts.

The fact that the receipts per car-kilometer are only slightly in excess of the expenses, inclusive of the money laid aside for new material and sinking-fund purposes, induced the company at an early date to pay particular attention to the supervision of the details of the traffic. It is evident that if the receipts amount to 30 pf. per car-km, and the expenses 25 pf. per car-km, a single superfluous trip would eat up the earnings of five other trips. For this reason the actual cost of operating a single-truck and a double-truck motor car, as well as a trailer, are figured up each year. In addition ten-day records are kept for each line, giving the cost of operation, distance traveled, the receipts and the profit. A separate table shows the profit or loss of that particular line as compared with the record of the year previous, so as to see whether the number of kilometers traveled, or the substitution of single-truck by double-truck cars is proportional to the increase in traffic. By means of these ten-day records the manager is enabled to institute reforms, after discovering an error which has existed for only ten days; he also knows how much is being earned by each section of the road during any portion of the year. The cost for clerical hire for keeping up these records is 3000 marks per year.

There is other public means of transportation besides the street cars, such as the passenger steamers plying along the Alsterbassin, the steamers in the harbor, and the junction railway operated by the state, i. e., the trains running through the city, some of which are local. In all these conveyances there were transported during the year 1900 the following:



MAP OF HAMBURG, SHOWING TRAMWAY SYSTEMS

			Trips per capita of population
S. E. G.	90	Million Persons	= 100.6
Centralbahm	12.3	" "	= 13 6
All the Street Cars Together	102.3	" "	= 114.2
Junction Railway	8.3	" "	= 9.2
Total Traffic on Land	110.6	" "	= 123.4
The Alster Steamer	4.7	" "	= 5.2
Harbor Craft	14.8	" "	= 16.4
Total Traffic on Water	19.5	" "	= 21.6
Grand Total on Land and Water	130.1	" "	= 145 0

CAR HOUSES

The company owns sixteen car houses, most of which are located in the suburbs. The oldest of these are transformed horse-car houses and stables, while the new ones are laid out on a large scale, and in accordance on recent engineering lines. One of these is the Lehmweg depot, which is shown on page 11.

The Brighton Corporation Tramways

The number of electric tramways in Great Britain is continually increasing, and if present rate continues at which horse railways are converted to electric traction, it will not be long before the horse car will be as rare a sight in a British as in the average American city. One of the latest roads in the United Kingdom to be equipped is that in Brighton, which was put in operation Nov. 25, the opening ceremony being witnessed by thousands of spectators. The first car was in charge of the Mayor, and was followed by six other cars, in which were present the members of the Corporation of Brighton, their wives, and other invited guests, viz., Mayors of Hove, Eastbourne, Worthing, Dover and other municipal bodies. After the Mayor had taken the first car over the entire route, and had returned to the starting place, he declared the tramways open to the public.

The history of the undertaking can be summed up in a few words. The corporation sought powers in the session 1900 under a bill for the construction of electric tramways, and obtained the royal assent in August, 1901. No time was then lost, and Thomas B. Holliday was selected and appointed as the corporation tramways engineer and manager. The same month immediate steps were at once taken to prepare the necessary drawings and specifications for the track and overhead construction, generating plant, with the requisite feeder and distributing cables, cars, equipments, etc., and the various contracts were satisfactorily placed before the end of the year.

Track Construction—Macartney, McElroy & Co., Ltd.

Overhead Construction—Robt. W. Blackwell & Co., Ltd.

Feeder and Distributing Cables—The St. Helen's Cable Co., Ltd.

Engines and Generators—Bruce Peebles & Co., Ltd., using Willans & Robinson engines.

Switchboard—Robt. W. Blackwell & Co., Ltd.

Rails, Angle-Plates and Ties—Bolckow, Vaughan & Co.

Special Work—Askham Bros. & Wilson.

Cars and Electrical Equipments—The British Westinghouse Co., Ltd., with cars by George F. Milnes & Co., Ltd.

The corporation decided to erect the buildings itself, under the direction of its engineer; the work of constructing the permanent way was commenced in February, 1901, and all the other contracts were arranged so that work proceeded uninterruptedly on all until the completion. The overhead trolley system, with side and center poles, was recommended and adopted.

PERMANENT WAY

The bed is of Portland cement concrete, 6 to 1, and of the depth of 6 ins. The rails, by Bolckow, Vaughan & Company are of the girder type, 6 ins. in height, with a 7-in. base, and weigh 101 lbs. per yard. The length of the rails is 36 ft., with a small proportion 30 ft. Extra strong angle-plates, weighing 46 lbs. per pair, were used, together with 20-in. steel sole plates, under the rail-joint, which rest on a 6-in. steel girder tie, securely anchored in the concrete. The method of laying the permanent way adopted was as follows: An excavation is made to the necessary depth for the concrete bed and ties, the latter were then bedded on a 6-in. foundation of cement concrete. The rails were then laid in position and brought true to the required level, and bolted up. The concrete bed for the permanent way was then put in, the effect being to securely anchor down the rail-joints, with the full weight of the concrete substructure. By this method, an entirely new departure in tramway track construction, it is confidently anticipated that the troublesome matter of loose rail-joints has been effectually overcome. The rail-joints are double bonded with No. 0000 copper bonds of the Chicago "crown" type. An even bed for the reception of the wood paving, which is used throughout, was provided in fine concrete in the proportion of three parts sharp sand to one of Portland cement. The wood selected, after full inquiries as to their relative merits, was American red gum, 9 ins. x 3 ins. x 4½ ins. The wood blocks were dipped in hot pitch when laid, and then grouted up with hot pitch. The track laid amounted to about 12 miles, but in addition there was a large amount of extra paving to be done in the streets, which, taken altogether, amounted to a superficial area of about 100,000 sq. yds. of wood paving laid on concrete foundation, and in addition about 10,000 sq. yds. or 12,000 sq. yds. of granite paving. The conduits, with ducts varying in number from one to sixteen, are laid, in most cases, between the tracks, and run into various manholes on the route, which are about 100 yds. apart. All the cables used were supplied by the St. Helen's Cable Company, and insulated with Dia's patent impregnable paper and lead covered.

A FINE PIECE OF SPECIAL WORK, BRIGHTON

The permanent way contract was commenced in February, 1901, and was completed about the end of September, 1901, a most creditable performance. The average number of men employed daily on the work during the eight months of erection was from 500 to 700.

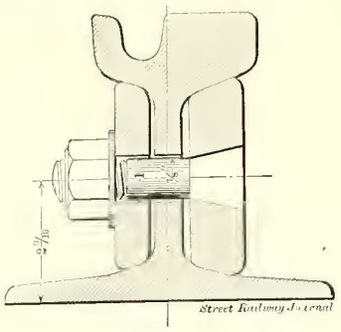
It is satisfactory to note that the whole of the permanent way, after completion, was highly appreciated by the corporation, and not the slightest fault was found by the Board of Trade. It may be mentioned here that not even a rail, curve or crossing was altered after being first laid

down, which, considering the large number of high grades, the steepest being 11 per cent, and curves with a very small radius, involving a considerable amount of special work, is also extremely creditable.

The special work, points, switches, etc., were supplied by Askam Brothers & Wilson, Ltd., of Sheffield, and consist of crucible steel points, their patent movable points, Dawson patent drain boxes, etc.

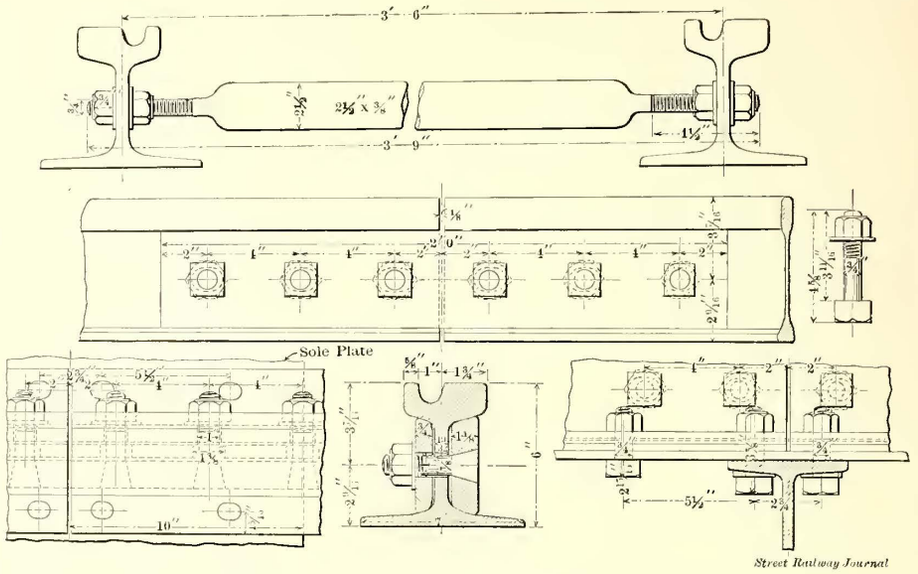
OVERHEAD CONSTRUCTION

Brighton being an extremely fashionable city by the sea, with neighboring parks of great beauty, it was decided that the overhead construction would require to be done with as great care as possible, and with as great a regard to the æsthetic point of view as was consistent with substantial work. This important work was intrusted to Robert W. Blackwell & Company, Ltd., of London, though the poles, which were manufactured by the British Mannesman Tube Company, of Llandore, Wales, were specially designed by Mr. Holliday, the tramways engineer and manager.

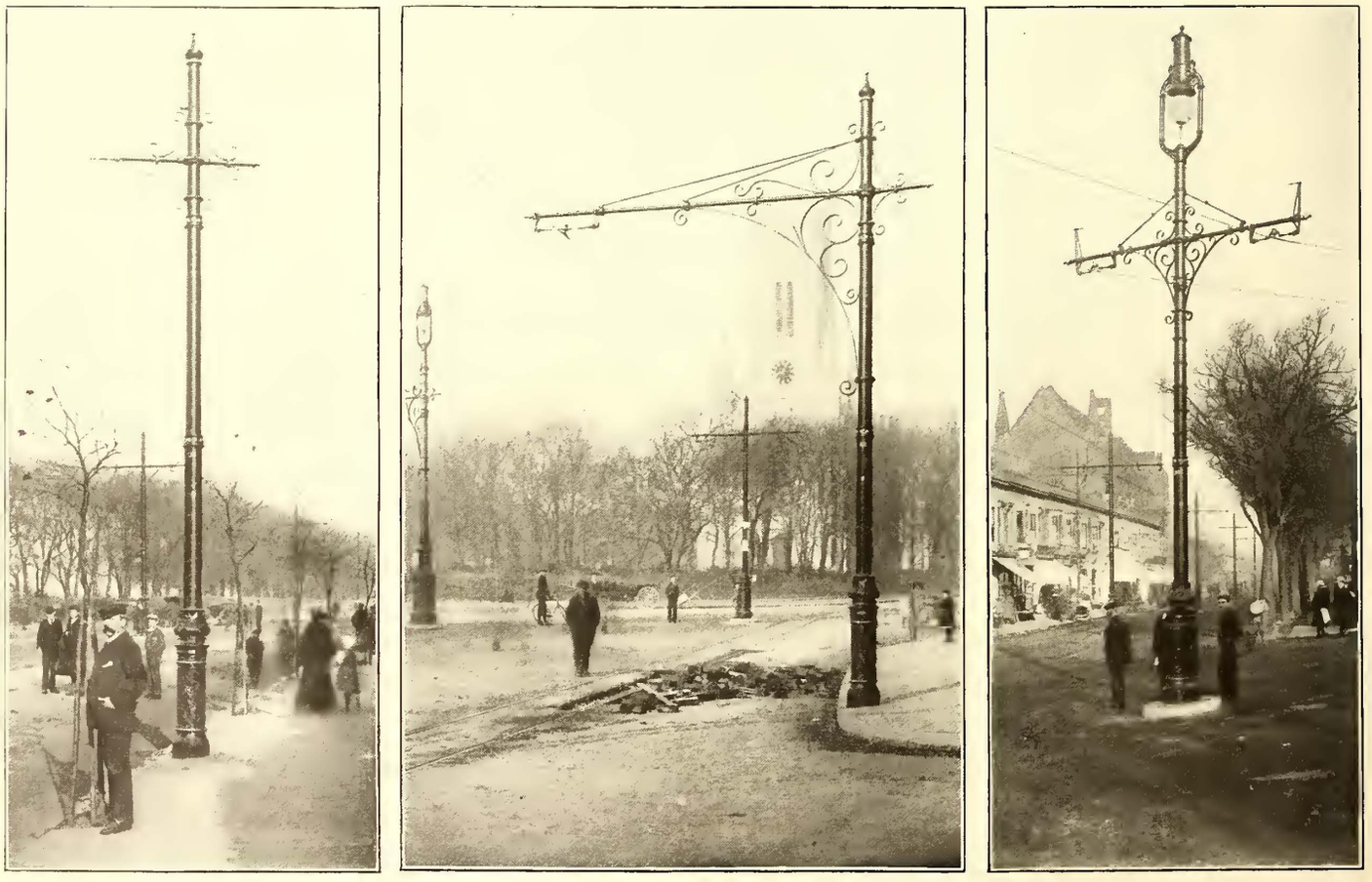


BRIGHTON RAIL JOINT

The poles are of drawn tubular steel, with bracket arms of 2½-in. steel tubing and ornamental wrought-iron scroll work of elegant design. The trolley wire is of No. 000 hard-drawn copper, of high conductivity, the breaking stress being 6000 lbs., and Wood's frogs and crossings are used throughout. Proper provision has been made by guard wires for the protection of the trolley wire from telegraph and telephone wires werever there are crossings.



DETAILS OF TIE RODS AND JOINTS, BRIGHTON

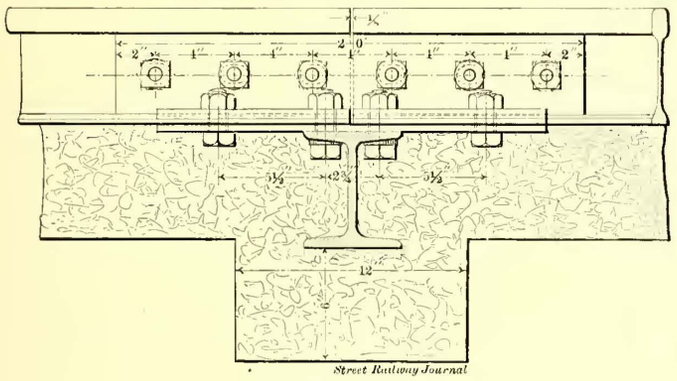


SPAN AND BRACKET POLES USED IN BRIGHTON

CARS AND EQUIPMENT

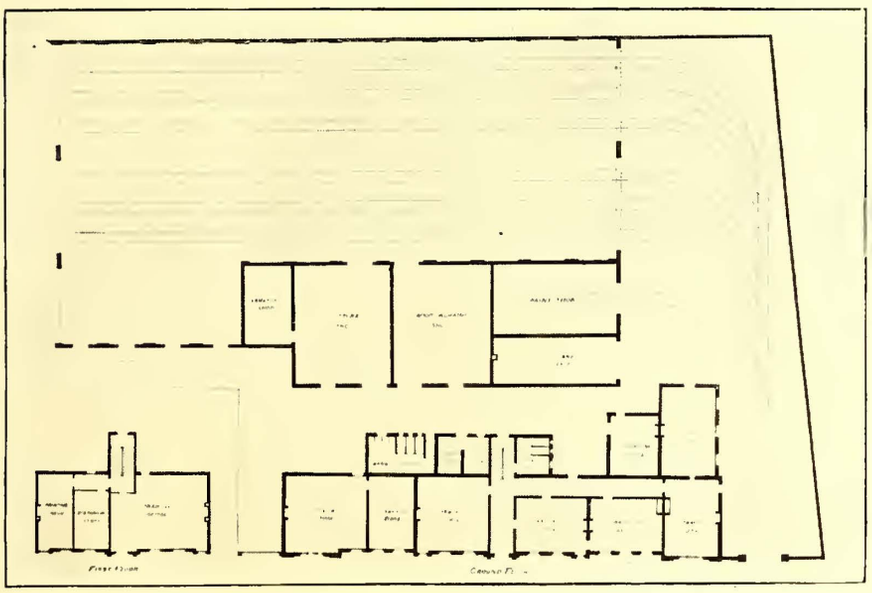
The cars were manufactured by George F. Milnes & Company, Ltd., of Hadley, Salop, and each is of the double-deck type, is mounted upon a Peckham standard

four-wheel truck, and has seating accommodation for twenty-four passengers inside, and thirty-three on the roof, making a total of fifty-seven. The interior is handsomely paneled in ash, with figured oak framing, the ceiling being of three-ply bird's-eye maple veneer. Oak handpoles are suspended from the roof by ornamental polished brackets, and with leather handstraps pendent therefrom. The seats are of three-ply perforated birch veneer, suitably curved for comfort, and covered with Axminster carpets of elegant design. The windows, of which there are three on each



RAIL AT JOINT, SHOWING GIRDER

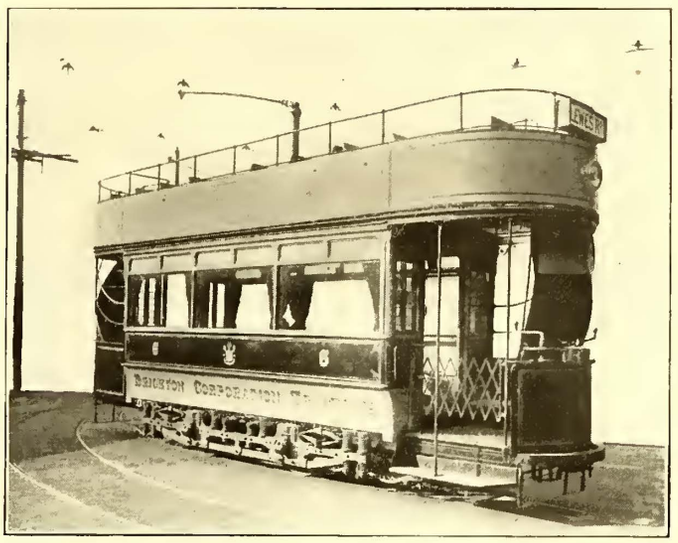
side, are of best ¼-in. polished plate glass, provided with sun blinds of old gold damask, sliding on brass rods and looped up to the side pillars by polished brass holders. Ventilation is afforded by swinging frames of oak above the windows, fitted with ornamental glass, and arranged to give ample ventilation without draft. Twin doors are provided at each end, having oak frames, with ash panels in the lower part, and glazed in the upper part with 3-16-in. polished plate glass. Access is obtained to the



PLAN OF CAR HOUSE AT LEWES ROAD, BRIGHTON

roof by a staircase of the reverse type, provided with brass handrails, and the treads fitted with non-slipping tread iron. The seats on the upper deck are of the "New London" dry seat pattern, and fitted with reversible backs. The roof is surrounded with handrails of polished brass, supported by strong wrought-iron stanchions.

The car is fitted with both wheel and track brakes, the track brake being operated by a brass hand wheel on the platform, provided with a tubular spindle, and allowing the ratchet brake spindle for the wheel brakes to work within the same. The interior of the car is efficiently lighted by incandescent lamps, fitted with ornamental cut glass globes. A polished brass headlight, fitted with powerful reflector, is recessed into the screen board above the canopy at each end, and arranged to throw light upon the



ONE OF THE BRIGHTON CARS

track in front of the car, and destination signs have also been provided, which are arranged for illuminating at night. An efficient system of electric signal bells is also provided, there being four pushes in the interior of the car, and four on the roof for the convenience of outside passengers, and a bell with distinct tone from the passenger's signal bell is provided on each platform for signaling between conductor and driver. Each car is also equipped with Wilson-Bennett life guards by Gabriel & Company, of Birmingham, after practical tests had been made with a dummy by Mr. Holliday.

The electrical equipments have all been manufactured and supplied by the British Electric Manufacturing Company, Ltd., and consist of Westinghouse No. 49-B motors, and No. 90 Westinghouse controllers, which are too well known to require description.

POWER STATION

An annex was built on to the corporation electric lighting station for the accommodation of the tramway generating plant, and three Peebles-Willans units have been installed, one of 325-kw capacity, and two smaller ones of 175 kw, the three giving a total capacity of 675 kw. A Peebles motor-driven booster has also been provided for the purpose of assisting the return current. The engines are of Messrs. Willans & Robinson's three-crank type, with a set of cylinders arranged tandem over each crank, steam being furnished by Babcock & Wilcox boilers. The larger engine gives 467 B. H. P., at 320 r. p. m. The high-pressure cylinders 440 mm (17.3 ins.), low-pressure cylinders 720 mm (28.3 ins.), and the stroke 260 mm (10.24 ins.). The other two engines give 252 B. H. P. at 350 revolutions, and have cylinders 12 ins. and 20 ins. x 9 ins.

All of the engines are capable of giving 25 per cent overload for half an hour, and are fitted with automatic variable cut-off gear, and also pass valves, which enable the engines to give their full power with 150 lbs. steam pressure instead of the normal 175 lbs. The sets work without condensa-

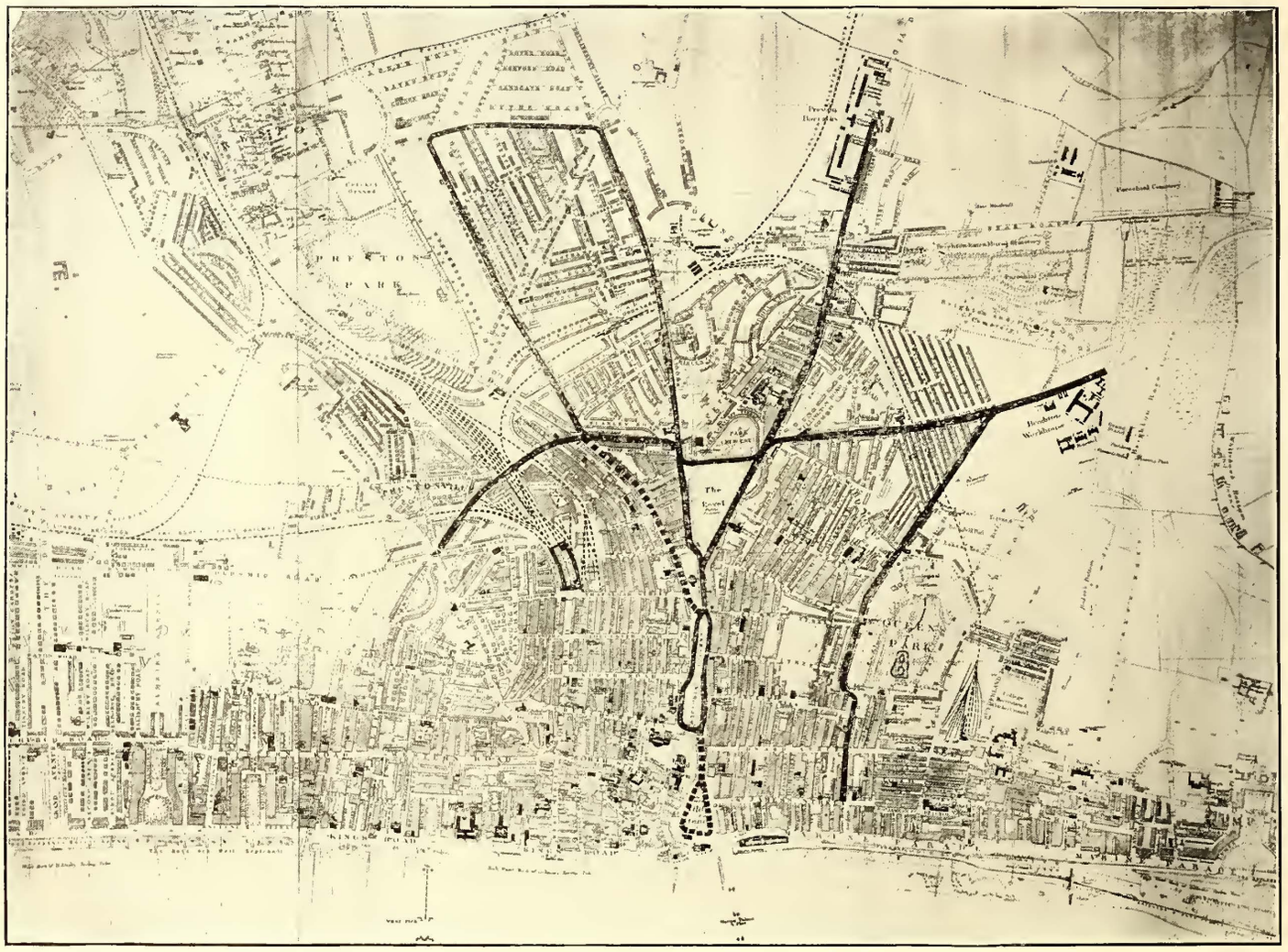
tion. The dynamos, which have been manufactured and supplied by Messrs. Bruce, Peebles & Company, of Edinburgh, are of their well-known multipolar fly-wheel type, compound wound for a pressure of 500 volts at underload, and 600 volts at full load. They are also designed to give an output of 25 per cent overload for half an hour, and 50 per cent momentarily without injury. In each case the armatures are of the slot-wound drum type, with ventilated cores, so that they will be suitable for running at full load for long periods, and the machines will run absolutely sparklessly at all loads from no load to over full load, without alteration in the position of the brushes. In the case of the small sets the engines and dynamos are mounted on one combination base plate, whereas in the case of the larger dynamo, separate base plates for engine and dynamo are provided. The accompanying illustration shows one of the sets described above. The motor-driven tramway booster consists of two separate machines, direct-coupled end to end, and mounted on a combination base plate. The motor is of Messrs. Bruce Peebles multipolar, shunt-wound, protected type, and is designed for an output of 40 B. H. P. when running at a speed of 800 r. p. m. It is designed to run off a 500 volts to 550 volts circuit, and will also give an output of 25 per cent over full load when required, and will run sparklessly under these conditions. The booster consists of one of Messrs. Bruce Peebles series-wound, multipolar machines, which is arranged to give an output of 1000 amps, at a pressure of 25 volts, varying down to 100 amps at a pressure of 10 volts. The machine is provided with a suitable shunt across the series fields, to enable this regulation to be effected.

The switchboard consists of eight panels in polished white marble, consisting of three machine, three feeder, one booster and one Board of Trade panel.

CAR HOUSES AND OFFICES

A suitable site was selected in the Lewes Road on which has been erected a handsome and commodious car houses, constructed of brick, with iron roof, and well lighted, to house thirty-six cars. Examination pits have been provided under each track, so that the moment a car comes to rest it is in a position ready for overhauling. The pits have been lined with white glazed bricks, in order that an efficient light may be obtained by bringing the walls into use as reflectors, and they also enable them to be maintained in a thoroughly sanitary condition. The headroom provided under the roof principals is 19 ft.; ample workshops have also been built in connection with the houses, comprising a fitter's shop, woodworking shop, armature winding shop and paint shop. Machinery of the most approved type has been selected, and the whole of the repairs will, therefore, be effected on the premises. A sand dryer has also been provided.

A handsome suite of offices has been built on the frontage to Lewes Road, a portion being two stories in height, the structure being of red pressed and Sussex white bricks, with facings of brown Portland stone. The ground floor is for the traffic department and stores, and the upper floor for drawing offices, etc., in connection with the engineering department.



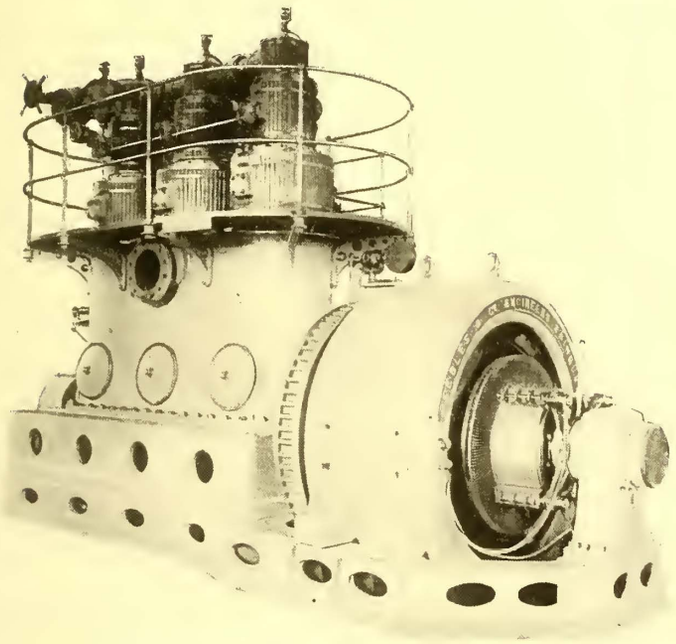
MAP OF BRIGHTON, SHOWING THE SYSTEM OF THE CORPORATION TRAMWAYS

THE TRAMWAY SYSTEM

Six and a half route miles have been constructed, or

eleven and a half miles of tramway as single line. There are five routes, viz., Lewes Road, New England Road, Elm Grove, Queen's Park Road, Beaconsfield Road and Ditchling Road, the latter being worked as a circular route.

Lewes Road will have a five-minute service of cars, and the other routes a seven and a half minute service, but, the Beaconsfield Road and Ditchling Road routes being worked as a circular route, will, in effect, give a three and three-quarter minute service at the extreme ends, as it is possible to reach the same point traveling in either direction. Thirty cars have been provided for the service. The terminus, or starting point, common to all routes, is in



GENERATING SET FOR BRIGHTON CORPORATION TRAMWAYS

Church Street, at the northern end of the Royal Pavilion Gardens.

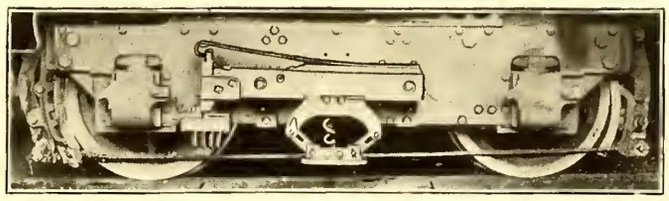
Further powers are being sought in the ensuing Parliamentary session for extensions, and the terminus will then be made at the southern end of the Old Steine enclosures, and in close proximity to the New Palace Pier and Winter Gardens. A further extension is to be carried along the London Road, which will connect the existing lines between the junction at New England Road and the southern end of St. Peter's Church, enabling the cars on the New England Road, as well as the Beaconsfield Road and Ditchling Road lines to be operated on the more direct route along the London Road to the sea front.

The engineer and manager, Thomas B. Holliday, has a large and varied tramway experience, extending over a period of twenty years, embracing horse, cable and electric traction in Melbourne, Australia, Bristol, Dublin, Stockton and Middlesborough and London, and acted as consulting engineer to the promoting syndicate of the Perth Electric tramway, Western Australia.

It might be said, in conclusion, that the system described above will be used chiefly by Brighton residents, as the route at present does not come down to the fashionable water front, and is chiefly in parts of the town which the casual visitor is not very familiar with. It will be of immense convenience, however, to Brighton people, as the town is full of hills, and extends long distances inland. Endeavors will, however, before long be made to get a line of tramways along the magnificent water front extending from Rotting Dene to Hove, and it must be said that such a line, even with well constructed overhead wires, would not mar the landscape so much as the perpetual line of antiquated carriages with their accompanying insanitation.

Third-Rail Sleet Cutter on the Lake Street Elevated, Chicago

Sleet has been the most troublesome condition brought on by the weather that electric elevated lines have had to contend with. A thin layer of ice between the contact shoe and the third rail so completely insulates the shoe from the rail as to stop or very much delay traffic. Brushes in advance of the contact shoes have been extensively used. The Lake Street and Northwestern Elevated Railroads of



SLEET CUTTER USED ON LAKE ST. ELEVATED ROAD, CHICAGO

Chicago, however, use a scraper with several blades, as shown in the accompanying engraving. The blades are of steel, 3-16 in. thick, and are at a slight angle less than 90 degs. to the third rail. They are fastened by having a block of iron cast around them, the ends of the blades in the casting having been upset before the iron is poured, to prevent them from coming loose. When let down to bear on the rail the sleet cutters are under the tension of the long, flat spring which is seen on the top of the device in the engraving. The blades, being rigid, must bend or break when they strike any obstruction like a high rail end. This occasionally happens, but the advantages of a positively rigid cutter are considered sufficient to compensate for occasional cheap breakages of this kind.

Winch Brake on the Oakland, San Leandro & Haywards Railway, California

The Oakland, San Leandro & Haywards Electric Railway has had in use for several years a brake which is extremely simple in construction and satisfactory in operation. Not being patented, no one has been interested in its introduction generally among electric railways, and probably for this reason it has not been more widely used. It is simply a winch on one axle of the car, which acts to draw up the brakes just as the air cylinder of an air brake would act.

A drum 14 ins. in diameter is mounted on one axle. This drum has flanges 1½ ins. high. Around this drum is one turn of 1½-in. hemp rope soaked full of tar. One end of the rope is connected to a lever on the front platform. The other end is fastened to the brake-rod which draws up the brakes. A movement of the motorman's lever to tighten the rope around the drum draws up the brake. The pull required on the motorman's lever is very slight. It would be thought that the wear on the rope with such a device would be very great, but the experience at Oakland does not bear this out. Ropes last two months and more, and are taken out before showing much wear. The application of this brake is as smooth as that of any brake.

It is so easily applied to either a single or double-truck car that it might be tried with advantage on many other roads desiring something quicker than the plain hand brake.

The Montreal Street Railway Company, it is said, proposes to divide $80 a month between the motormen and conductors who have not had a mishap to their cars during the previous month.

Development of Street Railway Traffic in Paris

BY E. J. LAVALARD

The history of the street transportation systems of Paris, in which I will include the omnibus as well as the tramway lines, is one of gradual growth. It dates back to 1662, in which year, according to popular tradition, the French savant, Pascal, suggested and secured the introduction into the city of a public conveyance for the transportation of passengers. It is not my purpose, however, to describe here these early vehicles, but to date the real origin of the city's present transportation system to 1828, when the first regular omnibus company was organized and authorized to transport passengers, at first for twenty-five and then for thirty centimes apiece, and put in service a number of these vehicles. The story has often been told how, through the Duchess of Berri, the original prejudice of the Parisian bourgeois of that day to the use of these busses was dispelled. This lady entered one of these unpopular stages one day when crossing Paris, and the incognito which she at first preserved was compromised when she gave the conductor a twenty-five louis piece instead of the five sous which was the price demanded. The story soon became common property, and the bourgeois, who, up to that time, had affected to despise the omnibuses and would not patronize them, were won over, and the cause of the omnibuses was won.

New lines of greater or less extent were established successfully, and in 1855 there were no less than twelve companies operating distinct lines, and employing 3925 horses. The names of some of these early companies were the General Omnibus, the Favorite, the Citizens', the Gazelles, the Parisian, the Tricycle, and the Excellent.

It is hardly necessary to say that the vehicles of these different companies were of various models, which were most part of ancient design. All, however, have disappeared from active service, though a few are preserved as picturesque reminders of early transportation methods in the collections of a few museums, as well as in that of the General Omnibus Company, of Paris, and in this connection formed a part of the exhibit at the exposition of 1900 of that company. Views of several of these old models can be found by the reader, if he is interested in the subject, in the 1887 and 1888 volumes of the Street Railway Journal.

The number of companies was found to be so large in 1850-54, and the competition between them was so severe that it became evident that for self-preservation a consolidation was necessary. As a result, and after many efforts toward this end, all of these roads were united in 1854 and 1855, and the consolidated company was awarded by the municipality a franchise of the exclusive right in Paris of transporting passengers and occupying the public streets with vehicles engaged in such business. This franchise was at first for thirty years; it was approved by imperial decree, Feb. 2, 1855, and the consolidated company took the name of the General Omnibus Company.

The new company commenced operations on March 1, 1855, with an effective force of 3285 horses and 569 vehicles, of which 116 ran into the suburbs. By the end of the same year the General Omnibus Company had in operation in Paris twenty-five lines of omnibuses designated by the twenty-five letters of the alphabet, covering a system of 149.7 m, and twenty-eight lines in its suburban business, covering a system of 195.4 km. Twenty-nine stables were in use; the effective number of horses had increased to 4389, and the number of vehicles to 437. The personnel employed by the company consisted of 2436 persons, divided as follows: 205 inspectors, 522 conductors, 522 drivers, 365 hostlers, 91 trippers, 61 mechanics, 53 starters and 617 miscellaneous employees.

A few years earlier, viz., 1853, attention began to be given to the subject of tramcars, and in 1853 a Mr. Loubat was authorized to establish a system of this kind as an experiment. This having proved successful, on Feb. 18, 1854, he was given the franchise for the tramway of Sevres and Boulogne. This line was for a long time known as the "American Railway," because many companies in the United States had previously installed roads of this kind. Another decree, of April 28, 1855, authorized the extension of this line from Sevres to Versailles. The operation of this line is now conducted by the General Omnibus Company, which includes it in its system.

