Street Railway Journal

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THE STREET RAILWAY SYSTEM OF ZURICH

The city of Zurich, which is popularly known as "the city of gardens," occupies a somewhat unique position among the cities of Switzerland from the fact that it is not only a popular tourist resort, but is also the chief city in a large industrial region. The canton of Zurich is in the northeastern part of Switzerland, not far from the border line of Germany. The city itself lies between two chains of mountains, at the foot of the Lake of Zurich, and is intersected by the Limmat River, which rises in the Lake of Zurich and falls into the Aar at Brugg, some distance below the city. Across this river, as well as across the Sihl, which also flows through the city, the municipality has constructed a number of bridges, one of which is shown in the illustration on this page. These, with the handsome quays which line the lake and river fronts, add greatly to the picturesque and substantial appearance of the city. In the immediate neighborhood of Zurich are the large manufacturing towns of Oerlikon and Baden, both prominent for their electrical products; Winterthur, famous for its engines, as well as Eglisau, Wädenschwyl and other cities noted for their manufactories of cotton and silk. The commerce derived from the fact that the city is the capital of the canton containing these industrial centers, its attractive location and therapeutic establishments, as well as its proximity to most of the popular tourist resorts in Switzerland, have made the city a prosperous one, and attract to it annually a large number of visitors.

VIEW OF QUAY ALONG THE LIMMAT RIVER, ZURICH

The layout of the city is an excellent one from a street railway standpoint, as will be seen from the map, Fig. 1. Roughly speaking, the city forms a V around the foot of the Lake of Zurich, the shores of which are comparatively flat for a short distance back from the lake, when they rise abruptly in a series of hills which are surmounted by the better class of residences and the health resorts. Directly in the rear of these hills are ranges of mountains, the summits of several of which have been made accessible by inclined cable railways, while to the south lie the snow-capped peaks of the Alps. The streets along the lake and the river banks, as well as the main streets in the city, are broad, easily accommodating two tracks, and are shaded by fine rows of trees. The industrial quarter of the city is east of the lake shore of the city, on a plain, and contains a number of manufacturing establishments which are world-wide in reputation, including the works of Escher, Wyss & Company, while the Oerlikon works to the northwest of the city can be reached by tramway or steam train, by a short ride.

The street railway system in Zurich is owned by the city, which has been taking over the different tramway lines since 1894, and practically the entire system is now controlled by the municipality. A number of new lines have also been built. The system thus acquired was not at all uniform. Some of the lines were operated by horses and others by electricity, while the gages of the horse and electric lines were different. The first thing to be done

was the adoption of a standard gage, and this was decided upon in 1899 when the meter gage, which was that em-

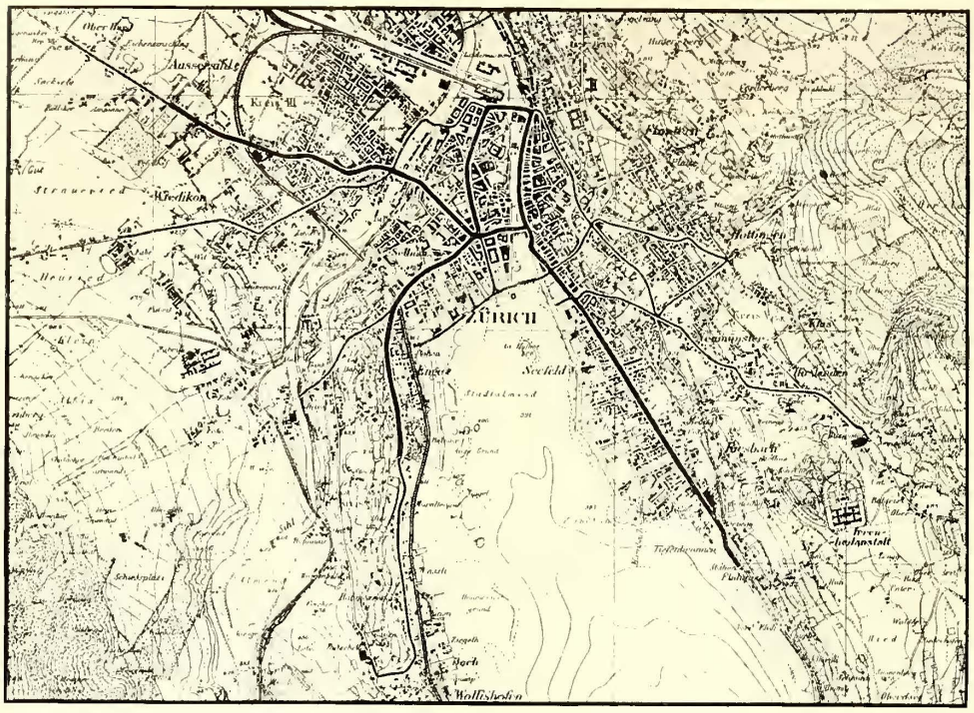


FIG. 1.—MAP OF ZURICH, SHOWING STREET RAILWAY SYSTEM

ployed by the electric lines, was selected for the entire system.

TRACK CONSTRUCTION

The minimum radius of curves in the streets is 18 m (59 ft.), while in the car houses there are some curves with a radius of 15 m (49 ft.). The steepest grade in the system is 2.5 per cent for a distance of 280 m (918 ft.).

With the exception of a few very short distances, such as at crossings with steam railroads, double track is used throughout. The distance between the centers of the two tracks is 2.5 m (8.2 ft.), and as each car is 2 m (6.6 ft.) broad, the distance between two cars, side by side on the two tracks, is 0.5 m (1.6 ft.). Some quite complicated pieces of special work have been installed, as will be seen from the views given of the layouts in Bellevue Place and Parade Place, Figs. 2 and 3.

Especial care was given to obtaining a strong and substantial roadbed construction. As it was impossible to install a uniform system of substruction throughout, a number of different systems were employed, and are clearly shown in Figs. 4 and 5. From these the reader can see at a glance the different types of construction employed, as well as the length of track for which each is in use.

In general, it might be said that there are five systems of sub-construction, viz.:

(1) Concrete sub-construction with wood paving.

(2) Concrete sub-construction with asphalt paving.

(3) Concrete sub-construction with macadam paving.

(4) Broken stone sub-construction with macadam paving.

(5) Tracks laid on the ordinary sub-construction of macadam paving.

Asphalt pavement was used only in the important streets and only where the grades were less than 1.5 per cent. For asphalt-paved streets concrete sub-construction was used, as well as for the streets on which it was thought asphalt will be laid in the future. For other streets where concrete had been used before and was in good condition it was left undisturbed.

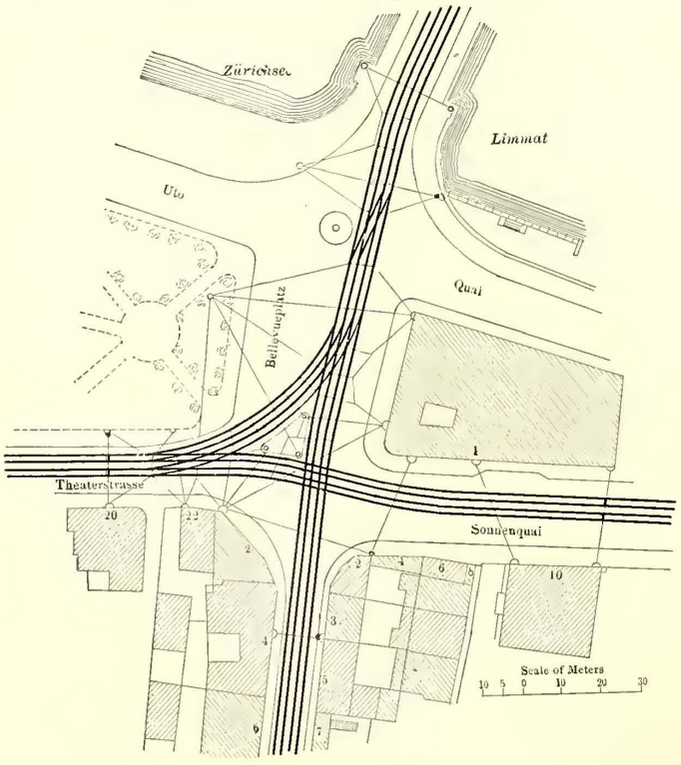


FIG. 2.—SPECIAL WORK AND OVERHEAD WIRING AT BELLEVUEPLATZ

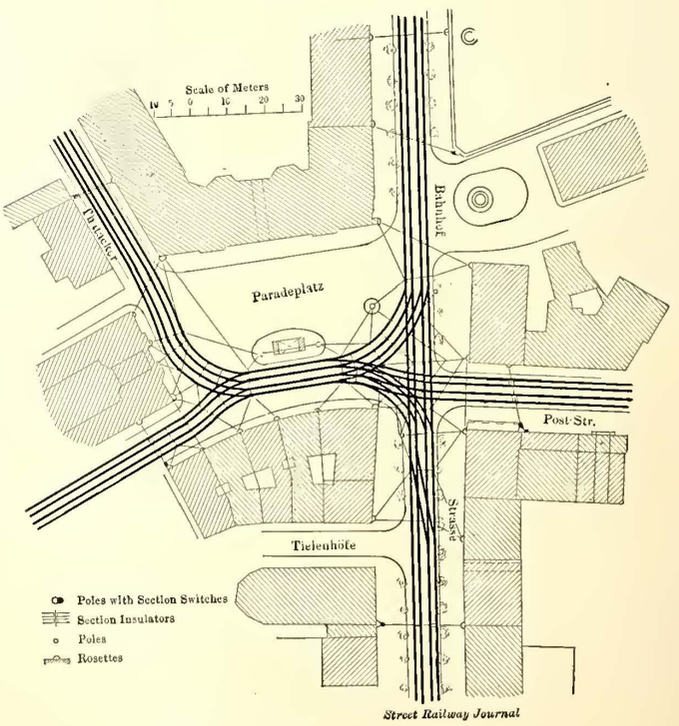
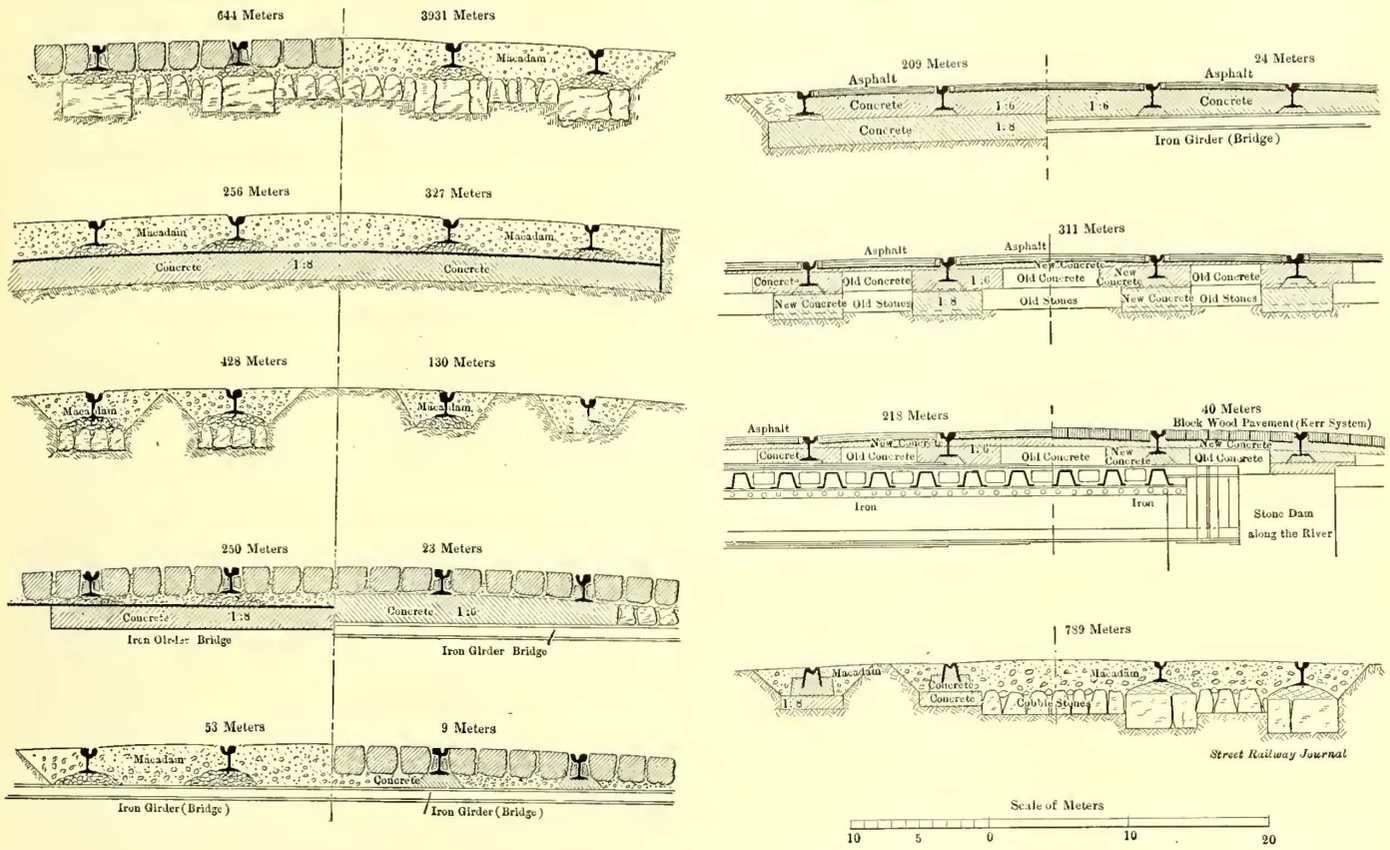


FIG. 3.—SPECIAL WORK AND OVERHEAD WIRING AT PARADEPLATZ

Before the streets were paved, the other municipal departments which were interested in sub-pavement work, such as the gas, water and telephone departments, were requested to make all the necessary repairs and new installa-

tions to their pipes, so that it is hoped that it will be unnecessary to open up the streets for work of this kind for quite a while to come. In order to be able easily to determine points where gas mains are damaged in asphalted streets, little tubes are provided at regular distances of about 50 m (164 ft.) for smelling the gas.