The growth of the traffic from 1854 to 1900 on the lines of the General Omnibus Company has been practically steady and continuous, except that 1867, 1878 and 1889, the years of expositions, reflect the increased traffic due to those events, while 1870 and 1871 and the next few years show the opposite effect of the war, the siege and the following period of business depression. Table I. gives the population of Paris, passengers carried by the General Omnibus Company and rides per capita by that company for the several years.

TABLE I.—POPULATION OF PARIS, AND PASSENGERS CARRIED BY THE GENERAL OMNIBUS COMPANY

	Population of Paris.	Passengers carried.	Rides per capita.
1810	600,000	.....	...
1830	786,000	.....	...
1850	1,054,000	.....	...
*1860	1,696,000	74,060,052	43.8
†1872	1,794,380	113,641,850	63.3
1880	1,988,806	188,711,143	94.9
1896	2,511,629	246,791,845	98.2

* Including suburbs annexed, with a population of 350,000.
† After two sieges.

Another important factor in the transportation system of Paris is the Chemins de Fer de Ceinture, or "belt railway," which uses steam locomotives. This line includes about 39 km, and carried in 1898 on its belt division 28,462,477 passengers, and on its Gare St. Lazare-Auteuil division 23,902,712 passengers.

In 1867, at the time of the World's Fair, a boat service was instituted on the Seine by a company which operated a similar service at Lyons. The number of passengers carried by these water busses has been as follows:

1868	3,500,000
1872	8,000,000
1875	10,000,000
1877	more than 12,000,000
1898	15,380,985

The success which followed the operation of boats led to the establishment of two other companies. The service extends from Charenton to Surennes, with stopping points on the two rivers at distances averaging 1000 m apart.

After the war of 1870 a number of omnibus lines were replaced by horse tramways. New tramway lines were started in 1872, 1873, 1874 and 1875 by the General Omnibus Company, and also by two new companies, called the Tramways Nord and the Tramways Sud. These companies had purchased certain franchises from the department of the Seine, in the suburbs, and entered the city of Paris over portions of the route of the General Omnibus Company. They paid at first a certain rate per kilometer, and maintained the tracks on which their cars ran in the interior of the city. As a result of this, a number of the suburban omnibus lines were withdrawn.

During the expositions of 1878 and 1889 the surface lines in Paris included the omnibus and tramway lines of the General Omnibus Company, the tramways of the Nord and Sud Companies, the Ceinture Railway and the Seine boat line.

In 1891 a cable line, called the Belleville line, was put in operation. This road is only 2000 m in length, and has a franchise running until May 31, 1910. During 1900 this tramway operated twelve cars, made 279,288 trips, and carried 5,455,367 passengers.

The omnibus system of the General Omnibus Company includes 45 routes, of which 11 are served by vehicles carrying 40 passengers, 30 by vehicles carrying 30 passengers and 4 by vehicles holding 26 passengers. It possessed in 1899 an equipment of 11,277 horses, and in 1890 of 12,676. The total length of route in 1900 was 261.382 km, varying in individual cases from 32.50 to 75.10 km. The tramway system included 36 lines, of which 19 were operated by horse cars and 17 by mechanical traction. The total length of line was 244.742 km. This latter figure is considerably higher than normal, because it included several extra lines put in operation because of the exposition. The animal Omnibus Company to give improved transit by the equipment with mechanical power of the horse lines, by which the length of the latter has been decreased during the year a total of 1.61.8 km, in spite of a total increase of 6.2 km in length of line operated.

The employees of the company number more than 10,000, divided as follows:

Conductors	1,847
Drivers and engineers	1,829
Inspectors	825
Station, car house and stable force	4,424
Shop force	940
Track force	500
Miscellaneous	480
Total	10,845

The company possesses five stations for mechanical traction, with a total horse-power of 10,000; fifty-eight car houses, having a total area, not including the power stations, of 400,000 sq. m in round numbers. It should be stated here that the company carries on at its shops a considerable amount of manufacturing and repair work for cars and other equipment.

TABLE II.—LIST OF TRAMWAY COMPANIES IN PARIS IN 1901 OUTSIDE THE CIE GENERALE DE OMNIBUS

NAME OF COMPANY	Started in	Number of Lines in Operation	Length of Line on Aug. 10, 1901		Motive Power
			Owned	In Operation	
			kilometers	kilometers	
Tramways de Paris et du Department de la Seine	1874	18	64.386	92.389	2 lines by steam; 15 by electricity (trolley and accumulators); 1 by horses
Cie. Générale Parisienne des Tramways	1874	13	65.100	86.469	7 lines by electricity (trolley and underground conduit), and 6 by horses.
Compagnie du Chemin de Fer du Bois de Boulogne	1900	1	6.529	6.529	Electricity (Vedovelli surface contact system, and trolley)
Compagnie des Tramways Mécaniques de l'Environs de Paris	1896–1900–1901	5	17.417	21.441	Trolleys and steam.
Compagnie des Tramways Electriques Nord Parisiens	1901	2	10 600	13.800	Trolley and Diatto surface contact system
Tramway Funiculaire de Belleville	1891	1	2.000	2.000	Cable, driven by a 70-hp engine
Compagnie des Chemins de Fer Nogentais	1897–1898	5	27.563	32.363	Compressed air and trolley
Cie. des Tramways de l'Est Parisien	1900	7	77 043	94.622	Trolley and Diatto surface contact system
Compagnie du Chemin de Fer sur Routes de Paris à Arpajon	1898	1	10.017	14.502	Compressed air and steam
Compagnie des Tramways de la Rive Gauche de Paris	1900	3	27.355	40.795	Trolley and Diatto system
Compagnie des Tramways de l'Ouest Parisien	1900	5	25.423	29.755	Trolley and Diatto system
Compagnie des Tramways Electriques de Vanves à Paris	1900	1	5.241	5.375	Trolley and Diatto system
Chemin de Fer Métropolitain	1900	1	15.000	1.500	Electric third rail

lines ran cars with 51 places, and the average number of passengers carried per car was 4860 in 1899 and 4434 in 1900. The lines operated by mechanical means used three systems, viz.: compressed air, 202 cars; storage batteries, 85 cars; steam cars, 111.

Table III. herewith gives the number and aggregate length of lines of the General Omnibus Company using different motive powers in 1899 and in 1900. It shows the great effort made during the last two years by the General

TABLE III.—MOTIVE POWERS USED ON TRAMWAY LINES OF GENERAL OMNIBUS COMPANY IN 1899 AND 1900

Motive Power.	No. lines.		Length of lines operated in km	
	1899.	1900.	1899.	1900.
Animal	26	17	164.855	103.177
Accumulators	..	2	.....	14.886
Compressed air	5	12	42.691	95.054
Purrey System	..	2	.....	13.389
Rowan System	1	..	2,760	.....
Serpollet System	3	3	18.237	18.237
Total	35	36	238.543	244.743

It would not be of great interest to publish at the present time the receipts for the different companies for 1900, as they were abnormal on account of the exposition, and the figures for 1901 are not available. The writer has therefore assembled in table II. herewith, data of the different roads which are in actual operation in Paris and its suburbs, with the date of starting, number of lines put in operation, the length operated and the different systems employed, the figures being taken from the *Journal Official* of Aug. 19, 1901. In this summary the lines of the General Omnibus Company have been omitted, as they are given in Table III.

Coal Famine in the West

The coal famine which has existed in the Middle West the past week, owing to the inability of the railroads to furnish cars enough for hauling coal from the mines, has brought forcibly to the front the wisdom of those engineers that have designed power houses with ample coal storage capacity.

Street Car Platforms—II

BY W. E. PARTRIDGE

Before going on with the completely enclosed vestibule, there are a few more examples of the simple open platform and the platform with a glass front, or open vestibule, which may be glanced at. When cars run constantly in one direction it is a practice on many street railways to use a completely enclosed vestibule on the front end of the car, while leaving the rear platform entirely open. Fig. 1 shows an arrangement of this kind on a car built by the Stephenson Company for Utica. The rear platform is not only entirely open, but is free from all encumbrances, being without controller, sand box or even a brake shaft and handle. It is 4 ft. 6 ins. long, and has an opening and step on one side only. The only arrangement which it has in common with the front platform is the channel iron buffer. This is carried, or backed up, by four heavy spiral springs. These are so placed as to take up the shock of a collision. In this car the forward platform is made very short. It is completely enclosed and has a narrow entrance on one side only. It is built to accommodate the motorman alone, and no more room is provided than that which is necessary for him to perform his duties.

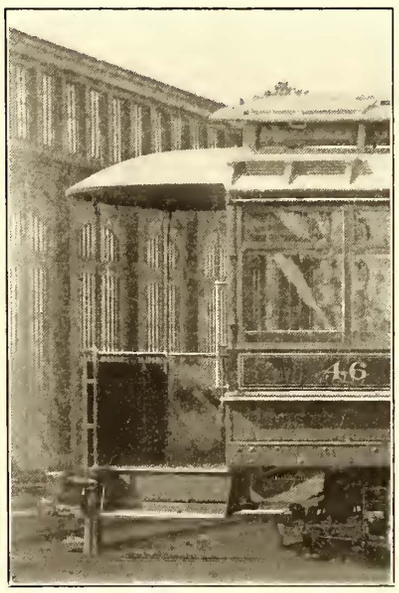


FIG. 1.—OPEN PLATFORM FOR ENTRANCE ONLY

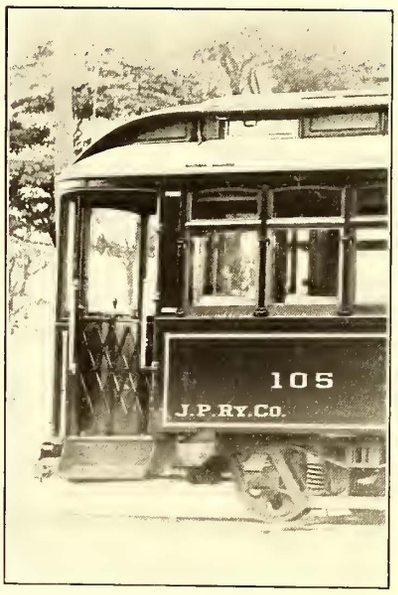


FIG. 2.—OPEN VESTIBULE FOR 8-WHEEL CAR

FIG. 3.—OPEN VESTIBULE WITH SASH SET AT SIDE

Of open vestibules, the Stephenson Company build two forms, which, in some of their details, depart from the ordinary styles. These are shown in Fig. 2 and Fig. 3.

The first of these shows an open vestibule for an eight-wheel suburban car built for Jamestown, Pa. It has a single step and a gate of the folding type, which does not, when closing the entrance, come above the level of the dasher. This feature, required by the specification, is not desirable. While it looks very well, safety calls for much higher gates. At the side of the vestibule, the space often filled solid is in this case filled by a narrow light of glass. This gives the motorman a wider range of view at the side, without diminishing the protection afforded. In Fig. 3 this extra glass is carried in an extra sash and made wide enough to increase considerably the depth of the protection afforded by the sides. In both cases the platform is dropped so as to bring the step well down, a feature which contributes to the safety of the passengers. This platform has channel iron bearers, or platform timbers, drop sash and spring bumpers.

In connection with vestibules, doors and the comfort of passengers there is one point that managers can give careful attention to, and be repaid by an increase of travel. This is the management of the doors. Usually there are neither rules nor instructions in regard to them. Conductors, as a rule, shirk as much labor as possible, and hence they leave the doors open in season and out, to the discomfort of passengers within the car. All vestibules, when open at the sides, send a strong current of air in at the rear door of the car when the latter is left open. This has been previously noted in connection with the portable vestibule. In the summer season this often fills the car with a cloud of dust and makes riding a discomfort. Usually the conductor pays no attention to this until some outraged passenger asks him to close the door. Then it is often done grudgingly. Some conductors habitually comply in part and leave a 2-inch opening, as if to save labor. In winter, with a cold car, or one but partially heated, the practice is the same. When smoking is permitted on the rear platform, if there is a vestibule, the whole car becomes a smoking compartment if the rear door of the car is left open when the car is going forward. There should, for these reasons, be a rule that would cover these cases. The rear door should be closed in summer, when there is dust, and in cold weather. Passengers may be constantly getting off or coming in, but that should not be taken as an excuse. The doors should always be closed, back and front, when the comfort of the passengers demands it.

As we have before remarked, the completely enclosed vestibule seems, theoretically, to be a development from the portable vestibule. As a matter of fact, the portable vestibule comes as a substitute for the complete enclosure. Both types have been developed together.

In Fig. 4 we have an example of the steam-car vestibule modified for street-car use. It is by J. M. Jones' Sons, of Troy. As far as possible the sides are of glass. The posts are arranged so as to obstruct the view as little as may be. In the center of the front sash there is a small window, so that in case of driving snow or rain an opening may be available for seeing without exposing the whole person of the motorman. Another small convenience is provided for the passenger by making the vestibule a little narrower than the car body, which gives a narrow end window. This is, however, just sufficient to give the passenger a view forward, which is entirely cut off by many types of vestibule. The

lower half, or dasher, is a segment of a circle. In case of accident this is a little stronger than the type having three flat sides, or half a hexagon.

A front view of this type and make of vestibule is given in Fig. 5. It differs, however, from the one shown in the previous figure, in having a large glass in the central sash. The projection of the hood at the side over the entrance is also advantageous. The hood is of the steam-car shape, but apparently not so framed as to become a part of the car body frame, a point of considerable advantage.

On suburban cars a close approach to steam road practice is frequently met, as is shown in Fig. 6. In this case little attempt is made to give the motorman a view at the sides. The front of the vestibule has but slight curvature, and a large corner post prevents a clear view at an angle of 45 degrees. The car, having a straight side, permits the door to be carried out to the side. The design is very good for a suburban road, when the cars are operated by the company on its own right of way. Another variety of this vestibule is seen in Fig. 7, when it is applied to a car having curved sides. The platform is made much narrower than the car body, and has a door on one side only. In this case it becomes practically a cab. At the other end of the car the platform is entirely open. Such a construction is, of course, intended only for a loop line, where the cars run in one direction only. Thus but two platform openings are employed, and both are placed on the same side of the car. This plan, which is very effectual in preventing accidents, has long been used in Cleveland, Ohio, where it is extended to the ordinary open cars, which are built with panels and closed platforms on the left-hand side.

The St. Louis Car Company has built a number of cars for the Union Traction Company, of Indiana, with vestibules, which had many steam-car features, but in some respects they were even stronger than the steam road type. One of these is shown in Fig. 8. The framing of the car is apparently carried out to the front of the vestibule, but the platform is dropped and short platform timbers are used. These are necessary, in order to permit the trucks to swing clear on curves. At the top the finish of the car is carried forward to the front of the vestibule. Although there are three steps, the doors are brought to the outside of the car and a trap used, so that the platform can be reached from the ground or a high station platform. The car is fitted with a cowcatcher at one end. No effort is made to give the motorman a clear view at the side, because an unobstructed view forward is all that is needed. In a car used exclusively for elevated railroad work it would be possible to frame a vestibule of this type, so as to obtain almost unlimited strength. This could be done by carrying the sills out to the buffer beam of the platform timber and making the platform floor flush. This would practically bring the vestibule inside the car body. The plates and the sills of the monitor deck would then run forward to the bow of the hood. Of course there would be one inside end frame at the rear of the vestibule, in order to give firm support to the side of the car. The baggage door, just inside that of the vestibule, shown in Fig. 8, is, of course, a source of weakness in this particular car, as it cuts off the side framing from the end. This, however, is one of the things which cannot be avoided where baggage compartments are introduced; but the plated sill and the heavy framing of the vestibule compensate for this in a large measure.

In Fig. 9 we have an example of a car framed in the way just mentioned. As it is devoted to express business only, steps are not needed. A stirrup iron is all that is necessary. Sills, plates and monitor sills can all be carried forward to the front of the vestibule, making the outer end of the car of the greatest strength. The round end is of value, not only because it increases the motorman's range of vision, but because such a form is stronger. Blows of all kinds glance from it readily. Telescoping with such a construction should be almost out of the question. In the combination cars of the Albany and Hudson cars it was necessary to modify the construction. The general style is preserved, but the platform has to be made narrower to accommodate the steps, of which there are two. The doors are set back to the edge of the platform, and in this case must fold against the vestibule. The platform is dropped so that it would not have been practical to run the sills through to the end timber.

It is a question, however, whether a change of construction for the sake of greater strength might not be worth all that it would cost. By bringing the platform up to the level of the car floor the buffer beam, or crown piece, would be on a line with the sills. These would then, in effect, be single pieces of timber from end to end of the car. In cases of collision, cars so built would have great advantages over any of the forms having platforms and buffer beams below the level of the sills. They would resist blows that would

FIG. 4.—ENTIRELY ENCLOSED VESTIBULE, MODIFIED STEAM TYPE

FIG. 5.—FRONT VIEW OF VESTIBULE, SINGLE LARGE CENTER GLASS

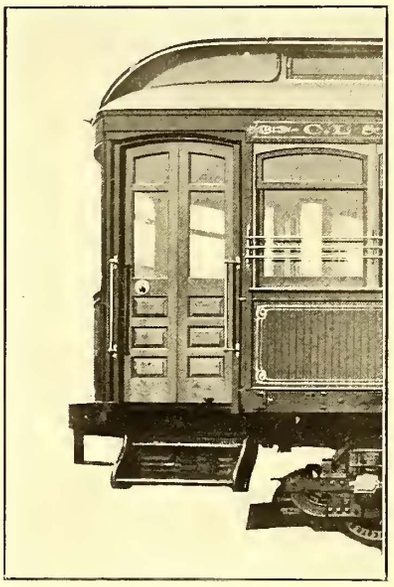


FIG. 6.—STREET RAILWAY VESTIBULE, CLOSE APPROACH TO STEAM CAR PRACTICE

probably destroy any car of the pattern illustrated. A railway using cars with flush floors, however, must be provided with raised station platforms like those of the elevated railroads. Passengers can only be taken on at regular stations, or at points where platforms have been built. As to the advantage of construction there is no possible doubt. On a few roads only it would be practicable, mechanically. Whether, on such roads, it would be a paying feature is a question that must be decided by those connected with the operating departments.

In the Albany and Hudson passenger cars a very satisfactory modification has been made of the preceding type (see Fig. 10.) The platform is dropped and two steps are necessary. This brings the door well inside the wall of the car, so that an end window is placed outside the door. The door itself folds against the vestibule. The front is well rounded so that the motorman has a clear view at the sides, as well as in front. The buffer is correspondingly round and has a good projection. It may be noted, incidentally, that the cars have track scrapers. This is a very useful piece of apparatus in summer as well as winter, because of its power to clean sand and gravel from the track. The doors of the Albany and Hudson vestibules are single, while steam-road vestibule doors, as well as a large proportion of those on street railways, are double. The double doors are not as convenient as single. The only apparent reason for them is the fact that with ordinary designs sufficient room is not available for the single door, and in order to get it out of the way when open, it must be double and so folded.

In Fig. 11 we give an illustration of a three-window closed vestibule, having a very wide entrance. It is one built for Milwaukee by the St. Louis Car Company. The doors are double, folding against the car body, the sides of which are curved, after the street car fashion. The hood is of the street car type, the end window in the roof making the car much lighter inside. In order to make room for the trucks the platform timbers are cut very short, and they are plated with steel to obtain sufficient strength. Increasing the width of the opening at the entrance to the vestibule is a valuable feaure, as it is equivalent to an increase of speed by shortening the stops. There is, however, a limit in this direction. The grab handles must not be so far apart that

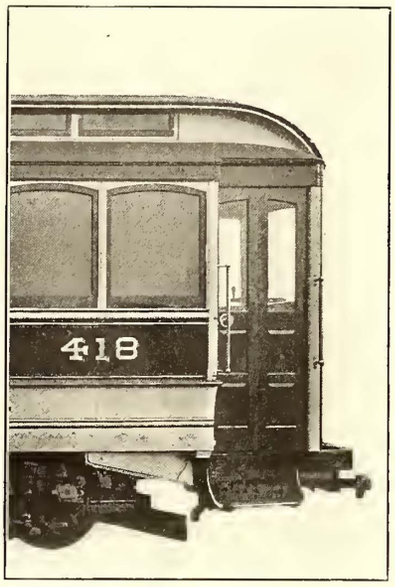


FIG. 7.—VESTIBULE NARROWER THAN BODY, DOORS ON ONE SIDE ONLY

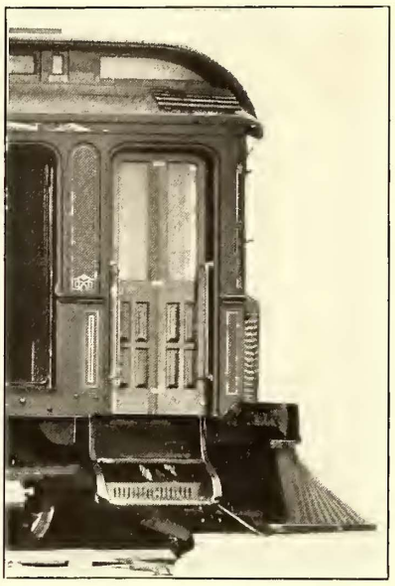


FIG. 8.—VESTIBULE STEAM CAR TYPE

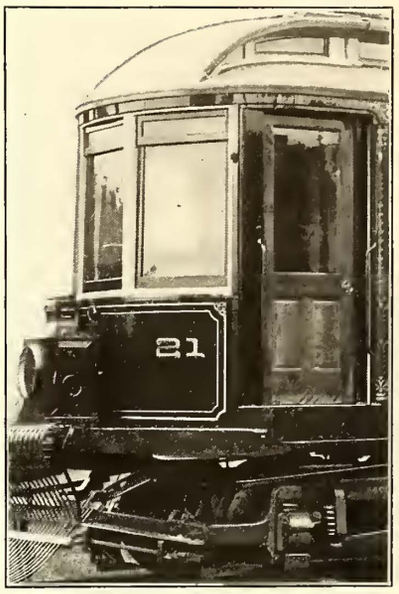


FIG. 9 —ALBANY AND HUDSON CAR, SILLS GOING THROUGH TO BUFFER BEAM AND CROWN PIECE

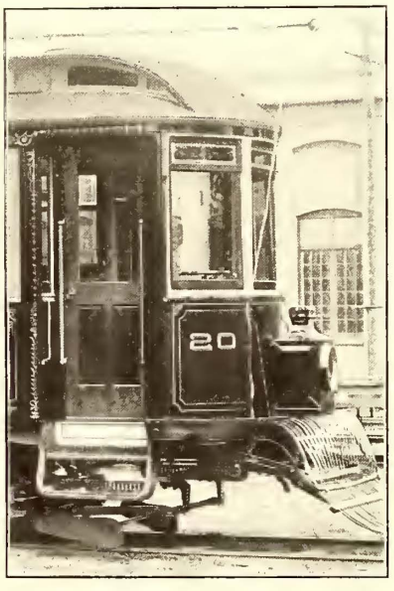


FIG. 10.—ALBANY AND HUDSON PASSENGER VESTIBULE

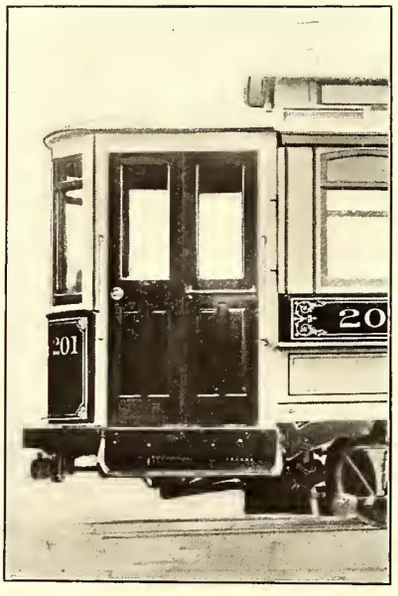


FIG. 11.—WIDE ENTRANCE VESTIBULE FOR HIGH-SPEED CAR

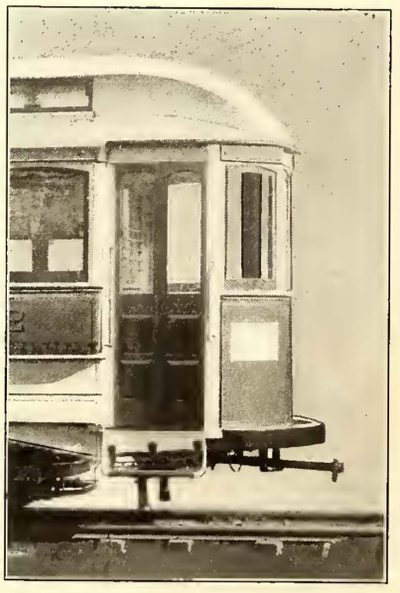


FIG. 12.—VESTIBULE WITH SINGLE ENTRANCE, DASHER SIGNAL LIGHTS

they may not be grasped easily on both sides at the same time. This rule holds good in all cases where a step is used, but it does not apply where the platform of the car is level with that of the station or stopping place.

The vestibule shown in Fig. 12 is one that was built by the J. G. Brill Company for the Cleveland roads. The vestibule is intended as a cab for the motorman, the principal entrance being at the rear platform, which is left entirely open and without protection. The reason for this is probably found in the necessity for making entrance and exit as rapid as possible. The cars of this type, like all those running in Cleveland, have entrances on the right-hand side only. The opening in front in the dasher contains an electric light. A transparent destination sign slides in front of the light, closing the opening. This is a very neat and effective arrangement, which was designed by Mr. Wason, president of the Cleveland, Painesville & Eastern Railroad.

The completely enclosed vestibule has the advantage of enabling the railway company to insure perfect safety of passengers when entering and leaving the cars. By keeping doors closed until the car has stopped, and by closing the vestibule opening (see Fig. 14.) Owing to the type of truck employed the step is high above the head of the rail, and the riser about equal to it. Gates of this type are arranged to be opened and closed by the motorman, so that getting on or off the car while in motion is hardly to be thought of. It is for the purpose of preventing anyone from riding on the steps that the leaves of the gates are mounted so far out, and the bottom bar brought down so as to touch the tread of the step. In this case the folding gate could not well be used, because it does not readily lend itself to operation by means of a single lever from the opposite end of the car.

In baggage, express and freight cars a three-window vestibule is very commonly provided. There is an entrance, but no step, a stirrup answering every purpose. This vestibule is really a cab, and is practically formed in the end of the car. The body is cut off by a light partition, which, in many cases, is without either window or door,

In the way of completely enclosed vestibules the European designers produce some astounding creations. An example of this may be found in Fig. 15. The height of the car is

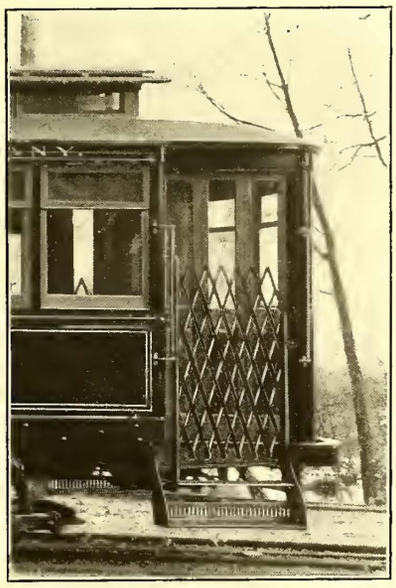


FIG. 13.—BOTH DOORS AND GATES AT VESTIBULE ENTRANCE

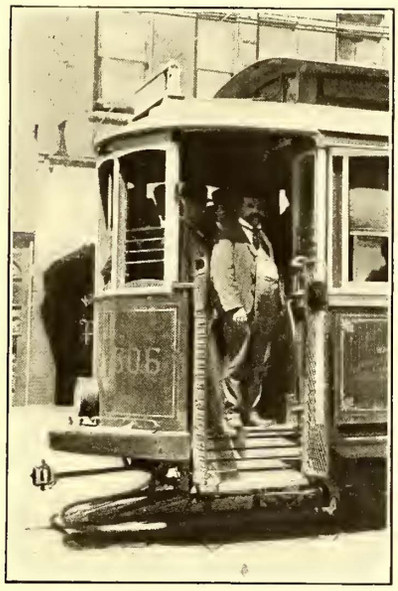


FIG. 14.—BOTH DOORS AND GATES OPERATED BY MOTORMAN

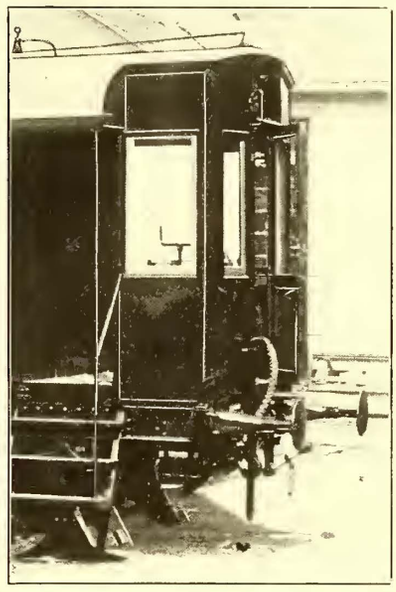


FIG. 15.—VESTIBULE AND CAB FROM EUROPEAN PRACTICE

them before starting, a very large class of accidents may be avoided. The St. Paul and Minneapolis roads, by adopting this plan, are able to secure themselves from many annoying claims. In summer, however, the doors have to remain open, and then the gate becomes necessary. Its application is not always easy, as the doors occupy much valuable space, and cannot readily be removed for the summer season. The gate, however, may be readily applied so that it folds against the dasher. Here it is out of the way of passengers, and is not liable to injury by contact with vehicles. By means of a gate the platform can, of course, be just as completely enclosed, so far as the passenger is concerned, as with a door, while it permits a free circulation of air. A gate is indispensable where both sides of a platform have entrances, and only one side is used at a time.

The Laclede Car Company built some cars for the Southern Missouri Electric Railway Company which had both doors and gates at the vestibule entrances. The doors were in three parts, folding away from the body of the car. The gates of the folding pattern were made very high (see Fig. 13), which shows the treble doors closed and the gate shut. Gates coming well up to a man's shoulder are an advantage, since they tend to prevent accidents.

In the next illustration we have double gates applied to so great that three risers are necessary, in spite of the fact that the lower step is some 19 ins. from the ground. The side is notched out for no apparent reason, except to make a place for the hand rail. At the opposite end of the car the rods which carry this rail and the steps are converted into a ladder, by which the roof may be reached. As will be seen by the buffers, the car is intended to be run in a train, and to permit passage through the whole length of the train a modification of the vestibule is necessary. Or rather, we should say, the end opening of the steam vestibule has to be retained. In this case, however, a door is placed in the opening, and fitted with a sash. Incidentally, it may be questioned whether a passage from one car to another would be wholly safe, or comfortable, for a lady, at least. The buffer castings project about 18 ins., so that a step of about 3 ft. would be necessary to reach the door of the next coach. As there is plenty of room between the cars, the doors are made to swing outward.

When building the cars for the now famous Washington, Alexandria & Mount Vernon Railway, the Brill Company was met with the problem of a completely closed vestibule having an end entrance. The cars were to be operated in trains, and it was, of course, necessary to pass from one to another. They produce a very much neater solution than

the last mentioned. As is shown in Fig. 16, they made a round end vestibule below and introduced a sliding door. The sash, however, were straight. Curved glass is a nuisance to be avoided where it is possible. It is not only expensive, but it must, in each case, be made to order, which is a matter of time. This vestibule has a decided advantage over those used on steam roads, because the vestibule can, when necessary, be completely shut up from the weather.

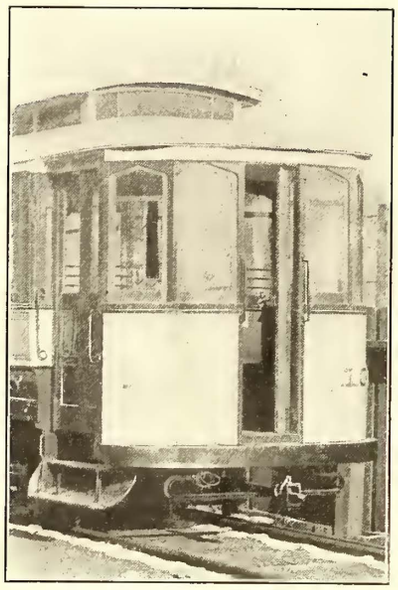


FIG. 16.—VESTIBULE FOR THE WASHINGTON, ALEXANDRIA & MT. VERNON RAILWAY

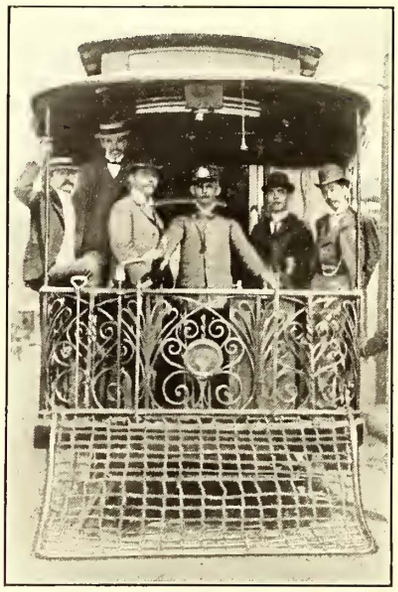


FIG. 17.—SPECIAL OBSERVATION PLATFORM

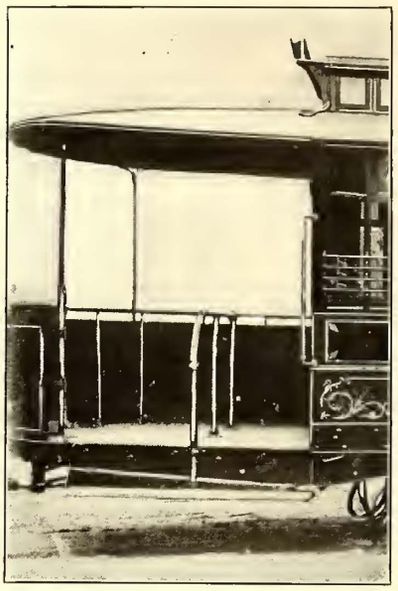


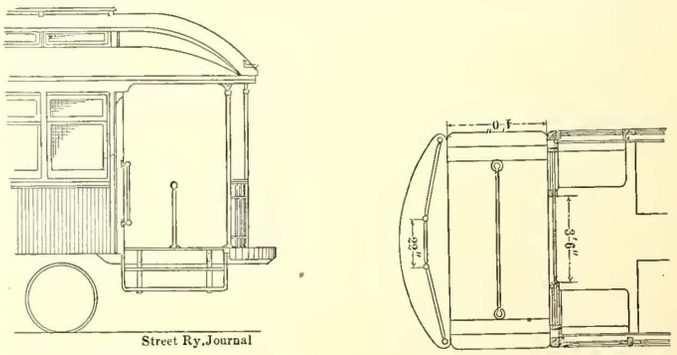
FIG. 18.—THE LONG DETROIT PLATFORM ATTACHED TO A CAR

In this respect the steam-road vestibule is faulty; there is no way of closing the opening.

While observation platforms do not properly belong to the subject of vestibules, yet a number of these having been collected while gathering material for vestibules, they may well be mentioned. Their value is beyond a doubt, not only for scenic lines, but for others as well. Wherever seats are to be had on the front platforms of open cars they are eagerly taken. In ordinary construction the available space is too small to afford much accommodation. The motorman and the large controller, often setting some inches away from the dasher, makes the remaining space too small for comfort, of even three or four persons. In a parlor or special car, like that shown in Fig. 17, there is sufficient room for half a dozen persons to stand, without crowding.

Seats on such a platform are not only possible, but highly advantageous. It is certainly convenient to have ample platform space when other conditions do not forbid. This applies, of course, to cars to be used during the excursion season. A consideration of these points has led to the construction of the Detroit platform, a view of which is given in Fig. 18.

The object of such an arrangement is to allow as many persons as may be to stand upon the platform, and at the same time preserve a passageway from the door to the step. The idea is certainly a good one. The constructive features at once attract attention. It will be seen that so long a platform, heavily loaded, will bring a very heavy strain on the sills as well as on the platform timbers. These have to be plated, and to reduce the strains as much as possible, they are all made as long as the position of the wheels will allow. In the car illustrated, which is one built for the St. Louis Transit Company by the St. Louis Car Company, they go as far as the bolster. As the front platform is short, the load is not counterbalanced, and the capacity of the springs in the trailing truck will have to be made stronger to carry the load. Even then there might be trouble, for it is notorious that an overhanging load always pounds most unmercifully at all but the slowest speeds. When the load is carried at the rear the action is still worse. All such things must be considered before any such plan can be safely adopted. The advantages are so great, however, that the difficulties are well worth study. In Fig. 19 we have another form of the same idea, built by the Jewett Car Company for the Denison & Sherman Railway Company of Texas, and illustrates the arrangement of the rear platform. The front platform is of the standard type, and vestibuled. The engraving gives plan and side elevation of a platform, with entrances on both sides. There is not quite so much space outside the rail as in the previous case. Practically it is an ordinary platform, cut into two parts by the central rail. It has immense advantages over the ordinary style, because those standing are at peace, while those entering and leaving the car do not have to crowd through those leaning about the door. As shown, the rail seems to be too low, and there would be a constant temptation to use it as a seat, a practice which would be extremely annoying. Nothing definite can be said of such designs until they have been used a sufficient time to bring out their weaknesses and disadvantages, as well as their good features. One point of the design may call for a little unfavorable criticism. In neither Fig. 18 nor Fig. 19 does the central railing provide a good hand hold for the person entering. The curved top rail is bad, and the straight rail is too low. To reach from the body grab handle to the hood support is too far for safety, if the platform is to be wide enough to be useful. If, as would seem in Fig. 19, the platform entrance is of the usual width,



Side Elevation. Plan.