As shown in Fig. 6, arrangements are provided to drain the grooves in the rails. At distances of 100 to 200 m (328 ft. to 656 ft.), according to the grades, slots 120 m



FIGS. 4 AND 5.—CROSS SECTIONS OF DIFFERENT TYPES OF TRACK CONSTRUCTION USED ON ELECTRIC LINES IN ZURICH

(about 5 ins.) in length are cut in the bottom of the groove; the water flowing in the grooves runs down through these slots into a basin where any sand is allowed to settle; the water then flows to the sewer.

The section of rail used is illustrated in Fig. 7. It is a modification of the ordinary Phœnix rail, the changes in which were designed by the engineer of the tramway system, Mr. Schenker, and is called No. 18 C by the Phœnix Company. It is used on the system throughout, with the

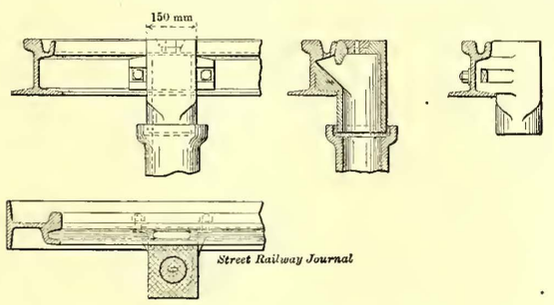


FIG. 6.—DRAIN FOR RAIL GROOVE

exception of about 800 m (half a mile). The weight of the rail is 49.5 kg per meter (99 lbs. per yard), and the weight of track, including fish-plates and accessories, is 116.25 kg per meter (233 lbs. per yard). Thomas steel of a tensile strength of about 7000 kg per square cm (99,000 lbs. per square inch) is employed. The rails have a length of 12 m (39 1/3 ft.). They were laid during the summer at a temperature considerably above the average temperature of the year, and were butted up close.

Before adopting a joint, the selection of the Falk cast-welded joint was very carefully considered. In view of the results obtained with this joint on many roads in the United States, as well as in Lyons, Marseilles and Berlin, its use on the system seemed advisable, especially as it was found to be not more expensive than other good joints. It seems, however, that the engineers of the city in their final deliberations were not quite sure that the use of the joint with Thomas steel rails would be as satisfactory as those which have been obtained with Bessemer steel, and principally for this reason the Falk joint was not employed throughout the system. The present angle-plate joint, however, can easily be discarded for the Falk at any time in the future, if the results on a trial section of 800 m (½ mile) length which has been put in with the latter joint proves satisfactory.

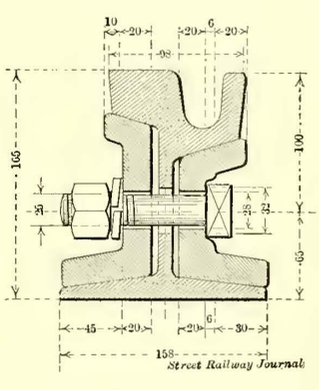


FIG. 7.—SECTION OF STANDARD RAIL

While the modified Phœnix section, as illustrated in Fig. 7, was adopted as standard, many members of the municipal tramway committee were much in favor of the adoption of the Demerbe rail, although nearly all the engineers who were consulted on the subject opposed this rail. The committee finally decided, however, to try it on a section 814 m (half a mile) in length. This rail, which is made of Bessemer steel by a Belgian company, is laid on a concrete stringer 15 cm to 20 cm (6 ins. to 8 ins.) in

thickness. The rail company has guaranteed to keep this line in good order for ten years.

DEPOTS AND CAR HOUSES

The selection of proper sites for the necessary car houses and repair shops of the system was, by no means, an easy

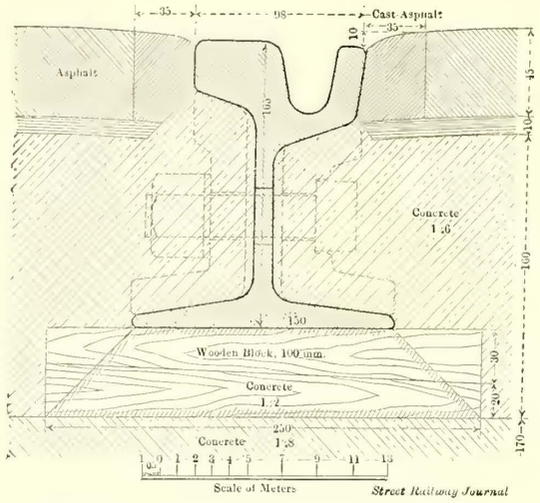
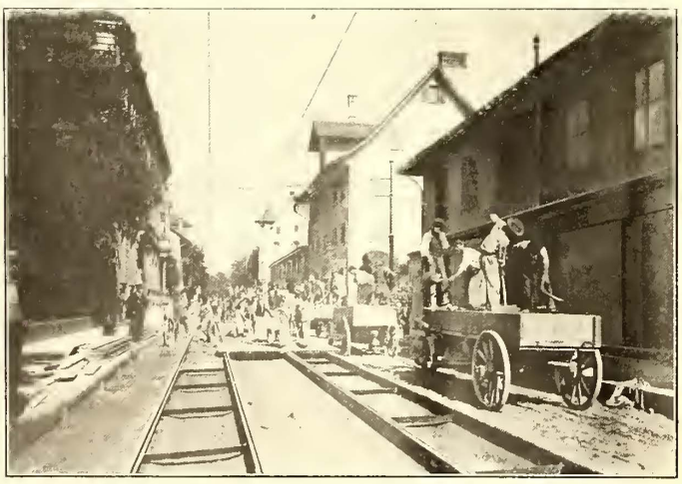


FIG. 8.—SECTION OF RAIL LAID IN ASPHALT

task. The local conditions did not permit the construction of a car house in the center of the city. At the same time the former horse-car house at Seefeld was too limited and the land there available was too contracted to warrant the construction, at that point, of a depot which would fulfil all requirements. It was finally decided to have several car houses and to accommodate not more than fifty cars in one building. As a result, the corporation has erected three car houses, viz., one in Seefeld Strasse, one in Badener Strasse, and one in Mutschellen Strasse, as well as a waiting-room on Parade Platz.

The property on which the car house in Seefeld Strasse (Figs. 9 and 10) was erected occupies an entire block. The building contains a car house with a small repair shop, the main repair shop and store-rooms. There is also a separate office building, in which is also the residence of the repair-shop manager. The building is particularly interesting from the fact that it is constructed entirely of



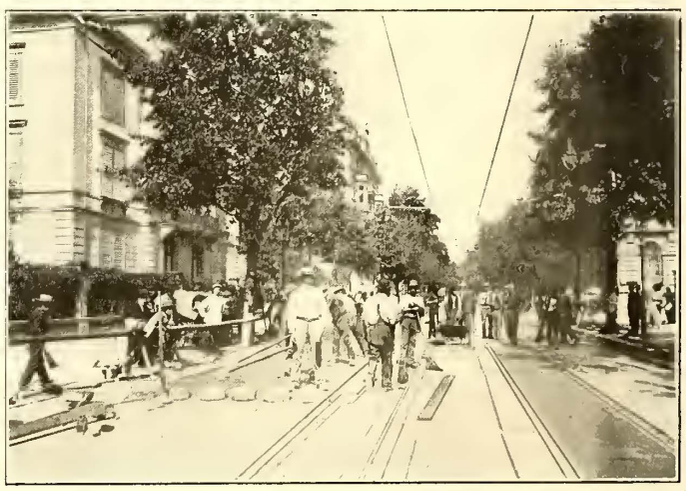
LAYING AND TAMPING CONCRETE SUB-CONSTRUCTION

concrete on the Locher system. The total area occupied is 4086 square m (43,982 square ft.). The entire cost of the building was 376,692 francs (about $75,300), so that the cost of the building per square meter was 92.19 francs (about $1.70 per square ft.).

The car house proper contains eight tracks, having a total length of 400 m (1300 ft.), so that about fifty cars can be accommodated in it. The building is heated by steam at low pressure. Large windows on each side and the monitor roof give good light during the day.

Following a number of late American models, about half of the track space is devoted to pit room, and the pit which is about 1.5 m (5 ft.) in depth is continuous under the tracks for half the length of the tracks and for the entire width of the car house. The rails and the wooden floor rest on a special iron framework. The pit floor is also of concrete. Parallel with the trolley wire over the cars in the car house is a dead steel cable, called a "resting wire," against which the trolley poles can be set when it would be convenient to have the poles dead, without pulling them down.

The main repair workshop has a floor area of 914 square m (9870 square ft.) with four tracks, each 12 m (39 ft.) in length, with pits extending their entire length; that is, the length and width of the repair shop, so that there is room for four large cars in the shop. The shop contains seven lathes of different size and construction, one screw-tap, five drilling and cutting machines, one plane, two milling machines, one automatic wheel shaper of American make, one large and one small plate-shearing machine, one punch, one hydraulic press, three grinding machines, one grind-stone, three work-benches with fourteen vises each,



LAYING ASPHALT PAVING

etc. The machine tools are all driven from a main shaft by a 15-hp electric motor. There are also two cranes, each able to carry 4000 kg (8800 lbs.). The winding is done in a gallery, which is 32 m (105 ft.) x 8 m (26 ft.).

In the same building is the smithy, of 73 square m (786 square ft.) floor space, containing a double forge with fan and hood, power hammer, three anvils, and miscellaneous equipment. Adjoining the smithy are the office of the superintendent of the repair shop, and the model-room, while on the second floor are the tailoring department and lockers.

An extension to the building contains the carpenter's shop, of 180 square m (1940 square ft.) floor space, in which a band saw, a planing machine and a universal machine for planing, drilling, etc., are operated from a shaft driven by a 15-hp motor; the same shaft operates an exhaust fan for removing shavings and dust from the woodworking machines. The same building also contains the painting and varnishing shop, of 380 square m (4090 square ft.) area, in which eight cars can be accommodated.

The store-rooms are partly in the main building and partly in the extension, the total floor space being 632 square m (6800 square ft.). In a special fireproof room,

which contains a small crane for handling the barrels, oil, paint and grease are stored.

The office building, which adjoins the car house, has, on the ground floor, a room for conductors, with twenty-six lockers, the office of the accountant and the office of the superintendent of the shop. On the second floor is a room for the motormen and a dining-room. The third floor contains the living rooms of the shop superintendent. In the cellar there is a bath-room with shower baths for the use of the employees, and below the roof there is a room for drying wet uniforms. The whole house is heated by the hot-water system.

The cubic area of the building is 2165 cubic m (76,468 cubic ft.), and its cost was 60,856 francs (or about $12,200), i. e., 28.10 francs per cubic meter (or about 15 cents per cubic foot).

The car house at Badener Strasse contains fourteen tracks. The total length of track in the car house is 435 m (1430 ft.), of which 159 m (522 ft.) are situated over a large pit. The car house has a capacity of forty-eight cars of 8 m (26 ft.) length. There is a small repair-shop room of 110 square m (1180 square ft.) floor space, and a store-room. The office building is of nearly the same arrangement as that at Seefeld Strasse. The total floor space of this car house is 2050 square m (22,076 square ft.), and its cost was 179,089 francs (about $35,800), i. e., 87.16 francs per square meter (or about $1.62 per square ft.). There is a space of 2100 square m (22,600 square ft.) available for future extensions.

A smaller depot is situated in Mutschellen Strasse; it contains four tracks, three being each 46 m (151 ft.) long. The fourth is 56 m (184 ft.) long and leads to the repair

INTERIOR OF CAR HOUSE ON SEEFELDSTRASSE

VIEW OF WAITING STATION AT PARADEPLATZ

shop. The car house has a capacity of twenty cars. The repair shop has a floor space of 75 square m (807 square ft.), and the store-room of 28 square m (301 square ft.). The total cost was 73,495 francs (about $14,700), i. e., 77.52 francs per square meter (or about $1.44 per square

the car houses already described. It measures 5.25 m x 3.5 m (17 ft. x 11½ ft.), and has separate toilet accommodations, for men and women, in the basement, as indicated in the cross section. The inside and outside walls of the waiting-room are rented out for advertising purposes. The