FIG. 19.—A MODIFIED DETROIT PLATFORM

the space between the central rail and the door is so narrow that trouble will be found in emptying the car at terminals. Large people, or those who have bundles, will find the space too small.

Rail Feeder Construction in San Francisco

BY S. L. FOSTER

In line with the discussion on Mr. Connette's paper on "The Best Manner and Mode of Conducting the Return Circuit to the Power House," at the last street railway convention in New York, as reported in the STREET RAILWAY JOURNAL, an account of the recent work of the Market Street Railway Company of San Francisco may be of interest. As was brought out clearly at the convention, each city presents a different problem for solution concerning the return path for the current from the electric cars. In San Francisco it was a comparatively simple one.

The company's main 500-volt, direct-current electric power house, of about 5000 kw capacity, is situated on a street having a double-track electric line on it, constructed of 62½-lb girder-rails. Exclusive of what current is brought back by the earth, a bonded 20-in. cast-iron salt-water pipe and an unbonded 30-in cast-iron salt-water pipe, all the current for the power house had to return from either of the two directions on this double-track road. The road as originally built had consecutive rails joined by fish-plates and bonded with three No. 000 B. & S. bonds. The rails opposite the power house were connected to the negative bus-bar by four 1,000,000 circ. mil bare copper cables. The capacity of the plant was then 1200 kw, and these provisions for the return were ample.

As the load increased from 1200 toward 5000 kw, however, the amount of power wasted in heat in the cables and the rails became excessive. At about equal distances (1000 ft.) north and south of the power house the double-track electric line is intersected by other double-track electric lines. Each of these points of intersection form centers from which twelve paths for the returning current radiate. The total section of these twenty-four paths amounts to an area of 160 sq. ins. of steel, or—at the usual ratio of 10 to 1—to 16 sq. ins. of copper, and is of sufficient capacity for the maximum current of 10,000 amps. The section of the return between these two centers, however, was not large enough to carry this current economically.

The copper cables became extremely hot at times, so hot, in fact, that the sleeve connections in them were partially unsoldered, and were only saved on one occasion by the chilling effect of streams of compressed air. This air was kept on continuously afterward during the peak loads. Whenever a fish-plate became loose or a bond broke, the rail-joint became hot. A few cases of alleged electrolytic destruction of lead service pipes occurred in this section. For these reasons it was decided to increase the capacity of this return path from the two centers mentioned back to the negative bus-bars.

For this purpose a nest of fourteen old 45-lb. steel horse-car rails was laid in a trench from one center to the other, and where this line of rails passed the power house it was connected to the negative bus-bar by two copper bars 1 in. x 5 ins. in section. This nest of rails consisted at first of fourteen separate single lines. The successive rails of each line were connected by a lap-joint 12 ins. long. The joint was made mechanically sufficient by four ¾-in. hot iron rivets, and its electrical conductivity was provided for by two copper tubes 13-16 in. outside by ⅝ in. inside diameter, driven into previously carefully reamed holes and swelled into perfect contact by a ⅝ in. x 1-64 in. steel pin driven through the tubes, as shown in Fig. 1.

This copper-tube bond alone was calculated to give the joint a conductivity equal to that of the same length of rail. Upon testing, a single joint showed 22 per cent more conductivity, the increase being due to the four ¾-in. iron rivets and the surface contact between rails. The joint was then immersed in salt water for a month, when it still

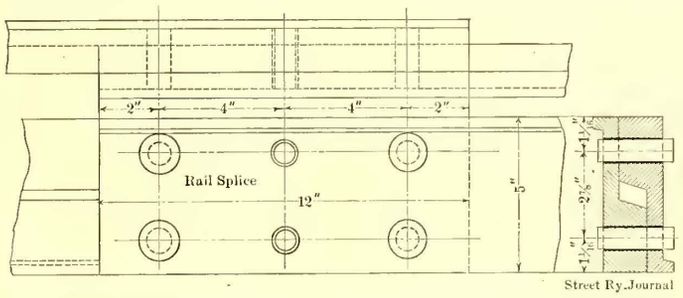


FIG. 1.—PLAN, ELEVATION AND SECTION OF JOINT OF RETURN CONDUCTOR, MADE UP OF TWO OLD HORSE RAILWAY RAILS

showed 17 per cent more conductivity than an equal length of rail.

The 1 in. x 5 in. copper bars 10 ft. long were planed, scraped to a true surface on the ends, lapped 7 ins. and held by eight ⅝-in. steel bolts. The joints in the bars were painted with insulating paint and taped alternately two coats, and then covered with concrete.

The steel rails were covered by the soil excavated from the trench. This soil was of clay, practically neutral chemically, dry when tamped, and is likely to remain so, as it is covered by the 6-in. concrete foundation for the 2 ins. of bituminous rock forming the pavement.

At the ends of this auxiliary negative of old rails, copper weather-proof cables were laid out to each service rail, made with an electrical conductivity equal to that of the rail-

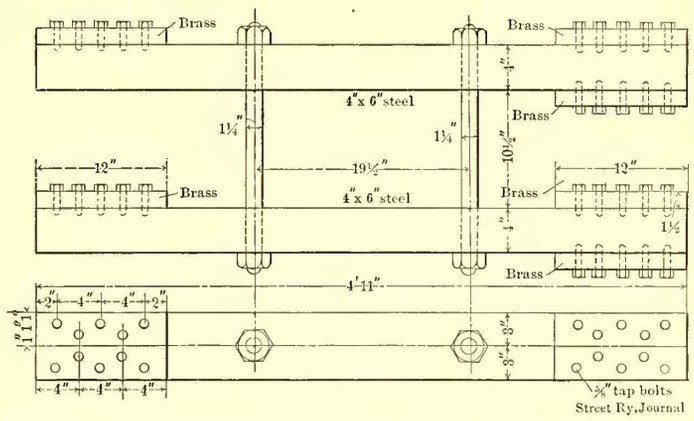


FIG. 2.—ARRANGEMENT OF STEEL BLOOMS AT END OF OLD RAILS AND AUXILIARY NEGATIVE RETURN CABLE

road connected at a point beyond all special track work and away from a rail-joint where there would be likely to be the least vibration of the rail. These cables terminated near the service rails in brass blocks into which the cables were soldered. To each brass block was bolted a corresponding brass block into which five No. 000 B. & S. bare, annealed copper wires had been soldered. The use of two brass blocks was to facilitate replacing of bond wires in case of breakage.

Each No. 000 wire was fastened to the rail web by a split steel sleeve having an internal diameter equal to that of the wire, and an external diameter such as to insure a hard-driving fit and continuous contact with the surface of the hole in the rail web. These sets of brass blocks were painted and taped in the same way that the joints in the

copper bars were. The bonding sleeves were also painted.

For fastening the various cables to the old rails at the ends and the copper bars at the middle of the line, steel blooms (6 ins. x 6 ins. at the ends and 7 ins. x 7 ins. at the power house) were planed for 12 ins. on each end on both bottom and top surface. Two blooms were placed below the bunch of old rails and two above, a bloom below being bolted firmly to one above. The old rails and the blooms were then thoroughly cleaned by the sand blast, and a cubic mass of iron, about 2 ft. x 2 ft. x 2 ft., at a heat to insure a weld, was then cast around the whole. It is estimated that 2900 lbs. of metal were used in each of the three joints. On to the planed surfaces of the blooms long brass blocks, into which the cables from the service rails were soldered, were bolted, care being taken to follow up the steel cap screws with the wrench until the joint was perfectly cold. The copper bars were similarly bolted to the two steel 7 ins. x 7 ins. bloom ends when it was clear that no further slackening of contact at the surfaces could result from contraction due to the drop in temperature. The bond wires, brass blocks, copper cables and cast-welded joints were then covered with concrete.

The result of the installation of this auxiliary negative as shown in the reduced heat at the switchboard and at the loose service rail-joints was immediately felt. The danger

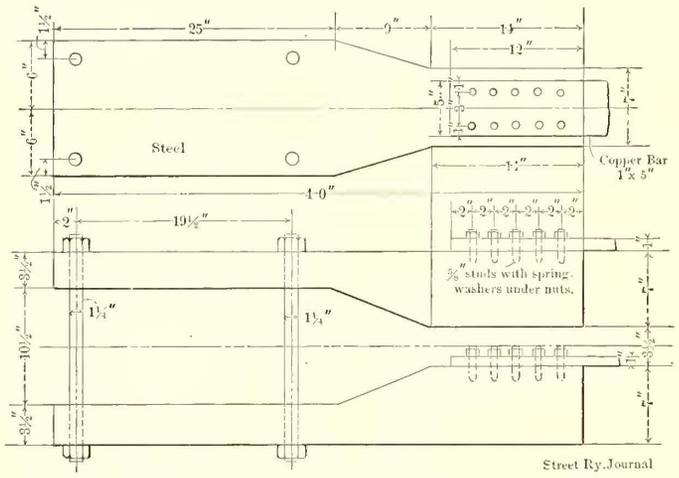


FIG. 3.—ARRANGEMENT OF STEEL BLOOMS AT END OF OLD RAILS, NEAR THE POWER STATION

of electrolytic action on nearby gas and water pipes must prove less now that the current density has been reduced to a maximum of 500 amps. per square inch of copper. The objects of the work were thus gained.

A valuable gain was also made in another direction. Careful tests were made before and after these old rails were connected up, and it was found that there was an annual saving made in power required to force the current back to the negative bus-bar from the two centers, referred to, amounting to 2¼ per cent of the total annual output of the power house. Looking at it from another point—kilowatt hours that cost $4,700 per year were released from the task of heating the negative conductors and applied to the propulsion of the cars. As 2¼ per cent of the cars on any one of the numerous lines of the Market Street Company's electric systems usually amounts to only a fraction of one car, it may not be possible to utilize this increase of available power to the extent of reducing the number of cars. The increase of the line voltage all over the systems by a few per cent, however, is sure to produce valuable results indirectly that will tend to increase the company's net earnings, as, for example, in increased flexibility of operation, reduced speed on down grades and over crossings, increased comfort, and therefore increased alertness and reliability of motormen, increased time for stops, etc.

The excellent results were undoubtedly helped by the fact that, after the old rails were connected up, the fishplates and bond wires were removed from the service rails on the double track passing by the power house and the joints were cast-welded. The resistance of the return paths from the centers to the negative bus-bar, as determined by the drop of the potential method, multiplied by the square of the average all-day current amounted after the change to but 21.3 per cent of what the resistance of the same paths before multiplied by the square of the same current amounted to.

Tests for potential existing between water and gas pipes and the rails in this vicinity and tests to determine the amount of current passing in these pipes have not yet been completed. Before the auxiliary return was put in the current in the water main amounted to considerably less than 1 per cent of the total returning to the power house, as nearly as could be determined by the well-known methods described in the Street Railway Journal some years ago by Mr. Herrick.

The estimated saving represents over 78 per cent per annum on the total cost of the work. Fig. 1 shows the rail splice, Fig. 2 the arrangement of steel blooms at the ends of the old rail and auxiliary negative, and Fig. 3 the arrangement opposite the power house.

Making the Park Pay at Champaign

The experience of the Urbana & Champaign Railway, Gas & Electric Company with its park and pleasure resort will no doubt be of interest to many other companies who are wrestling with the problem how to make pleasure resorts show a profit instead of a deficit.

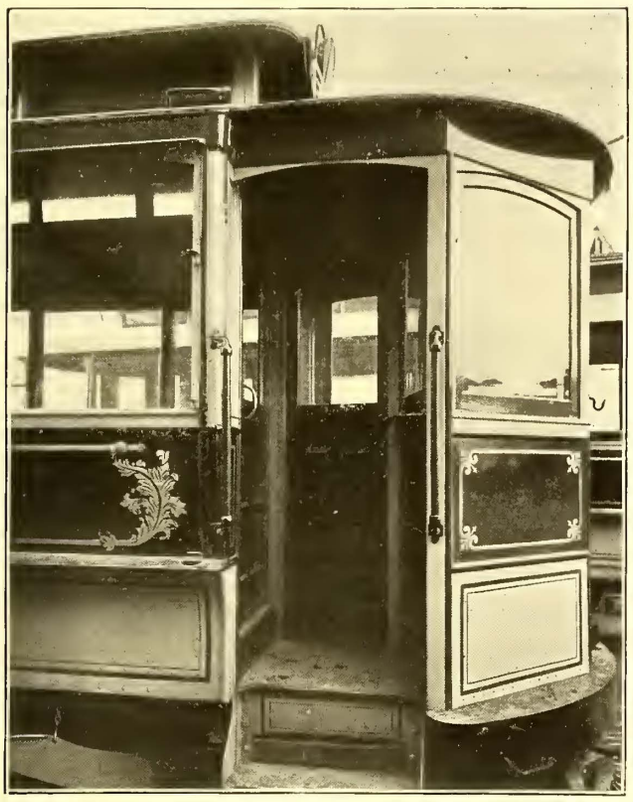
This company opened a park in the outskirts of Champaign eight years ago. For six years it was run every summer at a loss, and finally was shut down for two summers because of its failure to show returns. Last summer the park was again opened on a different plan, and for the first time in its history showed a profit. The plan upon which this park was conducted is that of H. J. Pepper, the superintendent of the company. He devoted considerable study to the matter and had the benefit of the previous unsatisfactory experience with the resort to guide him.

The plan is as follows: When the cars which run to the park get within a few blocks of the park the conductors distribute admission tickets to all the passengers. On each admission ticket so issued the theatrical company which furnishes the entertainment gets four cents. The theatrical company also has all the concessions in the park, and receives the revenue from all reserved seats. The practical effect of this is, of course, to give the street railway company six cents gross revenue from every passenger hauled to and from the park, for it is assumed that the majority of passengers ride both ways. On the very few passengers who live near the park and who walk home, the company, of course, gets only one cent, but this is a small proportion of the business, and the haul in such case is very short. Every night last summer from 1000 to 1200 people went to the resort. There were not seats enough in the pavilion, which has a capacity of about 700, and bleachers were put up outside. The company owns eleven motor and nine trail cars.

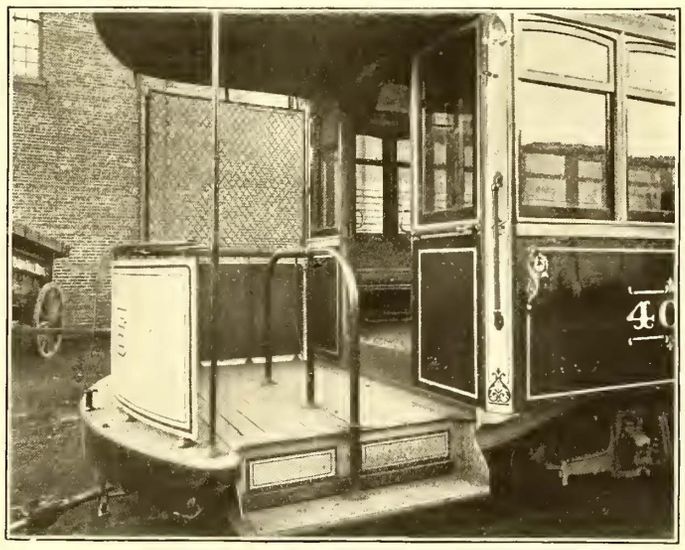
On Dec. 25 the Indiana Railway Company, of South Bend, Ind., posted in its car house notice of an increase in wages for its motormen, conductors and power station employees. The new schedule went into effect on Jan. 1.

Car Construction on the Indianapolis Street Railway

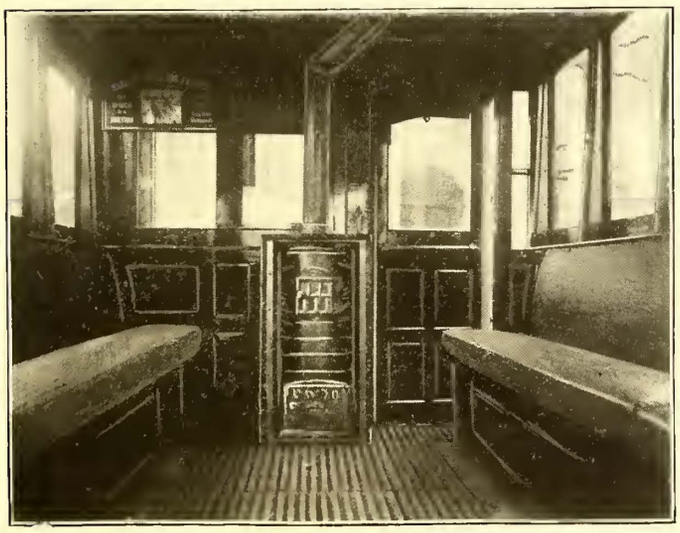
The visitor to Indianapolis is at once impressed with the well-kept appearance of the rolling stock of the Indianapolis Street Railway, and not only with the general appearance, but with the several peculiar features in car construction, some of them new, some of them well thought out adaptations of ideas put in use on other roads. The construction and maintenance of rolling stock is under the charge of Charles Romelius, master mechanic and chief engineer.



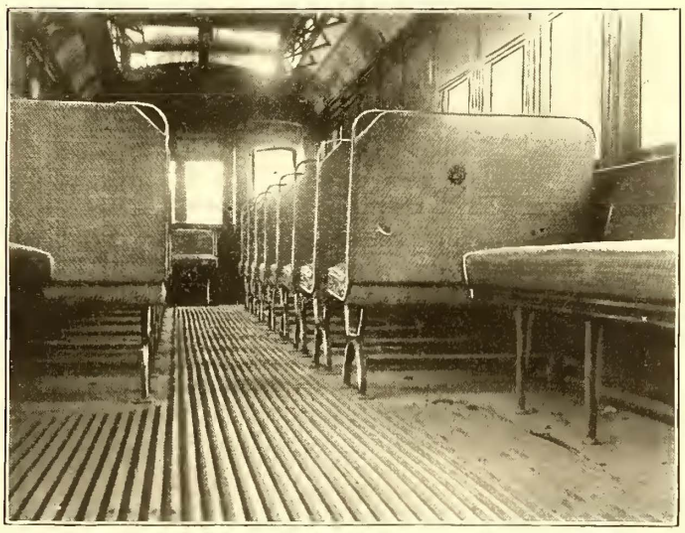
FRONT END OF INDIANAPOLIS CARS



REAR END OF INDIANAPOLIS CARS



FRONT END OF INDIANAPOLIS CARS—INTERIOR VIEW



REAR END OF INDIANAPOLIS CARS—INTERIOR VIEW

SHEET-STEEL PANELS

One of the first things noticed in car construction is the use of sheet steel, in place of wood panels, on both single and double-truck cars. On the long double-truck cars the panels are straight, and on the single-truck cars of the usual curved form. Although the use of sheet-steel panels in place of wood is by no means confined to Indianapolis, their extensive use there, and employment on cars with straight sides, as well as on curved, makes makes them worthy of note. Probably the most common objection heard to the use of sheet-steel panels is that there is more tendency for the paint to scale and crack off than on wood panels. In refutation of this, Mr. Romelius points to the use of iron dashboards, and the little trouble experienced with the paint on them, if proper precautions are taken. In this connection it may be said that neither the cars at Indianapolis or elsewhere, where sheet-steel panels are used, show any evidence of difficulty in keeping the paint on them. The sheet steel selected should be free from scale, and if a good priming coat of a primer that will stick well on iron is applied there is no difficulty in keeping the paint on.

When it comes to a question of ability to stand collisions with wagons, which are of such frequent occurrence, there is no comparison between the steel and wood, the steel is so much superior. Collisions which would ruin wood panels are of frequent occurrence, but have little effect on the sheet steel. Sometimes the car is even knocked off the track through the force of a blow on the panels, without injuring them.

The sheet steel used for panels is No. 10 gage on the long cars, with straight panels, and No. 12 on the short cars, with curved panels.

On the straight side of double-truck cars the sheet steel is placed on a wood backing. On the single-truck cars, with curved panels, the sheet steel is fastened directly to the window posts. As with wood panels, the steel panels are made of a length to go only between two window posts, and not the whole length of the car, as is sometimes done with steel panels.

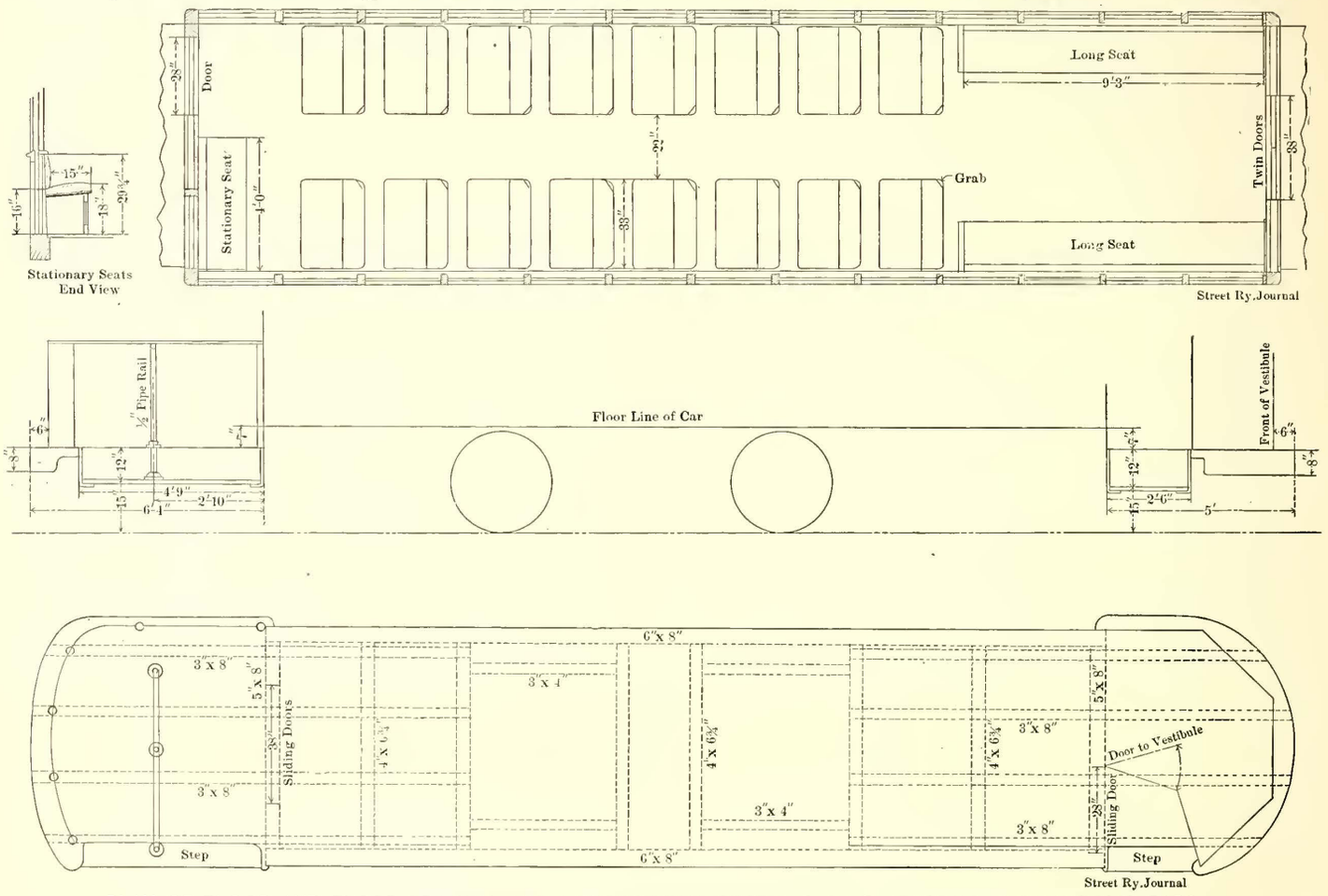
NOVEL VESTIBULE ARRANGEMENTS

All cars in Indianapolis are made to run one way only, which simplifies the vestibule design. In the cars formerly used on this road the front platform was vestibuled and closed to all passengers, just as an engineer's cab. In the cars now in use the advantages of having a closed cab for the motorman are retained, while at the same time passengers can enter by the front platform. The vestibule arrangement is necessarily slightly different in the long, double-truck cars from that in the short cars.

The two types of cars and the arrangement of each are shown fully by the engravings accompanying this article, which explain the construction better than can be done by words. In both cases enough is taken from the rear right-hand corner of the motorman's cab to give a passageway from the front step to the door, which is in the right-hand side of the front end. In the short cars a coal stove occupies the middle of the front end of the car. In the long cars a seat is placed against the front end, and the heat is supplied by a Baker hot-water heater in the motorman's cab, from which hot-water pipes run along the sides of the car.

PLATFORMS

The platforms are of the "Detroit" type, in which a passageway to the car door is separated from the standing room on the platform by a 1½-in. gas-pipe railing. The extra long platforms are supported by angle-irons along the car sills.



PLAN OF FLOOR AND FLOOR FRAMING AND LONGITUDINAL SECTIONS OF PLATFORMS—INDIANAPOLIS CARS

Franchise Taxation

BY C. L. S. TINGLEY

The recent decision of the Supreme Court of Illinois once more draws attention to a question which is of vital importance, not only to every corporation dealing in public utilities, but to those who compose them, the investor.

The question is a broad one, and involves the whole scheme of State control of quasi public corporations, from the granting of the franchise onward throughout its life.

It is a well recognized fact that many franchises are loaded down with onerous conditions in municipal legislative bodies, not for the purpose of securing any advantage for the municipality, but as a hold-up, to fill the pockets of the legislators. The corporation seeking the franchise then has the alternative of meeting these corrupt demands, and being pilloried in the public press as boodlers and thieves, or of going out of business.

In many of our States franchises are granted for a very limited period, in some cases so short that it is almost impossible to finance the enterprise. The ostensible reason for this is that what would be a fair return to-day for the privileges granted would be utterly inadequate twenty or twenty-five years hence. In a measure, the point is well taken, but how does it work out in actual practice? It simply means that periodically the company must throw up its hands and allow the city fathers to go through its pockets in the most approved Jesse James fashion.

Again, conditions have changed. A few years back—well within the memory of every man in active business to-day—the plant and equipment of a street railway, gas, electric light, or water plant represented a very modest amount of capital. Now these same plants, if modern and efficient,

giving the public the accommodation and service they have a right to demand, and which they must have if the property is to pay, represent a vast amount of capital and high-priced expert management, so large that capital (proverbially timid) will not undertake the project unless assured of a sufficient length of life to give reasonable hope of a sure return of the original investment, together with a fair interest on the same. How can this be done if, after paying fixed charges and operating expenses, along comes the tax gatherer, and takes all that remains, leaving nothing for sinking fund? If it be true that trade follows the flag, it is equally true that population follows public utilities, and that public-utility corporations are the great pioneers of the twentieth century, the municipality being repaid many times over for its franchise in the enhanced value of taxable real estate.

It is said by many that the profits of corporations of this class are great, and that they are overcapitalized. Have those making such claims studied the case, and do they know whereof they speak; or are they merely taking up what they believe to be a popular cry—that greatest of all fallacies, "Vox populi, vox dei"? How many such corporations are paying on the actual capital invested as high returns as can be had in commercial undertakings of like magnitude? And surely on the principle which the reformers claim to be the basis of all their actions, the greatest good to the greatest number, the small investor is entitled to as much consideration in his small stock holdings as is the millionaire who can embark in the commercial enterprise on his own account. In addition to all this the public-utility corporation has its rate of sales fixed by law; whereas the purely commercial can increase its income by raising its price, if the market will warrant it. Nevertheless, in spite of the fact that its income is fixed beyond control, the public-utility corporation must pay the increased price for materials and a fair scale of wages.

The objection to overcapitalization, if we granted that some of such companies are overcapitalized, is not hard to find, when the above facts are considered in connection with the one that a certain class of our citizens is always inveighing against corporate wealth. Such persons lose sight of the fact that corporate wealth means individual competency, for a corporation is but an aggregation of individuals. Many persons can hold a few shares of stock and secure an income therefrom, who could not put their small capital into active business, and who, if it were not for this opportunity, would have to be content with the 2 per cent of the savings bank, with the added disadvantage that small savings in a bank, where they can be had for the asking, are easily spent; whereas a few shares of stock-paying dividends would be held on to until absolute necessity demanded their sale. This investor, large or small (and the small far outnumber the large), does not care whether he has one piece of paper or a dozen to represent his dollars of capital, so long as he gets a fair rate of interest on his actual investment. To protect the investor—for the stockholder is the company, and it is he that pays the taxes—from the populistic element which demands the taxation of the corporation to save the individual, capital is watered to keep down apparent profits that the cupidity of the tax levying powers may not be excited.

Then along comes that invention of the devil, the tax on the fair cash value of the stock and franchise. Who can tell what is the fair cash value? The officers of the company? They certainly should know. But our eminent theorist says no; they are interested parties; they will lie about it, even under oath. The assessors or their equivalent? What do they know about it? Only what these same officers tell them in their reports, and our theorist says they may lie in them. So, they say, take the market value of the stock and assess them on that. Was there ever a more inequitable proposition put forth? Any messenger boy in a broker's office knows that the market value of a stock may or may not bear a true relation to the actual worth of the property it represents, in proportion to the speculative interest taken in the security. Take any market report, and you will find stocks that have never paid a dividend and may not for years, selling at par or above, and regular dividend payers selling below; stock, which except for its voting power, is not worth the paper it is printed on, selling freely, and stock which represents a good income and substantial value, seldom or never quoted. The fair cash value of stock is a delusion and a snare, and simply relegates the company to the tender mercies and caprice of the assessor. What are the facts of the case? Are all corporations which deal in public utilities public enemies? Look at our great cities; where would they be but for these same corporations? What would be the taxable value of real estate, especially in the suburbs, if it were not for them? It is a fact which is axiomatic that values increase in proportion to the facilities given, and that the municipality benefits in them in as great, if not greater, proportion than the company. What is the solution of this vexed question?

Grant all franchises for public utilities in perpetuity; remove from the municipality all power to place burdens on franchises, except reasonable police regulations, as to methods of construction, maintenance and operation; require the books of the corporation to be audited at least once a year by a certified public accountant, who shall make a sworn return to the State of the gross receipts; levy the tax on the gross receipts so ascertained, and apportion the same to the various municipalities in which the corporation does business in proportion to its occupancy of the public highway. Capital will then know what it has to expect; it will be able to construct its plant in the most approved manner for the benefit of the municipality, the comfort and safety of its patrons, and the general public; it can maintain the same at its maximum, for it will have no fear of periodical raids; it will make a safe security in which the poor man may place his savings, and as it prospers, the municipality will prosper with it. The public will be relieved of the scandal which now almost always accompanies the granting of municipal franchises; the crimination and recrimination in the public press, which exert a very demoralizing influence on the community at large, and destroy all confidence in public men.

Municipal ownership, the ultimate end desired by all franchise tax devisees! Just picture to your minds, if you can, the service that the public would get from a street railway or lighting plant run by the politicians, and think of the power added to the machine in the patronage available in the army of employees.

And then the tax payer! and we all pay taxes, for even if we rent or board, our landlord recovers the tax when he makes up our rent. Can any municipality which owns its public utilities and gives the same service as a private corporation would be compelled to give, show a profit when its books are honestly kept? By honestly kept, is meant the plant charged with all the operating expenses, including its proportion of management, kept up to its proper physical condition out of earnings and out of taxes or bond issues, charged with the interest on the bonds issued to build it, and with the taxes lost by its being municipal and not private property, charged with a fair insurance, and its proper proportion of the sinking fund and a proper reserve created to replace it when it becomes obsolete or worn out. Does such a plant exist?

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NOTICE.

Papers and correspondence on all subjects of practical interest to our readers are cordially invited. Our columns are always open for the discussion of problems of operation, construction, engineering, accounting, finance and invention.

Special effort will be made to answer promptly, and without charge, any reasonable request for information which may be received from our readers and advertisers, answers being given through the columns of the Journal *when of general interest, otherwise by letter.*

Street railway news and all information regarding changes of officers, new equipment, extensions, financial changes, etc., will be greatly appreciated for use in our news columns.

All matters intended for publication in the current issues must be received at our office not later than Wednesday of each week.

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Through the courtesy of the New York & Portchester Railroad Company we are enabled to present in this issue some additional run sheets and data reproduced from the plans and working drawings of that company, together with some further testimony presented at the hearing before the Railroad Commissioners during December, and additional estimates and data prepared and collected by the officials of the company as bearing on the subject. It may fairly be said that the testimony presented at this hearing and the plans prepared by the company form the most complete set of data every prepared of a proposed railway, if not the most complete which has ever been compiled, and the officials of that company certainly deserve great credit not only for the thoroughness with which they have gone into the details of construction and operation, but also for the generosity which they have displayed in making the results of their work public. The drawings published in the last issue showing the speed, distance and performance curves of the motors selected are, of course, applicable to all roads using the same equipment, as by interpolation the proper figures for any condition or set of conditions can be secured, while by following the same method of graphical presentation, similar diagrams for other motors or other gearing can be prepared. The run sheets published last month show the preliminary calculation of the power consumption and running time, while those published this month illustrate the economies possible by certain slight changes in the relations of acceleration, coasting and braking. It is not too much to say that the completeness of these plans were a revelation to the steam railroad experts who were present at the hearing, and, although at the beginning of the hearing they were stigmatized as chimerical by the representatives of the opposing steam railroad company, the latter at the end of the hearing withdrew all statements which they had made as to the lack of feasibility of the project from an electrical or financial standpoint, and announced that they would confine their objections to the construction of the road to legal grounds only.

* * * *

Electric railway operation has for a long time been so identified with *street* railway service proper that, as stated in a recent issue, it is impossible for the average steam railroad company, and, in fact, for nearly everyone who has not closely followed the development of electrical transportation methods of the last few years, to realize the possibilities and advantages of electric motors for high-speed service. It is true that a number of very successful interurban electric lines have been built, but comparatively few of these have been constructed exclusively, or even for the greater part of their length, over their own right of way. For this reason the electric-motor train has not been brought into direct competition with the steam locomotive in the latter's own peculiar field, except for elevated railroad service, so that its possibilities have not been demonstrated so clearly in practice as they might otherwise be. There is no doubt, however, that with the direct-current motor the field for electric traction is vastly greater than that to which it has up to the present time been applied, and that this field, extensive though it is, will be vastly augmented by the development of a practical polyphase motor.

* * * *

We have already called attention to some of the advantages which would accrue from the substitution of electric for steam power in suburban service, particularly in the direction of economy, high speed and greater gross earnings. There are others, however, which affect the public perhaps as intimately, if not more so, than those mentioned above. Thus, the operation of rapid, frequent, cheap and comfortable common carriers means in many cases the elimination from the smaller towns of the middleman in the distribution of commodities, from the fact that transportation from the large centers being so much quicker and cheaper, the stock of supplies of all kinds kept on hand in each suburban town need not be anywhere near so large, and the producer and consumer will be brought together more closely. This, it is apparent, will result in large reductions in the price of commodities to the consumer.

* * * *

The steam railroads have been, and are now, operated upon the theory that each train unit, whether passenger or freight, must be an independent paying or self-supporting unit. It is for this reason that steam roads so often de-

cline to augment their passenger or freight-train units, the invariable reason being that another train "won't pay." By this policy steam roads do not encourage riding, but follow that of "waiting until the business is there." Where electric railways have tapped the same territory as that served by existing steam roads, the rides per capita per annum have been increased three, four, five and more times what they were with the steam-railroad service. This increase is due essentially to the lower fares and more frequent service afforded by the electric railways, which until now have been essentially trolley roads. The result of the increased use of the electric systems on account of their lower fares and more frequent headways has been to show that while each or every car or train unit may not be self-supporting, yet the systems as integers are decidedly so, with the result that the cost per passenger-mile or per ton-mile can profitably be maintained far lower on electric than on steam transportation systems. All of these considerations, it might be said, were exhaustively worked out by the New York & Portchester Railroad Company, and were clearly demonstrated to the Railroad Commission of the State of New York.

* * * *

There are a few places near our greatest cities where the crowded conditions of the terminals and the great bulk and importance of the through passenger and freight business make the advisability of attempting to handle a local electric service with cars or trains on short headway very questionable. This is the case, however, at comparatively few points. To be sure, the adoption of an electric service on a steam road which would give approximately the same service as some of the latest electric interurbans would involve some radical changes in established steam road precedents and equipment. It is hard to believe, however, that it would not in most cases be easier and cheaper to put additional tracks on an existing steam road to accommodate such a new service rather than buy and build on an entirely new right of way. It ought also to be as easy for the electric cars of a steam railroad to operate over local street railway tracks as those of any other interurban company, if the inaccessibility of depots on the steam road was in the way of successful local traffic. Nor does it seem unlikely that if the steam road so desired very close traffic agreements for the exchange of business and for the quick and easy transfer of passengers could be made with local city systems, in the majority of cases. Less trouble and red tape than at present about a transfer from a car on the steam road to a local city car, combined with frequent electric service on the steam road, would make a combination hard to beat. This, however, is an outline of what might be, rather than what is likely to be. At present there is every indication that the building of electric interurban lines paralleling steam lines will go on with undiminished activity. With few exceptions, there is too much conservatism and inertia connected with as large an aggregation of capital as is invested in a large steam road to permit of any extensive movement toward supplying a local electric service until it is too late and smaller or less conservative collections of capital have covered the field with independent lines, as is now constantly being done.

We note with regret the action of the Reform Club of New York in opposing the grant to the Metropolitan Street Railway Company of the desired Elm Street franchise. It may be doubted whether a clearer case could be made out anywhere for increased service, but the club insists that traffic would be interfered with, on the ground that at present no north or south thoroughfare in or near the wholesale district is free from street car tracks. We cannot refrain from inquiring: What of it? Does anybody suppose that a company puts down tracks for its own pleasure? If the tracks were not for the benefit of the public, there would not be a single block of stone turned nor a single yard of rail laid. In fact, the club at once concedes this by insisting that the company will not pay enough for its franchise. Now, unless the payments came out of earnings in fares, it is evident that the charge would be unfair and an exaction, and we can hardly imagine that the club wants to argue in favor of that. Yet this is what it says:

> The compensation offered is insignificant. The ordinance provides for an annual payment of 3 per cent of the gross receipts for the first five years, and 5 per cent thereafter. Taking as a basis the amounts paid by the Metropolitan Street Railway Company under similar franchises, the total compensation under this provision would not exceed $5,000 for the mile or mile and a half of double track, and probably not more than $3,000. It is proposed for this insignificant sum to allow a company to maintain tracks in a street that has just been widened at a cost of $6,000,000, the interest on which, at the low rate of 3 per cent, amounts to $180,000. In other words, a company occupying perhaps one-fifth of the street, pays only one-sixtieth of the cost of widening alone.

Evidently the Reform Club has no notion of the fact that the company is a taxpayer in various other categories, and has to bear many other burdens quite heavy and beyond this incidental one, due to the proposed passage through a thoroughfare made at the general expense for the public good.

But strangest of all, the club kicks at the proposition to let the citizens of New York enjoy one more transfer free. It says:

> The grant completes the monopoly desired by the Metropolitan Company. This company already controls the entire surface street railroads upon Manhattan Island. The only important north and south street of any length that it does not control is Elm Street.

If this means anything, it means that the Reform Club would rather see Elm Street in the use of a separate company. If that is not meant, why should such a remark be made? But we cannot conceive any earthly benefit a road of that kind would be to anybody, for rather than pay five cents for a short ride travelers would certainly go at some inconvenience to the Metropolitan parallels and ride 15 or 20 miles for the same amount of money. In short, the truth is that the railway up Elm Street would be a distinct benefit to the public in relieving downtown congestion, and the Metropolitan Company, with wonted promptness, is ready to give the service, on fair terms to the city, and without a cent of extra charge to its passengers. These same conditions are encountered in other cities, where, as in New York, the great fact is lost sight of that, however selfish the object of a company might possibly be in spending money to extend or improve its system, the public must be the chief beneficiary, or the company is heavily "out." This partnership in improvements is the underlying fact, forgotten when it is proposed to load up the companies with new and heavier burdens, if an increase of service is suggested by them.

Handling Motors in Repair Shops

Electric railway repair shop practice has in this country divided itself into two general methods of handling motors for repair purposes. One method is to take the truck out from under a car whenever repairs are to be made on a motor or wheels are to be renewed. The other is to leave the truck under the car and do all the work from the pit, lowering armatures and wheels into the pit. A great many master mechanics have decided opinions one way or the other as to which of these methods is best, but practice is so equally divided between them, and so many large roads are found on both sides, that one is forced to the conclusion that the difference in results between the two methods cannot be great. Indeed, some roads are using both, and such find that there is not much difference between them, provided the repair shop in either case is fitted with the right kind of apparatus for fully carrying out the plan of motor handling for which it is designed, and the motor equipments are also arranged accordingly. Summed up briefly, the arguments advanced in favor of each method are as follows: When the trucks are taken from under a car the parts are in plainer sight and more accessible than if it is under the car. If the shop is as light as it should be, there will be little need for artificial light when working over a truck in the daytime, while if the truck is left under the car, artificial light must be used in any event. This itself is a disadvantage, not because of the cost of the light, but because men cannot work as fast or as well around a truck by artificial light as by daylight. It is also more agreeable for a repair man to work on a truck which is uncovered before him on the floor than with his head stuck up in a mass of dirty truck and motor mechanism, as he must if working from the pit, and better work can be expected of him. Truck bolts are in an awkward position to get at for a man standing in a pit. On the other hand, those who favor doing all from the pit point to the time required to disconnect motor leads and hoist the car body when the truck is taken out from under. Taking the truck from under disturbs bolts and connections that would not otherwise have to be touched. More floor space is required when the trucks are run out from under. If the shops are as crowded as they are in some large cities, artificial light must be used in any event. Supposing that equally rapid devices are used for hoisting and lowering in both cases, the time taken to remove an armature by taking it down into the pit or to remove wheels would be shorter than by running the truck out from under the car, considered purely on the basis of the number of operations that must be undergone in both cases. But right here comes the question of how much the darkness and inconvenience of things in a pit will influence the time required, and that is a matter of guesswork. Probably it is sufficient to make little difference between the two methods. The equipment needed in the two cases is radically different. When all work is done from the pit, hydraulic or pneumatic jacks and sectional track for removing wheels must be provided. The pits must be extensive enough so that wheels and armatures can be carted away when removed and hoisted out at some other point. If trucks are to be run out from under, there must be provision for quickly hoisting the car body by quick-acting jacks, or, preferably, by a crane or tackle hung from the roof. The latter necessitates strong roof construction.

Electric Roads as Freight Carriers

One of the most interesting developments in electric traction has been the steady tendency toward an invasion of the freight-carrying field, especially by interurban roads. Just how far the practice is useful and profitable depends upon individual circumstances. Many roads possess freight franchises, but few use them extensively, and in only a very small number of instances are the freight receipts an important factor of the earnings.

This condition arises in part from the close relation between urban and interurban traffic, and partly from the intrinsic difficulties of freight distribution. Sometimes spur connections with steam roads may be made in the suburbs, but the relations between steam roads and interurban electric roads are not generally of the most friendly character. In fact, there are now very few instances in which the construction of an interurban road is not a direct menace to the profits of some steam road which it parallels.

Thus, most through freight cannot be gotten at by the electric road, and the local freight is seldom considered by the electric railway manager, large enough in volume to repay a determined effort to secure it.

Moreover, freight traffic is a potent disorganizer of schedules, and where a frequent and fast car service is important freight must keep out of the way. The truth is that the modern conception of good service on an electric road requires the exclusive use of the tracks during a large part of the twenty-four hours, and freight, if handled at all, must be a subsidiary consideration. Express and mail business is another matter, since it is small in volume and weight and can profitably be handled by regular cars at regular speeds.

Now and then an effort has been made to handle freight at hours of very light passenger traffic, but the modern electric road runs eighteen or twenty hours a day, and the only hours of light service are those in which an unobstructed track is most needed.

There is, however, a considerable class of trolley roads which can, and do, derive no little profit from freight, and might derive more if their status were viewed by projectors and owners in a truer perspective. We have during the tremendous period of growth in electric traction so come to regard electric roads as the sure precursors of growth, gathering traffic as a ditch in a meadow gathers water, that the conception of a profitable road with a strictly limited opportunity for growth wounds our pride. The steam railroad men have learned their lesson long ago. They realize that a branch from Bungtown on their main line to Confed'rit Cross Roads will pick up enough traffic to be worth the while to build, yet they know in their hearts that Bungtown can never rival Chicago, and that Confed'rit Cross Roads will not become a great manufacturing center while time is finite. They cut their coat to fit the cloth accordingly, and while the contemptuous passenger looking out of the Pullman sees only a wheezy little locomotive trundling out of sight over two streaks of rust, the railway man sees a road that serves its purpose and more than pays for its keep as it stands.

Now, the present temper of the electric railway man is very different. He is conservative in theory, but he has seen populous suburbs grow up almost as fast as he could extend his lines, and he has boundless faith in the growth of his country. He turns up his nose at any track lighter

than 80 lbs. per yard and at all speeds less than 20 miles per hour. His new 60-ft. four-motor cars are models of comfort and beauty, but they would pound the everlasting ballast out of the Bungtown Branch in about six trips. He has made up his mind that if a road is not worth building on the latest interurban lines it is not worth building at all. This is just where he grievously errs, for the Bungtown Branch is very frequently worth building, if built with a due regard for what it really is. Not all roads can be trunk lines, even in growing America. There is a large class of actual and potential electric roads which must run between Bungtown and Confed'rit Cross Roads, where the traffic will be somewhat limited even to the end of time. And it is just this class, the smaller roads serving rural communities and little cities, that can make freight carrying pay. When the passenger schedule is of very moderate frequency, and is likely to remain so, it is not at all difficult to plan for the transit of freight cars in sufficient numbers to meet all probable requirements.

A small electric road is hardly worth talking about, if one judges merely by the size of its bond issue, but it very often is of great importance to the community, and its prosperity is a matter of public concern. Many small roads have freight franchises, and all should obtain them. As to methods of utilization of such rights the pattern to be followed is the local branch railroad, not the through line. The main point is to avoid interference with the regular passenger traffic. Just how this can best be accomplished must be determined by the relative amounts of passenger and freight traffic. As soon as a road gets down to a moderate limit of speed, freight hauling is greatly simplified. A rapid succession of fast passenger cars makes it exceedingly difficult.

A light freight traffic may be very easily taken care of by using freight cars—light ones—as trailers. We are aware that this will by some be regarded as a highly incendiary proposition, for it is an article of faith with the exponent of modern equipments that trailers are entirely bad, because they hinder the rapid acceleration that is just at present a shibboleth in electric traction. Even if one suggests that rapid acceleration is unimportant at a schedule speed of 8 to 10 miles per hour, he is told to go back and sit down as an old fogy entirely out of touch with modern methods. But, nevertheless, a freight trailer is in fact a very useful thing on small roads—not on every car, or at all times of the day, but when it is needed. Trailers can be easily dropped off at a siding to be loaded and picked up again when necessary. Much of the freight carrying on small roads, however, is from end to end, so that there is little trouble with shifting cars. We have in mind, for instance, one rural road about 8 miles long, which has proved a most useful freight carrier in a district where added facilities were very badly needed. This road has one terminus on a railroad, and from one year's end to another it carries an amount of freight surprisingly large for the population served. The cars make a round trip in two hours, thus giving, with two cars in daily use, an hourly service from each end of the line, and they obviously have time to hitch on a freight train when necessary.

As the amount of freight gets larger, a motor freight car, with a trailer when needed, can begin to make regular trips at convenient times of day, or at more frequent intervals, splitting the schedule with the regular passenger cars. Following out this line, it is easy for a rural road having termini of only moderate size to build up a considerable and remunerative freight business. Patrons of the road very quickly learn that it is cheaper to put their goods aboard an electric freight car than it is to hitch up a pair of horses and spend half a day or more hauling the same things over the road.

The next step beyond the convenient trailer is a regular freight service during such hours as will cause least offense. In point of simplicity the easiest thing is to work very early in the morning and late in the evening, using a powerful freight motor car capable of drawing a couple of trailers, so as to reduce the attendance and the number of trips. By this means a very large aggregate amount of freight can be handled annually without any apparent cumbering of the streets. When the passenger schedule is quickened this is about the only way of avoiding occasional inconvenience from the freight traffic—inconvenience which, as every manager knows to his sorrow, will not lose in the telling. Even in cities of medium size this arrangement can be worked successfully, but it soon leads to an extra shift of men if business increases. Unless one can work freight on a clear track it is very likely to lead to trouble in keeping the passenger schedule in its normal shape, and when one tries for ordinary interurban speeds, freight must be worked overtime, if at all.

There is still another type of road which may find profit in freight. This is the fairly long line linking several towns or small cities, but not assuming the graces of a full-fledged interurban road. Such a line may run half-hourly fast cars and occupy its tracks so fully that freight traffic will be difficult, or, on the other hand, it may construct a regular freight and passenger schedule, with ample service of both kinds. This suggestion implies short trains rather than a succession of single cars, but on some such lines a succession of short trains meets the general traffic conditions, passenger and freight, considerably better than a rigid adherence to single cars.

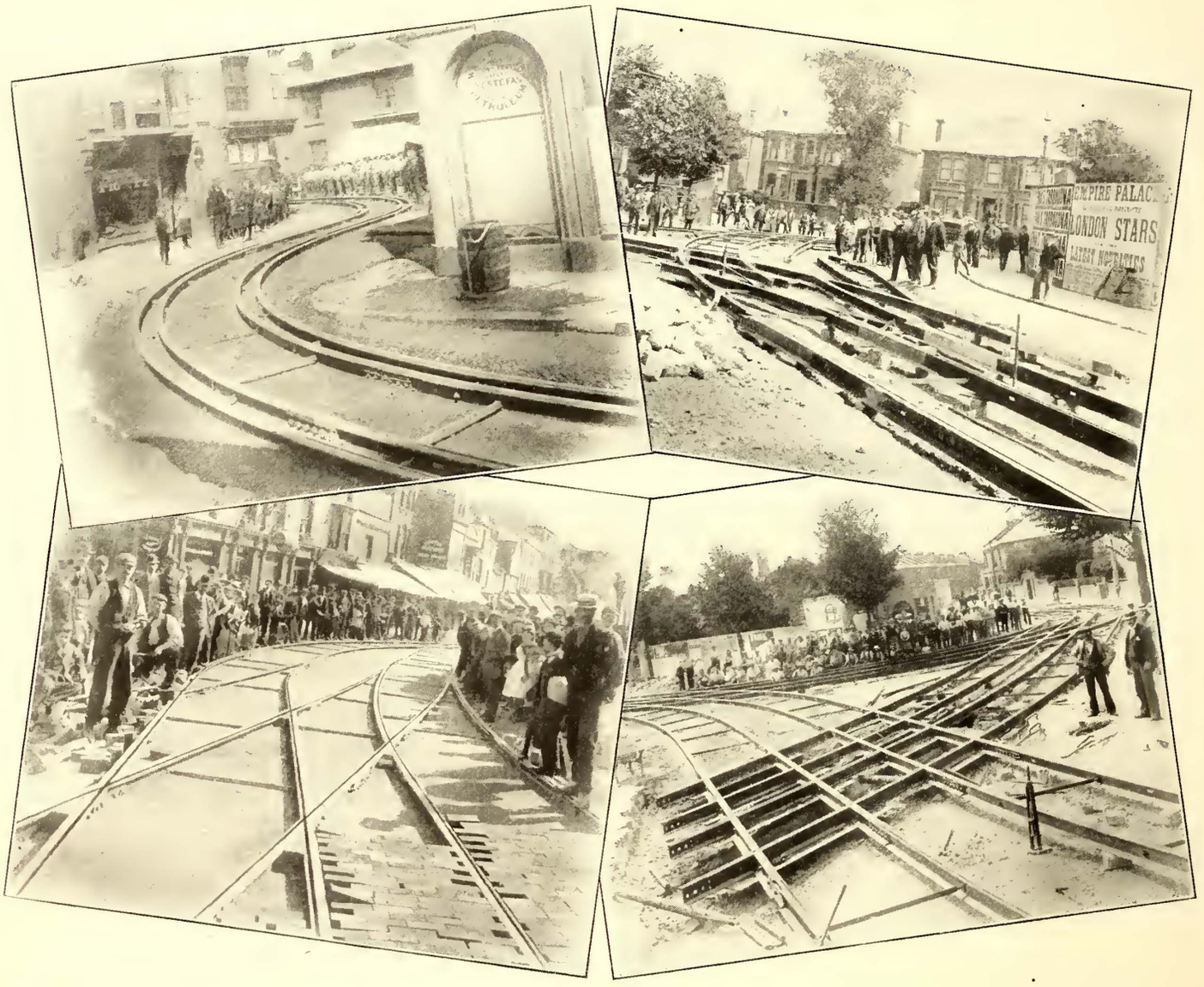
In the operation of such a service, however, the intrinsic advantage of electric operation, which is that of the economy of small units, should not be forgotten. This is perfectly understood in passenger service, but its force is not, perhaps, so fully appreciated in freight traffic, where the principle also applies, though, perhaps, in a slightly different way. It is frequent service which appeals to the consumer. In other words, while the steam railroad is holding freight cars for some point at its yards until enough of it accumulates to "make up a train," the corresponding electric road can have despatched a dozen or so of its shorter trains. As the delays on the steam road from this cause often aggregate several days for even a short haul, and more for a longer distance, the consignee is kept waiting for his goods, and as a result, if he is a merchant, has to keep a larger amount of goods in stock, and go to greater expense for watchmen, insurance, etc. A more frequent delivery, such as is possible with the light electric freight service, would wipe out a considerable part of these expenses, as well as much of the cost of double-handling the goods requisite when received in large quantities, *i. e.*, first into the storeroom and then on to the shelves of the store. As these expenses have to be added by the merchant to the selling price of his goods the electric road, with its frequent service, could compete successfully for freight with the steam road, at even a higher rate per ton-mile.

The Portsmouth Electric Tramways

Elsewhere a full description is given of the Brighton electric tramways, from which a good idea can be obtained of the present activity in tramway construction in Great Britain, and the substantial types of roads which are being built in that country. Below will be found full particulars of another English road, that in Portsmouth, which is also a newly constructed, municipally owned and operated electric tramway, and which forms the largest municipal system in the South of England. The tramways were acquired early in 1901, from the former private corporation being 14 miles of double track and crossings, and one-half mile of single.

TRACK CONSTRUCTION

The track construction, which employs the unusual gage of 4 ft. 7¾ ins., is particularly heavy. Steel grooved rails weighing 96 lbs. to the yard have been used, these being supplied in lengths of 40 feet; the angle-plates weigh 130 lbs. per pair, and differ from the ordinary type, in that they are combined with a tie or sole-plate. Tie-bars of wrought iron are placed at intervals of a little less than 8 feet. The special track work consists of 24 double line junctions, nine single line junctions, 86 junctions double to interlacing,



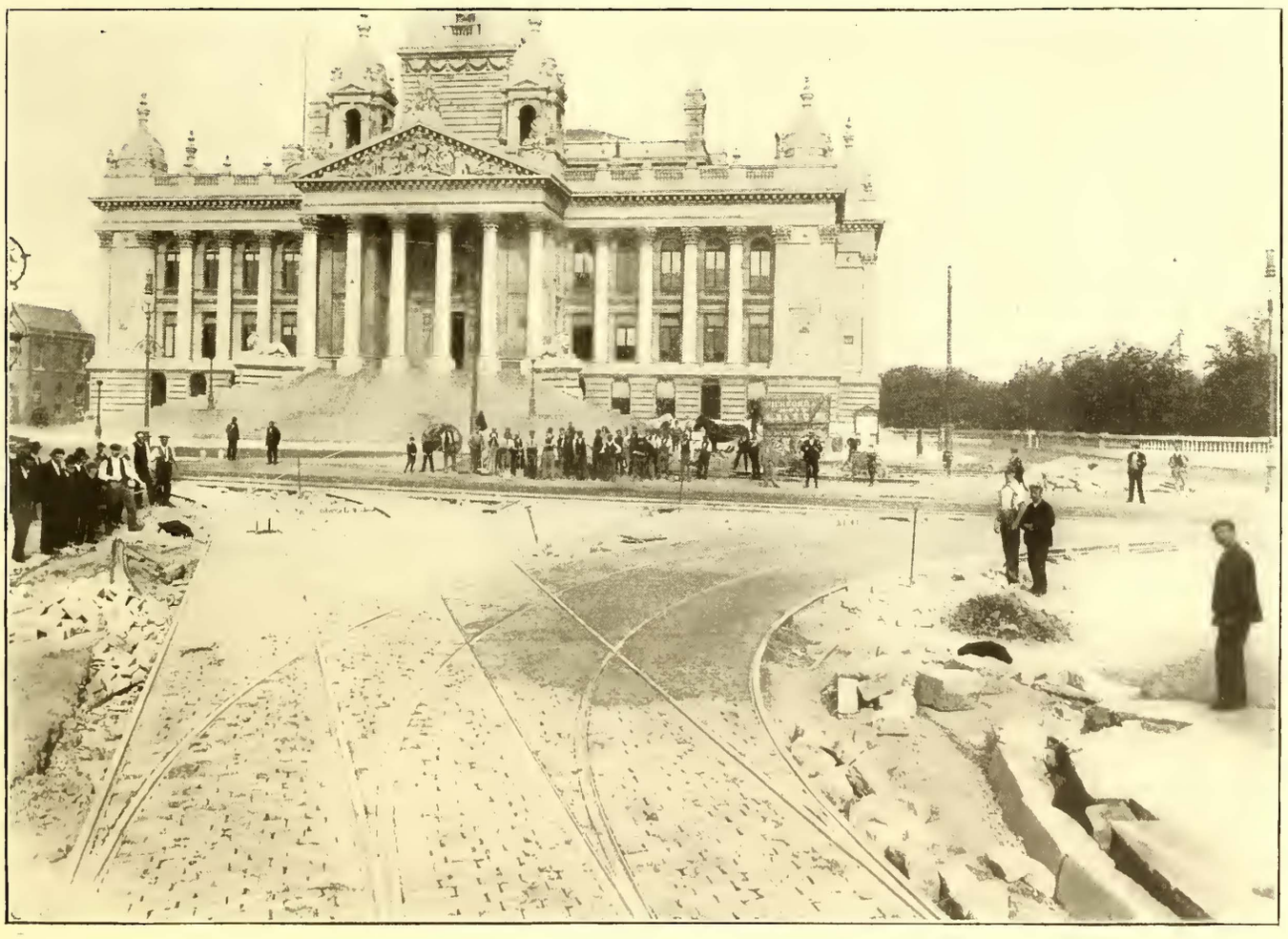
COMPLICATED PIECES OF SPECIAL WORK AT PORTSMOUTH

operating them, and steps were immediately taken to secure their conversion. It was decided by a majority of the council to keep the undertaking quite distinct from the lighting system, and the tramway is, in consequence, supplied from a station devoted exclusively to that purpose, thus following the policy adopted by Glasgow, Sheffield, and other towns. In the early autumn of last year contracts for the power-house plant, the track construction and cables, as well as the cars, were entered into with Dick, Kerr & Co., the overhead equipment contract being given to Macartney, McElroy & Co. The power-house plant cost about £30,000, the track construction over £200,000, and the cars nearly £50,000. The trolley system is used. The total route length is approximately 14½ miles, there and eight junctions single to double. The rails are double-bonded with Neptune bonds 30 ins. in length, and at intervals of 40 yards are again cross-bonded. The substructure consists of a minimum of 6 ins. concrete, which varies to a depth of 13 ins.; the rails are laid direct on the concrete, and are then paved in wood or granite blocks.

THE OVERHEAD EQUIPMENT

Of the three types of overhead construction in common use, viz., span wire, overhead bracket and center pole, the first two only have been adopted to any extent in Portsmouth. In many cases the narrowness of the streets necessitated brackets with side arms, while in many cases there was not enough room to permit the use of poles between

SOME TYPICAL OVERHEAD CONSTRUCTION, PORTSMOUTH



TRACK WORK IN FRONT OF TOWN HALL, PORTSMOUTH

the tracks. In a few cases, however, such as in front of the town hall, center poles have been used with a very effective result. Over 1100 poles have been employed, weighing respectively 800 lbs., 1200 lbs., and 1600 lbs.

A No. 00 B. & S. trolley wire is used, divided up in sections not exceeding one-half mile. The system is fed by means of fourteen feeders, the longest being 14,000 ft. and the shortest about 400 ft. For the most part they are drawn in conduits, a small portion, however, being laid on the solid system.

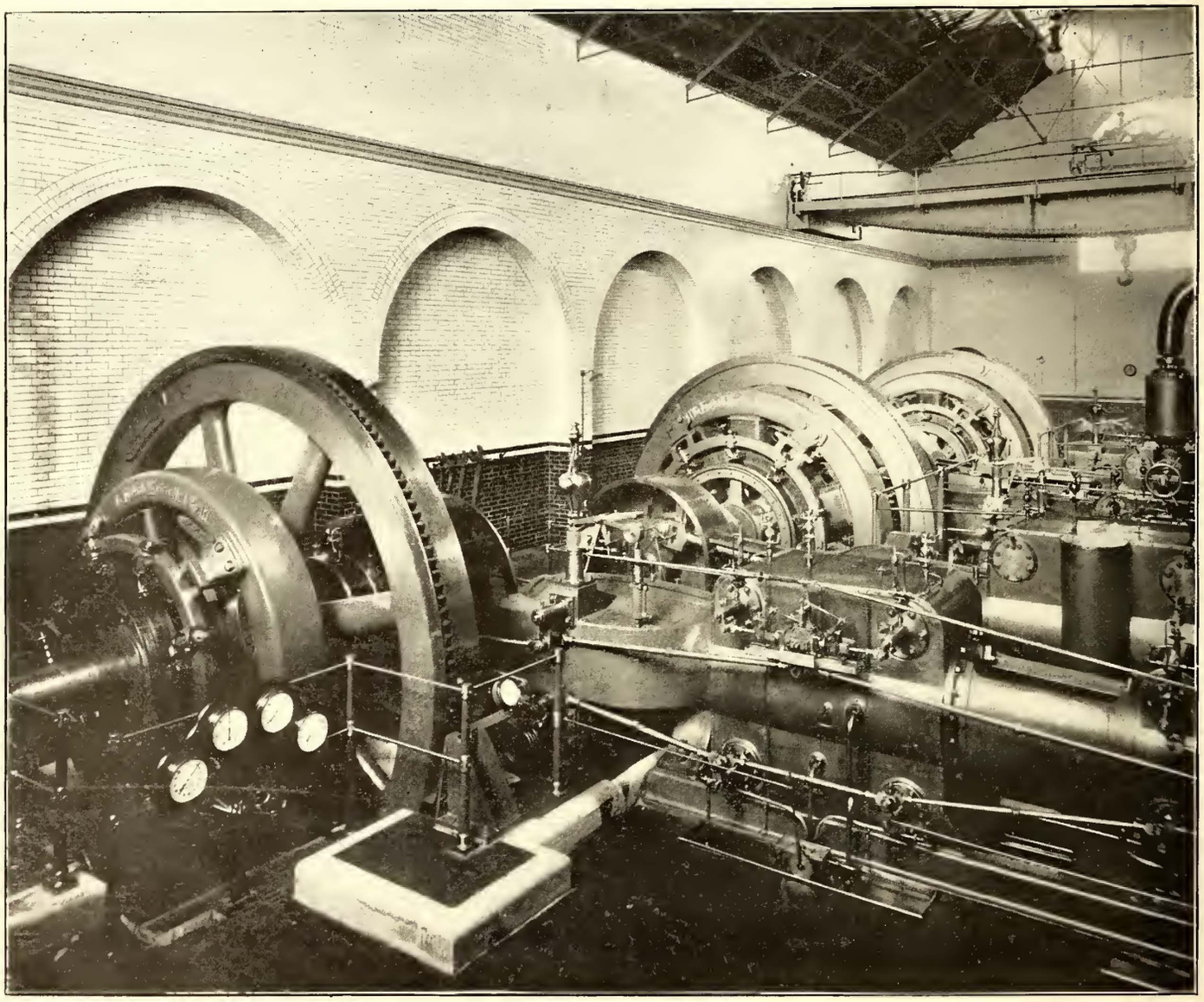
THE STEAM PLANT AND AUXILIARY APPARATUS

The steam plant comprises three boilers of the water-tube type, each of which is capable of evaporating, under ordinary working conditions, 12,000 lbs. of water per hour at a working pressure of 160 lbs. per square inch. Needless to say, there is a considerable factor of safety provided for in the construction of the boilers, and, if necessary, they may be safely worked at a steam pressure of 200 lbs. per square inch.

Two of the engines are the horizontal cross-compound type, with Corliss valve gear, each developing 640 ihp under normal conditions and at the most economical load, and 900 ihp at their maximum load, when running at a speed of 90 to 100 r. p. m., and with a pressure at stop valve of 150 lbs. per square inch and working condensing. The third engine is of the horizontal tandem-compound type, with Corliss valve gear, and develops 320 ihp under normal conditions, with an overload capacity of 450 ihp running under the same conditions as the larger machine.

The following are the principal dimensions of the engines: In the two larger sizes the diameter of high-pressure cylinder is 18 ins., low pressure 36 ins., stroke 42 ins., diameter of piston-rods $4\frac{1}{4}$ ins., diameter of crankshaft $17\frac{1}{2}$ ins., and diameter and length of main journals 14 ins. x 26 ins. The diameter of fly-wheel of the large sets is 18 ft., and it weighs, approximately, 25 tons.

The diameter of the high-pressure cylinder in the smaller engine is 15 ins., the low pressure 30 ins., the stroke being 36 ins.; the diameter of fly-wheel is 16 ft., and weighs, approximately, 22 tons.



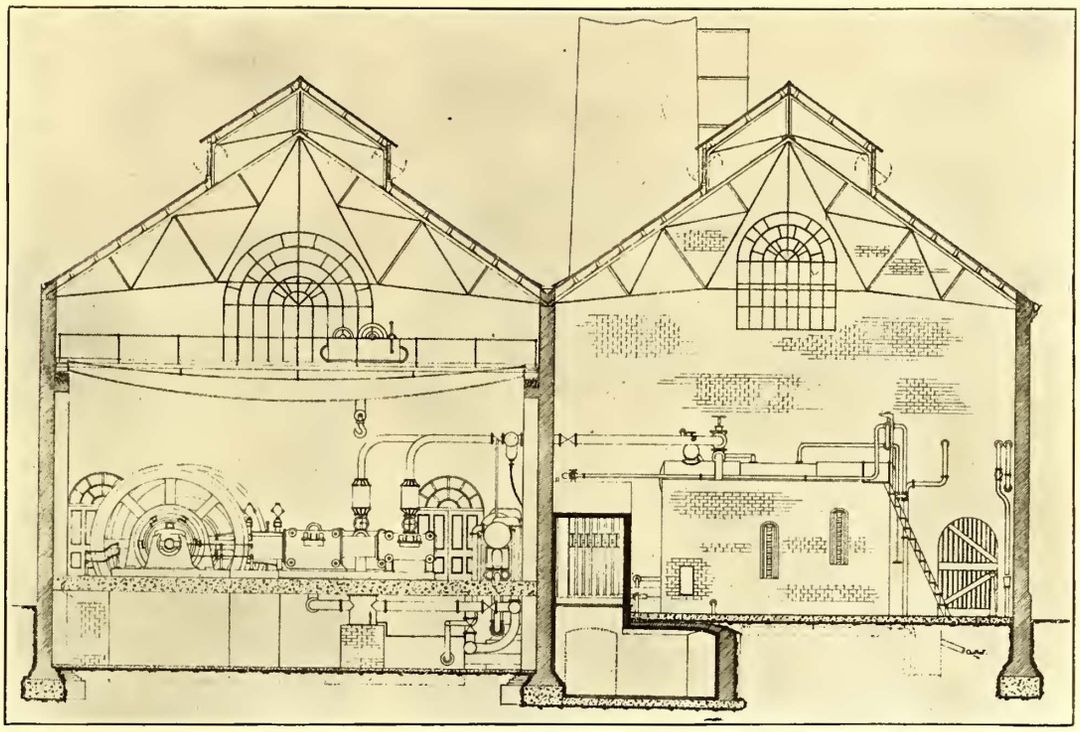
INTERIOR OF POWER STATION, PORTSMOUTH CORPORATION TRAMWAYS

The cylinders are of hard, close-grained cast iron, and both high and low-pressure cylinders are steam jacketed. The valve gear is of the Corliss type, and the valves of both cylinders are provided with automatic variable cut-off gear, actuated directly by the governor, provision also being made for adjustment by hand. The crankshaft is of forged Siemens-Martin steel, and is swelled at the middle to receive the fly-wheel of generator armature.

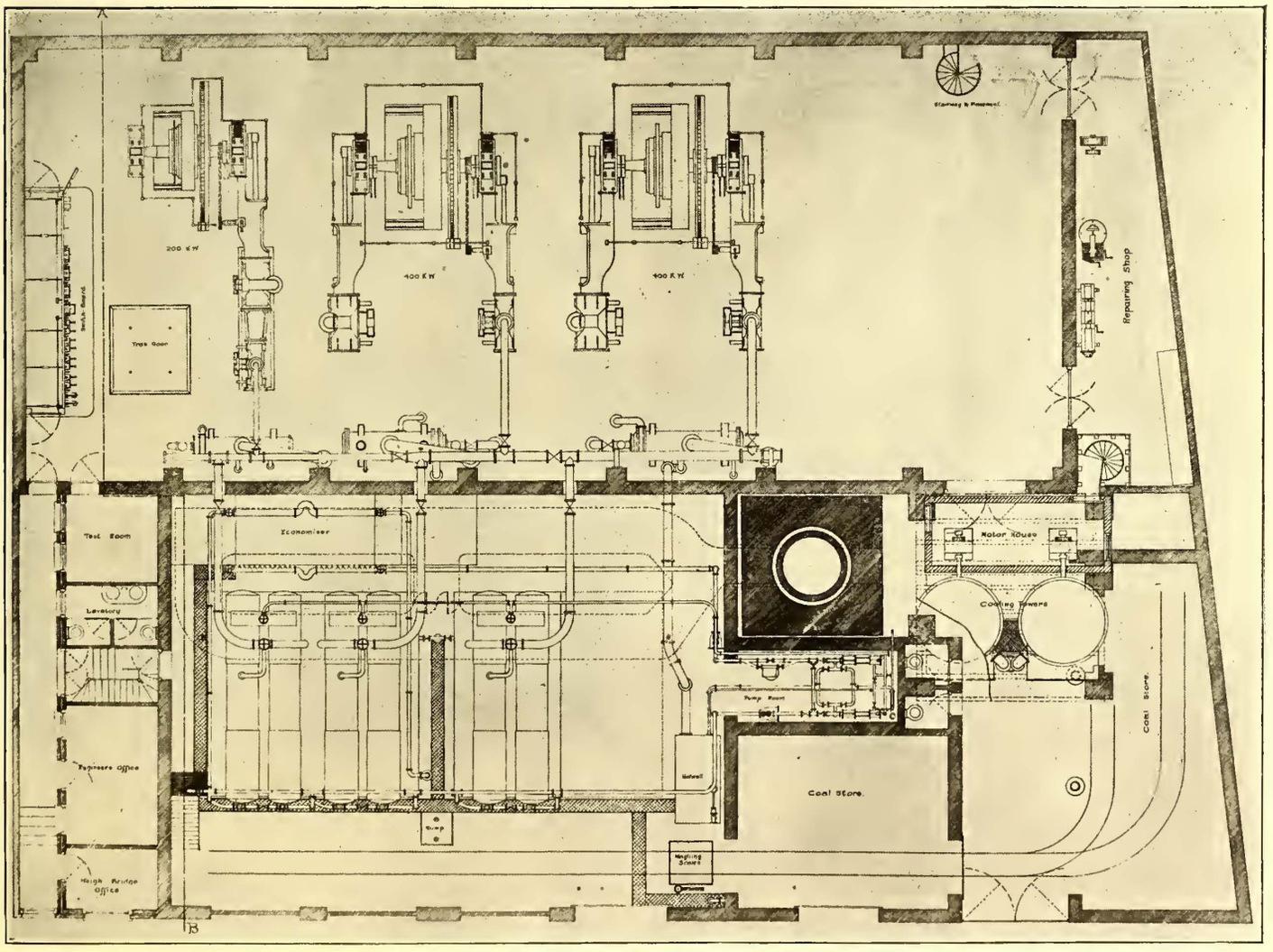
Following the practice commonly adopted on both sides of the Atlantic, the fly-wheel is provided with a flange for coupling to a corresponding flange on the armature spider of the generator, the object of this flange being to take the heavy, sudden strains of overload off the shaft and keys. There is a complete system of automatic lubrication pro-

vided throughout the engine. It is specified that permanent speed variation shall not exceed 2 per cent from the mean speed when the load is varied under ordinary working conditions; the greatest variation under extreme temporary load conditions is not to exceed 5 per cent from the mean.

The generators, which are three in number, are of the type generally supplied by Dick, Kerr & Co., and manufactured by the English Electric Manufacturing Company, with whom they are associated, and whose methods of generator manufacture were described in the last October issue of this paper. The output of the two larger ones is 400 kw, and that of the smaller one, 200 kw when running at the rated speed under normal conditions.