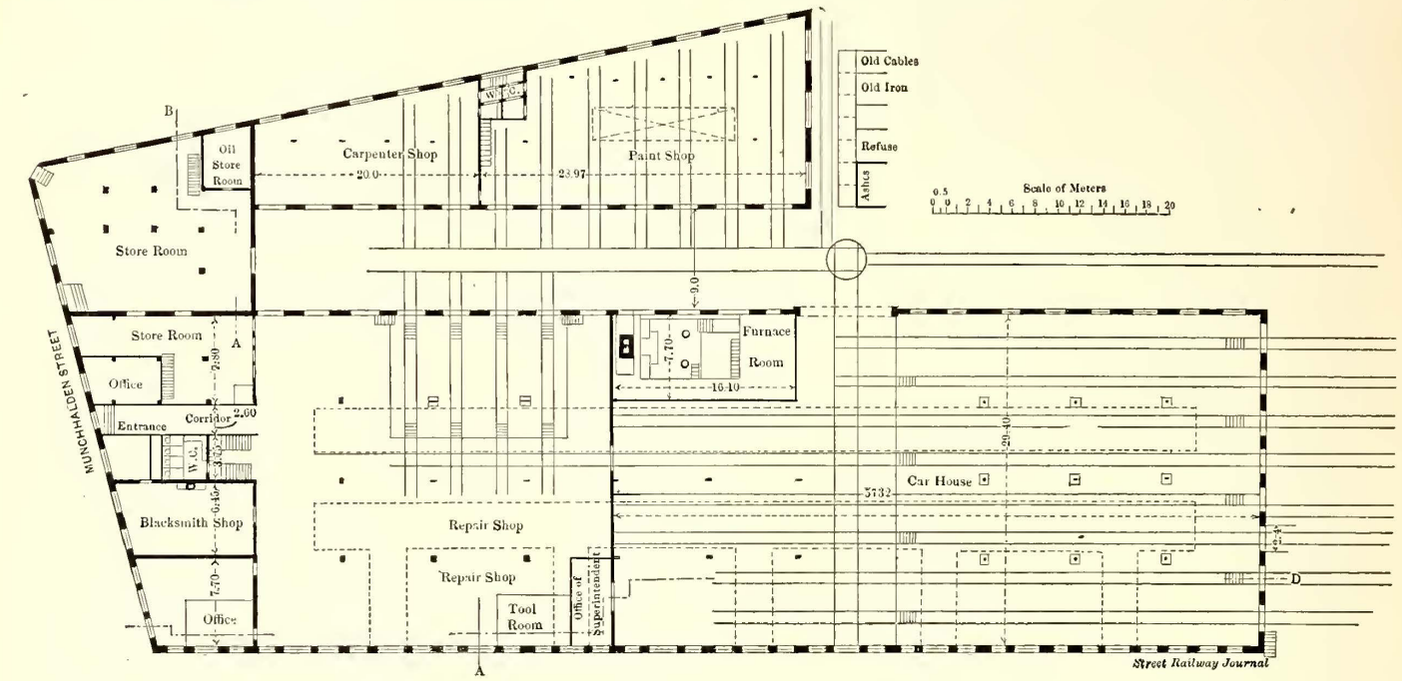


FIG. 9.—PLAN OF CONCRETE CAR HOUSE IN SEEFELDSTRASSE

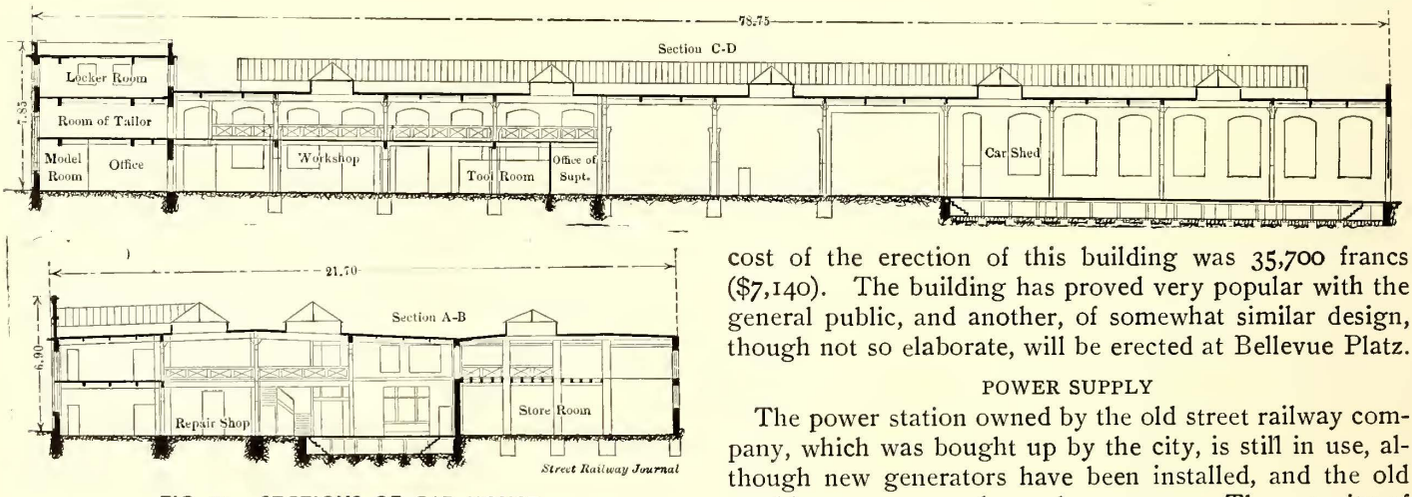
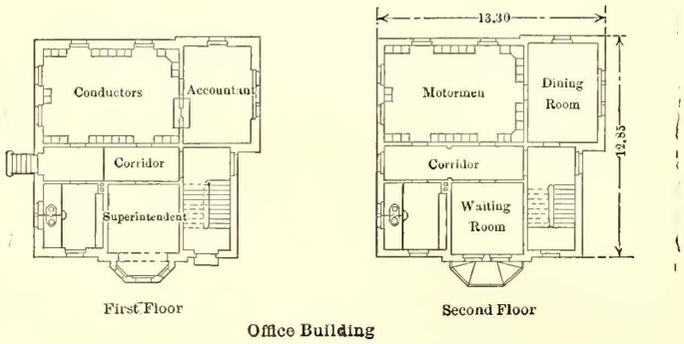


FIG. 10.—SECTIONS OF CAR HOUSE

ft.). There is enough additional space available for doubling the capacity of the car house in the future.

WAITING ROOM

An account of the buildings belonging to the Zurich system would not be complete without a reference to the waiting-room at Parade Platz, which is illustrated herewith, and which is much better known to the public than

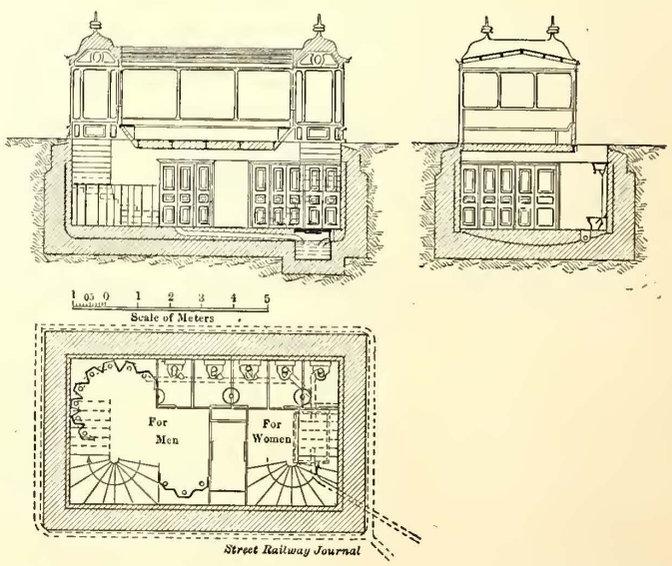


PLANS OF FIRST AND SECOND FLOORS OF OFFICE BUILDING

cost of the erection of this building was 35,700 francs ($7,140). The building has proved very popular with the general public, and another, of somewhat similar design, though not so elaborate, will be erected at Bellevue Platz.

POWER SUPPLY

The power station owned by the old street railway company, which was bought up by the city, is still in use, although new generators have been installed, and the old machines are now only used as reserve. The capacity of this plant is, however, not sufficient to furnish the power



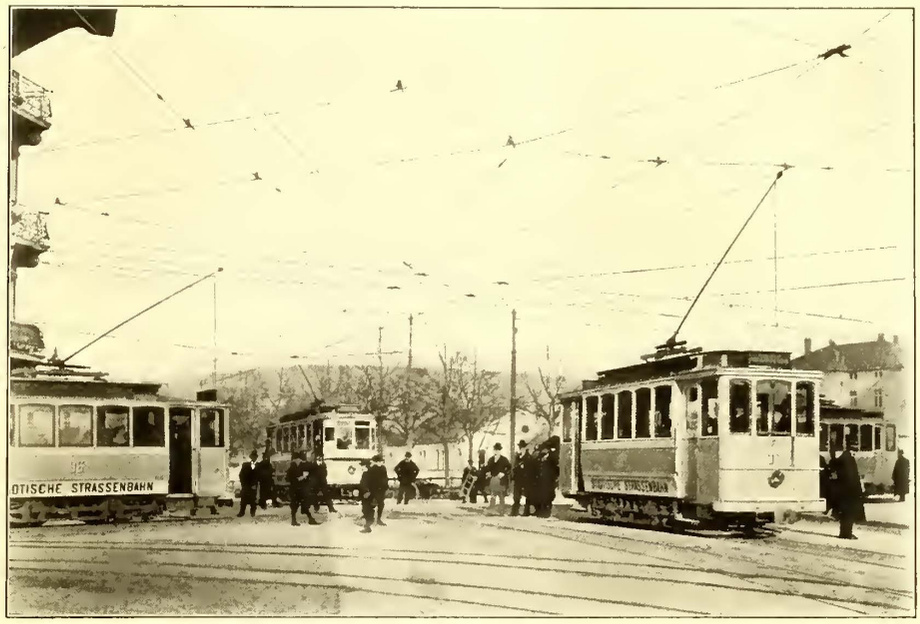
SECTIONS AND PLAN OF BASEMENT OF WAITING STATION

for the entire system. A sub-station has, therefore, been erected, which is supplied with 2000-volt, three-phase current from the municipal central station. Three 200-kw rotary converters change the three-phase current into 550-volt direct current. The charge of the central station is 12 centimes (2.4 cents) per kw-hour, measured at the direct-current terminals of the rotaries. The cost of coal in Zurich is about 34 francs ($6.80 per ton).

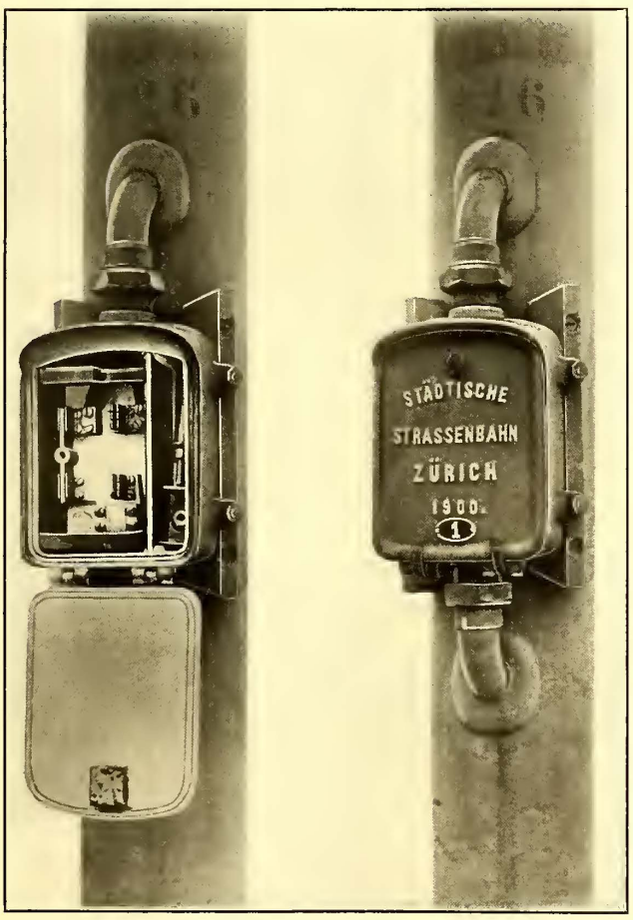
OVERHEAD CONSTRUCTION

The trolley line is divided into fourteen sections. In most cases, besides the outgoing feeder, a return feeder serves each section. Both outgoing and return conductors are laid in clay conduits 0.9 m (3 ft.) below the surface of the street. The outgoing feeders are connected to the trolley line by means of Edstroem switch boxes, one of which, open and closed, is shown on this page.

The trolley wire consists, throughout, of two harddrawn copper wires of 8 mm (1/3 in.) diameter. For each section of the line, at least one lightning arrester is provided. Three different systems are in use, viz., those of the Garton-Daniels Company, of Keoukuk, Ia., which depend on the action of a solenoid, the General Electric, of Schenectady, which has a magnetic blow-out, and the Siemens & Halske, of Berlin, which is of the "horn arrester" type. The power station is protected by lightning arresters of the Oerlikon Company. Guard wires earthed at suitable distances are used. For rail-bonds both the Bryan and the Edison-Brown plastic bond are employed.



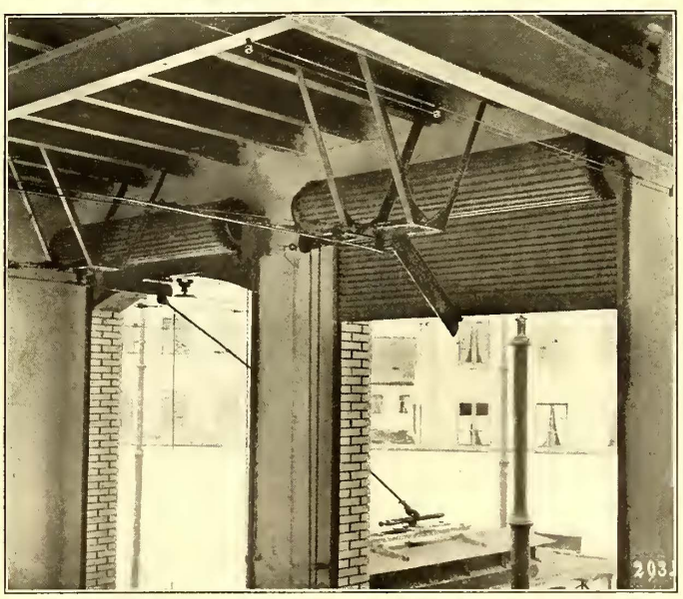
DOUBLE-TRACK CROSS-OVER ON THE SIHLBRUCKE



SECTION SWITCH BOXES, OPEN AND CLOSED

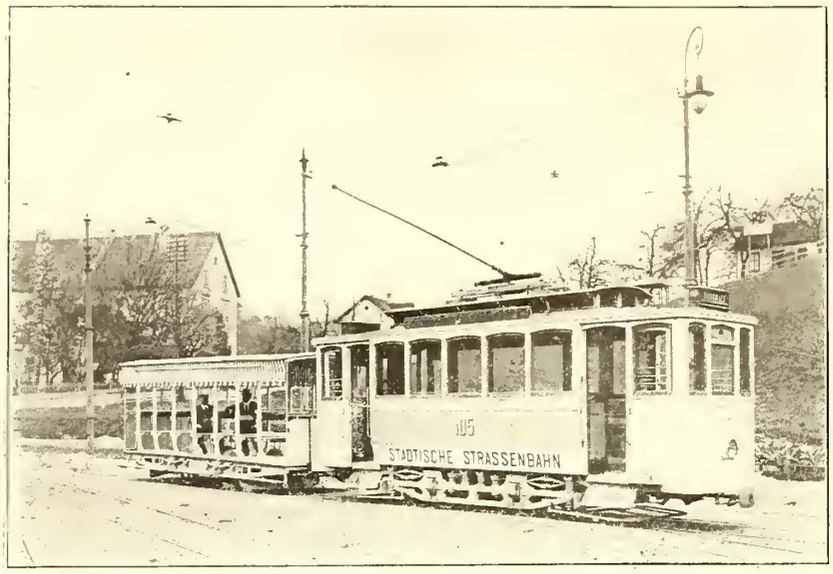
ROLLING STOCK

When the change from horse to electric traction was decided upon, the tramway managers expected to buy fifty new motor cars, and to use twenty old horse cars, after proper changes, as trailers. Up to the present time, however, only forty-two motor cars have been bought. These cars are vestibuled, and have, on their platforms, standing room for seventeen passengers, as, according to the usual European practice, passengers are allowed on the front platform. The interior of the car has a seating capacity for sixteen passengers. The standard car weighs 8400 kg (18,480 lbs.), including the electric motors, etc. Most of the cars are mounted on Peckham trucks. Each motor car is equipped with two 20-hp motors, either G. E. or Oerlikon make. Each car has also been fitted with an ingenious device for cutting out any defective lamp in the car, invented by Mr. Schochli, superintendent of repair



AUTOMATIC CUT-OUT AND ROLLING DOORS OF CAR HOUSE

shops. The terminals for each lamp in use, as well as for one extra lamp, are brought to a small board with sockets over one of the doors, and one lamp can easily be short-circuited by a plug, and the extra lamp cut in to make the five in series required. The car bodies were supplied by



STANDARD CLOSED CAR AND OPEN TRAILER

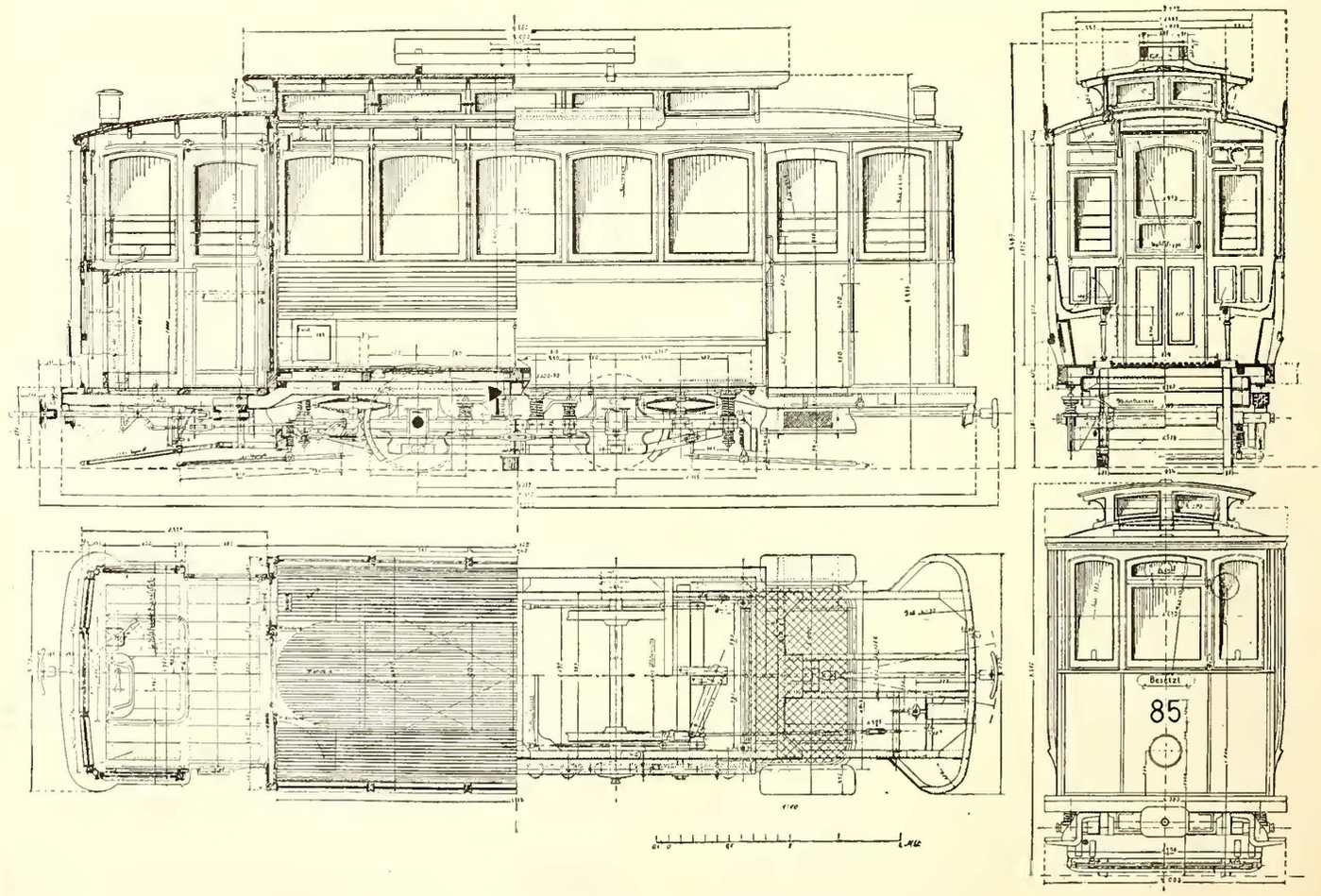
Giessberger & Co., of Zurich, and the Schweizerische Industrie-Gesellschaft, of Neuhausen.

An open car body, as shown in one of the illustrations herewith, was bought for trial purposes, in view of the extended use of such cars in America and elsewhere. It is mounted on a single truck, and its platform is easily accessible, being only 0.6 m (2 ft.) above the top of the rails. The car has proved very popular on hot days, but as it can not be used during the morning hours and on cooler days, no more cars of this kind will be bought.

CONSTRUCTION WORK

The work of changing the horse-car lines over to electric operation was begun on June 18, 1900, and was finished on Oct. 1, of the same year, in accordance with the programme. The force required consisted of 4 engineers, 9 foremen and 493 workingmen. There were only 6½ days on which rain interrupted the work; the construction was, therefore, finished in 89½ days. As the length of the old horse railway lines was 9802 m (32,150 ft.) and the length of track (reduced to single track) was 19,201 m (62,980 ft.), and an average 110 m (361 ft.) of the line, or 215 m (705 ft.) of track, were finished per real working day. The working hours were from 4 a. m. to 7:30 p. m., or from 6 a. m. to 9 p. m. Night work was done only in exceptional cases.

An experiment was tried, during this work, of using a cheaper cement than Portland cement for making concrete. For the concrete substruction, in Theater Strasse, Choindez cement was, therefore, used, but did not prove quite satisfactory, in spite of great care used in its employment. The same cement was also used for a short section of track on Bleicherweg. On all other lines, however, the concrete was made of Portland cement.



SIDE ELEVATION AND SECTION OF STANDARD MOTOR CAR

The following mixtures were used in making the concrete: For the lower concrete layer (1:8), 1 part of Portland cement or Choindez cement, 3 parts of sand, and 5 parts of screened gravel; for the upper concrete layer (1:6), 1 part of Portland cement, 2½ parts of sand, and 3½ parts

of screened gravel; for 1 : 2 concrete, 1 part of Portland cement, 1 part of sand, and 1 part of screened gravel. In Figs. 4 and 5 the proportion of the mixture used in the different places is indicated.

One of the contractors made the concrete in the immediate neighborhood of the construction work, while the other contractor made it at a distance of 2 km (more than a mile) and transported the concrete on trucks to the place of construction. On very hot days the trucks were covered with wet cloths. The preparation of the concrete was continually watched by experts of the city. The surface of the concrete was covered with a layer of cement mortar of 1 cm (0.4 in.) thickness.

The heating of the powdered asphalt was not done in the immediate neighborhood of the streets to be paved, but in the yard of the shops at Sihlfeld. It was heated there to 150 degs. C. (302 degs. F.), and was transported to the place of construction in covered trucks. At arrival, the temperature was 130 degs. C. (266 degs. F.). The powdered asphalt was then placed upon the foundation, about 62 mm (2½ ins.) thick, and was then rolled at once with a warm hand-roller of 350 kg (770 lbs.) weight, 0.8 m (2½ ft.) diameter and 0.5 m (1½ ft.) width. It was then rammed with hot rammers and afterward leveled with a second roller of 900 kg (1980 lbs.) weight, 1.3 m (4¼ ft.) diameter, and 0.5 m (1½ ft.) width. The asphalt was finally polished with hot iron. When finished, the layer of asphalt had a thickness of 45 mm (1¾ ins.). The street was opened to the public after two days.

During the hottest days of the construction work it was necessary to cool the pavement artificially at repeated intervals with water.

From experience obtained in other streets, the engineers did not consider it advisable to lay the rammed asphalt directly against the rails, because in this position it was found to get loose soon and crumble off. They, therefore, decided to place a strip of cast asphalt of 3.5 mm between the rammed asphalt and the rail. The approved form of construction is shown in Fig. 8.

A considerable part of the overhead and other equipment of the system was supplied by Alf. Diener & Company, of Zurich, manufacturers and agents of electric railway supplies.

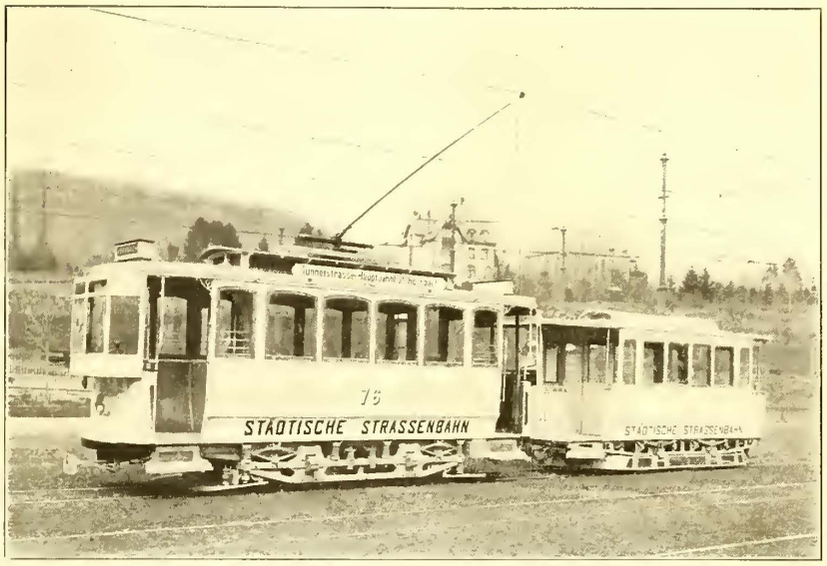
Although the last horse-car line was changed to electric traction during the end of September, 1901, so that the whole line was in operation by the beginning of October, the work of construction was not fully finished at that time, and work was continued all through the year 1901. The official report, dated January, 1902, states that some further work will be done in 1902, which will require an expense of 78,000 francs ($15,600). When the whole work is finished, the expense will be lower than the original estimates. These called for an expenditure of 4,000,000 francs ($800,000), but the total expense will be only in the neighborhood of 3,600,000 francs ($720,000).

The manager of the system is A. Bertschinger, and the paving work was supervised by W. Dick, superintendent of streets for the city of Zurich.

The Utica & Mohawk Valley Railway Company, of Utica, N. Y., is planning to establish an express service on all of its lines this month. The main express office will be at Utica.

Opening of the Valtellina Three-Phase Railway

On Sept. 4 the two northern sections of the Valtellina Railway, Italy, which has been equipped with the Ganz three-phase system of electric traction, were put in operation. The Valtellina Railway, which has frequently been referred to in these columns, and which has attracted wide attention as being the most important installation of three-phase electric traction in the world, extends from Lecco, on Lake Como, to Colico, and from that point two branches are run to Chiavanna and Sondrio. It was these latter divisions on which the service was inaugurated for both freight and passenger traffic, and the line, according to latest reports, has been in operation successfully ever since.



STANDARD CLOSED CAR AND CLOSED TRAILER, ZURICH

The delay in opening the line, according to local testimony, seems to have been due more to mechanical difficulties experienced in the overhead construction rather than to any trouble with the electrical apparatus, for the electrical equipment has been on the ground for a number of months. The route of the road for the greater part of its distance extends along the eastern side of Lake Como, and passes through a large number of tunnels. According to engineers on the ground, the high speed of the electric cars required a greater elevation of the outside rails and curves. When these rails were raised the adjustment of the two wires required in the overhead system to the new track elevation required considerable time. In addition, the varying heights of the trolley wire, due to the large number of tunnels on the line and the fact that the insulation of the overhead line, particularly in the tunnels, suffered deterioration through the smoke consequent upon the constant operation of steam trains necessary to care for the regular traffic, were the principal difficulties in completing the electrical equipment. The overhead system has in consequence been subjected to a number of changes, but it is now thought to have become standardized, and the sparking at the 3000 volts used on the trolley line does not seem to be any more severe than that experienced in ordinary 500-volt direct-current operation.

The system of lightning arresters in the primary circuits has also been changed, and at the power station at Morbego a novelty has been introduced in the use of a jet of water for the high resistance of the arrester. The water resistances in the car have also been provided with cooling apparatus. An extension of the line from Lecco to Milan is contemplated.