SECTION OF PORTSMOUTH POWER STATION

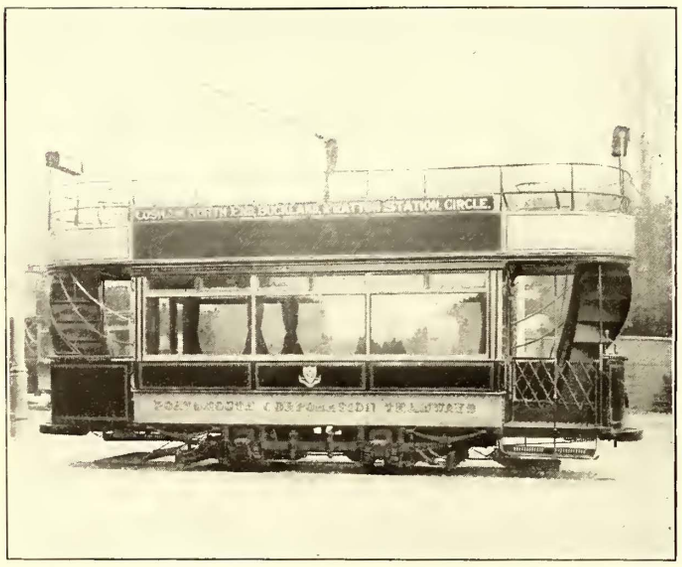


PLAN OF PORTSMOUTH POWER STATION

Each is provided with a long bearing surface to the shaft of the engine, to which it is to be fitted. It is bored accurately to a gage supplied by the engine builder, and is made slightly smaller than the diameter of the shaft, so that it requires about 100 tons pressure to force it into position, it being then secured by means of two keys.

The main steam pipes are of lapwelded mild steel, with wrought steel flanges; the short bends are of solid drawn copper, with gunmetal flanges. The exhaust pipes are of wrought steel.

There are three surface condensers of the Worthington Admiralty type, two of which are each capable of condensing, under ordinary working conditions, 12,000 lbs. of steam per hour, and the smaller one capable of condensing 6,000 lbs. of steam per hour. The outer shells are of cast iron, the tubes being of solid drawn brass, secured into two plates in such a manner as to allow free expansion and contraction of tubes. The condenser is so arranged that the circulating water commences at the bottom, passes twice along the entire length of the tubes, and leaves at the top, a baffle-plate being provided for distributing the exhaust steam over the whole surface of the tubes. The cooling



STANDARD, DOUBLE-DECK CAR IN PORTSMOUTH

tower consists of two sections, each of sufficient capacity for one large condenser, the tower being constructed of steel plates; each section is fitted with a fan of ample size to cause fresh air to circulate over the cooling surfaces, the fans are driven by electric motors, and the shafts are of steel.

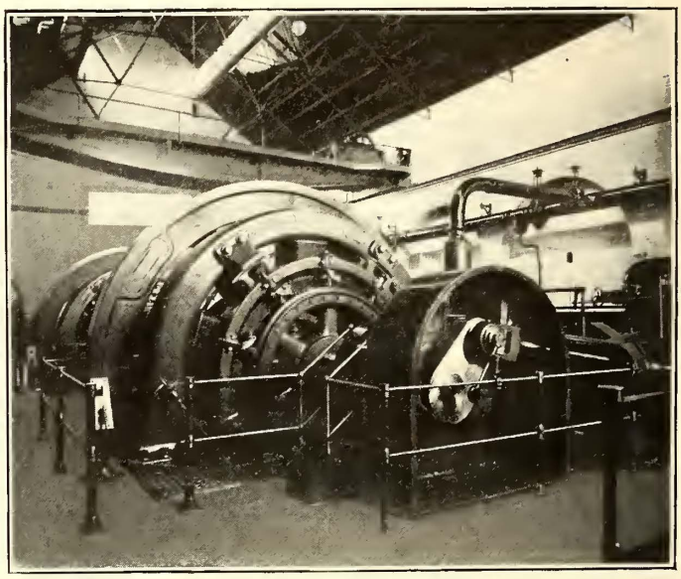
There are three sets of combined air and circulating pumps with compound steam cylinders, the pumps being independent and each connected to one condenser. The air pump is of sufficient capacity to maintain the vacuum specified, and the circulating pump is capable of drawing water from the storage tank and lifting it to the top of the cooling tower. The boiler feed pumps consist of two, one having a capacity of 24,000 lbs., and the other of 12,000 lbs. of feed-water per hour, respectively, against the full working pressure of the boilers.

A Green's economiser is in use, and is of the high-pressure type, with straight tubes, ranged vertically and consisting of 192 tubes, in two sections. It is constructed to stand a working pressure of 160 lbs. per square inch, and is of the most modern design, and gives ample facilities for access to all parts. The scrapers are driven by a 500-volt Lundell motor.

The switchboard is of the usual traction type, and is divided into panels, which are carried on vertical angle irons secured together with bolts, a suitable means being provided for fixing the angle irons to the floor and stays to support the board about 3 ft. clear of the wall. Automatic circuit breakers are provided on both generator and feed panels; all the instruments are of the usual type. There is, of course, a special panel provided to meet the requirements of the Board of Trade.

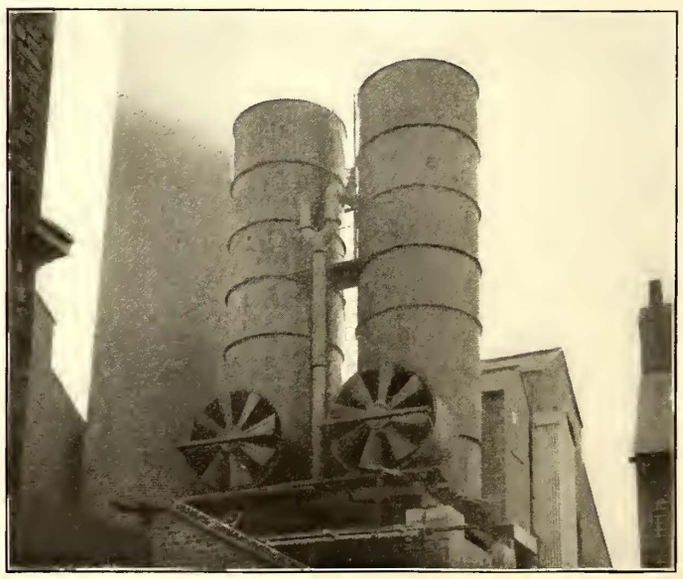
THE ROLLING STOCK

The rolling stock will consist of 80 double-deck single truck cars. The car bodies have been manufactured by the Electric Railway & Tramway Carriage Works, of Preston, and the electrical equipments by the English Electric Manufacturing Company, of the same town. The car



GENERATING UNIT

bodies are constructed with the "Bellamy" reversed staircase, which gives an increased seating capacity and permits the ingress and egress of the passengers to be made with greater facility than in the ordinary type of double-deck car. The interior of the car is neatly finished in quartered



COOLING TOWERS WITH FANS, PORTSMOUTH

oak. The cars are mounted upon Brill 21-E trucks. The braking of the car is usually sufficiently provided for by the hand brake. It is, however, supplemented by the electric emergency brake operated from the controller by the motorman.

In conclusion, it should be added that the complete system of electric tramways has been designed by and carried out under the supervision of A. Rotter, who, in addition to being engineer to the tramways, also acts as manager.

Elevated Railway Repair Shop Methods in Chicago

The increased number of interurban electric railways using motors of large size make the methods used by the elevated roads of Chicago for handling motors and armatures in their repair shops of special interest, because these roads have all been in operation for some time, and the benefits to be obtained from their experience should be considerable to interurban lines which are just starting in business. The repair shop methods of a road using very heavy motors, such as an elevated road or electric interurban, must necessarily be somewhat different from those found in the repair shops of the various city street railway systems, where small motors are used and lighter trucks adapted to city use.

The first elevated road to be electrically equipped in Chicago was the Metropolitan West Side Elevated Railway. M. N. Scott is present general foreman of these shops. The plan employed on this road is to run all cars to be repaired into the second story of the repair shop, which is on a level with the elevated structure. All work

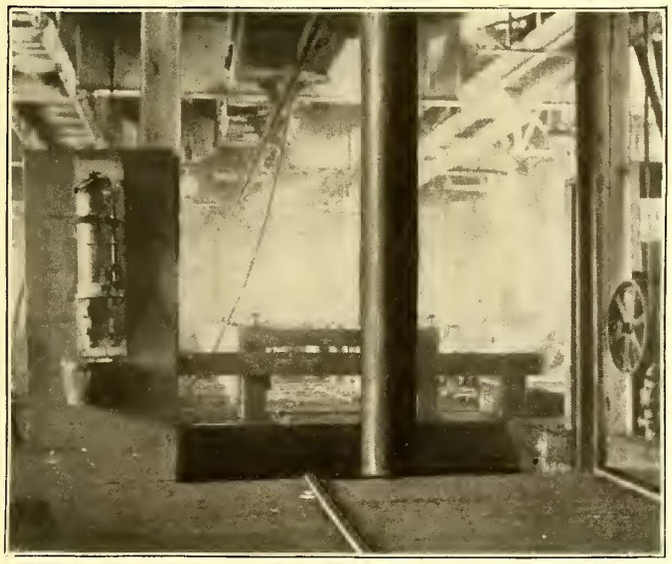


FIG. 1.—BOTTOM OF HYDRAULIC TRUCK ELEVATOR SHAFT, SHOWING TRACKS AND ELEVATOR PISTON

on the car bodies and small repair work is done on this second floor. The cars themselves are never taken down to the first or main floor. The special point which is of interest to companies operating surface lines, however, is the way in which trucks and motors are removed and repaired. Whenever repair work is to be done on a truck or motor it is lowered away from the car body to the first floor of the repair shop. For lowering trucks in this way for repairs a hydraulically-operated elevator platform is used. This platform has a direct-acting piston under the middle, leaving it entirely clear on top, so that when it is raised to the level of the second floor to receive a truck no part of it projects above the floor. The truck to be repaired is run on to this platform, a supporting timber is put across under the car body, and the truck is lowered away to the first floor. On the first floor there is a track on the floor level leading up to the elevator platform at one end. Leading up to the platform at the other end is a track elevated about 3½ ft., to bring the truck and motors to a convenient height to be worked upon, as shown in Fig. 1. Over this track is a small crane, which runs on a track hung from the ceiling (Fig. 2). The hoisting is done by a small electric motor on the crane, which takes its power from a trolley wire running alongside the crane track. This crane takes motors and armatures out of trucks and deposits them on the floor, where the armatures can be rolled to within reach of the revolving cranes at the machine tools. The shop equipment was originally designed to handle G. E.-2000 armatures and motors. These are now operated as four-motor equipments. In order to increase the motor capacity that could be put on a single truck with inside hung motors, the G. E.-55 motor was designed, which has

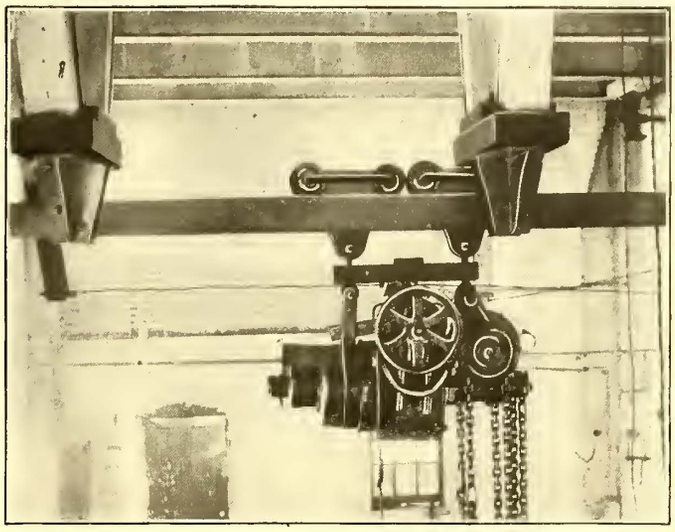
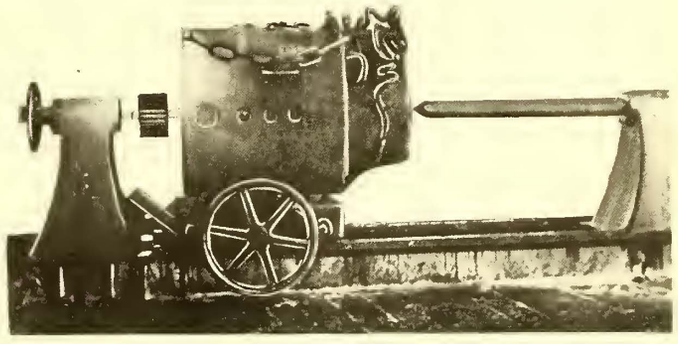


FIG. 2.—CRANE FOR HOISTING MOTORS

a motor casing which overhangs the bearings. The motor casing is not divided into halves, as had been the practice in electric railway motor designing in America previous to the time that this motor was brought out. It has, instead, an opening in the end of the case, through which the armature is taken out. To remove an armature in this way, of course, required somewhat radical changes from any previous practice in removing armatures from motors. For



FIF. 3.—APPARATUS FOR REMOVING ARMATURES

this purpose a machine was designed somewhat on the lines of a lathe with two tail-stocks in place of a chuck and a tail-stock (Fig. 3). The motor is placed on the sliding carriage of this machine upon four plain surfaces, which correspond to four plain surfaces on the casing of the motor. The centers on each end of the machine are then run up so as to support the armature by the ends. The casing of the motor is then moved endwise, leaving the armature free to be hoisted out of the centers for repairs. This operation, however, is a rather slow one, and it is considered that the method used by the Lake Street Elevated Railroad, described later, is superior in the point of time, if the proper hoisting equipment is at hand for handling the motors. For a small shop, where there is no crane of sufficient capacity for rapidly handling a motor, the machine used on the Metropolitan Elevated may have some advantages. In the Metropolitan shops the head room under the crane is not sufficient to permit handling motors by the Lake Street method.

The Lake Street and Northwestern Elevated Railroads both have their repair work done under Master Mechanic F. D. Ward at the Lake Street shops.

The Lake Street method of removing G. E.-55 armatures from motors is to put an attachment on the motor pinion

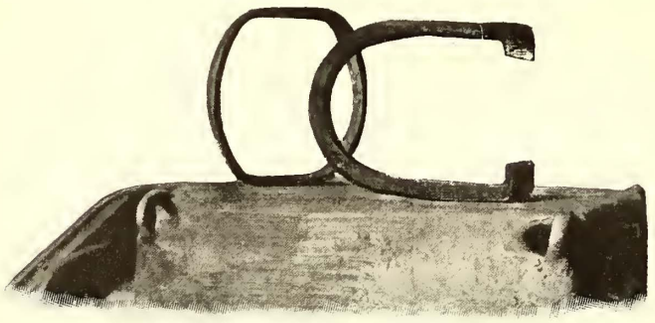


FIG. 4.—ATTACHMENT FOR PINION FOR REMOVING ARMATURE

to which the hook of the traveling crane can be attached. The motor is then lifted up by the pinion and set down on end, with the pinion up (Figs. 4 and 5). The bolts holding the end of the motor casing are then taken out, and the armature is hoisted directly up out of the case. These shops have a 12-ton electric traveling crane, which not only serves to handle motors, but lifts car bodies as well (Fig. 6). The practice in removing trucks in this shop is to put grappling hooks under the platform corners. These hooks are supported from the ends of a yoke to which the traveling crane hooks. The traveling crane lifts one end of the car body clear of the truck. The truck is then run out and motors can be lifted out by the traveling crane. Some of the tracks have pits, but most of the work is done on the floor level with the aid of the traveling crane. The time required to get an armature on the floor from the time a car comes in is stated to be twenty minutes. The tracks in this shop are on the ground level, and cars are run down an incline from the elevated structure to get into the shops. To avoid having a live third rail in the shop, a flexible cable, with plugs on each end, is used to connect the car with the source of current supply for moving cars around the shop.

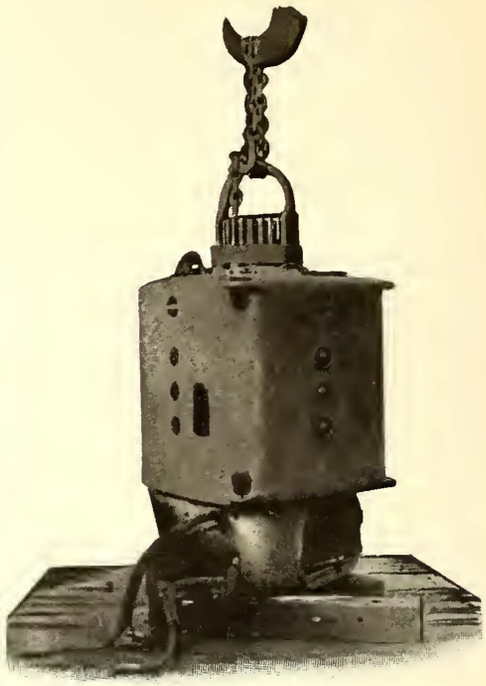


FIG. 5.—APPARATUS READY TO LIFT OUT ARMATURE

Some remarkable records on bearing and pinion wear have been made by the G.E.-55 motors running on Lake Street. The first G. E.-55 motors were put on this road Feb. 4, 1898. One of these ran three years three months and twenty-seven days, or 133,752 miles, with a bearing wear of 1-64 in. These bearings were of genuine babbitt, and were on the motors when they came from the factory. There many other motors on the same road which have made an equally good record. Pinions are also in use which have run over 133,000 miles, and one of these, which has been taken off, shows so little wear that it is probably good for at least 60 per cent longer life. These pinions were also furnished with the General Electric original equipment. There are also many other pinions on this road which have made equally good mileage, and the only reason that all have not has been that some defective gears have broken and caused the breaking of the pinion. Bearings and pinions do not wear so long on the Norwestern Elevated, where traffic is heavier. This shop also has the repairing of cars of the Suburban Railroad. In the armature bearings of these latter cars a rather novel mixture of bearing metal is used. This is 100 parts lead to 7 parts antimony. It would be thought that this would make such a soft alloy as to be valueless for bearings, but it seems to give good results. This mixture is also used on both the Lake Street and Northwestern Elevated and Suburban Railroads. Mr. Ward believes that the long life of bearings under his care is due to good lubrication, and that a lack of this is mainly responsible for unsatisfactory wear of bearings. He uses oil on all bearings. The oil cup, of course, fits inside the regular motor grease cup. The method of feed, which is a

FIG. 6—LAKE ST. ELEVATED SHOPS. CRANE AND YOKE FOR LIFTING CAR BODIES

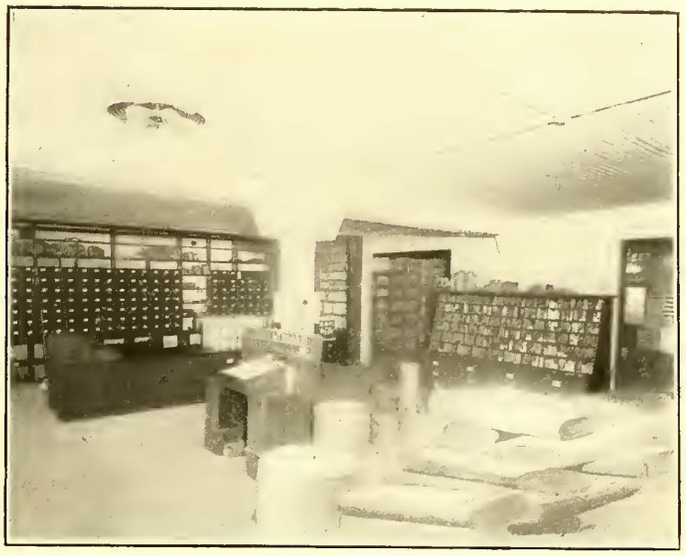
well-known one, is to have a hole in the bottom of the oil cup, into which is fastened a brass tube running down toward the bearing. Inside of the brass tube is a copper pin or rod of a diameter about one-hundredth of an inch smaller than the brass tube. This, of course, gives very small clearance around the copper pin, and makes a slightly loose sliding fit. The lower end of the copper pin rests on the journal, and as soon as the journal warms up, the heat is conducted up the copper and tends to soften the oil and make it flow more readily. The oil used is the No. 1 motor journal oil of the Standard Oil Company, and at average temperature of the air is about as thick as molasses. The heat of the motor frame is sufficient, of course, to keep the oil at higher temperature than surrounding oil, so that there is no difficulty from its failure to run down to the bearing. The use of a thicker oil than this would result in much oil escaping from the journal boxes, and, as Mr. Ward puts it, oiling the elevated structure instead of the motors.

Stockrooms and Stockkeeping of the Metropolitan Street Railway Company, New York City

The purchasing, storing and distributing of the supplies used on a large street railway system is a problem of the largest proportions. Upon this department depends to no inconsiderable extent the profits obtained from operation, as a wastefully-run storeroom is a constant drain on the gross earnings, and in building up the organization of the Metropolitan Street Railway of New York City President H. H. Vreeland has given this subject the most serious consideration. When he accepted the presidency of the road he placed the purchasing and distributing of supplies in the hands of A. C. Tully, who has carried out most satisfactorily the work of placing the entire system on a basis of economy never before reached. In the following pages a few of Mr. Tully's methods for minimizing labor and getting the greatest value out of all money spent through his department are detailed, and a general description is given of the Metropolitan's storerooms.

The configuration of Manhattan Island makes the operation of a street railway thereon a most peculiar proposition. Nearly all the office business of the city is done at the southern extremity, where many of the tall buildings each contain the population of a good-sized town during the day. In reaching their offices in the morning and their homes at night these great crowds of passengers strain the transportation facilities of the city to their utmost, and of the 300,000 persons using the lines in Manhattan about one-half use surface cars. Nearly all the longitudinal lines have been converted to the underground trolley system, but as yet with but few exceptions the cross-town lines are operated by horses. One of these exceptions is the storage-battery system on Thirty-Fourth Street, and until recently compressed-air cars were also operated on another line. On account of this great variety of motive power and the difference between the traction systems in use in New York and in other cities, less than one-fifth of the storerooms' contents corresponds to that ordinarily found in the street railway supply clerk's books. It is not, therefore, in the face of transportation difficulties alone that the management of the Metropolitan Street Railway Company has built up one of the most perfect systems of the world, but the purchasing department is continually dealing with questions that ordinarily have nothing to do with electric street railway equipment or operation.

The illustrations herewith presented give an excellent



ONE OF THE STOCK ROOMS

idea of the arrangement of some of the departments in the storerooms. The building is situated on Eighth Avenue, between Forty-Ninth and Fiftieth Streets. Mr. Tully's office is on the first floor above the ground. Adjoining

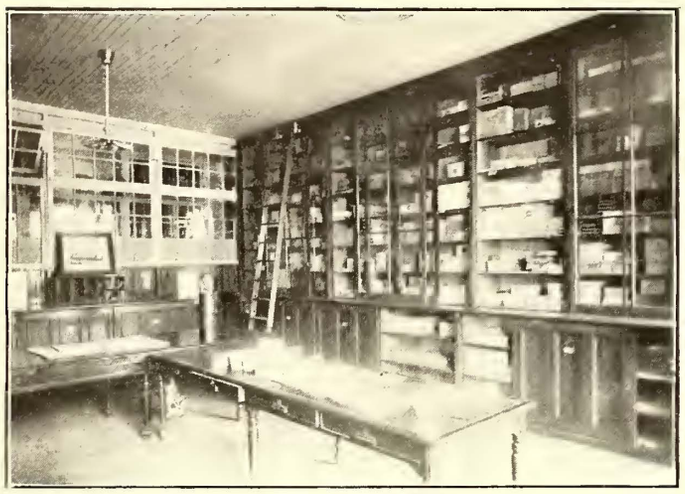
THE MAIN STOREROOM

this private office is that of the storekeeper, where all the routine work of the storekeeping department is performed and all inquiries received. In this room are placed the telephones, watchman's time-recording dial and other accessories. Next to this room is the stationery room, which has been arranged with cases extending to the top of the ceiling, with sliding glass doors and sliding stepladders.

In these cases and closets beneath the cases are contained the 500 forms in daily use in different departments. These forms are numbered from No. 1 up, and placed consecutively, so that any form desired can be obtained without delay. Other cases contain blank books and stationery supplies.

The next room is the largest of the offices, where all the

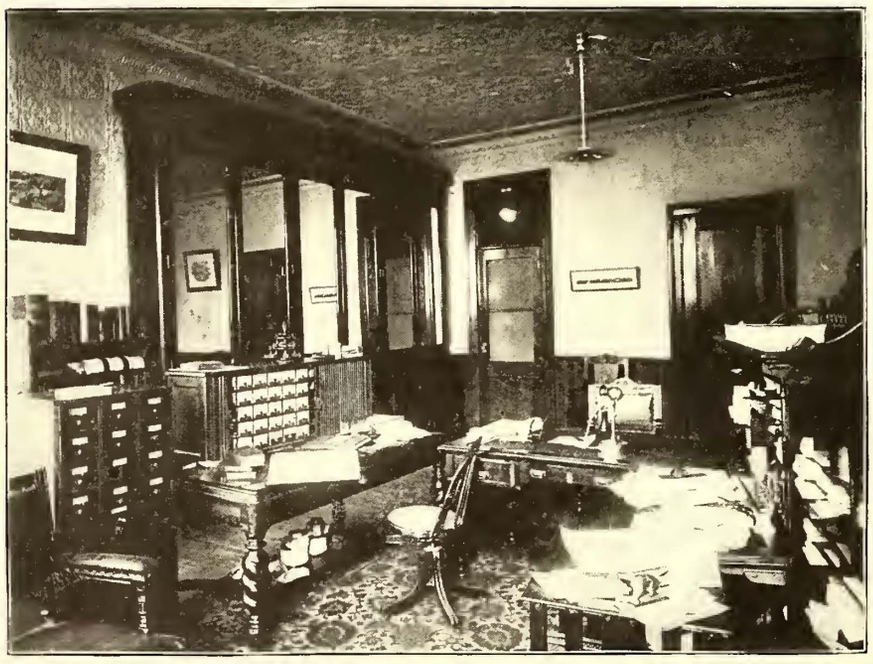
bookkeeping of the charging and distribution of the supplies is done. The two precepts which have simplified the operation of the department have been cleanliness and system, so that everything runs like clockwork. Mr. Tully has



STATIONERY DEPARTMENT

set aside two mornings—Tuesday and Thursday—for receiving calls from the representatives of business houses who solicit his patronage, and this rule has been found of great advantage to both sides. Representatives from out of the city are received any day.

All material is received on the ground floor, either by trolley freight car or by ordinary merchandise trucks. A



PURCHASING AGENTS' PRIVATE OFFICE

track runs into the receiving room, as shown in the illustration, so that the cars are brought directly up to the unloading platform. The heavier supplies, such as gearwheels, gear casings, castings, etc., are kept on this floor. A large, light room, furnished with an overhead traveler and differential pulley block, is situated directly behind the receiving platform, and used for storing these heavier articles. At the end of this room, and conveniently reached by the traveler, is the fireproof oil and paint room, where a supply is always kept on hand. Oil or paint in large quantities is, of course, sent directly where required, without passing through the storekeeper's hands, but this auxiliary supply is sometimes of the greatest importance for replenishing the stock at some power station or car house, when it is either inconvenient or impossible to get a fresh supply from the dealers.

On the second and third stories the various classes of materials are stored away on shelves, floors, tables, etc. The heavier articles are placed around the sides of the room, against the walls, relieving the floor from as much strain as possible. An electric elevator of two tons capacity connects all the stories, and the shaft is most conveniently located for both receiving and delivering goods from the cars or wagons on the ground floor or for distributing the supplies in the storerooms above. Electric push buttons and bells are installed so that the storekeeper can call his assistants, no matter in what part of the building they may happen to be. The degree of refinement to which the system has been brought may be partially appreciated from the fact that there are only three of these assistants.

There are many different classes of supplies, and, as stated above, but few correspond to the ordinary kinds found in street railway storerooms. For example, the 5000 horses in use on the railway require the keeping of drugs and medicines enough to stock a large veterinary hospital, not to mention harness supplies, blankets and farriers' tools. The underground electric system, the storage-battery systems, etc., each have peculiarities of equipment, the details of which are found in the storeroom.

The system of bookkeeping that has been developed contains many features of interest. By having the purchasing agent's office directly at the base of supplies, *i. e.*, at the storeroom, a large amount of detail work is dispensed with, as familiarity with every condition of the stock can be obtained by personal supervision. Except for the yearly inventory required by law, it is only necessary, therefore, to have the entry on the receiving book in the store, the clerks knowing the disposition on the shelves of every article and requiring no "catalogue."

There are two classes of supplies—those which are purchased at the request of the various heads of departments, or superintendents for their own departments and those which are to be placed in stock until needed. When a requisition is received for material it is first approved by the purchasing agent, and then turned over to the storekeeper. If the material is in stock the order is filled and at once sent to the part of the system desiring it, but if the requisition is for something not on hand an order is immediately sent to the manufacturers or dealers, as will be described later. Before the requisition reaches the purchasing department it is approved by the chief of the department from which it comes, and passes through the president's office, but until approved by the purchasing agent no material can be taken from the storeroom or ordered. This gives the purchasing agent an opportunity to make many small economies, his long experience with the road having given him a very exact comparative knowledge of the requirements, especially as to quantity, of the different divisions.

The form used in ordering goods for the railway is shown herewith. This form is printed in copying ink, so that after being made out a complete copy of both form

and contents may be taken for reference. Before the order is sent this record is taken in an ordinary copying book with tissue paper leaves, each page containing the copies of two blanks. It will be seen that the blanks are numbered in the upper left-hand corner. When the blank is made out this number becomes the number of the order, and must necessarily follow directly after the number on the last order made out. In this way it is not only practically impossible for a clerk to make a mistake in numbering an order, but should one of the blanks get into the hands of dishonest persons it would be immediately missed, and the

A VIEW OF THE THIRD FLOOR

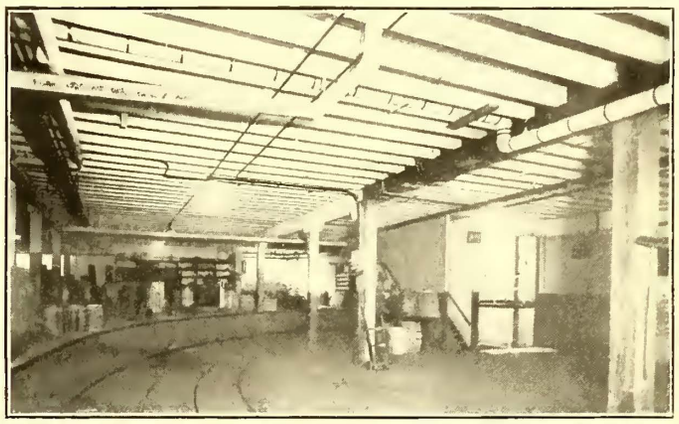
issuance of a fraudulent order guarded against. Since the introduction of the system over seventy thousand orders have been used, but so accurate is the method that out of the entire number every one is accounted for, with but a single exception, which was probably due to a printer's error in numbering the blanks consecutively.

With this order is sent a duplicate billhead form for the use of the firm selling the goods. This blank is filled out as a duplicate bill for the material and returned to the

OIL AND PAINT ROOM

purchasing department when that bill is rendered, and this duplicate bill is retained by the purchasing department. In this way duplicate bills of a uniform size, convenient for filing, and with special spaces left for index marks and memoranda are obtained by the bookkeeping department without expense. Three different colors are used for these order blanks. Those for the Metropolitan Street Railway Company proper are yellow, those for the Third Avenue road are red and those for supplies to be used in new construction work are green. The duplicate billheads which accompany these orders are of a similar color, and in this way much confusion is avoided. The bill for material, if ordered to be delivered direct by the purchasing agent, is sent with the duplicate to the department making the requisition, and if correct as to quantity and quality, is approved and returned with the duplicate.

A concise description of all material received in the storeroom is entered in the Receiving Book. As seen from the reproduction of a page from this book presented herewith, sufficient opportunity is provided to record in connection with the original entry the various items of interest regarding its future disposition, such as the amount of bill, the acceptation by the department for which it was ordered, etc. When the material is taken from the storeroom for



RECEIVING AND DELIVERING ROOM

delivery an itemized entry is made in a triplicating book, whose pages are numbered consecutively. The original is kept by the storekeeper and the two duplicates are sent with the goods to the department ordering the supplies. One is signed and returned, making a receipt for the safe arrival of the material, and the other is retained by the recipient. Most of the deliveries are made by trolley freight

STOREROOM FOR HEAVY MATERIAL

car, and the motorman is required to sign for all packages received.

The accounting part proper—that is, the portion of the work that is purely clerical—is much simplified by these preliminary checks and cross-checks. The copying book wherein are registered the original requisitions in numerical order, is, of course, in a way the foundation of the system. The plan of using different colored pencils for different classes of entries has been adopted in this connection, so that but two or three remarks written across the page of the requisition book tell the whole history of the order. Thus, when a bill has been sent out to the department ordering the goods, the amount and date are written on the requisition copy in red; and, later, when certified by

the division superintendent or head of department, the amount and date are written in blue immediately below the red memorandum. The amount is repeated, as quite frequently discounts are allowed, with which the operating departments are not familiar, or other changes are made in the purchasing price.

Everything that leaves the purchasing department or storeroom, whether merchandise or accounts, must be receipted for. A special form of receipt is used, for example, in connection with the bills sent to the auditor's office, and accompanies all invoices sent there for final approval. No complicated system of bookkeeping has been attempted, the chief book being similar to an ordinary journal in double-entry practice. All records, however, are provided with liberal spaces for the making of memoranda and different check marks, so that complete information concerning any detail of an order from the time the requisition is received from the operating department until the bill is sent to the auditor can be obtained almost, if not quite, as readily as with much more expensive methods of accounting.

A detailed statement of accounts is submitted to the auditor of the company every month. The items specialized on these statement sheets follow in general the recommendations of the Street Railway Accountants' Association, and the main divisions are as follows: (a) Maintenance of Way and Buildings; (b) Maintenance of Equipment; (c) Transportation Expenses; (d) General Expenses. These are subdivided as follows: (a) Repairs to roadbed and track—material, steel rails, switches, castings and track tools, ties and timber; repairs of overhead and underground—material, cable; repairs and renewals of buildings, material; removal—ice, snow and street cleaning, material. (b) Repairs of cars and vehicles, repairs of electrical or cable equipment of cars, repairs of steam plant, repairs of electrical or cable plants, repairs of tools and machinery, repairs of harness, stable equipments. (c) Horse shoeing; cost of provender, car house expenses, car lighting, car service, fuel (power house), light and supplies (power house). (d) Law expenses, miscellaneous expenses, general supplies. These items are given for every division of the street railway system, which includes twenty separate lines operated under the Metropolitan Street Railway Company proper in addition to the subsidiary lines leased with the Third Ave. Railroad Company.

No. 48865

820 Eighth Avenue, N. Y., 1901.

Please furnish on account of this Company the following material. Send bill promptly to this office **NUMBERED AS ABOVE.** *No charge for freight, drayage or package allowed.*

NOTE.—Please render Original Bill on your Bill-head, and therewith Duplicate Bill on enclosed Form.
Allow blank space on original invoice at least 2 inches X width of your form for necessary certification.

To be delivered and marked

.....

SEND BOTH ORIGINAL AND DUPLICATE BILLS
TO
General Storekeeper,
820 Eighth Avenue, N. Y.

Form 25 X. 5,000—7-1901.

METROPOLITAN STREET RAILWAY CO.,
Per .....
PURCHASING AGENT.

DUPLICATE. *Order No.*.....

Examined by..... Entered in Book No. ..... Page No. ..... List No. .....

The ORDER NUMBER must be given in every instance, or the bill will be returned. Orders must be kept separate in rendering bills. Put no two orders on the same bill.

METROPOLITAN STREET RAILWAY CO. *190*

To ..... Dr.

ADDRESS .....

TOP AND BOTTOM OF REQUISITION BLANK AND DUPLICATE BILL HEAD. SIZE, 8½ IN. X 7 IN.

496

METROPOLITAN STREET RAILWAY COMPANY.

MATERIAL RECEIVED.

Purchasing Agent Memoranda	Req. No.	Date Received	FROM WHOM RECEIVED	Quantity or Weight	DESCRIPTION OF MATERIAL	MEMORANDA

A PAGE FROM THE RECEIVING BOOK. SIZE, 16 IN. X 11 IN.

In connection with the storeroom is run the Lost Property Department of the company. This is in charge of a separate clerk, and a room has been partitioned off for the keeping of all property found in the cars. Of course, a large percentage of these articles is claimed within a day or two after being received at the office, but sufficient is left uncalled for to rapidly fill up the space allotted for storage. This department is conducted according to a

law of the State of New York, which allows the company to dispose of all unclaimed articles at public auction, if not called for within three months, and the proceeds to be turned into the treasury of the benevolent association connected with the company.