The Electric Urban and Interurban Railway at the St. Louis Exposition

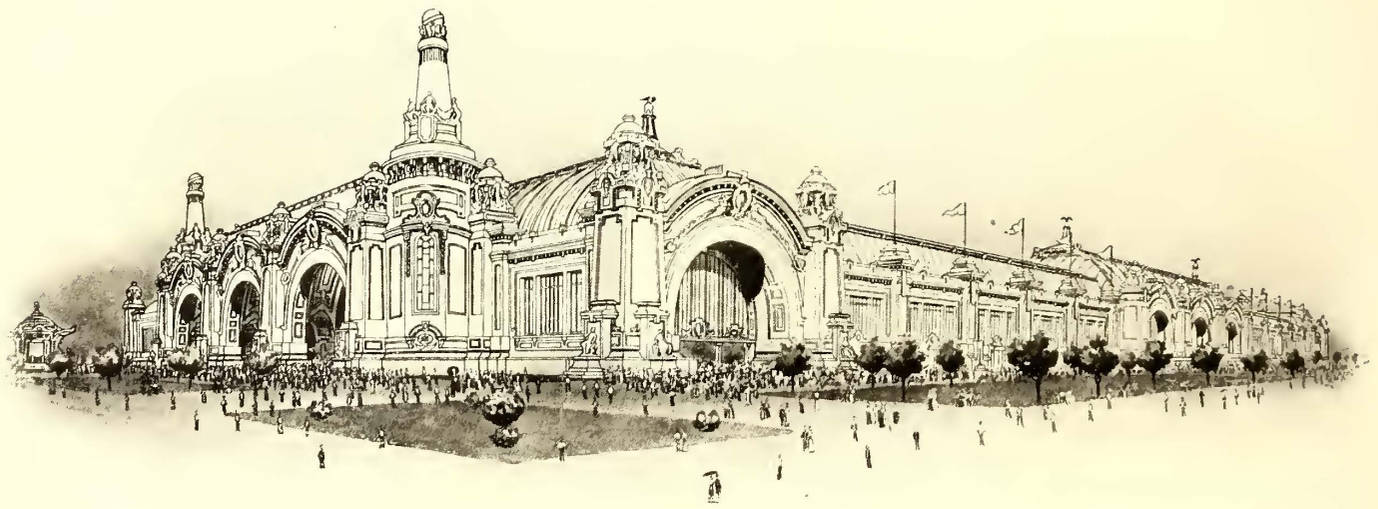
BY W. E. GOLDSBOROUGH

The presentation of electric railway exhibits on a scale and in a manner to meet the approval and expectation of the men who are so rapidly building up this new department of transportation, is a matter that will require active and strenuous effort during the months that intervene until the time of the opening of the great Louisiana Purchase Exposition. When the total volume of the energy that is being put into the electric railway movement is realized, the difficulties in the way of giving the public a true picture of this wonderful activity present themselves. The progress in electric railroading is in fact so rapid, that the things which are new to-day are old to-morrow. There is hardly any department of engineering of which this can be said in anything like the same degree as electric railroading, and it is not too much to expect that the practice of to-day will be superseded or modified prior to the close of the exposition, by some new and better creation. This is the spirit, this is the unprecedented activity, which typifies the national progress that the directorate of the exposition has undertaken to picture. It is needless to say that a great work confronts all exposition workers, and in this particular instance the task is much more exacting than any which met the builders of previous expositions. A new condition has to be faced. Almost a new problem has to be solved. The people of America have in a few short years, since the Columbian Exposition, been educated to such an extent in matters pertaining to expositions that they are developing an appetite for the new, the interesting and the edifying, in a measure almost eclipsing in its growth the great advances in science and industry.

To be a success and meet the approval of America and the world, to gain historic standing as a great world's event, the St. Louis Exposition must bring out latent elements in exposition work with such force, such vigor and such attractiveness, as to cause the great world public to stop and listen, if but for a moment, to the story of the fame of this new city of to-day.

Linked with this great undertaking, among many other important problems, is that of the proper presentation of the electric urban and interurban railway interests. Those who are interested in the progress and development of electric transportation are stimulated in their work by the personal interest and pride they take in two of the great divisions of engineering. At heart they are all railway men, and they put into their railway work the heart and brain power which would bring success in any sphere of railway engineering. Added to this, they feel to a man, with a keen sense of satisfaction and pleasure, that they are making chapters in the history of the development of electricity and electrical engineering. They have a wonderfully firm belief in the possibilities of electricity, and this belief is confirmed and stimulated by every electrical advance, whether it be directly connected with the electric railway problem or be in some other department of electrical endeavor.

To meet the expectations of the electric railway men, it has been decided to give them a large share in two of the principal exhibit pictures that will be presented on the exposition grounds. The electric railway properties, gaged strictly as a railway problem, have attained to such magnitude that transportation would not be doing justice to itself did it not picture on a large scale and in a broad way all those transportation devices which combine to make the electric railway mechanically successful. So also has the electrical side of this great problem assumed such proportions that it stands at the head of all the electrical undertakings of the age. No story of the industrial application of electricity would therefore be complete without a recognition in a most comprehensive way of all that the railway engineers have done to build up and expand, to improve and to ramify the transmission and the application of electricity in many different ways.



TRANSPORTATION BUILDING AT ST. LOUIS

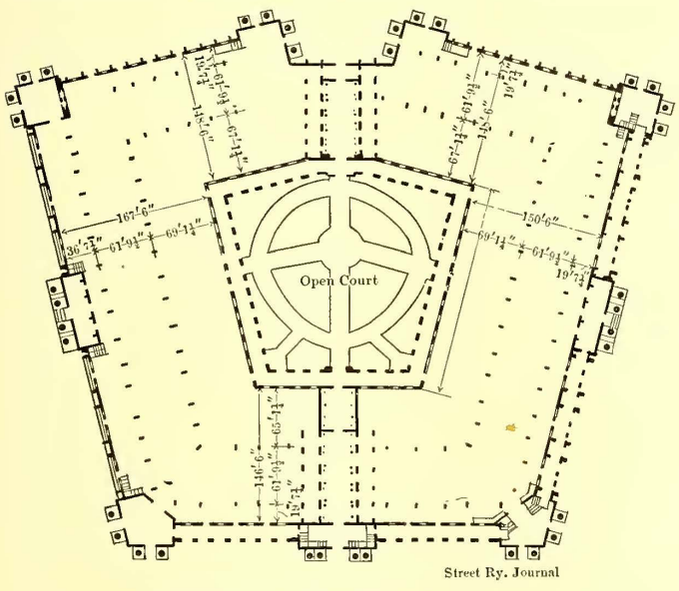
I am advised by Willard Smith, chief of transportation, who has been long and favorably known to the transportation world on account of the distinguished success attained by the Transportation Department of the Columbian Exposition, as well as through his intimate connection with the general railway interests of the country, that the urban and interurban transportation problem will receive a most adequate presentation on the four miles of track which are brought within the limits of the great Transportation Building. In the Transportation Building, therefore, electric railway rolling stock, trucks, tenders, passenger coaches, parlor, freight and service cars, track sweepers and snow plows will be exploited, and in addition, all matters pertaining to maintenance of way, grading and bridges, ties,

spikes, chairs, fishplates and other parts of the track; switches and crossings; transfer tables, turn tables and bridges; signal systems and apparatus for securing the safety of traffic, will be here shown. Exhibits will also be made covering general railway management; time tables, distribution of rolling stock; cleaning and disinfection; handling of traffic, passengers, freight, postoffice matters, express, parcels, tariffs; and methods and equipment for caring for the needs of all the interests having occasion to use or make use of electric railways. No elements of importance are to be neglected in any way.

In the Electricity Building space is to be given to all those matters that pertain to the generation and distribution of electricity and to the use of electricity as a motive power. In the Electricity Department, therefore, generators producing direct, alternating and multiphase currents will be exhibited. Boosters, motor generators, transformers and rotary converters will also be shown here. Direct current and alternating current railway motors, electric locomotives and methods for the control of cars and trains; overhead, third rail, contact and underground conduit systems; multiple control methods and other special railway devices, such as electric signaling apparatus, complete station and sub-station switchboards, instruments, lightning arresters, circuit breakers, telegraph and telephone appliances, storage battery equipment, bonds and bonding, and overhead construction material will all be given place.

The electric railway needs and demands in one way or another almost all of the electrical apparatus to be found on the market, and consequently it is a logical conclusion to group all these electrical appliances together in such a manner as to enable them to be most advantageously studied.

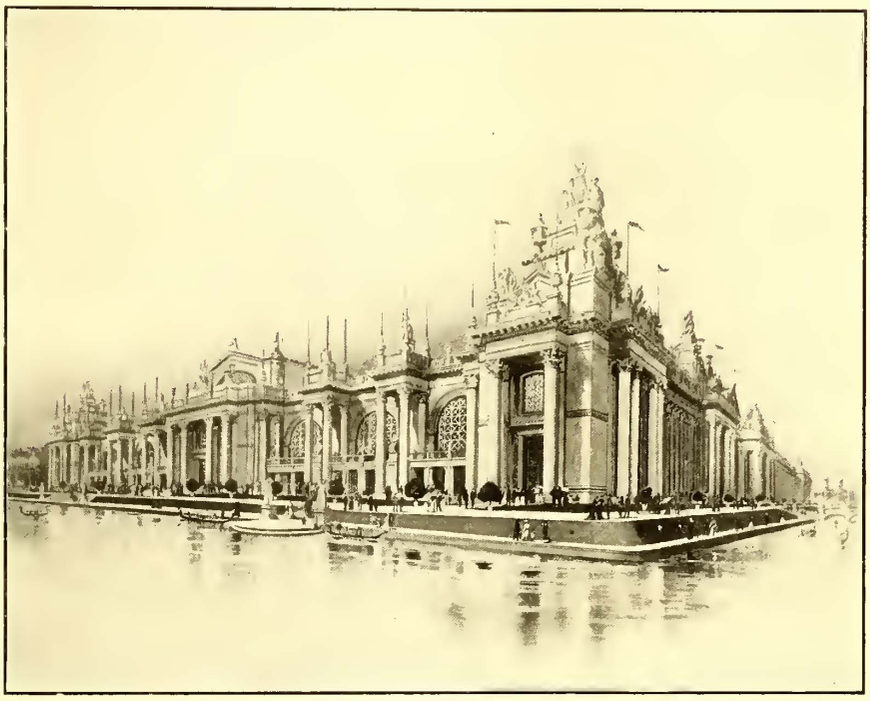
From the foregoing it will be seen that by the fortunate provisions of the official classification of the exposition, the electric railway engineer will go to the Transportation Building to study all matters pertaining to maintenance of



PLAN OF ELECTRICITY BUILDING

way, traffic maintenance, service equipments and all other matters that pertain directly to the mechanical side of this great problem. While on the other hand, he will go to the Electricity Building to study the street railway or the electric railway problem from the generator through the transmission system, the transforming devices, the sub-station and the storage battery, out over the line and through the motors to the car axle.

It is not only with exhibit matters that Mr. Smith and myself are concerned in our endeavor to have our presentation of the electric railway problem include all those elements which make it attractive and interesting to the electric railway men; the active operating side of the railway problem needs recognition which has never yet been accorded to it by an international exposition, and it has been especially along this line that efforts have been directed to enable us to pro-



THE PALACE OF ELECTRICITY

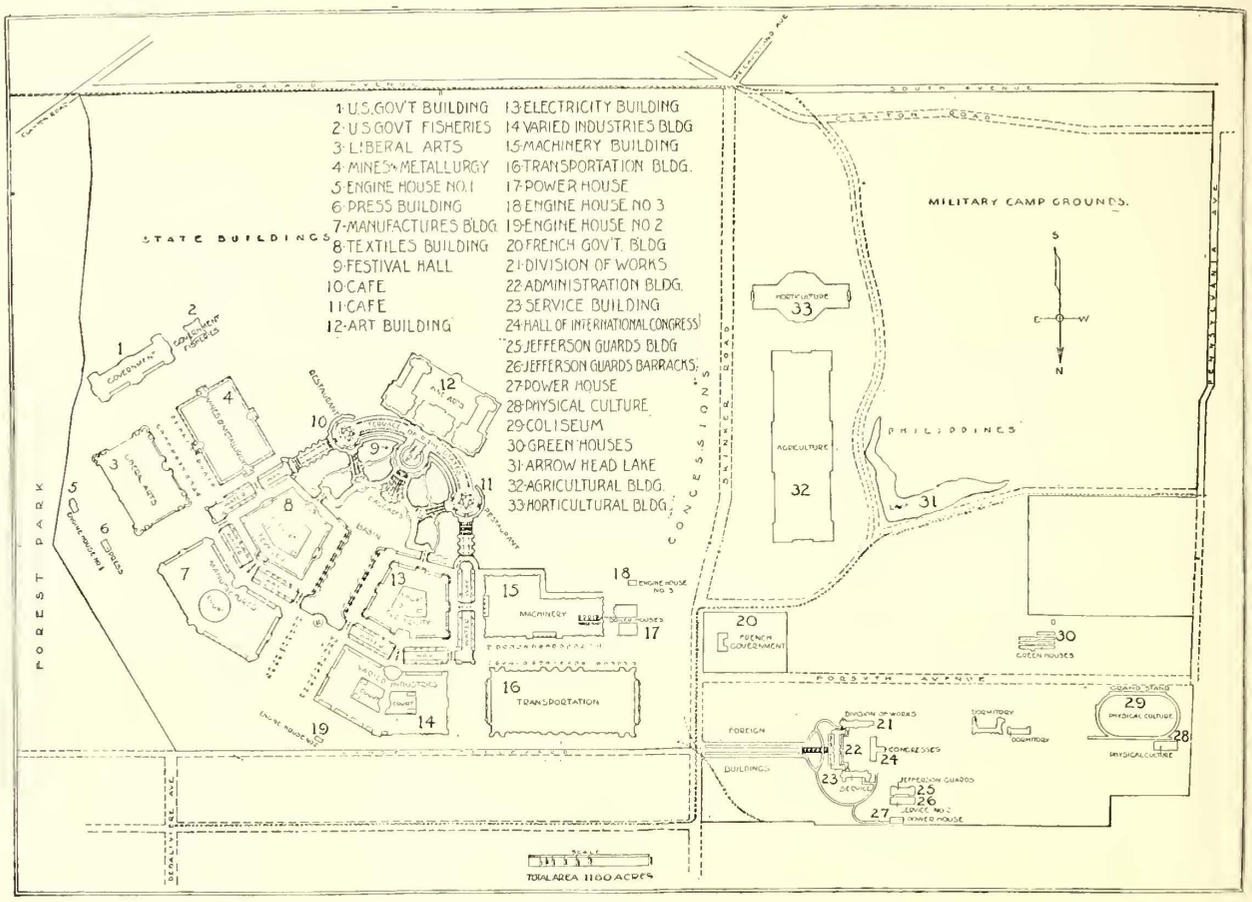
vide for space for the actual operation and test of railway equipments. After working on the matter for several months, it has finally been deemed expedient to set apart a space for this purpose north of the Transportation Building and paralleling it, which will be 1300 ft. long and 25 ft. wide. This right of way will admit of the installation of double tracks upon which an outdoor exhibit can be made of the actual operating efficiency and reliability of railway equipments. I take great satisfaction in being able to make this announcement for the reason that I feel certain it will be a matter of much gratification, not only to the superintendents and engineers of operating railways, but also to the manufacturers of electric railway equipments. It is our desire that these tests shall be organized along very broad lines and that during the progress of the fair much data and information shall be recorded which will be of enduring benefit to the railway interests. At the present time it seems very probable that by the summer of 1904 numerous systems for electric railway operation using alternating current will be in the field, as well as the systems we now have for the operation of electric railways by direct current, and it should be a source of much gratification to us all to contemplate the possibility of being able to study all of these systems exploited at the same time, on the same ground, by engineers and experts of the several companies making exhibits.

The plans of the exposition contemplate even a more radical step in opening up avenues for exploitation along the line of electric transportation. In order that inventors shall be stimulated to use their best efforts in devising

means whereby motive power equipments for use in aerial navigation may be improved, the exposition has offered a prize of $3,000 for a successful attempt to drive an airship motor by energy transmitted through space either as electric radiation or in some other form of electric energy to an actual amount of 1-10 hp at the point of reception and at a distance of at least 1000 ft. The test must be made on the exposition grounds by experts satisfactory to the jury. This last provision it is thought rounds out and completes a picture which embodies in it opportunities in every avenue of electric transportation.

The Transportation Exhibits Building is placed on the extreme northwest corner of the main picture of the fair. It is the most expansive structure yet designed for the

On the north and south fronts the architect has deemed it well to repeat the three massive archways which form the center feature of smaller fronts. This treatment pleasantly breaks the unwieldy facade of 1300 ft. On the north and south fronts the pylon feature is omitted, but massive piers are repeated at intervals and lend dignity to the design. Flanking these three openings on the long fronts are great rows of magnificent windows as wide as the archways. Not only will visitors be admitted through the twelve huge portals mentioned, but subsidiary entrances are supplied at frequent intervals in the remaining stretch of walls. The roof treatment of the building is peculiarly happy. Over each of the big archways is a lofty curve which supplies a back-ground for the architectual features.



PLAN OF GROUNDS AND ARRANGEMENT OF BUILDINGS AT ST. LOUIS EXPOSITION

Louisiana Purchase Exposition. When all the exposition buildings are up it will be exceeded in size only by the palatial Agricultural Building. The Transportation Exhibits Building covers an area of 525 ft. by 1300 ft. and includes more than 15 acres. The facades show a most pleasing adaptation of the French Renaissance. The building combines a feeling of the magnificent exposition building and of the high-class railroad depot which prevail on the European continent. These two essential elements are apparent throughout the structure.

On the east and west fronts are three magnificent arches which embrace more than half of the entire facade. Each of these arched openings will be 64 ft. wide and 52 ft. high. Through these archways 14 permanent railroad tracks will be laid from one end of the building to the other. At the sides of these three openings the projecting angles are accentuated by tower or pylon effect, which reach to a height of 150 ft. to the base of the crowning statue. These pylons are not so much accentuated as to be obtrusive, or out of harmony with the structure. A floor plan of this building was published in the Street Railway Journal, Aug. 16, 1902.

The statuary is happily placed in front and at the base of the main piers, at the sides of the grand openings. This affords 16 groups which will illustrate transportation in all its phases as well as the progress made by the United States in this science. There will also be four groups of statuary surrounding the four pylons placed at the east and west fronts. The architect has subdued the use of sculpture in the building. He depends on mass effects and on the grouping of masses. That is, he depends on architecture rather than on tawdry decorations for his effect. The management of the plan is simple and direct. The entire width of the building is spanned by five well designed uniform trusses. Special endeavor has been made to afford plenty of illumination by day without the use of skylights. Light is introduced through the monitor windows over each span of the five trusses.

The building will contain about four miles of standard-gage railroad track. Even with this immense trackage two entire bents of the building are left free of rails and afford an exhibit space of 270,000 sq. ft.

There is a novel disposition of the toilet rooms of the building. They are placed in the bases of the projecting

pylons, and are so arranged as to receive light and ventilation and be accessible from the exterior, so that no exhibitor can make the objection that he has been placed in the neighborhood of the plumbing conveniences. At the east end a gallery 20 ft. in width extends across the building. This affords a place for guard rooms and for the office of the department chief, and will be an excellent place from which to view the picture below.

The Electricity Building of the Universal Exposition of St. Louis in 1904 is the largest ever provided for electrical exhibits and displays. It covers virtually 300,000 sq. ft. of ground space as against 250,000 sq. ft. covered by the Electricity Building at the Columbian Exposition at Chicago in 1893, and 75,000 sq. ft. by the Electricity Building at the Pan-American at Buffalo in 1901. It is of most graceful design and proportions, forming an elaborate pentagon, each of its five sides presenting a succession of splendid columns after the richest Corinthian order, and on four sides being surrounded by a balcony of rare grace and beauty. It encloses an open central circular court surrounded by rich colonnades, which will be banked with masses of flowers and make a pleasing retreat for visitors to the building.

Its location within the exposition grounds is most favorable. It rises directly at the foot of the grand terrace and cascades and thus constitutes a prominent feature of the main arrangement of the rich section which is called the main picture of the exposition. The eastern exposure of the building fronts 525 feet on the main avenue of the exposition. This broad thoroughfare leads up from the main entrance to the Grand Basin and cascades and is penetrated by the central lagoon. The southern exposure, facing the Grand Basin and cascades, is in direct view of the electric fountains, the peristyle of the Festival Hall and the Fine Arts Palaces. On the west and north the building is bordered by other principal avenues of the exposition and additional extended arms of the lagoon. It is therefore completely surrounded by water. It is led up to by splendid arch bridges which will discharge the crowds into the broad avenues directly surrounding the building. Four main entrances are provided, one imposing portal at the meeting of the two north facades, and one at the centre of each of the other sides. Graceful and ample entrances are also provided at the corners of the building. The doors are of gigantic dimensions, 11 ft. x 18 ft. The north facades of the building measure 600 ft., which makes its greater dimensions 525 ft. x 600 ft.; 176 trusses and 185 tons of steel have been used in its construction.

The details of the building are well executed in every respect. The columns supporting and adorning the sides are carried down close to the ground to give height and effect to the facades. The facades are accentuated by elevated pediments and tower effects which rise over the four main entrances and at the corners. For variation, a twin column treatment is provided at different intervals along the sides and over these as well as over the elaborate entrances and corners opportunity for ample sculptural decoration is supplied.

The fenestration of the building is bold, liberal and appropriate, giving ample light, while affording substantial wall treatment. On two sides graceful and capacious loggias have been extended which enhance the general beauty of the facades, offering pleasing effects of light and shadow. A rare scheme of indirect illumination is being worked out and will be applied to the building, which will accentuate its beauty at night.

The design of the building and its general and special proportions and arrangement are peculiarly adapted for an effective display of exhibits. There are numerous openings in the facades, such as exhibitors seek in selecting their exhibit spaces, and the entire 300,000 ft. of floor space is directly available, advantageously situated, compact, symmetrical, well lighted, well distributed according to aisles and entrances, and well provided with all conveniences. Most important of all, it is all ground floor space, there being not a foot of gallery space in the building nor in any other exhibit building of the exposition, a feature of the Electricity Building and of the Universal Exposition that will be welcomed and appreciated by exhibitors and visitors alike.

A great traveling crane to be used in the placing of the heavy electrical machinery which is to be exhibited, will be installed in the building, and all other conveniences afforded to exhibitors in locating and placing their exhibits.

Improvements in San Francisco

The United Railroads of San Francisco, which is the name of the new company which has consolidated the Market Street and other important systems in that city, have inaugurated a number of important improvements. One of these is an extension from San Francisco to San Mateo. The extension is about 12 miles long, double track, and is being laid with Falk cast-welded joints. It will be completed by about Dec. 15. The cars on this line will run at high speed after leaving the city limits, and part of the line is built over a private right of way. The overhead trolley is being used. The company has just placed an order with the Laclede Car Company for twenty cars for this service. The cars are 45 ft. 9 ins. over all, and are provided with smoking compartments and twenty-four cross seats each. Four G. E. 57 motors and K-14 controllers will be used, mounted on Brill 27 trucks. The company expects to run the round trip of 45 miles in 170 minutes.

The company is also building a large power house at North Beach. The dimensions of the building are 130 ft. x 330 ft. The equipment will include Babcock & Wilcox boilers, two Union Iron Works marine vertical engines of 4000 hp each, and two General Electric 1200-kw alternators, with distribution at 13,000 volts. Two sub-stations will be installed. This station, like all of the other power stations of the company, will use oil as fuel. The company is also building a car house at Twenty-fourth and Nebraska Streets with a capacity of one hundred cars.

The extent and variety of the company's service is shown by the following statement of some of the equipments now in operation on its lines:

326	combination cable cars.
49	open cable cars.
2	United States mail cable cars.
63	dummy cable cars.
383	combination electric cars.
1	parlor electric car.
1	observation electric car.
2	funeral electric cars.
1	mail electric car.
2	tower electric cars.
11	freight electric cars.
2	electric cars for carrying street sweepings.
2	oil tank cars for delivering fuel oil to power houses.
16	steam coaches.
4	locomotives.
5	horse cars.

It will be remembered that the general manager of the company is George F. Chapman, formerly of the North Jersey Street Railway Company. The master mechanic of the United Railroads of San Francisco, F. F. Bodler, was also formerly connected with the North Jersey system.

The Bremgarten-Dietikon Interurban Electric Railway

The confines of Switzerland are not large enough, and the country does not contain sufficiently large cities, to justify the construction of such interurban electric railway systems as are built in the United States, but a number of short interurban lines have been installed in that country, and some of them are extremely interesting. The road which is made the subject of this article differs from most of the European electric railways in that it combines a passenger and freight business, and has a large traffic in the haulage of freight.

TYPICAL SCENES ALONG THE BREMGARTEN-DIETIKON INTERURBAN RAILWAY

The total length of the line, which extends from the station at Dietikon to Bremgarten, is 10.96 km, of which practically all is on the highway with the exception of the four curves, where the sharp corner of the public highway compelled the railway company to purchase right of way in order to have a curve of longer radius, as is clearly shown in one of the illustrations on the following page. The gage of the line, which is a single-track road, is 1 m. There are several turnouts, the inside rails of which are spaced 35 m apart, so that there is a space between the cars, which are 2.2 m in width, of 1.3 m. A clear space is left between the cars and any buildings along the line of 2.1 m.

The sharpest curve on the regular track is 30-m radius, although in the car house there are several of 25-m radius. Of the total length of track there are 2.81 km on curved and 8.15 km on straight track.

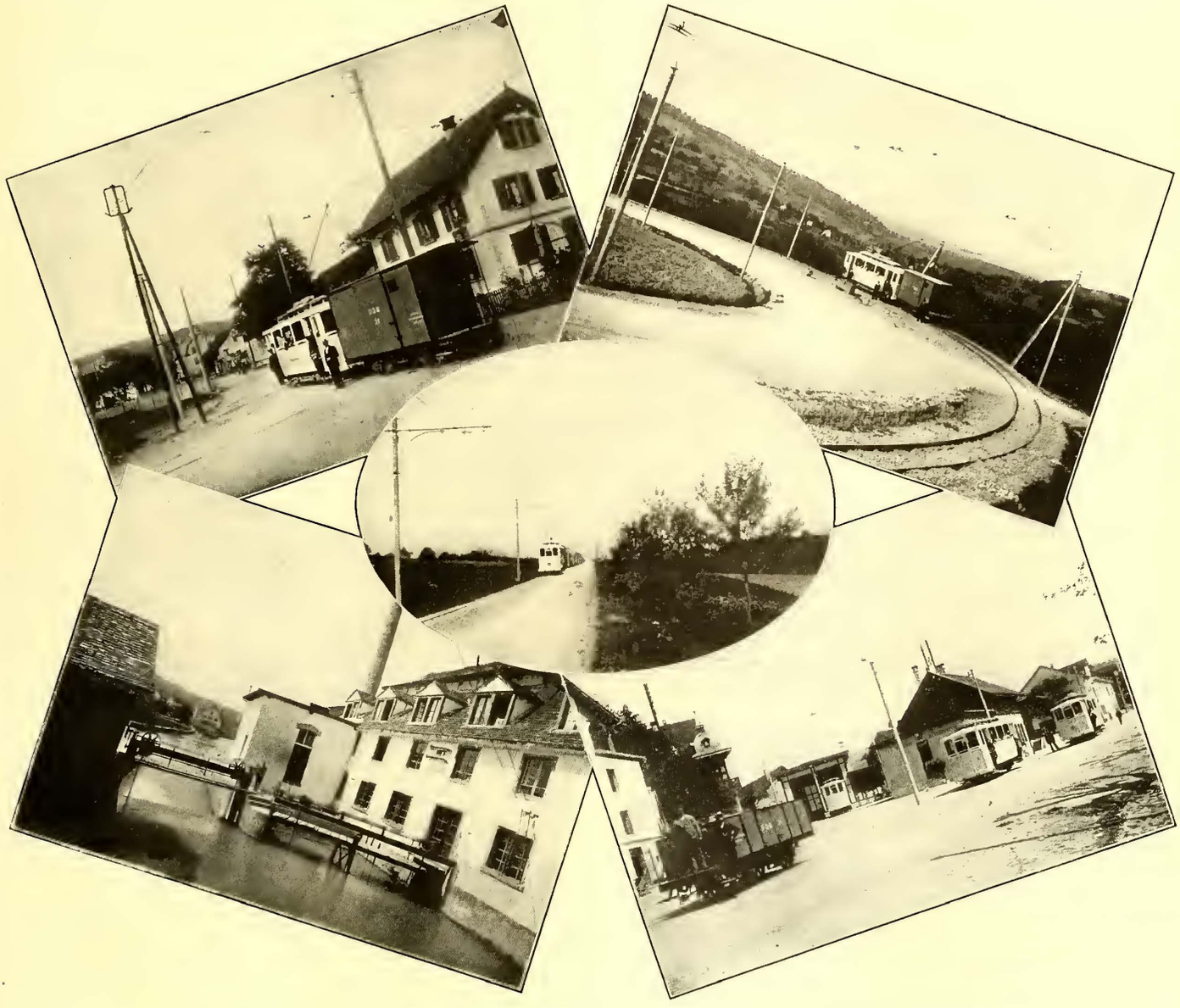
The maximum grade is 6 per cent for a distance of 90 m, and is close to the town of Dietikon. The average grade on the entire line is 3.15 per cent.