Should an article sent to the Lost Property Department contain any papers or other matter that would indicate the name and address of the owner, such persons are immediately notified by postal card. For this purpose a printed card is used which does not specify the character of the article, so that if it falls into dishonest hands the owner will not be defrauded.

The New York and Portchester Railway Hearing

The hearing before the Railroad Commissioners of the State of New York on the petition of the New York & Portchester Railway Company for permission to construct a high-speed electric railway between 132d Street, New York City, and the City of Portchester, New York, which was begun in October last, and which was the subject of an extended article in last monthly issue of this paper, was recommenced Dec. 9, and was continued several days. The hearings held in October and November were devoted to hearing the testimony of the applicant company on the convenience and necessity of the road, as well as the practicability of it from both an electrical and financial standpoint, and a considerable part of the testimony, so far as it related to the technical questions involved, was presented in the previous article.

At the commencement of the hearing in October, the New York, New Haven & Hartford Railroad Company and the Union Railway Company, who were opposing the petition, announced to the commission, through their respective counsels, that the estimates of the costs of construction and real estate, as well as those of the operating expenses and probable earnings, as given by the president of the Portchester company, William C. Gotshall, and published in this paper last month, were absurd, and that they would tear them all to pieces. At the time of making this announcement they demanded a detailed statement of these various estimates, part of which were also published in the STREET RAILWAY JOURNAL. These estimates were duly furnished them, and submitted to their experts for a period of four weeks. Just before the close of the case on the merits, on Dec. 12, William C. Trull and F. S. Smith, of counsel for the New York & Portchester Railroad Company, challenged the opposition, and demanded from them a statement relating to their previous threat, whereupon the Union Railway Company, through its counsel, William H. Page, Jr., announced that that company withdrew all of its previous statements as to the estimates, which were admitted to be correct, as were also the engineering data, train sheets and other diagrams which were published in these columns last month, and which were then in the hands of the commission. This statement on behalf of the Union Railway was also reluctantly concurred with by the New York, New Haven & Hartford Railroad through its counsel, Henry W. Tafft, after a challenge by Mr. Trull.

These admissions will undoubtedly be of great interest to the railroad world in general, in view of the recent rapid strides which are being made in heavy and high-speed electric traction. As the correctness of them is now undisputed, they will undoubtedly be invaluable for reference in the determination of the cost, operating expenses and earnings of other projected enterprises along the lines of the New York & Portchester Railroad Company.

The case is now in the hands of the Railroad Commissioners, with the exception of the summing up by the attorneys on both sides, and a decision will undoubtedly be announced some time in January.

As the main interest of the readers of this journal lies in the discussion held at this hearing on the engineering and financial features of the proposed undertaking, some further testimony relating to these subjects offered by the applicants last month is presented below. This consists, first, of additional testimony given by President W. C. Gotshall on the probable gross earnings of the property. This is worked out on a different basis than that used last month; that is, the territory is divided off into different zones, according to the fares charged, and the gross receipts for each zone are calculated.

In arriving at the probable earnings upon this basis, a careful study was first made of the average railway fare expenditures per capita as they now exist in this territory, that is of the approximate amounts of money paid to the existing steam and trolley roads by the residents of the different zones into which the district was divided. For the purpose of arriving at this information a careful count was made for a period extending over three months of the number of passengers on the trolley cars at different points in this territory, as well as of the number of people using the steam road at each of the stations in the territory in question. The information thus obtained was checked, in the case of the steam road, by purchasing tickets from the ticket agents at stated intervals. As each ticket is numbered, the difference between the number on the last ticket and the one previously purchased gave the number of passengers purchasing tickets from this station for the period between the date of purchase of the first ticket and that of the last ticket. When all this information had been obtained, a series of curves was plotted, showing the relations between receipts per capita and population for different periods and localities or zones. From these curves the figures for the receipts per capita given in this issue of the STREET RAILWAY JOURNAL were taken. Of course, the earnings per capita given in this issue are less than the results actually obtained, as the figures here given are those estimated for the New York & Portchester road only.

The future gross receipts as determined by this method, and published below, approximate very closely those reached by the first method. The estimate made on both earnings and expenses for the Portchester road are substantiated by figures taken from the reports of other roads. Some reports of this kind, filed with the Railroad Commissioners, are reproduced below under the heading "Traffic on Other Roads." As certain of these reports were given to Mr. Gotshall in confidence, the names of the operating companies are withheld, and the different roads are designated by letters of the alphabet.

In addition to this financial testimony, some additional run-sheets are published this month, which further explain the method employed of determining the energy consumption of the road.

In the article on the New York & Portchester Railroad, in the last monthly issue, reference was made to the energy consumption for express train and local train service, which were stated to average 130 and 150 watt-hours per ton mile, respectively. Attention was also called to the possibility of reducing the average energy consumption, by altering the relative amounts of acceleration, coasting and braking. An exhaustive study of the question is being made by the company's engineers, through whose courtesy this paper is enabled to present herewith some additional charts, which show graphically, in a very interesting manner, what can be accomplished by a careful study of the speed-time and energy-time curves, corresponding to a given run between stations. The four charts re-

produced in Figs. 1, 2, 3 and 4 correspond to four runs, which happen to be the same for both the express and the local train service, for which reason they have been selected. In all other cases, the express run corresponds to, and covers the distance of two or more local runs. In these particular cases, the express trains and local trains make the same stops. In consequence of this fact it is possible to superpose on the same chart the speed-time and the energy-time curves for both the express and the local trains. The superimposition of these curves at once shows the differences in speeds, also the variation in the amount of acceleration, the amount of coasting, braking, etc., as well as in the energy input.

Fig. 1 shows the speed-energy-time curve for the run between the southerly terminal station at Willis Avenue, and the first stop at 149th Street.

Fig. 2 shows the curves corresponding to the run between Mt. Vernon and Pelham.

Fig. 3 shows the curves corresponding to the run between New Rochelle and Larchmont.

Fig 4 shows the curves corresponding to the run between Rye Neck and Rye.

In Fig. 2 there are only two sets of curves, designated, respectively, by the letters *A* and *C*. In each of the other three engravings there are three sets of curves, designated respectively by the letter *A*, indicated by a dotted line; *B*, by a line of dashes; and *C*, by a solid line. In every case the letter *A* designates the curves corresponding to the express train runs, and the letter *C* designates the curves corresponding to the local train runs. The letter *B* serves to designate a *modified* run, which, in the case of Fig. 1 and Fig. 4, is a modified express run, and, in the case of Fig. 3, is a modified local run.

The areas enclosed by the energy-time curves are shown shaded, and where they are superposed, the fact is indicated by a finer shading, as well as by grouping the characteristic letters, or *A*, *B*, *C*. Thus, the first part of each diagram, showing the start of the car and its acceleration from full stop to the particular maximum speed attained during the first acceleration, being common to all the curves, has the energy area finely shaded, and also marked with the letters *A*, *B*, *C*, corresponding to all the curves. When points are reached at which the acceleration for any of the three curves, *A*, *B*, *C*, is discontinued, which point is also the point at which the current is cut off from the electric motor, the fact is readily indicated by the difference in the shading, and the lettering of the shaded portion.

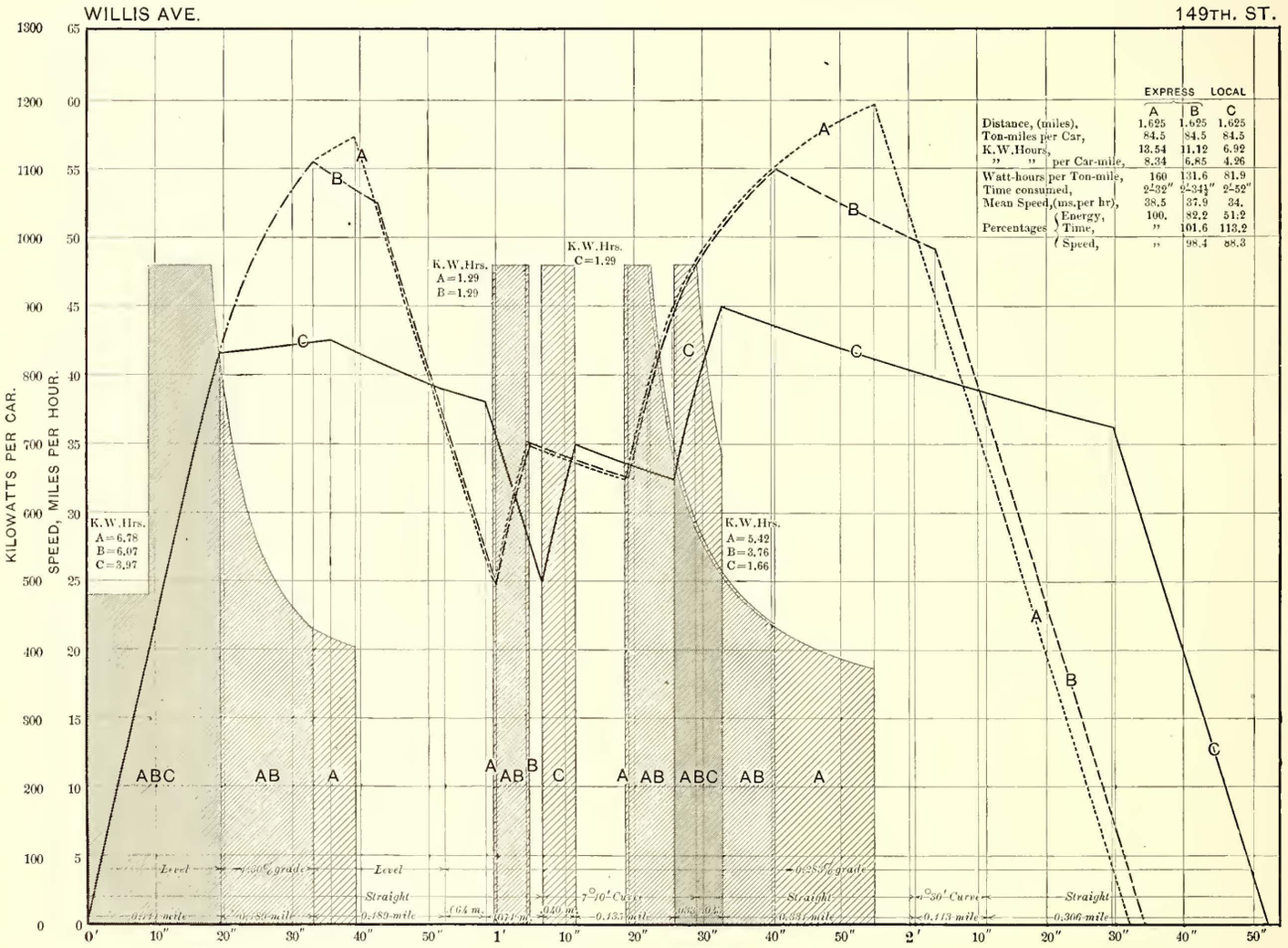


FIG. 1.—RUN SHEET FROM WILLIS AVENUE TO 149TH STREET

In all the four charts, the data given at the lower portion of the chart, in relation to curvature, grades and fractional distances of the run, are those which correspond to the local train curve, *C*, in every case. In Fig. 4 the fractional distances corresponding to the express curve, *A*, are also given at the upper part of the chart.

Fig. 1 is of special interest, owing to the fact that this run includes a curve of 7 deg. 10 min., which is the curve of shortest radius on the entire line. The fact that this curve occurs about midway in the run, and that it requires the speed to be reduced, is responsible for and at once explains the notches which are seen in the middle portion of the charts (Fig. 1).

In making the express run, the car is allowed to accelerate until it attains a speed of about 57.5 miles, whereupon the brakes are applied, and the speed is reduced to 25 miles. The current is again turned on, and acceleration again takes place, until a speed of 35 miles per hour is reached, when the car is allowed to coast until it has entirely passed out of the curve, whereupon the car is again allowed to accelerate to a speed of about 59.5 miles, at which time the brakes are put on for the final stop (Curve *A*).

Curve *A* is the curve of maximum speed, and also the curve of maximum energy, as the data given in the table on the chart will readily show.

Curve *B* shows the effect of cutting off the current a little sooner than in the case of curve *A*. In the first acceleration, the current is cut off when a speed of 55.5 miles has been attained. It will be noticed that while this extends the time of the run by less than half a second, yet it reduces the energy consumption for the corresponding part of the run by over 10 per cent. In the second portion of the run, the current is cut off when the car is accelerated to a speed of 55 miles. This causes a greater increase of time proportionally, but still the increase is very small in comparison with the gain in economy. On reference to the table of data given on this chart (Fig. 1), it will be seen that, while the modified run increases the running time by 2-5 seconds, it decreases the energy consumption from 160 to 131.6 watt-hours per ton mile.

Curve *C* shows the performance of the motors for the local run. The current is turned off when the car is accelerated to a speed of about 41.6 miles, at which point the car enters a down grade, in consequence of which it continues to accelerate slightly as shown by the gentle upward slope on the curve. On reaching the level portion further along the speed begins to diminish. The coasting is continued until the speed has fallen down to about 48 miles, at which point the brake is applied so as to further reduce the speed to 25 miles per hour at the point where the car enters the sharp curve. In passing over the curve, the speed is allowed to accelerate to 35 miles per hour, and the car then coasts exactly as in the case of the express run; the energy required for acceleration in this portion of the run being exactly the same as in the express run. After passing out of the curve, the speed is again accelerated to 45 miles per hour, and the car then coasts until the brakes are applied. The time consumed for the run is 20 seconds longer than for the maximum speed express run. The energy consumption, however, is reduced almost 50 per cent, being only 81.9, instead of 160 watt-hours per ton-mile.

In Fig. 2 the maximum speed reached during the express run is 53.2 miles, while in the local train run, the current is cut off after a speed of 45 miles per hour has been attained. The local run requires 6.5 seconds more time, but the energy consumption is only 125.4, as against 172 watt-hours per ton-mile.

In Fig. 3 curve *A* is identically the same as the curve shown in Fig. 9, published in the December issue. Curve *B* is a local train run produced by cutting off the current when the car is accelerated to a speed of a little over 61 miles, and allowing the car to coast until the time of braking. Curve *C* is another local run, obtained by cutting off the current after a first acceleration to a speed of 55 miles per hour, then allowing the car to coast until the speed has been reduced to 46 miles per hour, then accelerating again to a speed of nearly 55 miles per hour, and then coasting until the time of braking. It will be noticed on comparing the tabulated data corresponding to curves *A* and *C*, that, while the time of the run has been increased 16 seconds, the energy consumption has been reduced from 114 watt-hours to 86.9 watt-hours per ton-mile. The mean speed in miles per hour, in the case of curve *C*, is still considerably higher than what is required for the proposed schedule time, even making allowance for the fact that some runs must be made at a higher schedule speed, in order to compensate for the shorter runs, in which it is impossible, without excessive expenditure of energy, to obtain a mean speed equal to the mean speed for the entire length of the line.

The proposed mean schedule speed, including time of stops, is 40.45 miles per hour for the express trains, and

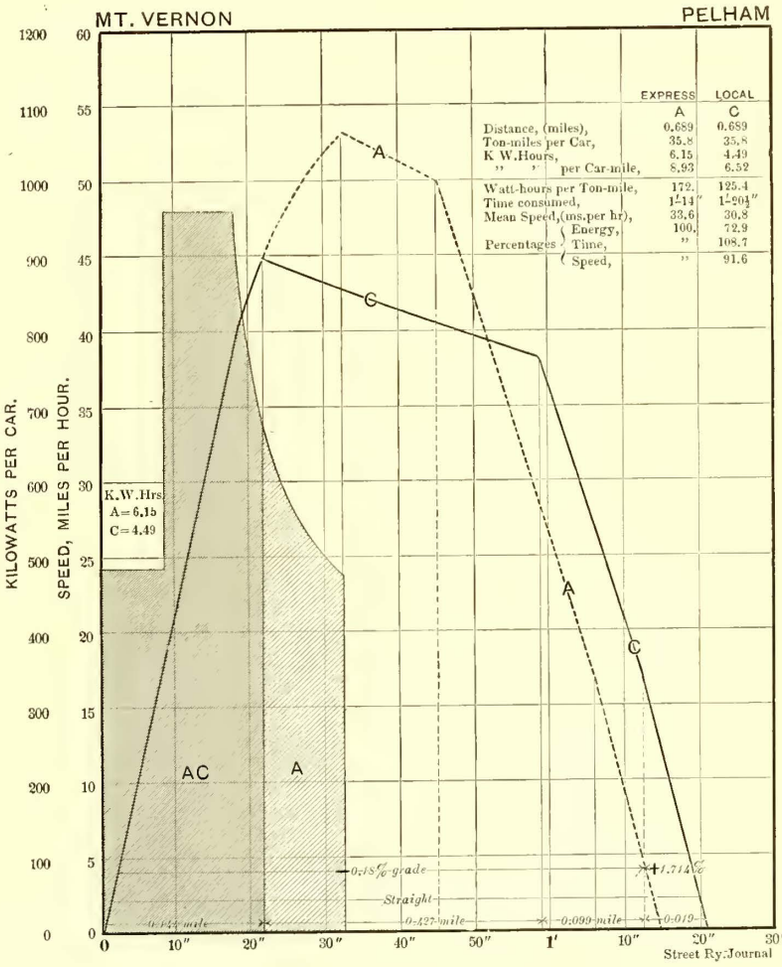


FIG. 2.—RUN SHEET FROM MT. VERNON TO PELHAM

27.9 miles per hour for the local trains, and the mean running speed, exclusive of the time of stops, is 44 miles per hour for the express trains, and 28.7 miles per hour for the local trains. In the shortest runs, such as between Mount Vernon and Pelham (Fig. 2), it will be seen, from the curve, that the distance (0.689 mile) between the two stations is too short to enable a high mean speed to be attained. The shortest running time between these two stations would evidently be obtained if the acceleration in curve *C* had been continued to a point at which it would just meet the braking curve, if extended; that is to say, if the coasting had been eliminated entirely. The time gained by this would probably exceed one-half second, and, consequently, the increase in the average speed during that run would not be material, being only a few tenths of a mile per hour. As the energy per ton-mile for the express run is already high, it would, therefore, have been unwise to further increase it by continuing the acceleration

beyond the point shown in curve *C*; indeed, it is quite likely that in the definite curve the acceleration will be discontinued at a lower speed, thereby enabling the energy consumption in watt-hours per ton-mile to be considerably reduced at the expense of a slight increase in the running time for that particular run. This increase in the running time can be compensated for by reducing the amount of coasting on some of the other runs, especially the longer runs; it could also be evidently reduced by changing the gear ratio of the motor, or by slightly increasing the accelerating current, either or both of which expedients would enable the rate of acceleration at the beginning of each run to be increased, thereby enabling the car to cover more distance within a given time in the early part of the run. In this manner, it is possible, by intelligent analysis and modification of the *speed-time* curves, to obtain the most economical *energy-time* curve for a given service over the total run. In this particular run, the mean speed is considerably below the mean schedule speed which we have just mentioned; but it is easy to exceed this mean schedule speed in the longer runs in such manner as to maintain constant the total time required for the trip, or, in other words, the mean schedule. It will be evident, however, from what has just been said, that there is a particular set of speed-time curves for all the runs of the total distance whose corresponding energy-time curves show the lowest expenditure of energy for a given service when measured in watt-hours per ton-mile. The charts presented in this issue are not the definite final curves, but are intended to indicate the general manner, and to show some of the steps by which the engineers are predetermining the particular curves corresponding to maximum economy of operation.

In Fig. 4 the notches in the two express runs indicate the slackening of speed required at points where there are curves, the speed being brought down, in each case, to about the point at which it is deemed entirely safe by the engineers to enter the curves of the radius given; thus, the speed at the point where the car enters the two 3-degree curves on this run is reduced to 50 miles per hour, although there are cases on record where such curves are taken at a speed of 55 miles to 60 miles per hour. The curve *B* shows the effect of cutting off the current at 59 miles per hour, instead of allowing the acceleration to reach the higher point (60.9 miles per hour), corresponding to curve *A*.

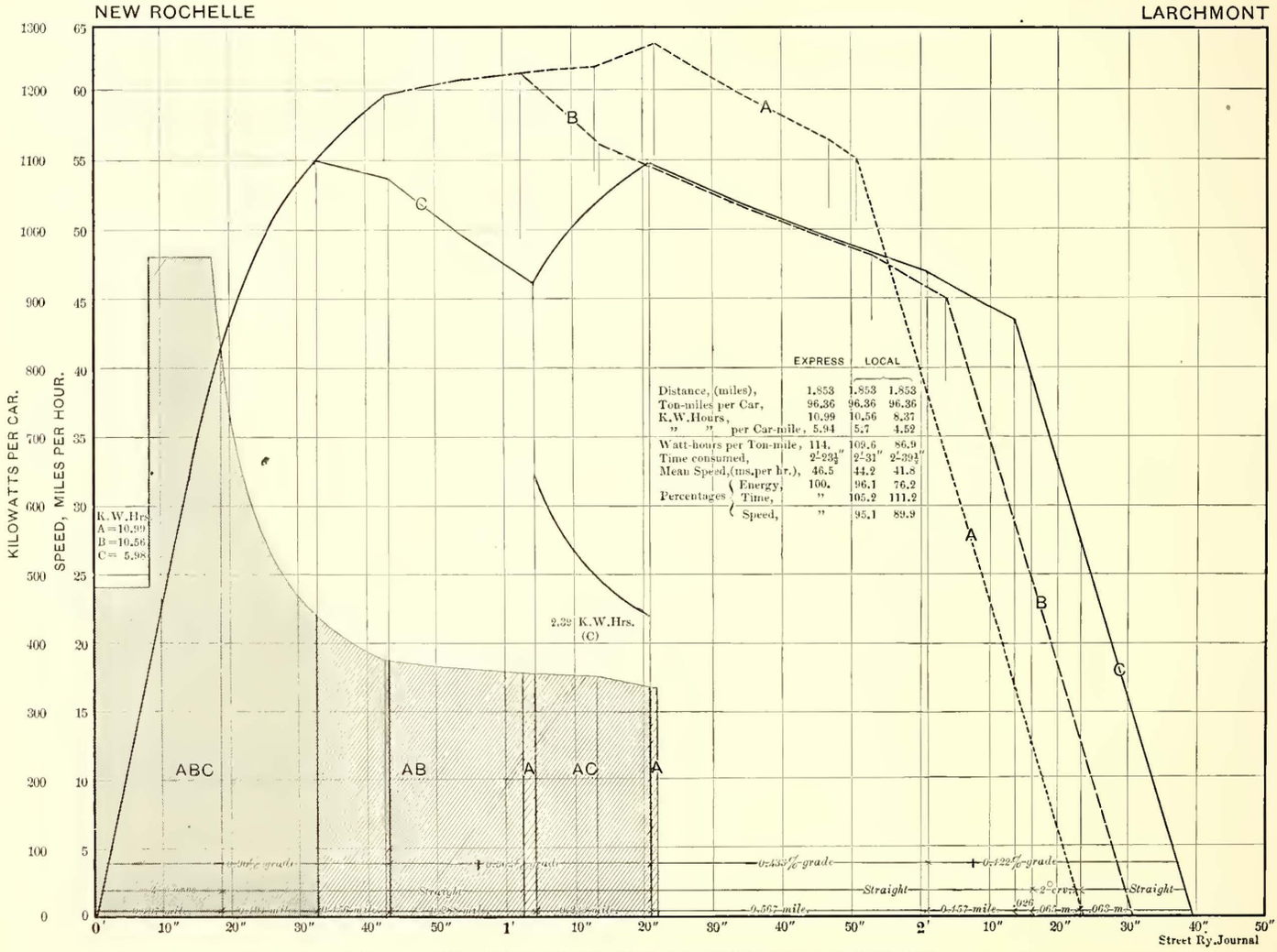


FIG. 3 —RUN SHEET FROM NEW ROCHELLE TO LARCHMONT

In the curve of the local train run (curve *C*), the current is cut off when the car is accelerated to a speed of 53 miles per hour, and the car is allowed to coast until the speed falls down to about 41 miles per hour, when the current is again turned on for a few seconds to raise the speed to 45 miles per hour, after which the car coasts until the time of braking. The table gives the comparative data showing that the increase in time of curve *C*, as compared with curve *A*, namely, 13 seconds, enables the energy consumption to be reduced from 144.2 to 89.4.

The company's engineers are also making a study of the speed energy time curves for local trains made up of a motor car and a trailer, instead of two motor cars.

The analysis of these results, so far as it has proceeded, indicates that the estimates of energy consumption given by the engineers in the statements presented before the

Railroad Commissioners, are considerably in excess of the figures which can be realized in practice. The engineers have, indeed, already found that the energy consumption given for local train service, namely, 160 watt-hours per ton-mile would be more than sufficient, even if the local train speed were increased to such an extent as to reduce the total time of local train runs as much as 9 minutes, making them 40 minutes, instead of 49, as originally proposed. It is not unlikely that the local trip time will be shortened to 45 minutes, or that the time of stops will be lengthened, and the engineers of the company now know that even this can be accomplished with an energy expenditure per ton-mile of less than 120 watt-hours. In the case of the express trains, the investigations have shown that, by increasing the schedule time a few seconds, the energy consumption can also be brought down to considerably less than 120 watt-hours per ton-mile.

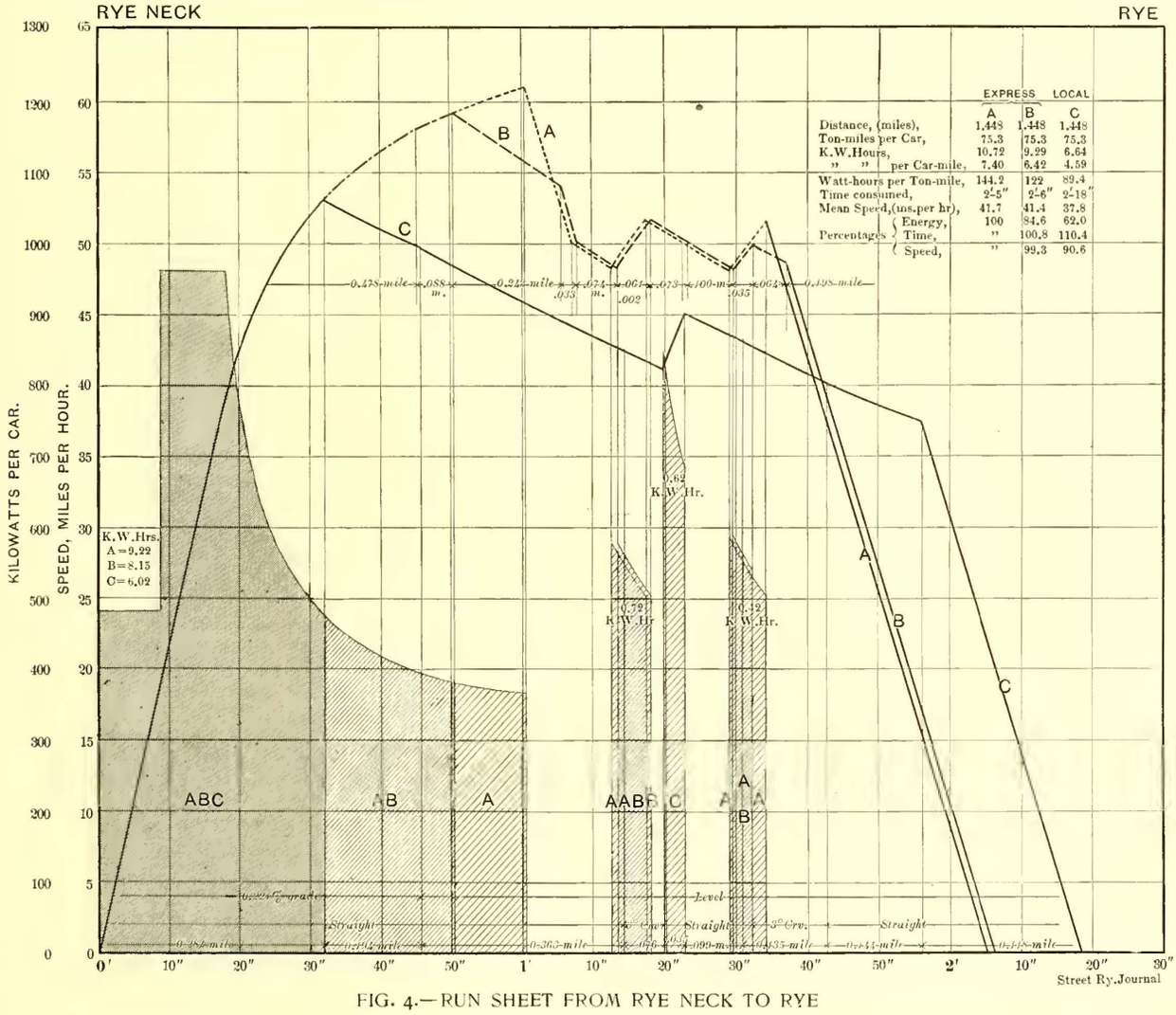


FIG. 4.—RUN SHEET FROM RYE NECK TO RYE

From the above it will be seen that, by the scientific and intelligent use of the speed-energy-time curves in determining the results under various conditions of operation or service, it is possible to predetermine the results which may be anticipated in actual use, and definitely determine the most economical and satisfactory conditions of operation of any system.

Following these run sheets, a typical stress diagram is published of one of the concrete bridges to be used on the New York & Portchester line. Readers of the article in the last monthly issue will remember that reference was there made to the proposed use of a concrete bridge instead of the ordinary girder or truss steel bridge. As the concrete bridge is unusual in railroad construction, and as full strain diagrams of all of the bridges to be employed on the Portchester line were filed with the Railroad Commissioners, one of the diagrams is included in the illustrations published this month.

It should be stated that while this style of bridge is unusual in railroad work, one of this type has been in use for about four years to carry eight Michigan Central tracks over a street in Detroit. The United States Government has also just finished the erection of one of these bridges over the Jacagaus River in Porto Rico. The total length of this latter bridge is 320 ft., made up of two spans of 100 ft., and one of 120 ft. There are about 100 of these bridges now in use in this country, and about 300 more in Europe. The cost of a concrete bridge is about 80 per cent that of a steel bridge, and it is considered more durable. A full description of the strain sheet published, and the method of constructing these bridges, as taken from the report of the company, is given under the heading "Data on Concrete Bridges."

The testimony, diagrams and other data referred to above follows:

ADDITIONAL EXTRACTS FROM THE REPORT OF W. C. GOTSHALL TO THE NEW YORK & PORTCHESTER RAILROAD.

EARNINGS ON PER CAPITA BASIS BY DIVIDING TERRITORY INTO ZONES

Between.	Population.	Earnings Per capita.	Total.
Portchester and New York.....	8,000	$15.00	$120,000
Harrison, Rye and New York....	2,000	15.00	30,000
Mamaroneck and New York.....	5,000	15.00	75,000
New Rochelle, Lachmont and New York	20,000	12.00	240,000
Mt. Vernon, Pelham and New York	30,000	10.00	300,000
New Rochelle and Portchester...	30,000	3.00	90,000

Between	Population.	Earnings per capita.	Total.
New Rochelle and Mt. Vernon...	45,000	3.00	135,000
Mt. Vernon and Portchester.....	80,000	1.50	120,000
Portchester, Bronx and Mt. Vernon	100,000	3.00	300,000
			$1,410,000

DAILY DIVISION OF BUSINESS

A total of 18,000,000 fares per annum for the New York & Portchester Railroad Company would mean, on an average, 49,300 fares per day. This business will probably be divided as follows:

The early morning commercial business will commence at 7 a. m. and continue until about 10 a. m. A schedule with a five-minute local headway and a 10-minute express headway would mean 12 local units, or 12 cars, going from Portchester to New York per hour. The 10-minute express schedule would mean 6 units, or 12 cars, going from Portchester to New York per hour, making a total of 24 cars going toward New York per hour on the regular schedule. Each one of these cars will hold, at its maximum load, about 150 people, whence 24 cars would hold or carry 3600 people per hour. This business, continued over a period of three hours, would enable this road, using the regular train units, and the 5-minute local headway, and the 10-minute express headway, to carry 10,800 people from Westchester County into New York City between the hours of 7 and 10 a. m.

Should the cars in service as now contemplated with the headways given not be sufficient to do all the business, or should a congestion occur at any time during these hours, it would be but necessary to increase the size of express units, or the local units. If one more car was added to the express units for one hour, it would increase the capacity of this train service by 900 people, and thereby provide for a total capacity of about 12,000 people during the commercial hours.

Attention is called to the fact that during these hours there will, in all probability, be a decreased headway on both the express and local service on account of the running out of trippers, each making but one or two trips.

Commencing at about 10:30 a. m. the business will consist essentially of what might be called the "shopping trade;" that is, the women of the territory will start for New York for shopping and other purposes. This business will probably continue until about half-past twelve. For a 10-minute local service, allowing 12 cars per hour, and a 15-minute express, allowing 4 cars per hour, making 16 cars per hour, the road will be able to carry, approximately, 1600 people per hour. If this business were continued over a period of two hours, there would be carried toward New York 3200 more.

Commencing at about half-past eight in the morning, the travel from New York to Westchester County will commence. In summer this will be essentially recreation business, and will undoubtedly be very large. This travel will continue during the summer months from about 8:30 a. m. until 11 o'clock, during which two hours and a half there will probably be carried 3400 people, which will probably be a fairly regular traffic. On account of the recreation facilities of Westchester County, I think the average throughout the year of the traffic from New York to Westchester County will be over 3400 people, which, however, would make a total business during the morning hours of 18,600 people. As this business will be practically of a stable nature, and almost all the passengers will make the return trip; that is, the shopping people will commence to return about 3 p. m. This shopping will, of course, lap over into the regular business return, which will probably commence about 4 o'clock.

What then will practically be the regular business will be represented at 37,200 people per day.

Commencing at about 7 p. m. the theater and evening business will begin, which will continue from 7 to 8, and during which time, without doubt, an extra service will have to be run.

This theater and evening business will probably average 1500 people traveling each way, which would be equal to 3000 fares.

The total thus far, of what would be probably regular business, is 40,200 fares per day. Between the hours of half-past 8 and half-past 11 p. m., there will be some traffic, which, however, I do not think will exceed an average of 1500 fares per day.

There will, of course, be some traffic between the hours of 11 p. m. and 7 a. m. the next morning, which business would probably be the equivalent of 4000 fares. This business will not, of course, be all passenger business, but will, in all probability, consist of a considerable amount of mail and express business, which, for purposes of comparison, is given on the fare basis.

This would make a total of 46,700 fares per day, without allowing for the excess due to the recreation business, which will easily bring the total up to an average of 50,000 fares per day.

This recreation business from New York to Westchester County during the months of May, June, July, August and September will commence early in the morning, and drop off somewhat between the hours of 12 and 2, continuing, approximately, until half-past 3, when it will again drop off, and be very large after dinner, and continuing until late in the night.

Receipts of $1,500,000 gross will be equivalent to an annual earning of $15,600 per mile of single track.

TRAFFIC ON OTHER ROADS

MANHATTAN RAILWAY COMPANY

For the year ending June 30, 1900, the Manhattan Railway Company, of New York, earned $9,138,572, operating 107 miles of single track, including sidings, or about 85 miles of main line single track, showing an earning of about $95,000 per mile of main line single track. The Manhattan Elevated Railroad, for the year ending June 30, 1900, carried 190,000,000 fares, operating 107 miles of single track, which is equivalent to 1,770,000 people per mile of track per year.

SOUTH SIDE ELEVATED RAILWAY COMPANY

The South Side Elevated Railroad Company, of Chicago, operating 19.44 miles of single track, and extending into the southern suburbs of Chicago, is earning about $91,000 per mile of single track per year. A gross passenger traffic of 18,000,000, with 92 miles of main track, is equal to 195,000 passengers carried per mile of main track of railway per year. The South Side Railroad Company, of Chicago, is carrying about 100,000 people per day, which is equivalent to 1,725,000 people per mile of single track per year.

LYNN & BOSTON RAILROAD COMPANY

The Lynn & Boston Railroad Company, for the year ending Sept. 30, 1900, carried 166,124 passengers per mile of single track per year, operating a trolley road on public highways, with the usual speed limitations of such service. The operating cost was $.1008 per car mile, or 56.8 per cent of the gross receipts.

THE LOWELL & SUBURABAN RAILWAY COMPANY

The Lowell & Suburban, of Massachusetts, in 1900 carried 144,408 passengers per mile of single track per year, and operated for $.1006 per car mile, or 54 per cent of the gross receipts.

THE LOWELL, LAWRENCE & HAVERHILL STREET RAILWAY CO.

The Lowell, Lawrence & Haverhill Street Railway Company in 1900 carried 166,124 passengers per mile of single track per year, and operated for $.1207 per car mile, or 55½ per cent of the gross receipts.

THE NEW YORK & STAMFORD RAILWAY COMPANY

The New York & Stamford Railway Company, for the year ending July 1, 1901, earned the sum of $82,168.91, and carried about 1,640,000 people. This road owns about 15 miles of track and serves a population, exclusive of New Rochelle, of about 16,000 people. If the population of New Rochelle be included, the total population served would be about 38,000 people. This road is owned by the New York, New Haven & Hartford Railroad Company.

THE WESTCHESTER ELECTRIC COMPANY

The Westchester Electric Company, operating in Westchester County and the Bronx, for the year ending June 30, 1900, carried 250,000 people per mile of track.

THE NEW YORK, NEW HAVEN & HARTFORD COMPANY

The New York, New Haven & Hartford Railroad Company, according to the annual reports of the New York Railroad Commission, is doing a suburban or local business in New York State equivalent to about $2,000,000, and is carrying, according to the reports of the New York State Railroad Commission, 7,404,483 local passengers per year.

Mr. N. H. Heft, of the New York, New Haven & Hartford Railroad Company, makes the following statement:

COMPARISON OF PASSENGERS CARRIED

	Steam.	Electric.
Nantasket Beach	304,292	702,419
Highland Division	387,695	1,060,617
New Canaan Branch	98,302	184,728

The Nantasket Beach, and the Highland Division, and the New Canaan Branches of the New York, New Haven & Hartford Railroad Company consist of hourly and half-hour service. As will be seen, the passenger business on these roads has been increased from two and one-half to three times, by the introduction of an electric system of traction, and even in the face of the fact that the headway on these branches is very great.

THE UNION TRACTION COMPANY OF INDIANA

The Union Traction Company, of Indiana, operating between Indianapolis, Oaklandon, Lawrence, Anderson, Muncie, Alexandria, Elwood, Dundee, Fairmount, Jonesborough, Gas City and Marion, Ind., for the year ending June 30, 1901, showed a gross

earning of about $650,000, and an operating expense of about $300,000, or an operation of less than 50 per cent of the gross receipts. This road will have, when in complete operation, about 164 miles of track. The total population served by the Union Traction Company is about 125,000 people, or it is serving a population equivalent to about 762 people per mile of track.

THE A & B RAILWAY COMPANY *

The A & B Railway Company is an extensive suburban property in the Central States, and one terminal enters a large manufacturing city. It operates 56 miles of track and owns 127 motor cars. For the year ending Dec. 31, 1901, the statistics of this road are as follows:

Receipts per capita	$8.01
Population per mile of track	1,745
Population per car mile run	.0294
Receipts per car mile	$.2355
Operating expenses per car mile	.0969
Suburban population served	97,734
Total passengers carried	15,779,223

Population carried 162 times.

Per cent operating expense to gross receipts is equal to 40 per cent.

Passengers carried per car mile	5
Earnings per mile single track	$13,999

THE C & D RAILWAY COMPANY*

This is an interurban railroad in the West, operating 23 miles of track between two cities, one of about 200,000, and the other of about 20,000 population.

The operating statistics of this road for the year 1900 are as follows:

Receipts per capita	$9.32
Population per mile of track	932
Population per car mile run	.02275
Receipts per car mile	$.212
Operating expense per car mile	.1215
Suburban population served	25,932
Total passengers carried	2,974,635

Population carried 115 times.

Per cent operating expense to gross receipts is equal to 57 per cent.

Passengers carried per car mile	4
Earnings per mile single track	$10,508

THE E & F RAILWAY COMPANY*

This company operates a line 52 miles in length in one of the richest of the Central States, and for the greater part of its route is paralleled by a steam railroad. The earnings of this property for the year ending Dec. 31, 1901, will probably be in the neighborhood of $350,000, and the estimated operating expenses for the same time, that is the year ending Dec. 31, 1901, are about $170,000, but slightly less than 50 per cent of the gross receipts. The population served by this road, excluding any part of the main terminal city, is about 100,000 people, which is equivalent to about 2000 people per mile of track. This road is a single track road, operating on public highways for a large part of the way, and is earning between $6,500 and $7,000 per mile of track. For the year 1899, the gross receipts were $240,317; for the year 1900, the gross receipts were $294,906, an increase of $54,000. The estimated receipts for 1901 are an increase of about $60,000 over those of the year 1900. This road is operating on half-hour headway, and has been handicapped on account of an exceedingly poor roadway.

* Name omitted for reasons specified above.

MAINTENANCE OF WAY AND STRUCTURES

In arriving at all the estimates of the cost of maintenance of way and structures, the following items have been taken into consideration:

1. Repairs of Roadway.
2. Renewals of Rails.
3. Renewals of Ties.
4. Repairs and Renewals of Fences.
5. Repairs and Renewals of Telegraph.

The allowance made for this item on the New York & Portchester Railway is $1,000 a mile, or about 2 cents per car mile.

The New York, New Haven & Hartford Railroad Company reported to the Railroad Commissioners of Massachusetts for the year ending June 30, 1900, the following items:

Repairs of roadway and structures	$2,442,086.18
Renewals of rails	67,631.40
Renewals of ties	565,159.14
Repairs and renewals of bridges and culverts	508,818.79
Repairs and renewals of fences, road crossings, signs and cattle guards	859,949.80
Repairs and renewals of buildings and fixtures	830,494.24
Repairs and renewals of docks and wharves	82,490.66
Repairs and renewals of telegraph	13,704.65
Stationery and printing	2,069.26
Making a total of	$5,372,404.12

This is equivalent to $1,343 per mile operated. The items in the foregoing report, which would be applicable to the New York & Portchester Railroad Company, are as follows:

1. Repairs of roadway	$2,442,086.18
2. Renewals of rails	67,631.40
3. Renewals of ties	565,159.14
4. Repairs and renewals of telegraph	13,704.65
Total	$3,088,581.37

Dividing this by 4000, the mileage of single tracks operated will show the cost of maintenance of way and structures for the above item of $772 per mile of road operated.

At the close of the year ending June 30, 1900, the Cleveland, Cincinnati, Chicago & St. Louis Railway Company operated 1,838.11 miles of road, which, with second and third-rail tracks, equalled 3,180.98 miles of single track. The maintenance of way and structure item of the company for the year was $1,815,555.07, equivalent to about $600 per mile of single track.

The Columbus, Sandusky & Hocking Railroad Company operated in 1900 about 300 miles of track. The item for maintenance of way and buildings was $177,799.67, or about $600 per mile of track per year.

The Illinois Central Railroad Company in 1900 operated 3,678.74 miles of road, or 4,881.21 miles of track, at a cost for maintenance of way and structures of $4,283,496.42, or $877 per mile of track.

In arriving at the costs of the maintenance of way and structures of the New York and Portchester Railroad Company, the following figures were taken as the annual cost per mile of single track:

Renewals of rails	$256
Renewals of ties	108
Renewals of ballast	135
Labor	364
Repairs and renewals of fencing	25
Total	$882

COMPARISON

ROAD	Total Miles Single Track	Population Served Per Mile Single Track	Receipts per Mile Single Track	Population Carried	Passengers Per Car Mile	People Carried Per Mile Single Track	Receipts Per Capita	Receipts Per Car Mile	Operating Cost Per Car Mile	Per Cent. Operation to Receipts
New York & Portchester	100	1,800	$15,000	100 times	4	180,000	$8.30	$0.333	$0.153	46%
A & B Ry. Co	56	1,745	13,999	162 "	5	282,000	8.01	0.2355	0.0969	41
C & D. Ry. Co	23	932	10,508	115 "	4	129,300	9.32	0.212	0.1215	57
Lynn & Boston	255	1,250	7,620	121	5.1	159,385	6.02	0.255	0.147	57
		1,019		149			7.39			
Lowell, Lawrence & Haverhill	68.12	1,760	8,008	92	10	166,124	4.50	0.289	0.163	55.5
Lowell & Suburban	64.6	1,798	7,175	87	4.5	144,308	4.00	0.183	0.099	54
South Side Elevated	20	----	64,331.8	--	4.5	1,288,636	----	0.214	0.103	48
Lake Street Elevated	30	----	25,265	--	3.4	495,062	----	0.168	0.084	49 9
All Chicago Elevated roads	112	15,100	49,500	--	--	785,000	2.67	----	----	----
Manhattan Elevated	107	19,500	97,718	99	--	1,950,000	4.97	----	----	50
E & F Ry. Co.	52.5	2,000	5,760	--	--	------	3.00	----	----	52
New York & Stamford (excepting N. Rochelle)	15	1,200	5,478	85	--	110,000	5.00	----	----	62
Southwestern Missouri	41	1,445	5,216		--	------	3,61	----	----	55
Union Traction Co. of Indiana	164	762	4,000	--	--	------	5.25	----	----	50
Lorain & Cleveland	22	1,100	4,400	--	--	------	4.00	----	----	42

There will be several other minor items entering into this cost, such as the cost of occasionally changing the switches, the cutting of weeds, and maintenace of the block signal system, which, however, would not materially augment the above sum. In order, however, to be on the safe side of this matter, I have taken $1,000 per mile as the cost of maintenance of way and structures, and have taken a total mileage of 96 miles.

The cost of the rail splices, bolts and spikes is $5,092 per mile of single track. The cost of the ties per mile of single track is taken at $1,848. The steam trunk lines of the United States estimate the life of their rails for main line service at fifteen years, after which they are replaced, and the old rails used for sidings and other light and intermittent service. A service of fifteen years on trunk lines using the heaviest steam engines is certainly equivalent to a service of twenty years for conditions such as will prevail on the New York and Portchester Railroad. A life of twenty years is equivalent to 5 per cent for renewals. Applying the same reasoning to the item of tie renewals, and allowing 6 per cent for this item will equal $108 per mile of single track per year. Five per cent per mile of single track per year has been allowed for renewal of the rock ballast.

The cost of the labor item has been arrived at by dividing the road into sections three miles in length, and allowing five trackmen, at a total of $9 per day, and two linemen, at a total of $5 per day per section. Sections three miles long, of four tracks each, or 12 miles of single track=$14 per day, or $14 x 312=$4,268 per 12 miles per year, or 4368÷12=$364 per mile of single track per year.

The main line of the New York & Portchester Railroad will be about 21 miles long, making 84 miles of single track. The Clason's Point Branch will consist of 2 miles of double track, making 88 miles of total single main line track. I have taken 8 miles for the switches, sidings and yards.

DATA ON CONCRETE BRIDGES

The strain sheet (shown in fig. 5) is for a 100 ft. clear span, concrete-steel arch designed for the New York & Portchester Railroad, strain sheets being submitted at the same time for 50 ft., 60 ft. and 80 ft. clear spans for the same railroad. All these strain sheets are worked out by the same method, viz., by the elastic theory of solid elastic arches, which, since the publication of the exhaustive experiments made by the Austrian Society of Engineers and Architects in 1895, has been fully demonstrated to be the correct theory of the arch whatever may be the materials used in its contsruction. The arches have been carefully designed, the intrados having three centers, and the curve of the neutral line of the arch being such that it is similar to the curve of the equilibrium polygon, so that the bending moment under dead load or under a full dead and live load is very small, and seldom cuts any figure in the maximum section required at any point of the arch. The arch is also calculated under the condition that one-half the span carries the maximum live load, while the other half is unloaded. The table given on the strain sheet gives the maximum thrust and bending moment under different conditions at the governing points. The maximum stress allowed on concrete is 500 lbs. per square inch in compression, and 50 lbs. per square inch in tension; the maximum stress allowed on steel is 10,000 lbs. per square inch in compression and 1000 lbs. per square inch in tension, the stresses on concrete and steel being inversely proportioned to their moduli of elasticity. By careful designing the tension on the concrete has been eliminated, and the compression falls considerably short of the allowed limit. As the allowed tension in the steel cannot under ordinary conditions exceed 1000 lbs. per square inch, there is a very large reserve strength in the steel which can be brought into action if required to satisfy any unusual conditions due to settlemen of foundations or other causes, which would not hold true in any purely concrete bridge.

The strength of hand-mixed concrete, 1 part cement, 2 parts sand and 4 parts broken stone, according to careful and reliable experiments made at Watertown Arsenal, was found to be as follows: one month old, 2400 lbs. per square in.; three months old, 2900 lbs. per square in.; six months old, 3700 lbs. per square in.; and the strength continues to increase up to an age of two years or more. At the age of one month the concrete would have a minimum factor of safety of from six to eight in the different spans; at the age of three months it will have a factor of safety of from seven to ten; at the age of six months it will have a factor of safety of from nine to twelve, and at the age of one year it will have a factor of safety of from twelve to fifteen, and will continue to improve with time.

The factors of safety above given are based on hand-mixed concrete, but in all probability the concrete for these bridges will be mixed by a machine, and will give much better strength. Experiments of a mixture of one cement, two and one-half sand and five parts broken stone, which is a poorer mixture than the concrete it is proposed to use in these bridges. From the experiments made at the Munderkingen Bridge in Germany, gave an average strength of 3730 lbs. per square in. in twenty-eight days, and allowing for the difference in mixture, this strength would have been about 4000 lbs. per square in., or 66⅔ per cent stronger than the hand-mixed concrete at Watertown, increasing the factors of safety above given to that extent.

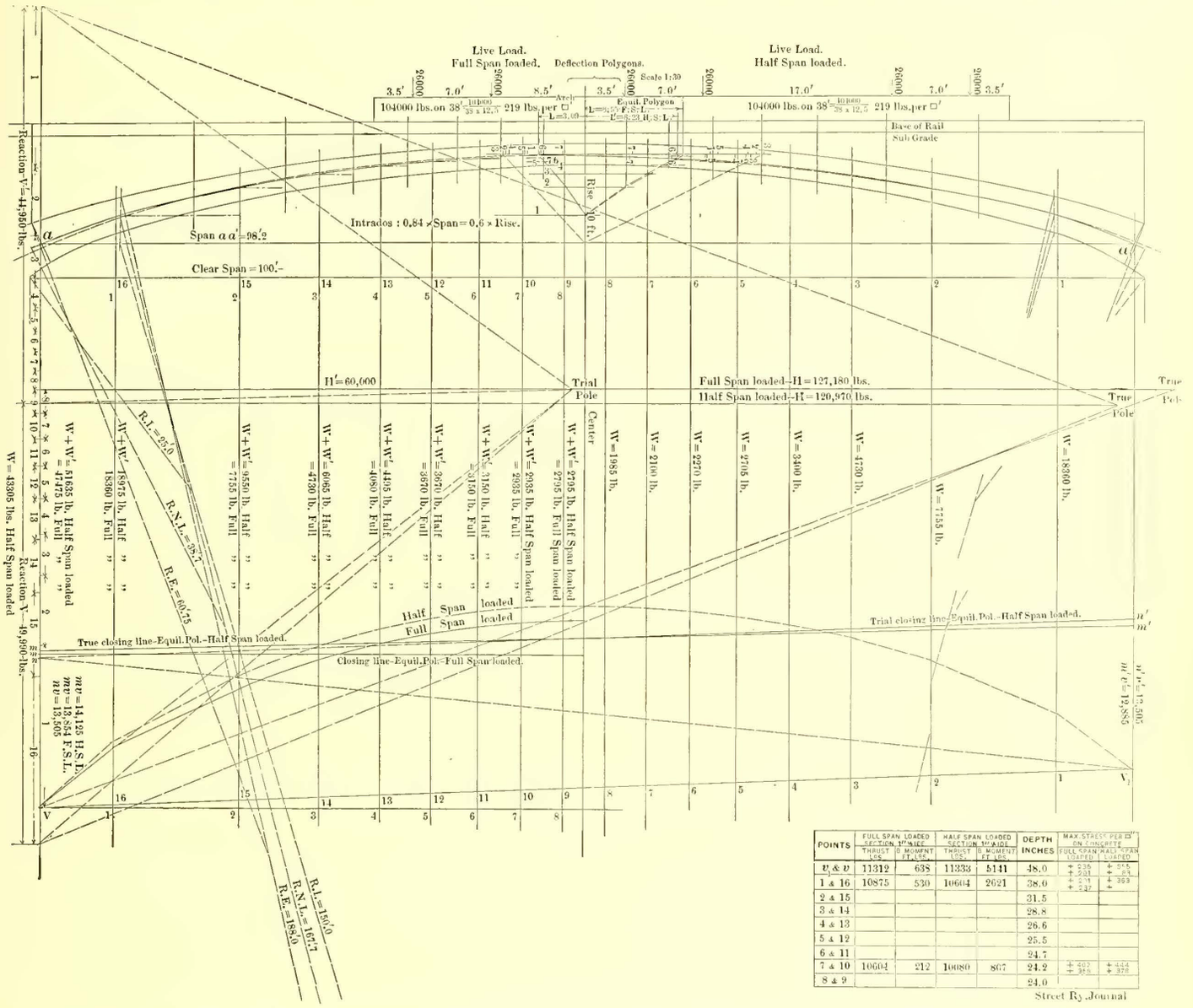
The spandrel walls in all spans will be provided with expansion joints at the ends and at frequent intermediate points, to avoid any cracks that might otherwise take place due to settlement on the removal of the centering. More than one hundred spans of concrete steel bridges have already been built in the United States, and probably three times this number in Europe, all of which

Index of Articles on Heavy Electric Traction and Bridges Quoted to the Railroad Commission.*

Subject	Author	Where Found
Increased Business Due to Changing from Steam to Electric Traction	N. H. Heft.	St. Ry. Journal, Sept. 8 & Aug. 25, 1900
Application of Electricity to Steam Railroads	N. H. Heft.	St. Ry. Journal, Nov., 1897, p. 777
New York, New Haven & Hartford Electric Railroading	N. H. Heft.	St. Ry. Journal, June, 1897, p. 329
New Haven Business, Division of	Mass. RR. Com.	Report for 1901, p .50
New Haven Maintenance, Costs	Mass. RR. Com.	Report for 1901, p.166
Tolls Paid by New Haven to New York & Harlem	Poor's Manual.	Vol. for 1901, p. 24
New Haven Local Business in New York State	N.Y. RR. Co.	Report for 1900, vol. 2 p. 396
Lynn & Boston, Costs, Earnings, etc	Higgins	St. Ry. Journal, Sept. 1898
Lowell & Suburban, Earning, Costs, etc	Higgins	St. Ry. Journal, Sept. 1898
Lowell, Lawrence & Haverhill, Costs, Earnings, etc.	Higgins	St. Ry. Journal, Sept. 1898
Volume and Density of Traffic of Mass. Roads	Mass. RR. Com.	Report for 1901, p. 74
Population Carried Mass. Roads	St. Ry. Journal.	May, 1897, p. 283
Operating Costs	Vreeland	St. Ry. Journal, Nov., 1898
Pittsburg, Fort Wayne & Chicago, Maintenance of Way and Structures	Poor's Manual.	Vol. for 1900, p. 727
Union Traction Company	St. Ry. Journal.	Dec. 7, 1901
Maher on Union Railway Business	Maher	St. Ry. Journal, Oct., 1901, p. 481
Stopping Time at Stations	Gerry	St. Ry. Journal, Aug., 1897, p. 471
High-Speed Service	St. Ry. Journal.	Dec. 30, 1899, p. 853
Receipts per Mile of Track	St. Ry. Journal.	April, 1899, p. 227
Rapid Transit Service, Power Consumption of	Armstrong	St. Ry. Journal, pp. 312, 376, 432, 539, 1898
Advantages of Rapid Acceleration	John Lundie	St. Ry. Journal, Apr., 1899, p. 228
Train Acceleration and Braking	Potter	St. Ry. Journal, Oct., 1897, p. 670
Concrete Arch Bridge Construction	W. J. Douglas	Engineering News, Oct. 31, 1901
Concrete Steel Bridges in Porto Rico	Edw. Thatcher.	Engineering News, Aug. 1, 1901
High-Speed Railroads		
Columbus, London & Springfield	St. Ry. Journal.	July 20, 1901, p. 78
Naples, Aversa, Caivano	St. Ry. Journal.	Aug. 3, 1901, p. 117
Milan, Gallarate	St. Ry. Journal.	Aug. 3, 1901, p. 137

* Readers of our International Edition will find all articles quoted above as appearing in the American Edition, in the International Edition as well, in the corresponding monthly edition.—[Eds.]

have given the best of satisfaction and are no longer an experiment. They are commended highly by the best engineers in this country and abroad, and are rapidly increasing in number, superseding steel bridges to a great extent. They offer many advantages over a steel bridge, they are more beautiful and graceful in design, architectural ornamentation can be applied as sparingly and as lavishly as desired, they have vastly greater durability and generally greater ultimate economy. They are comparatively free from vibration and noise, they are proof against tornadoes,



POINTS	FULL SPAN LOADED SECTION MADE		HALF SPAN LOADED SECTION MADE		DEPTH INCHES	MAX. STRESS PER □" ON CONCRETE	
	THRUST LBS.	B. MOMENT FT.-LBS.	THRUST LBS.	B. MOMENT FT.-LBS.		FULL SPAN LOADED	HALF SPAN LOADED
v_1 & v	11312	638	11233	5141	48.0	+ 236 + 501	+ 505 + 83
1 & 16	10875	530	10604	2621	38.0	+ 219 + 237	+ 393 +
2 & 15					31.5		
3 & 14					28.8		
4 & 13					26.6		
5 & 12					25.5		
6 & 11					24.7		
7 & 10	10604	212	10080	867	24.2	+ 402 + 385	+ 404 + 378
8 & 9					24.0		

Street Ry. Journal

FIG. 5 —STRAIN SHEET FOR PROPOSED 100 FT. SPAN CONCRETE BRIDGE—NEW YORK & PORTCHESTER RAILWAY

high water or fire, the cost of maintenance to the pavements or track is no greater than any other part of the street, home labor is employed in building them, and the greater part of the money that they cost is left among the people who pay for them. Their cost, as a rule, does not much, if any, exceed that of steel bridges carrying a pavement, and in many cases, conditions being favorable, they can be built at a less cost than steel bridges. The steel ribs used in the arches are perfectly protected from oxidation, concrete being the best possible preservative of iron and steel.

In these anchors of 50 ft. width (four tracks at 12 ft. 6 ins. centers) there are seventeen steel ribs; that is, the ribs are about 3 ft. centers.

"Hasten at Leisure" is the title of a booklet which the Cleveland Electric Railway Company has shown its enterprise in issuing for the benefit of the public, and especially for visitors to Cleveland who may wish to know the points of interest around the city which they should visit. Along with a running account of the city and its leading features are half-tone engravings scattered profusely on every page and very artistically arranged. The book is printed on a paper which brings out the engravings to good advantage, and the entire book is printed in two colors.

Activity in Car Construction at Preston, England

The Electric Railway & Tramway Carriage Works, of Preston, England, has had a year of great prosperity, and, although the works have been in operation only two or three years, the number of cars turned out last year considerably exceeded the number for which it was originally designed. These orders have come not only from British roads, but from many outside the United Kingdom. Among the latter the company numbers among its customers the Cape Electric Tramways, to whom by the end of January the company will have shipped twenty-four top-seat cars, ten to be mounted on Brill 21 E single trucks and fourteen on bogie trucks; and the Camps Bay Electric Tramway Company, for whom the company has built seven single-deck cross-bench open bogie cars, seven single-deck combination cars with closed centers and open ends, and one combination sprinkler and freight car. All of these latter cars are mounted on Brill 27 G trucks with slipper brakes. The company is also engaged on an order of 100 cars for Calcutta, of which seventy-five have already been shipped. Half of these are open and half closed. The single-deck cars have 18 ft. bodies and are mounted on Brill 21 E trucks. The company has also orders for Hong Kong for a number of cross-bench open cars with 30 ft. bodies.

The space available this month does not permit an enumeration of the many domestic orders which the company has received during the past month, but one might be mentioned for twenty-eight new cars for the Great Northern & City underground electric road of London. These cars will run in trains of seven cars, each consisting of four motor cars and three trailer cars. They will be 32 ft. long and will be mounted on McGuire trucks. It is expected that this road will be in operation by July 1, 1902.

Report on Electrical Equipment in San Francisco

As stated recently in the Street Railway Journal, J. C. H. Stutt, of San Francisco, made a trip to New York, Washington and other cities in the interests of the municipality, to investigate the subject of the cost of construction and operation of conduit and trolley electric traction and their adaptability to the Geary Street cable line. Mr. Stutt's report has just been rendered to C. E. Grunsky, chief engineer of the city, and to the Board of Public Works. The writer states that he found the cost in Washington for constructing a mile of double track of electric conduit road was from $85,000 to $90,000. This did not include any crossings, cross-overs, switches and removal of obstructions, such as pipes, etc., below the surface of the street. The report gives the following estimate for electric conversion of 3.33 miles of double track from cable to electric conduit, the construction of 6.57 miles of new electric conduit road, and the construction of 5.74 miles of double-track trolley road:

TOTAL COST

Geary Street conversion	$54,650
New conduit system, all complete and with Falk welded joints, crossings, cross-overs and witches	800,680
Trolley system, all complete, with Falk joints, switches, crossings and cross-overs	334,990
Ducts, all complete	52,140
Lead-covered insulated conductor cables	423,650
Power house, chimney, car houses, wharf, coal bunkers, oil tank and office	96,900
Engines, boilers, economizers, electric machinery and machine tools, all complete	196,500
75 cars 28 ft. long, double ender, with full electrical equipment	221,250
For removing gas and water pipes, conduits, etc. (uncertain)	50,000
	$2,230,760
Add 10 per cent for contingencies	223,080
Grand total	$2,453,840

The above estimate is based on the following prevailing prices:

Steel rails, f.o.b. San Francisco, per ton	$53.00
Steel slot rails, f.o.b. San Francisco, per ton	53.50
Steel conductor, f.o.b. San Francisco, per ton	73.00
Steel yokes, f.o.b. San Francisco, per pound	.03½

But no real estate for the office or car houses is included in the above.

GEARY STREET CONVERSION

Cost per Mile of Double Track.—This includes conductor rail, bolts, rail-bonds, manholes and covers, insulators, sewer connections and traps, slot hatches, putting in conductor rails, bonding all complete, at present prices, $16,500.

NEW CONDUIT

Cost per mile of straight double track, with no crossings, turnouts, or switches.

Rails, steel girder, 9 in. deep grooved, 60 ft. long, 107 lbs. per yard. Steel yokes, 234 lbs. each. Slot rails, 40 lbs. per yard. Conductor rails, 23½ lbs. per yard. Copper bonds. Man-holes, 15 ft. centers. Sewer connections at every street crossing. Insulators, slot hatches, twelve to a mile.

Duct connections, all complete, per mile	$94,970
Per mile with basalt blocks relaid	97,980
Per mile with asphalt pavement	116,040

This assumes pavement between tracks and 2 ft. outside of tracks.

For welded Falk joints of rails add $1,900.

OVERHEAD SYSTEM

Cost per mile of double straight track. Rails, steel girder, 9 in. deep grooved, 60 ft. long, 107 lbs. per yard. Ties 6 ins. x 8 ins. 8 ft., 30 ins., etc., copper bonds, No. 000 trolley wire, poles, insulators, hangers, wire, etc., all complete, with wooden poles, $29,310.

With wooden poles, basalt blocks relaid, $32,320.

With wooden poles, asphalt pavement, $50,375.

With drawn poles it will cost $3,380 more per mile.

With Falk welded joints for rails add $1,250 more.

Pavement between tracks and 2 ft. outside of tracks.

The above figures do not give the cost of crossings, switches or cross-overs, as these are separate and distinct from the straight track work. Nor do they include any figures for the removal of underground obstructions, as water or gas pipe, conduits or cables; all these are uncertain factors.

On the lower end of Market Street, for instance, the yokes will be placed 3 ft. centers, and a concrete pier placed underneath every third yoke, and this pier will rest on two piles 30 ft. long, driven into the ground. This makes this portion of the road very expensive. Here we have also a horse road with 5-ft. gage to support on the yokes, and a double cross-over near the ferry depot. All these items bring the cost of construction of this portion of the conduit system very high.

Operating Notes from the Boston Elevated

The elevated division of the Boston Elevated Railway Company completed its first six months of operation on Dec. 10. Although the operating design of the road was worked out with great care in advance by the engineers in charge, many details have been perfected and new problems solved, which were impossible to readily anticipate before train movements began. Owing to the extremely severe conditions which the road has to meet, coupled with the complete change in transit facilities, which the opening elevated service inaugurated, the management has given the closest attention to all possible improvements in the system which could render its train movements more positive, safe and regular.

To facilitate the despatching of trains from the Sullivan Square Terminal an ingenious indicating system has been installed on the platform of this station, also in Tower A, which is the controlling tower of the interlocking switches and signals of the terminal yard. The apparatus, as described a few weeks ago in these pages, consists of a panel board, on which is shown a diagram of the Charlestown division, with all block signals marked in their respective positions. Opposite each signal a one-half cp 110-volt incandescent lamp inserted in the board and electrically connected with its corresponding signal on the track. Whenever a train enters a block the signal automatically goes to danger behind it, and this is indicated by the lighting of the miniature lamp opposite that signal on the board. This lamp is extinguished when the train leaves the block, so that the course of any train passing over the division is instantly followed by the successive lighting and extinguishing of the lamps. It is estimated that over 100,000 passengers use this terminal station daily, and as but one train can stand in the station at any one time, it becomes of vital importance to save all possible time in the braking, unloading, loading and accelerating of the cars. The indicating signalboard enables the train despatchers to ascertain at a single glance the exact condition of the northbound and southbound tracks between the terminal and the Charlestown Bridge, as regards train position and spacing. The average length of stop at the terminal is about 60 seconds, so that if any gap occurs between trains normally operating on a two-minute headway, as during rush hours, the despatcher controls the admission of relay trains from the yard by reference to the indicating board, which covers over 6,000 ft. of double track. The service has shown marked improvement since the indicator was placed in operation.

At Park Street Station in the Subway another indicating system is in operation, which shows the berth number and destination of each approaching surface car on the Back Bay loop. It consists of two transparent boards hung above the southbound platform, with the various car lines printed clearly upon it at one side. At the right of the destinations the berth numbers are painted on a cloth transparency, backed by 16-cp incandescent lamps. About 30 seconds before a car arrives at its stall an operator in an observation tower east of the train platform, switches one of five lamps into circuit opposite the destination printed, enabling the passengers in the crowd who wish to take that particular car to pick their way to the stall at which it will stop, and board the car with ease and despatch. Enormous relief of congestion has resulted from the use of these indicators, the outer edge of the platform being comparatively unimpeded, except at the moment of arrival of a car, at which time, and also on departure, platform guards and conductors are obliged to bar entrance to the cars by standing on the steps until a dead stop is reached, or the platform cleared by the rear end.

The present operating schedule is about 44 minutes for the round trip between Sullivan Square and Dudley Street, via the Subway. It is probable that this schedule will be slightly lengthened in the near future, on account of the operation of routes via Atlantic Avenue, Subway and north and south elevated terminals, and the excessive length of station stops, which average 22 seconds, and often exceed 45 seconds. A large percentage of the delays on the system can be directly traced to the slow movement of passengers in boarding and leaving the trains. High acceleration and braking, with multiple unit control, lose their effectiveness when passengers distort a reasonable stop into an exasperating delay by inability to move quickly at stations, but the use of side doors reduces this trouble considerably. Four-car trains are now

being operated in rush hours, with signal success in relieving excessive station stops. During light hours, three-car trains are operated on the main line between Dudley Street and Sullivan Square, and two-car trains on the Atlantic Avenue loop. Four-car trains throughout may be operated on the receipt of 50 new cars recently ordered from the Wason Manufacturing Company and St. Louis Car Company. The operation of four-car trains necessitated the extension of platforms at many of the stations, especially in the Subway. Each two-car train consists of a smoker and an ordinary passenger coach, giving the unusually high proportion of 50 per cent in favor of the smoker.

Several block signals have been moved forward to accommodate the four-car train standing at stations, this being necessary on account of the automatic stop attached to each signal and car.

Special precautions are being taken by the company to avoid short circuits, caused by insulator breakdowns, all the goose-neck third-rail insulation in the Subway having been replaced by wooden blocks, anchored into the concrete. The officials desire no repetition of the curious tie-up that was recently caused by the dropping of a bundle of brass curtain rods across the track pit at Sullivan Square by a woman passenger, which short-circuited the system and stalled all the trains for over half an hour. Wherever hook bolts come near the base of insulators at the terminals and on curves they have been removed, as a further precaution against heavy grounds. These hook bolts run directly from the ties to the structure, and come too near the bases of the insulators, which were set on the ties near or over them.

An offset has been made in the "pantagraph" or "lazy tongs" gates between cars, to take care of the buckling which occurred when four-car trains were run over the reverse curve at the foot of the 8 per cent Boylston Street grade. The brake shoe beams, which were formerly solid oak, are now being built in two pieces of oak, in order to stand the strain of carrying a third rail sleet scrapper, in addition to the shoe. In order to withstand the strains of the Subway grades and curves, the drawbars have been made heavier. Side-door locks have been changed from an ordinary door lock to a special conical type, which nearly cuts in half the time of door opening by platform guards. The service generally shows marked improvement, owing to the keen study of the difficulties of the Boston problem by the operating officials of the company.

Boston Transit Commission

The seventh annual report of this body, covering the year ending August 15, 1901, has just been published. The commission devotes most of its space to the construction progress of the East Boston tunnel, and gives but brief mention of the subway changes which were made by the Boston Elevated Railway Company prior to the operation of the elevated trains. During the year expenses on the subway have amounted to about $2,100, of which one-half was for the construction of a pipe sewer under the Common to carry away storm water from the Boylston Street station, and for work done in consequence of the break in a 30-in. water main near the Hotel Touraine in August, 1900.

Drawings are given showing the location of dividing fences and third rails in the four-track portions of the subway, as approved by the commission, and to these are added clearance diagrams of surface and elevated cars.

Section A of the East Boston tunnel, extending from Maverick Square in East Boston to a point 100 ft. southwest of Webster Street, has been completed. Work on Section B is progressing at the rate of about 5 ft. a day, and reached a point August 15 296 ft. from the Harbor Commissioner's line. The space about the Maverick Square incline has been seeded and prepared for a fence like that in the Public Garden. The agitation of the Boston Elevated Railway Company for a width of tunnel great enough to accommodate the largest freight and Pullman cars together, with space for electric wires for other than street railway purposes, was without avail.

In view of the proposed Washington Street subway's effect on the transit situation, the commission changed the route of the tunnel on July 25 from the South Ferry to the State Street terminus, permission being granted by the War Department and an agreement reached with the Boston Elevated Railway Company.

The cost of Section A was $63,896.92, and to Aug. 15, Section B, $134,725.73.

The cost of the Charlestown Bridge, over which the Boston Elevated trains operate, was $99,252.39 for the year, including over $63,000 in land damages. The total cost of the Boston subway has been about $4,162,000, and the cost of alterations for elevated service nearly $244,000.

The cost of the East Boston tunnel to the date of the report is $407,787.66.

The report of Chief Engineer Carson is replete with photographs and drawings of the shield work in the tunnel construction. The shield was built by the James Russell Boiler Works Company, South Boston, and weighs, without hydraulic jacks and feed-pumps, about 62 tons. Its diameter is 28 ft. 10 in., and its length 12 ft. 6 ins. There are sixteen hydraulic jacks in use with the shields, each with a capacity of 75 tons, and the air compressors were made by the Ingersoll Sergeant Drill Company, of New York.

The shield was brought to the ground in mainly two sections, and assembled on top of the finished sidewalks in the shaft, which was suitably timbered. When the shield was assembled and riveted sixteen hydraulic jacks were placed in prepared openings and connected with pumps also placed in the shield. The shield rests on sixteen live iron rollers, eight on each side, which in turn rest on steel plates on top of the sidewalks. These plates are flanged to act as a guide to the shield when moving. The rollers are 8 ins. in diameter, and 16 ins. long. The shield was moved up to the bulkhead, the latter was removed and the shield forced into the bank, the jacks thrusting against 12 in. square timber arranged so that the pressure was transmitted directly to the arch of the completed Section A. The shield was forced into the bank to its full length, the interior arch being removed as the shield advanced, the first arch being turned 2½ ft. long.

Sixteen lines of iron push rods, each 3½ ins. in diameter and 30 ins. long, are imbedded in the concrete arch in position to receive the thrust of the jacks. Curved steel ribs made of 10-in. channels 30 ins. apart are used as centering for each ring of arch. Logging 6 ins. thick is placed on the ribs cut to radical lines as the concrete is put in. Wooden bulkheads attached to the plungers of the hydraulic jacks help confine the fresh concrete. A cross beam of the steel supports the platform from which the concrete is put into the arch. The final laying up of each ring of the arch is done through two 13-in. holes in the rear girder at the top of the shield. Curved sheet-iron troughs are extended from these holes to the top of the arch. Concrete thrown into the troughs is then pushed by hard rammer into the remaining unfilled space at the crown of the arch. As soon as one ring of arch is completed the shield is forced forward 30 ins. and another ring of arch put in. The space left vacant over the completed arch ring by the advancing tail piece of the shield is filled with gravel, composed of two or more parts of fine sand and one part cement. Each center is kept in place 30 days and is then struck and carried forward to be used again. The excavation of the core is done at the same time the arch is being built. The invert is excavated and concreted in 10-ft. sections at a distance of about 25 ft. back of the shield. Inaccuracy in placing the rollers has sometimes gotten the shield out of line, but the interior axis of the tunnel has not been changed.