The track is substantially laid on a ballast of broken stone, on which is a dressing of macadam, having a total thickness of from 25 cm to 30 cm, and a width of 2 m. In the cities, where paving is required, the rails are laid on a sub-base of concrete.

Within the cities and towns girder rails are used. These rails have a weight of 30.46 kg per meter, a height of 115 mm, a base of 88 mm, and a groove of 30 mm in depth. The rails are rolled in 12-m lengths. The ties, which are of iron, are 1.50 m long, weigh 25 kg each, and are spaced eleven to the rail length in straight track and thirteen to the rail length on curves. The weight per running meter of track, angle-plates, ties, bolts, etc., is 88 kg.

The Vignole or T-rail used on the company's right of way have a weight of 24.2 kg per meter, a height of 110 mm, a base of 90 mm, and a web of 9 mm thick. These rails, which are also 12 m in length, are laid on ties which are spaced fourteen to a rail length in straight track and fifteen to a rail length on curves. The ties are of the same length as with the girder rails, but weigh 5 kg less apiece. The total weight of this track, with angle-plates, etc., is 75 kg per meter. There are eleven switches required on the section laid with girder rails. The curves have an initial radius of 40 m. There are only two switches required on the T-rail section, and these have an initial curve radius of 50 m.

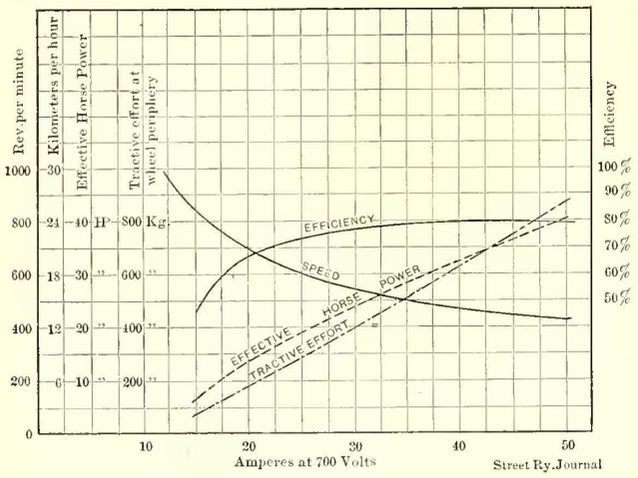
In Bremgarten a waiting station has been erected, which includes not only rooms for passengers, but also the office building, residence and restaurant, together with a freight station. Adjoining this office building is the car house for four motor cars with the repair shops. At several stations along the line of route attractive waiting stations have been erected, combining a freight station, waiting room for passengers, office and residential rooms for the station master. There is also a small car house in Dietikon.



EXAMPLES OF OVERHEAD AND ROADBED CONSTRUCTION, THE POWER PLANT AND PASSENGER STATIONS

Power is derived from the lighting station in Bremgarten, for which purpose two generators have been installed. These are driven from a turbine by means of a belt. Friction clutches allow each generator to be thrown in and out of connection with a common pulley, so that either machine can be driven. Usually one generator answers for the power demands of the line. The generators are of the standard compound four-pole railway type of the Oerlikon Maschinenfabrik, having an output of 35 hp each, and running at 170 r. p. m., with 750 volts pressure. The armature has a diameter of 520 mm. In each of the slots are two coils, consisting each of 2 x 2 conductors, of which each consists of two parallel wires of 2.8 mm x 3.4 mm. The commutator has a diameter of

380 mm, a width of 75 mm and 199 bars. The field winding on each pole consists of 3720 turns, of 1.3 mm x 1.5 mm wire for the shunt coil, and 13.5 turns of 0.5 mm x 105 mm copper band for the series coil. The weight of the machine, with base plate, is 3090 kg, and that of the armature 825 kg. The machine has an efficiency of 91 per cent on full load, 88 per cent on half loads, and 76 per cent on



CHARACTERISTIC CURVES OF OERLIKON MOTOR

quarter loads. Adjoining the engine room is a storage battery installation for the balancing of the load. This consists of 400 cells, with a capacity of 123 amp.-hours, at the one-hour discharge rate. The switchboard is of white marble on an iron frame.

There are two feeders from the power station, each consisting of a bare cable of 100 sq. mm, connected to the trolley wire at five points. The length of feeders, which are protected by lightning arresters, is about 3 km. The trolley wire has a diameter of 8 mm, and is carried about 6.4 m above the track. Four section insulators are employed, and the trolley wire is protected by thirteen lightning arresters. Both span and bracket overhead construction are employed, and the trolley wires are trebly insulated. The poles are of impregnated wood. They are from 8 m to 9½ m in length, and protected and ornamented by cast-iron caps. About 470 poles are employed. The voltage on the line is 70.1.

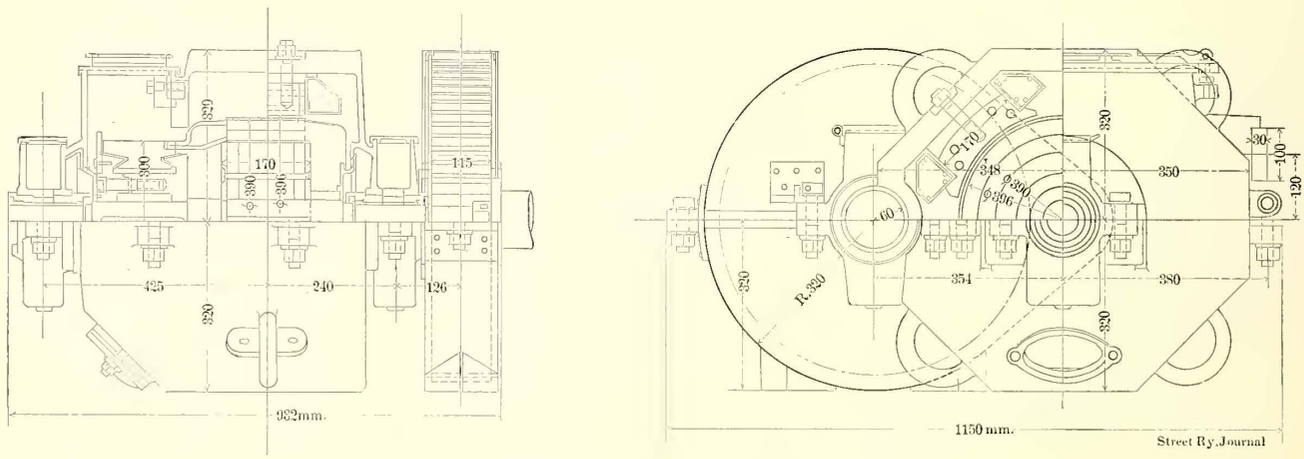
The rolling stock consists of three motor cars, three passenger trail cars, and two open and two closed freight cars. The motor and trail passenger cars have accommodations for eighteen sitting and ten standing passengers. The length of these cars over buffers is 8.1 m. The cars are mounted on single trucks, with a wheel base of 2 m. The wheels are steel-tired. The cars are furnished with wheel guards and ratchet hand-brakes. The motors are designed to carry a car up a grade of 5 per cent at a speed of 12 km per hour for a maximum grade length of 697 m, hauling a loaded trail car.

The motors are of the enclosed type. The armature has a diameter of 390 mm. Each of the forty-five slots, which are 41 mm x 11 mm, contains thirty-six wires of 2.4 mm x 2.65 mm. The commutator is 265 mm in diameter, 115 mm wide, and has 135 bars. The field coils have 138 turns, of 4.6 mm x 5 mm wire. The gear reduction is 1 to 5. A series parallel controller is used with electrical and short circuit brake, and is fitted for the connections with electromagnetic brake. On each car are seven lamps, of which six only are in use at one time, viz.: two headlight lamps, two single lamps and three lamps for the interior illumination of the car. The cars are also equipped with electric heaters, and the motor cars are equipped with electric couplings for the lamps, heaters and electromagnetic brakes on the trail cars. The freight cars are also equipped with electromagnetic brakes.

The entire installation was made by the Maschinenfabrik Oerlikon and Locher & Co., of Zurich, and cost 318,600 francs.

Electric Railway for Havana

The plan of the Havana & Janitos Railroad Company, mention of the incorporation of which was made in a recent issue, is to build at this time an electric railway in Havana, with lines to Maraniac and Jaimanitas Beach, about 10 miles from Havana. The first concession that the company secured in Havana and from the Railroad Commission of Cuba gave the company the right to build from the Public Square, Havana, to Marianao and Jaimanitas



END AND SIDE ELEVATIONS OF OERLIKON MOTOR

Beach, but the company has recently applied for additional grants in Havana. It is the desire to build a line that will extend from the Public Square, pass the custom house, post office and other public buildings and give a direct and independent entrance to the city. This would secure for the company considerable local traffic and enable it to carry suburban passengers to their destination with a minimum of discomfort. It is planned to begin construction work as soon as it is possible to get the materials on the ground. Offices will be opened in Havana at once.

In connection with the plan of the company to build the proposed railway, it is said that interests identified with the company have acquired 100,000 acres of land about 40 miles west of Havana, which it is proposed to develop for building purposes. To carry out this work the Cuban Land Company has been organized with J. W. Hayes, of Cleveland, as president.

The Graphical Representation of Street Railway Statistics

BY W. C. GOTSHALL

The profits in electric operation depend upon so many factors that the operating manager necessarily must watch very closely every item of expenditure, and be especially careful that the profits do not pass insensibly away through the uneconomical administration of some one or more departments. Fortunately, street railway operation is now so well systematized that it is not difficult to determine whether one department or another is costing too much, provided accurate records are kept and studied, not only with regard to themselves, but also as compared with those of preceding years. The keeping of the records is a comparatively easy task, but it is doubtful whether the full benefit is always obtained from statistics of this kind. Figures of the cost of power house operation, car repairs, trainmen, etc., are in many cases received by the operating manager and are filed away until a time when he shall have a chance to digest them, but this time rarely comes. Again, it is often difficult to grasp fully the significance and the relation to each other of vast numbers of figures spread over three or four tables; and even if the manager himself has the time and the knack of fully understanding these figures and the effect of one item upon another, it is frequently an entirely different thing to impress their significance upon his directors or executive board. The result is that many busy men have come to look upon statistics, "the kilowatt-hour per car mile," "the car miles per passenger carried," "the train expenses per car hour," as calculations which absorb more time than the value warrants, and as introducing a routine of red tape which is almost useless.

Most of the objections to these calculations disappear, however, when, instead of tabulating these statistics, we use a graphical method of recording and comparing them.

Early in the nineties, while seeking a method to analyze the variable costs of the different items entering into the operation of railroads, I devised and used what I then called the graphical method. This method simply consisted in the plotting of the variable expense items upon sheets of co-ordinate paper. To illustrate, taking the car mileage of any given system, and having the receipts per month, the cost of car repair per month, the cost of power house expense per month, the cost of conducting transportation per month, the cost of maintenance of equipment per month and the car mileage for the corresponding period, each of these items was plotted separately by using the axes of abscissæ to represent the various months or other periods of time, and by using the axes of ordinates to represent the cost. By taking a sufficiently large scale on the axes of ordinates, the variations or changes in value are amplified

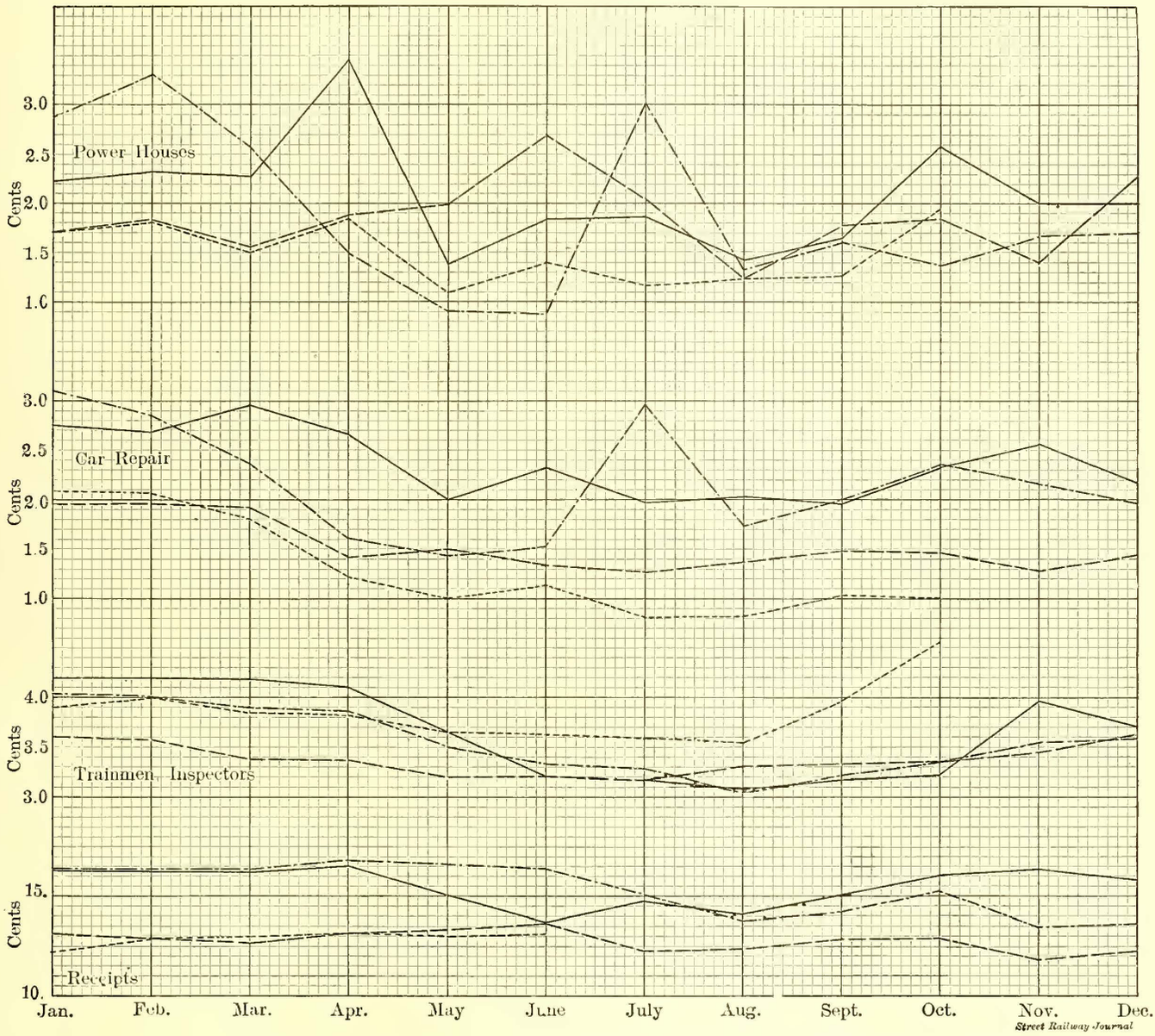


FIG. 1.—DIAGRAM SHOWING METHOD OF PLOTTING STREET RAILWAY OPERATING STATISTICS

and made more evident. Hence a slight variation in the unit cost can be made readily apparent. This is very desirable in the case of the road having a large car mileage, since a slight variation per unit would, of course, mean a considerable difference in the total operating costs for any given period. Subsequently, this system was taken up and developed quite extensively by M. K. Bowen, formerly president of the Chicago City Railway Company, and myself. A great number of curves were prepared, showing the several items entering into the operation of a street railway.