Various concrete tests are shown in the appendix.

Tests of Mechanical Stokers at the General Electric Works at Schenectady

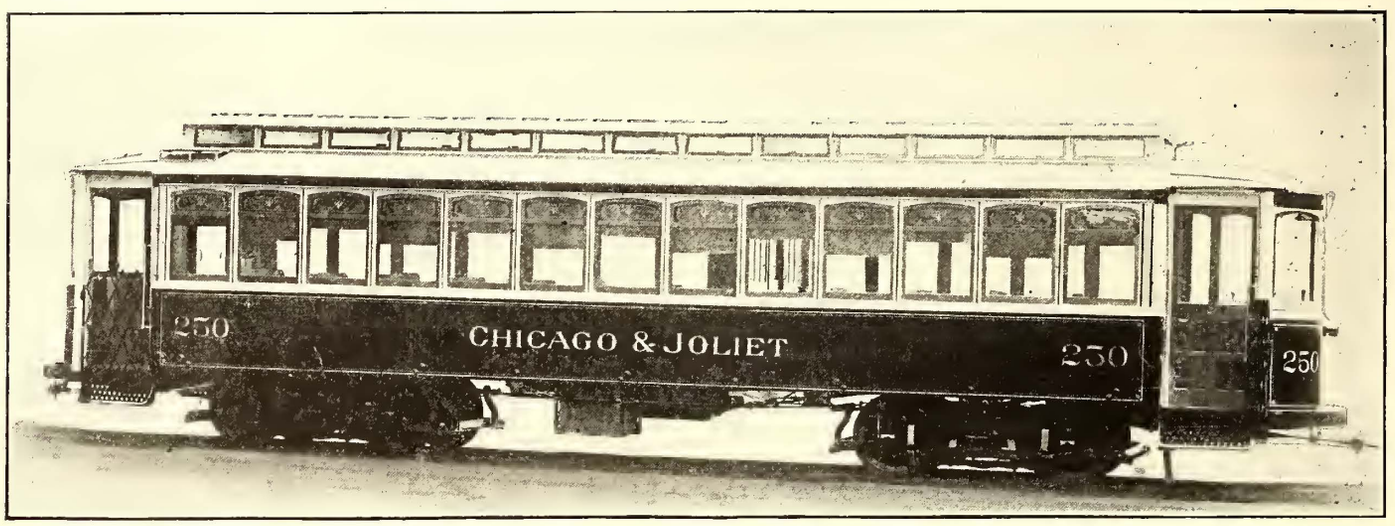
Owing to an oversight on the part of our proofreader, due probably to Christmas week, the headings of the columns in the table presented by Mr. Roney in his letter in our last week's issue on the recent stoker tests in Schenectady were transposed. While this fact would have been apparent from the rest of the letter, the table is printed below in the form in which it should have appeared:

Costs per hp per year.	American Stokers. Repairs according to 3 mos. record on log book.	American Stokers. Repairs guaranteed in contract.	Roney Stokers.
Cost of coal	$34.95	$34.95	$35.76
Cost of repairs	0.77	0.12	0.48
Wages of fireman and helpers	1.44	1.44	1.44
Interest and depreciation	0.38	0.38	0.38
	$37.54	$36.89	$38.06

By substituting the above corrected table for the form in which it appeared in the issue of Dec. 28, the reader will understand better the comments in Mr. Roney's communication which seemed contradictory when read in connection with the table as incorrectly printed.

High-Speed Suburban Cars

The engraving which accompanies this article represents a type of car intended to meet the requirements of a suburban road which expects to run at an extremely high speed. It was built by the J. G. Brill Company, of Philadelphia, for the Chicago & Joliet Electric Railway Company. The length of the body is 36 ft., which, with 5 ft. vestibules, makes the length over the dashers 46 ft. The width is 8 ft. 8 ins. Each one of these cars is provided with four powerful motors. The sides of the car are straight, following steam car practice, and the arrangement of the trucks is such that the steps are brought within reach of the ground. This is accomplished by dropping the platform. The windows are large, and seem still larger, from the ornamental glass above them. The



HANDSOME HIGH-SPEED CAR FOR CHICAGO & JOLIET

inside is exceedingly neat, the head-linings being of quartered veneer decoration and being relieved by a fine gold line. The trim over the windows is also of quartered oak. The seats are of the walk-over type without arms at the end next the aisles, with the corners of the backs cut away so as to give a convenient hand hold. This arrangement makes it unnecessary to use straps. The interior of the car is divided into two compartments. That devoted to smoking is 14 ft. in length, while the passenger compartment is 22 ft. long. There are thirteen ventilator sash on each side, with a single transom light at each end. The trolley board extends the whole length of the roof. The cars are fitted with air brakes, in addition to the ordinary hand brakes, and there is one sand box at each end of the car. There is a special panel in the passenger compartment, and a recording wattmeter in the smoking compartment. There are eight baggage racks over alternate windows in the passenger compartment, and six in the smoking compartment. The trim inside the car, as well as on the body, is of solid bronze throughout. The car has electric heaters, arranged in ten double sections 60 ins. long, with three sections in the smoking compartment and seven in the regular passenger space. One of the features which completes the resemblance between this car and that of the complete railroad train is the introduction of a toilet room against the partition in the passenger compartment. This feature is somewhat unusual in electric railway practice, but when it is provided the electric car becomes in itself as complete as the ordinary steam railway train.

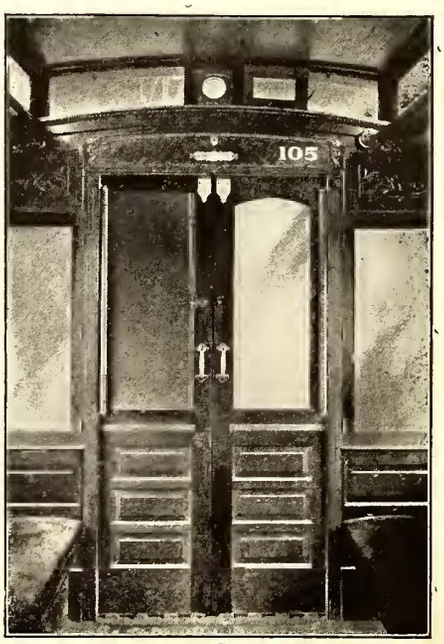
These cars are fitted with the heaviest form of No. 27 trucks. They have solid forged frames, with spring links of the latest pattern, which go over the side frames. These frames are quite a new departure, solid forgings taking the place of cast steel, and, while they reduce the weight about 20 per cent, the increase in strength and stiffness is claimed to be fully 50 per cent.

A contract was recently closed by the New Haven Car Register Company, of New Haven, Conn., with the Boston Elevated Railway, which probably comprises the largest amount of the material concerned that has ever been included in a single order. It calls for between 1500 and 2000 New Haven car registers of the single type. Besides this order, the company has recently received one from Columbus, Ohio, for 200 fare registers of the double type. Other contracts are pending, and a busy year is in prospect for the firm's factory.

A Novel Vestibule Shade

As street railways grow in importance and wealth they begin to adopt various appliances which facilitate rapid transit and lessen the chances of accident. Among these appliances are sand boxes, trolley catchers, electric headlights, special types of seats, improved window-curtain fixtures, etc., all of which are now regarded as a part of the standard equipment. A new device which has recently been invented and patented is being placed on the market by the Trolley Vestibule Shade Company, of Bridgeport, Conn, and has already become practically indispensable, especially to interurban and suburban roads. It is a shade designed for the purpose of keeping the light inside of the car from entering the vestibule, so that the motorman can see clearly ahead of him at night. A number of devices, mostly makeshifts, have been in use for some time on nearly all roads operating outside of lighted city districts. The conductor in many cases carries almost anything that will keep out the light and pins it up as best he can.

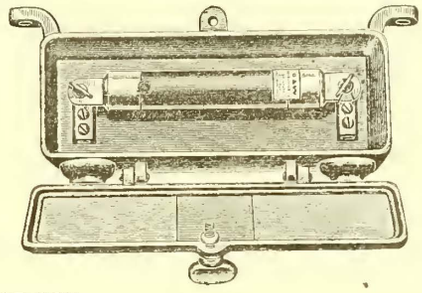
The improved shade recently perfected is inexpensive and convenient, and answers every purpose desired. It is simply a dark curtain attached to an ordinary Hartshorn roller, which is fastened vertically to the jamb of the door. In the daytime it is left rolled up and out of the way. At night it is fastened by a button to the edge of the door. As the door is closed it unrolls the curtain, pulling it across the doorway and completely shutting out all light from the vestibule. Although the company was started only about eight months ago, it has already equipped over 150 roads in various parts of the country with this convenient and unique device, and it has been specified for many cars now being built. The illustration shows the invention applied to double doors, one-half only being closed. This gives the appearance of the shade in both the daytime and at night. The device is, of course, equally applicable to single doors. Besides taking orders for the shades directly at the Bridgeport factory, a number of selling agents have been secured, viz.: Frank Ridlon Company, Boston, Mass.; Mayer & Englund, Philadelphia, Pa., and the Western Electrical Supply Company, St. Louis, Mo.



SHADES FOR CAR DOORS

Enclosed Fuses in Railway Work

Although one of the oldest and simplest protective devices in electrical work, the fuse for various reasons has often been responsible for much inconvenience and damage. This was in a large measure due to the little attention paid to its design and construction, which naturally resulted in imperfections mechanically and electrically that gradually caused it to grow into disfavor with those who experienced the troubles it produced. For the last few years, however, great strides have been taken in the developments of enclosed fuses, which, while retaining all the advantages of simplicity of installation, etc., have done away almost entirely with the objectionable features of the old open fuse. As in all fuses the principle involved is the raising of the temperature of a conductor to its melting point by the passage of an excessive current, the accuracy of the fuse depends in a great measure upon the conditions surrounding the fuse wire. Thus, if a current of cold air is passing rapidly over the fuse wire, a much greater current will flow through the wire before it has elevated the temperature to the required degree, and little reliance can therefore be placed on devices of this kind where it is necessary to protect circuits against the current above a certain fixed amount. Another objection is to be found in the danger from fire resulting from the blowing of an open fuse, while in street car work the noise and flame have not infrequently caused a panic among the passengers, even though the blowing fuse was merely on the lighting circuit.



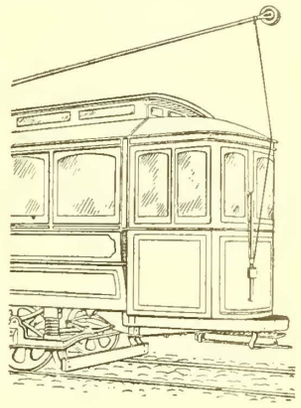
ENCLOSED FUSE AND FUSE BOX

The D. & W. Fuse Company, of Providence, R. I., has perfected a type of enclosed fuse which has proven of great value in all kinds of work. This fuse consists of a fuse wire link placed within an insulating tube and surrounded by a pulverized material. The central part of the tube is left free, there being no filling at this point. When the fuse blows, due to excessive current, the metallic vapor which is formed is so broken up by the pulverized filling that it is impossible for the arc to be carried from one terminal of the tube to the other even though the whole is so tightly enclosed that there is no external effect from the fusing of the wire. The fuses are made in various types and sizes for different voltages and currents. It is evident that a fuse designed for a 110-volt circuit would not be suitable for use on a 500-volt circuit, and certain other modifications are also necessary. For example, the fuses which are used on lighting circuits are designed to blow at their rated capacity a very few moments after this capacity has been exceeded; while in power and railway work, where the circuits are subject to overloads for a short time without injurious effects to the apparatus, a fuse is necessary that will carry this overload for a considerable period before having its temperature sufficiently raised to break it down. One of the illustrations shows the general appearance of the fuse ready to be placed in a circuit. The terminals are so arranged that the insertion of the binding posts is greatly facilitated by having the slots which receive the binding posts cut at right angles to each other, as shown. The other illustration shows a type of fuse block which has been perfected for use on electric cars. As can be seen, this design makes a cut-out of the greatest simplicity containing marked advantages both as to cheapness and reliability. The company also makes a serviceable cut-out for high-tension conduit work which is especially adaptable to subways. This box has its cover tightly clamped on and is claimed to be absolutely water tight. Many other special types of fuses and cut-outs are manufactured by the company, all of them containing special features of safety, accuracy and reliability.

A Novel Trolley Catcher

The accompanying illustration shows an effective and safe trolley catcher, which has recently been placed on the market. It is known as the Kilbourn Trolley Catcher, and contains many features of novelty. The mechanical simplicity of the device will at once commend it to managers of high-speed electric roads who are constantly on the lookout for a thoroughly reliable safety device which will obviate the frequent and expensive repairs to line work caused by the inevitable jumping off of the wire by the trolley, and the consequent crashing of the trolley poles against spans, occasionally tearing down whole sections of overhead work and nearly always interrupting traffic for a considerable time.

The catcher consists simply of an iron block furnished with a pulley at its upper end, through which the trolley rope passes. One end of the rope is attached to the neck of the trolley harp and the other fastened to a hook surmounting a rod screwed on to the center of the dashboard, or back of vestibule in the case of closed cars. The block slides on this rod, and its play up and down is amply sufficient for any variation in the height of the overhead wire between 10 feet and 16 feet. The block itself is provided with a hinged lid, so to speak, which at the sudden jerk of the pole leaving the wire, locks the block fast to the upright rod and remains so until relieved of upward strain, when it releases itself. This locking effect is produced as follows: The block projects round the ends of the rod, which is rectangular in cross section, and is provided with grooves which fit loosely thereon. A hole is bored vertically in the block and the trolley rope fastened to a pin held in this recess by a spring. A sudden jerk pulls out this pin a short distance, makes it lift the lid which is grooved to fit the rod similarly to the cast-iron block, and causes the grooves in the lid to be in a different line from those in the block. This makes the moving parts grip the rod effectually and locks the rope.



IMPROVED TROLLEY CATCHER

As the object of the block is to furnish sufficient gravity to keep the trolley cord straight or free from kinks at all times, the utmost distance that the trolley can spring before being locked is under two inches. This minimizing of the jump is one of the features that will most strongly recommend the Kilbourn catcher, outside of the cheapness and durability of its construction. Wendell & MacDuffie, of New York, are the exclusive agents for the device for the United States. It was invented by W. H. Kilbourn, of Greenfield, Mass., the inventor of the well-known track sanding device which bears his name.

Automatic Switches for Street Railway Tracks

Many street railway managers throughout the country fully appreciate the advisability of installing electrically-operated track switches on their lines, and the general adoption of these devices is rapidly following. The cost of placing a switchman at every junction, of course, prohibits this practice, and any other way of moving a switch tongue, except automatically, has very objectionable features. Among these may be mentioned unnecessary wear and tear on the switch and serious delays to traffic. Much trouble is experienced in derailed cars where the switch is imperfectly thrown by the motorman leaning out of his vestibule window and trying to get his switch set in a hurry. If, on the other hand, it is the conductor's duty to attend to the switches, he has to leave his platform and run ahead of his car, thus being unable to watch either the trolley rope or passengers, and generally skipping a number of fares.

The American Electric Switch Company, of Pittsburgh, Pa., is putting on the market a recently perfected electrical and mechanical switch which is proving most satisfactory in service. The switch is operated by current from the feeder wire passing through a strong electromagnet placed in a box on the feeder pole. The connection between the armature of the magnet and the switch tongue is purely mechanical, so that no delicate electrical apparatus has to be placed under ground, where it is liable to be affected by moisture and dirt. An iron box, containing the mechanism for operating the tongue, is placed against the switch casting, and its contents protected by means of a stuffing box. The mechanical connection between this box and the magent box on the pole is made by rods enclosed in an iron pipe with bell cranks at the corners, and every pull on this rod causes the switch to be thrown to the opposite position from which it is at the time the impulse is received from the magnet. A short section of trol-

ley wire a little distance from the switch is insulated from the rest of the trolley wire and electrically connected through the magnets to the feeder.

If the switch is in the right position, the motorman runs by this section of trolley wire with his controller "off"; if in the wrong position he stops his car for an instant while the trolley-wheel is on the insulated section, and in starting takes sufficient current to actuate the switch. Of course the switch can be thrown without stopping the car, but this practice is not advisable, as unless the motorman times the throwing on and off of current accurately, the operation of the switch is liable to be unsatisfactory To prevent all possible delays, should anything fail to work perfectly, or should the motorman misunderstand its operation, an auxiliary hand lever is placed on the pole, by means of which the switch may be thrown mechanically. Fuses and a lightning arrester are provided for safety to the electrical part of the mechanism. One of these switches has been in constant service on the road of the Brooklyn Heights Railroad Company for several months, and has required absolutely no attention. It is located at one of the busiest junctions. In Pittsburg there are thirty installed, with equally satisfactory results.

A New Form of Incandescent Lamp

The accompanying illustration shows a novelty in incandescent lamps which has recently been perfected at the Crawford-Voelker laboratory in London. The lamp is peculiar in two respects, the filament being made of carbide of titanium, and the bulb having the peculiar bifurcation shown in the engraving. The production of the lamp has necessarily involved considerable original research extending over a large field, much of which was hitherto unexplored for commerce. The lamp, as it is made to-day, is hardly suitable for immediate placing on the market, but those interested in its production are confident that before many months its commercial practicability will be assured.

A NOVEL LAMP

Some remarkable results have been obtained from tests made on this type of lamp. Some tests made with fifty 16-cp, 200-volt lamps, resulted as follows:

Watts per candle at starting	2.535
Watts per candle after 500 hours	2.845
Watts per candle after 1000 hours	3.35

It will be seen from this that the manufacturers have good reason in making the claims for extremely low wattage.

The bifurcation of the bulb gives a much better insulation of the leading-in wires and little fear of arcing across the leakage between the ends of the filament on high voltage. This makes it quite possible to produce a 500-volt lamp which has as long a life as that now attained by the ordinary 110-volt lamp. When perfected, the 500-volt lamp will undoubtedly be of considerable use in connection with street railways, not only for lighting the cars themselves, but for station, car house and office lighting, where the present system of lamps in series often results in inconvenient complications with the wiring. British and continental engineers are much interested in the results obtained by Mr. Voelker with this lamp, and some have even gone so far as to state that they believe the electric light has reached a condition where it can compete with gas on an equal basis of expense. It must be remembered, however, that the results so far obtained represent simply laboratory work. So far, over 200,000 filaments have been made, and lamps are being now tested on many of the different circuits in London and continental cities. It is of interest to learn that William Lawrence Voelker, the inventor, is an American citizen. A company is being formed to push the manufacture of this lamp, and it is expected that the management will not only be in able hands, but that a strong financial backing has become interested in the business.

New Publications

Duncan's Manual of Tramways, Omnibuses and Electric Railways, 456 pages. Price, five shillings. Published by T. J. Whiting & Sons, Ltd., London, England, 1901.

The twenty-fourth edition of this well-known reference book and directory of English transportation companies resembles its predecessors in general appearance. The method of compiling the accounts, however, has been somewhat altered, the figures being given for two years in a clear manner, the column representing the figures for one year being on the right-hand side of the page, and that for the previous year on the left-hand side of the page; in this way no confusion can result. The compiler has, as heretofore, only published such figures as are authentic, and that have been obtained from the reports of the companies, so that the accuracy of the accounts can be thoroughly relied upon. The directory of street railway directors, engineers, auditors and other officials has been carefully brought up to date, and is of greater value than ever.

Manual of Statistics, Stock Exchange Handbook. Edited by Henry E. Wallace. 812 pages. Price, $5. Published by Charles H. Nicoll, New York, 1901.

This well-known manual is now in its twenty-third year, and the amount of information which it contains makes it a valuable companion to all interested in financial matters. The present volume contains accounts of 89 street railways, and gives statistical information regarding their financial standing, and also short descriptions of the roads themselves. But a small portion of the book, however, is devoted to this branch of the stock market, the various other interests occupying the greater part of the volume.

Report of the Twentieth Meeting of the American Street Railway. 342 pages. Published by the association, 1901.

Report of the Fifth Annual Meeting of the Street Railway Accountants Association of America. 172 pages. Illus. Published by the association, 1901.

The promptness which characterizes the business and proceedings of the two national associations of this country is marked by the short time which elapses between the holding of the annual meetings and the appearance of the verbatim and corrected reports of the association, as published by the secretaries. The proceedings of both associations were replete with more than the usual amount of information in the form of papers and discussion, so that the labor required in preparing reports of this kind and obtaining corrected revisions of their remarks from the speakers who took part in the discussion is considerable and far more than anyone who has never undertaken anything of this kind can realize. Each report is prefaced by a handsome steel engraving of the respective president, both good likenesses. In addition, the report of the American Street Railway Association contains reproductions of the pages of the very tasteful menu provided at the annual banquet, and a complete list of the attendants, and both reports give a copy of the constitution and by-laws and a list of the members of the association.

Water Power. By Joseph P. Frizell, 595 pages. Illustrated. Price, $5. Published by John Wiley & Sons, New York, 1901.

This book is an outline of the developments and application of the energy of flowing water, and having already passed through two editions, promises to take a prominent place in the literature of hydraulic engineering. The author has had much experience in the practical development of hydraulic undertakings, and he combines the theoretical principles of his subject with their practical application in a way which not only holds the student's interest, but enables a much clearer understanding of this branch of mechanics than it is ordinarily possible to obtain. The volume is profusely illustrated with a class of illustrations which show the construction of the various devices described, and the various steps of construction of dams, flumes, etc. This book will be found as serviceable to the working engineer as to the student, and all those who are connected with the engineering problems connected with the installation of water-wheels or the building of dams will find in its pages much that will simplify their work. While the work is in no sense elementary, higher mathematics being used where it seems more advisable, there are but few portions of it that cannot be readily understood by any technical man. The large interest at present taken in the development of water powers and its intimate connection with street railway building in new localities gives an added value to the subject.

NEWS OF THE WEEK

After the St. Louis Companies

With the councils of Chicago, Cleveland and other cities wrestling with the street railway problems, of course St. Louis cannot afford to be "out of date," and consequently there has recently been introduced in the House of Delegates of that city a batch of ordinances and amendments to ordinances containing balm for one hundred and one street railway evils. It might not be too much to say that it is impossible to keep track of the numerous ordinances and amendments, but certainly the most unique bill that has found its way into the House is one which provides that but a 2-cent fare shall be charged passengers who are not provided with seats. Heretofore in various cities there has been much talk of introducing a measure of this kind, but the "stand-up" fare so proposed has always been 3 cents. Not to be oudone, the St. Louisans have gone one (cent) better, and the ordinance has really been placed before the lawmakers.

Substantial Recognition

The Union Traction Company, of Philadelphia, and the Indiana Railway Company, of South Bend, Ind., announced just previous to Christmas that they had decided to increase the wages of their employees, which was certainly an opportune time for making such announcements. Besides these announcements of increases in wages many were the companies that had devised plans for lending to the cheer of their employees at this festival of festivals. Probably the most generous of these other announcements were those of the Schuylkill Traction Company, of Norristown, Pa., and the Syracuse Rapid Transit Company, of Syracuse, N. Y. The former unfolded to its employees a plan for dividing among them 10 per cent of the gross earnings of a stated week before the holiday season. It so happened that the week decided upon was not an ideal one, so far as weather conditions were concerned. There being an appreciable decrease in the earnings for that week, the company announced that the following week's receipts would be divided. Not only did the motormen and conductors benefit by this generosity, but the power station employees, track walkers and others were included. Every employee of the Syracuse Rapid Transit Company received a cash present of from $3 to $5, and the good tidings were conveyed to them by placards placed in the various barns, stations, etc., of the company. This notice read: Employees Syracuse Rapid Transit Railway Company:—In recognition of faithful and efficient service during the past year the company will give each of its employees a cash present. The foreman of each department will distribute the gifts on Christmas morning. The notice of increase in wages of the motormen and conductors of the Union Traction Company and the Indiana Railway Company were posted in the car houses of these companies on Dec. 24. The wages of the employees of the Union Traction Company were increased from 18 to 19 cents an hour, and the new schedule became operative on Jan. 1. About 5000 men are affected. Eighteen months ago this company voluntarily increased the wages of its employees 1½ cents an hour.

Consolidation Opposed by City in Atlanta

Negotiations between the city of Atlanta and H. M. Atkinson, looking to an agreement of terms for a consolidation of the different public utility corporations in Atlanta represented by Mr. Atkinson, have been declared off. Mr. Atkinson and the special committee from the city have failed to agree, and, as a result, the Atlanta Rapid Transit Company, the Georgia Electric Light Company and the properties of the Atlanta Railway & Power Company may not be consolidated, as proposed.

The point in which Mr. Atkinson and the committee could not agree is said to have been that regarding the taxation of the combined properties. Mr. Atkinson, it is said, declared it was his understanding that the limit of $2,200,000 for the first ten years of the agreement should be upon the entire properties both inside and outside the city. The committee, however, held to it that this limit was to be upon the property inside the city, and that it could have nothing to do with the property outside. That was the main point of difference. Section 4 of the agreement, as drawn by the city attorney, stipulated that should the assessment for city taxation on the consolidated properties for ad valorem taxation during the ten years following the adoption of the ordinance, beginning with the year 1902, exceed the sum of $2,200,000, then there should be deducted from the amount paid to the city annually as a percentage of the companies' gross receipts, whatever sum is paid on the tax assessment in excess of the $2,200,000. The city's assessment on the properties at present is nearly $1,600,000, while the properties outside the city are assessed at about $600,000 more. The rate of ad valorem taxation in the city is 1¼ per cent. The agreement as prepared by the committee provided that in the event the assessment of the property in the city exceeded $2,200,000 during the first ten years, or $3,000,000 during the second ten years, or $3,500,000 during the third ten years, then the company should be entitled to a rebate of this excess at the rate of 1¼ per cent on the sum paid in as a percentage of the gross receipts annually. It was decided that for the first three years of the agreement the company should pay to the city, in addition to its ad valorem taxes, 1 per cent per year of its gross receipts; during the next three years, 2 per cent per year; during the next two years, 3 per cent per year; during the next two years, 4 per cent per year, and 5 per cent each year from that time until the expiration of the franchise. The report of the special committee of the Council, appointed to consider the application of Mr. Atkinson, is dated Dec. 18, 1901, and after reciting the plans for repealing the present ordinances, restricting consolidation, etc., the report continues:

Sec. 3. The above ordinances, and agreements therein set forth, are made and passed upon the consideration growing out of the following clauses of this section, which Mr. Atkinson represents said companies are willing to accept and undertake, and it is a condition precedent to the consummation of the consents, grants, rights and powers herein ordained that the several companies named in the first section of this ordinance shall, within ten days from date of adoption of this ordinance, file with the clerk of this Council a copy or an extract from the minutes of their board of directors, showing that the terms of this ordinance has been considered by said board, and they have accepted its provisions and agreed to all its terms, and if a new company is formed in and by said consolidation, like writtten evidence of agreement of the terms of this ordinance shall be filed with said clerk within five days of its organization. The clauses referred to are as follows:

(a) Said companies as now operated, or if hereafter consolidated, shall pay into the treasurer of the city of Atlanta the sum of $50,000 within five days after the adoption of this ordinance.

(b) Said companies, as now operated, or if hereafter consolidated, shall, beginning with the first Monday in February, 1903, annually pay into the treasury of the city of Atlanta from the gross receipts of said companies each year, from all of said properties—street railway, light, power and heat—whether operated within or without the city limits, as follows:

From the gross receipts of all said companies and properties for the first three years, beginning with the year 1902, a sum equal to 1 per cent thereof annually.

From the gross receipts from all said companies and properties for the years 1905, 1906 and 1907, a sum equal to 2 per cent thereof annually.

From the gross receipts from all said companies and properties for the years 1908 and 1909 a sum equal to 3 per cent thereof annually.

From the gross receipts of all said companies and properties for the years 1910 and 1911 a sum equal to 4 per cent thereof annually.

From the gross receipts from all said companies and properties for the years following 1911, and until the end of this agreement, a sum equal to 5 per cent thereof annually.

Sec. 4. Should the assessment for city taxation on the said consolidated properties for ad valorem tax during the ten years following the adoption of this ordinance, beginning with the year 1902, exceed the sum of $2,200,000, then there shall be deducted from the amount above agreed to be paid to the city annually whatever sum is paid on said assessment in excess of $2,200,000.

In like manner whatever sum is paid to the city annually on ad valorem tax on assessments in excess of $3,000,000 during the ten years beginning with 1912 shall be deducted from said agreed annual payment to the city.

During the remaining term of this agreement whatever sum is paid to the city annually on ad valorem tax on assessments in excess of $3,500,000 shall be deducted from said agreed annual payments to the city.

Sec. 5. Said consolidated companies shall grant transfers on tickets sold on any line except over parallel or contiguous routes.

Sec. 6. At the first meeting of the General Council in January of each year the Mayor shall appoint a board of railway and light commissioners consisting of one Alderman, two Councilmen and two citizens, whose duty it shall be to make examinations of the books, papers and records of said consolidated companies, ascertain each year the correct amount of its gross receipts and report such findings to the first meeting of the General Council in February of each year. Said companies, separate or through their consolidated officers, shall, at the same meeting file, under oath, a statment showing annual gross receipts of each and all said companies and properties.

These statements and reports shall cover the calendar year, viz.: from Jan. 1 to Dec. 31 of year preceding each February at which said reports are made.

Sec. 7. The terms of the railway, light, power and heat grants or franchises now held by said companies shall in nowise be extended by this settlement nor by this ordinance, but said grants or franchises shall expire as now fixed by their terms or by the operation of law.

Sec. 8. All ordinances and parts of ordinances in conflict with this ordinance are hereby repealed.

Annual Meeting of the Southwestern Gas, Electric and Street Railway Association

Final arrangements have been perfected for the fourth annual meeting of the Southwestern Gas, Electric & Street Railway Association, which is to be held in San Antonio, April 18, 19, 20 and 21. There is every indication that there will be a larger attendance at the convention. Some very important papers are to be presented, as the following programme shows:

Fuel Oil, by H. F. MacGregor, general manager Houston Electric Street Railway Company, Houston, Tex.

Flat Rate Evil, by T. D. Miller, general manager Dallas Gas & Steel Company, Dallas, Tex.

Progress Clubs of Texas, by E. H. Jenkins, president San Antonio Traction Company, San Antonio, Tex.

Office Management of Street Railways, by J. H. Stuart, secretary Waco Street Railway & Electric Company, Waco.

Inspection and Inside Wiring, by Warren B. Reed, New Orleans, La.

How to Increase the Business, by A. E. Judge, general manager Tyler Electric Company, Tyler, Tex.

Personal Injury and Damage Cases, by F. E. Scovill, superintendent Austin Rapid Transit Company, Austin, Tex.

J. F. Strickland, general manager Electric Company, Waxahachie, is to present a paper, the subject of which has not been chosen.

The officers of the association are: H. F. MacGregor, president; E. H. Jenkins, vice-president; F. H. Stuart, secretary; J. D. Miller, Treasurer.

A Plausible Impostor

We have heard a number of complaints recently in regard to a swindler who seems to be operating principally among manufacturers of street railway supplies. He represents himself as an Englishman connected either with some well-known tramway or commercial house abroad, and after talking about placing a good-sized order, generally succeeds in effecting a small loan. It is needless to say that this is the last seen of either the borrower or the money. The man travels under several names and is described as being about 5 feet 8 inches in height, of good appearance and from 25 to 30 years old.

PERSONAL MENTION

MR. GEO. H. GIBSON, of the Westinghouse Company's Publishing Department, was married Dec. 25 to Miss Jackson, of Chicago.

MR. F. W. ZIMMERMAN, formerly of the Atlanta Railway & Power Company, has been appointed general manager of the Aurora Street Railway Company.

MR. D. A. BELDEN, of Aurora, Ill., has been appointed general manager of the combined properties of the Atlanta Railway & Power Company, and of the Atlanta Rapid Transit Company.

MR. C. F. FRANKLIN, who has held a number of prominent positions with steam roads, has been appointed general manager of the Toledo, Columbus, Springfield & Cincinnati Railway, now under construction between Lima and Bellefontaine, O.

MR. A. P. JENKS has left the New York office of the General Electric Company to return to Schenectady, where he will be connected with Mr. W. B. Potter. His many friends will be glad to learn that his new position is of considerably greater importance than the one he leaves.

MR. JOHN HAYWARD GLOVER, secretary and treasurer of the Jewett Car Company, of Newark, O., is dead. Mr. Glover was prominently identified with the Baltimore & Ohio Railroad for a number of years, and became associated with the Jewett Car Company only a few months ago.

MR. CHARLES N. ARMATAGE has been appointed superintendent of the freight and express departments of the United Traction Company, of Albany, N. Y. Mr. Armatage has had considerable railway experience, and was at one time assistant superintendent of the Buffalo division of the West Shore Railroad.

MR. B. P. CRAFTS, of Boston, has been appointed superintendent of the Saginaw Valley Traction Company, of Saginaw, Mich., to succeed Mr. Lloyd M. Richardson. Mr. Richardson was compelled to resign because of the death of his father, whose estate is so large as to require Mr. Richardson's undivided attention.

MR. ALONZO F. WALTER, formerly auditor of the Boston Northern Street Railway Company, of Boston, Mass., has been appointed general superintendent of the Michigan Traction Company, of Kalamazoo, Mich, to succeed Mr. R. L. Rand, who will superintend the construction of an electric railway to connect Battle Creek and Jackson.

MR. A. C. GOUDIE, formerly general manager of the Cuban Electric Company, Havana, has recently become associated with the firm of Wendell & MacDuffie, New York City. During his connection with the Cuban Electric Company, Mr. Goudie had charge of the construction and operation of the electric road from Regla to Guanabacoa.

MR. ERNEST WOODRUFF has resigned as president of the Atlanta Railway & Power Company, to take effect Jan. 1, 1902. He will be succeeded by Mr. D. A. Belden, of Aurora, Ill., as mentioned above. Mr. Woodruff has been connected with the Atlanta Railway & Power Company for about ten years, as president, vice-president and general manager, and for the last five years has been president of the company.

MR. J. MILLAR, formerly assistant master mechanic of the Chicago Union Traction Company, and for so many years master mechanic of the North Chicago Street Railroad previous to consolidation, has been appointed master mechanic of the International Traction Company, of Buffalo, where there is abundant opportunity for the exercise of the ability Mr. Millar has displayed in his many years' experience as master mechanic of large properties.

MR. GEORGE L. RIVES, who is to be Corporation Counsel of New York, has resigned from the New York Rapid Transit Commission, and will be succeeded by Mr. John Claflin. Mr. Claflin served as a member of the commission from 1894 to May 10, 1899, and resigned when it was doubtful whether the city would ever see the rapid transit railroad constructed according to the plans of the commission. Mr. Claflin's resignation in 1899 was at the time Mr. Orr resigned as president of the Chamber of Commerce. As the president of the Chamber of Commerce Mr. Orr was a member of the Rapid Transit Board ex-officio, and Mr. Claflin resigned to allow Mr. Orr to become a regular member of the commission.

MR. L. B. STILLWELL, electrical director of the Rapid Transit Construction Company of New York, who made a recent trip abroad with certain officers and other engineers of the Rapid Transit Company, visited, while in Italy, the Lecco three-phase railway, now being installed by Ganz & Company, and made a study of its equipment. Other cities visited were London and Paris, where investigations were conducted on the recent underground railways in those cities, and Baden, Switzerland, where the works of Brown, Boveri & Company were inspected. At the latter plant some 3000-kw generators direct connected to steam turbines were under construction, and attracted considerable attention from the visitors.

MR. H. H. ADAMS, master mechanic of the North Jersey Street Railway Company, has resigned to accept the position of superintendent of motive power of the United Railways & Electric Company, Baltimore, Md. Mr. Adams has been connected with the operation of the road he leaves for a number of years, and the change he has made is regretted alike by his superiors and the men in the shops. In token of their friendship and esteem they presented him on Dec. 31, the date of his leaving the company's employ, with a handsome silver tea set and many good wishes for a happy and prosperous New Year and success in his new position. Mr. Adams' successor as master mechanic is Mr. F. F. Bodler, his former assistant, and recently master mechanic of the Jersey City, Hoboken & Paterson Street Railway Company.

MR. E. A. STANLEY, manager of the English Electric Railway & Tramway Carriage Works, of Preston, England, arrived in this country Dec. 21 on the Campania, for a visit of about four weeks. Mr. Stanley is well known among the car builders of this country, having gone to the English works of which he is now the manager, directly from the Jackson & Sharp Works, in July, 1898. He has been abroad continuously ever since. Previous to his connection with Jackson & Sharp Mr. Stanley was connected with the Gilbert Car Manufacturing Company, and has a high reputation as a designer and constructor of cars. His English factory has been most successful, and although it has been in operation for only a little over two years, it has been extended from its original building capacity of 600 cars a year, on the basis of top-seat 56-passenger cars, so that during the last year over 700 cars, on this basis, were turned out. The works employ about 850 men.