There is shown herewith in Fig. 1 a series of curves which were obtained from the Union Depot Railway Company of St. Louis for the years 1892, 1893, 1894 and 1895. In these diagrams the records for corresponding years are shown by the same kinds of line, that is, the solid lines indicate the records for one, dotted for another year, etc. In an actual notebook or manager's record, it is better to distinguish between the years by lines drawn in inks of different colors. An examination of the diagram will also show that it is not necessary to have a base line of zero for each set of lines, but the ordinates can be selected so that the curves for the different departments will be comparatively near each other without overlapping. This has two advantages; it takes up less room and a comparison between the fluctuations can be much more easily made by the manager. My connection with the Union Depot Railway Company commenced in 1895, but for the purpose of ascertaining what had been transpiring, I collated and plotted the data for the preceding years. The results given are undoubtedly of great interest, not only as showing the operating cost in any period, but by showing the readiness with which any variation in the operating cost can at once be made apparent. This system of plotting data was used in every branch and department of the Union Depot Railway Company; that is, all of the subordinates were compelled to show their results in this manner. The effect is remarkable, for it is only necessary to explain to an individual the meaning of the rise of a line to put him on the *qui vive* and cause him to exert every effort to avoid a repetition thereof. The advantages of the graphical method will at once be apparent, when it is remembered that the old method contemplated long rows of figures, which differed but slightly, and which did not show readily the marked differences that a slightest difference per car mile produces upon a road having a considerable car mileage.

Another advantage of the system is that the relations between the various curves can easily be determined and the nature of the defect, if any exist, detected. For instance, we can take a chart similar to that shown in Fig. 1, but indicate on it by one line the kilowatt-hours per week or per month, and by another line directly above or below it the pounds of coal burned during the same periods. If the station efficiency is constant, that is, if the same number of pounds of coal are burned to produce a kilowatt-hour each week, the kilowatt-hour line and the pounds of coal line, if plotted, one above the other, will remain the same distance apart, although each will have fluctuations depending upon the output. If, however, through the use of an inferior quality of coal, or from some other cause, the station production becomes less efficient, the result is instantly shown by the coal line approaching closer to the kilowatt-hour line if it is below the latter, or departing from it, if it is the upper line. This change in direction instantly points a moral which would be equally shown, of course, by a table, but would not be so visually evident. If we wish to carry the work still farther, other lines can be added to the same chart, or drawn separately to show "car miles run," "passengers carried," etc., and each will point its lesson.

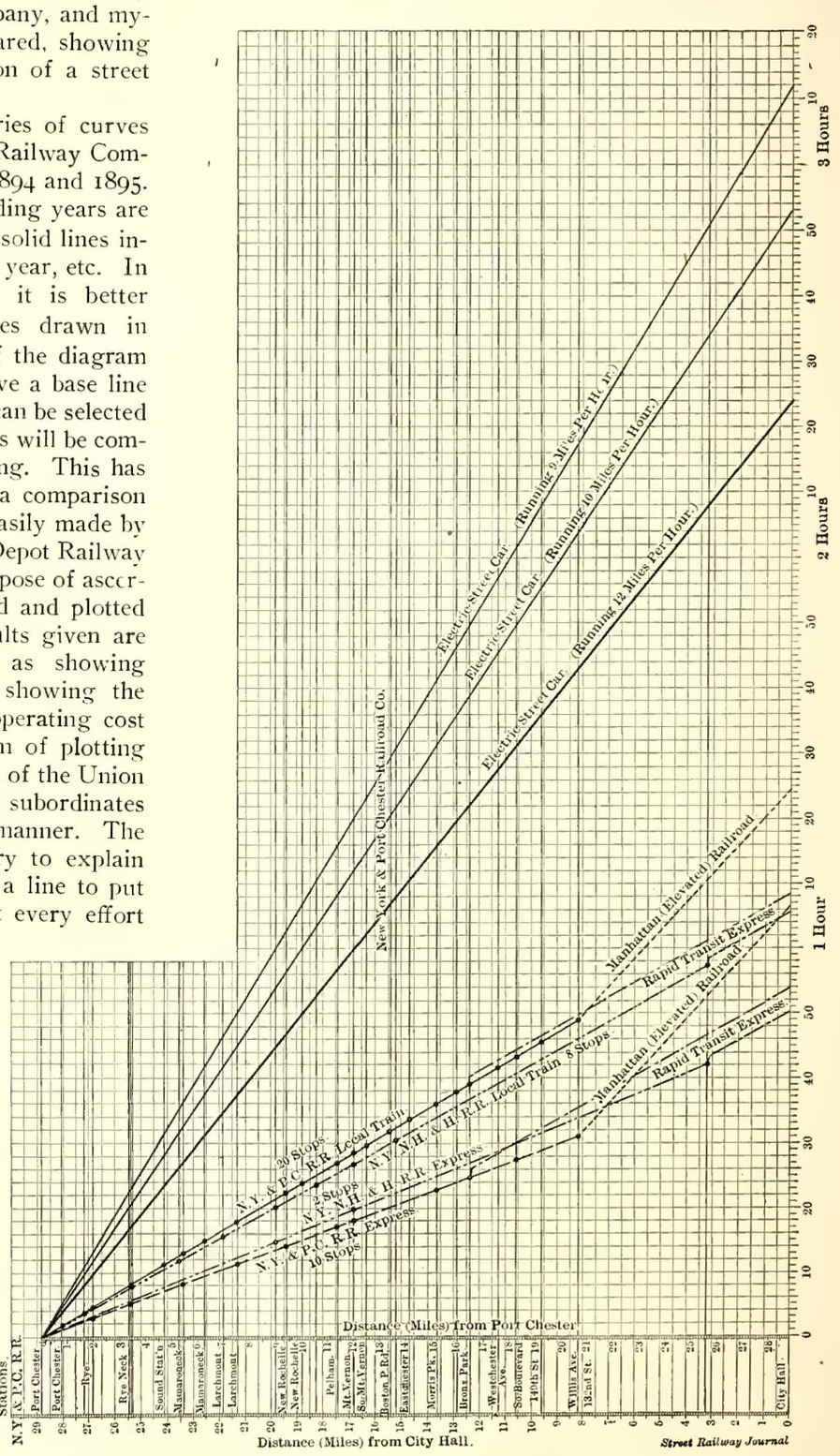


FIG. 2.—METHOD OF GRAPHICALLY ILLUSTRATING VARIOUS RATES OF SPEED

For instance, if the "kilowatt-hour" line plotted by weeks or months is below the "car mile" line and approaches it, it discloses the fact that more power is being taken per car mile than formerly. If the cars are of the same size and carry practically the same loads at the same speed, the inference is that there is some difficulty in the transmission system, and an investigation of the rail-bonds, overhead line or car equipments is in order.

This method can be applied to any system of variable quantities. In the case of an electric light station, it would be but necessary to reduce it to a kilowatt hour basis, and every quantity entering into the cost of the operation of such a station can be applied by using time as abscissæ and cost as ordinates, and any variation in such quantities readily and strikingly shown by making the scale large enough.

This system I have also used in comparing the costs of operation, as well as the earning and other data of several street railways throughout the country. The data is applied upon the ordinary co-ordinate paper; the paper is then mounted on linen, and a number of sheets relating to any sets of data are then bound in book form. For the purpose of showing the exact costs which might be difficult to interpolate upon the sheet of co-ordinate paper, the actual figures are all tabulated and also bound in the same form.

The graphical method was used extensively in the development and representation of the details of the New York & Port Chester Railroad Company before the Railroad Commission of the State of New York in the application of this company for the certificate of the Railroad Commission. One of these charts is reproduced in Fig. 2, whereon are shown the different times occupied by different transportation systems in passing from Port Chester to New York city. The variations are readily seen and appear at once, not only to an engineer, but to laymen interested in such matters. The graphical method is essentially a pictorial representation of such a nature as readily to impress any differences upon the mind.

While the analysis of results may seem comparatively complicated when expressed in type, it will be found not only most simple of comprehension, but as occupying very little time, when the graphical method of comparison and analysis is employed. Co-ordinate paper is now not only cheap, but easily to be obtained in almost every city, and the time required to draw in the lines on a sheet of this kind takes certainly no more time than to keep the figures in a book, and as the records of several years can often be superimposed on each other to advantage, as shown in Fig. 1, the chart occupies very little space.

I also desire to call attention to the fact that while the advantages of the graphical method are so apparent for the keeping of records of street railway and electric lighting enterprises, its applicability does not, by any means, cease there. The method is, of course, invaluable to any engineering office. Its applications for the use of engineers are innumerable, and its value is almost inconceivable. One of the interesting applications of this method is in representing train schedules. In the STREET RAILWAY JOURNAL of December, 1901, there appeared one of the train schedules of the New York & Port Chester Railroad Company, wherein the entire representation was made by means of the graphical method. In its application for this purpose the axes of abcissæ are, of course, used for time, and the axes of ordinates for distance. On the axes of ordinates, at their proper distances from the starting point, are, of course, indicated all the stations. The intersection of a line through any station parallel with the axes of abscissæ with any given run line will, of course, instantly show the exact time at which any car leaving the terminus would pass any station. This can be readily seen by referring to the diagram in the December issue of the STREET RAILWAY JOURNAL for 1901. In addition thereto, its application to almost any business is oftentimes of great advantage. All industries reduce the items of cost of production or output to some unit basis. In the course of a production of any article of necessity, the units will vary and the cost per unit will vary with different seasons of the year and with the variable cost of raw material, etc. These variations can be strikingly shown by a system of plotting similar to that here shown for the Union Depot Railroad Company, and any differences noted and checked before such differences assume serious proportions.

Transformers for Testing Railway Armatures

One of the most troublesome faults to detect in a railway armature is the short-circuited coil; that is to say a spurious contact between two adjacent commutator bars or the wires connected to them. This trouble should be sought for in a recently completed armature and its possibility thoroughly eliminated before it is placed in a machine. There are numerous causes. Careless soldering is a prolific trouble, as extra solder may get in behind the lugs and bridge them. Carelessness in insulating the leads may also give trouble, and in several other ways the difficulty also obtains. The resistance of the armature coil is so low

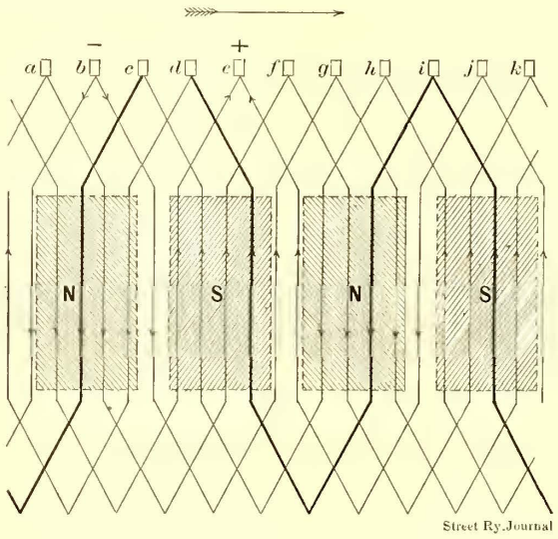


FIG. 1.—DIAGRAM SHOWING WAVE FORM OF WINDING

relatively to the short-circuit that the device of measuring the resistance between adajcent commutator bars all the way around the commutator, fails unless applied with moderate care, and moreover testing the resistance with instruments of any kind is an operation too delicate for the rough-and-ready methods employed in a street railway repair shop, where too often the only testing equipment to be had is two terminals directly connected to the 500-volt service and protected with five lamps in series.

Where alternating current is available, it provides an easy means for detecting short-circuited coils or even coils liable to short-circuit, and is sometimes employed for that purpose. To understand the principle of the apparatus it would be well to consider Fig 1, which displays a four-pole wave winding such as is used on all modern street railway armatures. The shaded surface in the developed plan represents the pole pieces, and the lines together with the small rectangles represent the armature wires and their connections to the commutator bars. It is of course a well-known fact that as this structure revolves under the pole pieces electromotive forces are generated in the wires in the direction shown, and if for any reason there should be a spurious connection between the commutator bars *c* and *d*, or the wires connected thereto, a very heavy current would be generated in the short-circuited coils shown in heavy lines in the figure. This current would be sufficient to burn the coil out if the field were strong enough and the rotations fast enough, and this is exactly what would happen if the

armature were operated practically; therefore this is a contingency to be avoided.

It is very plain that if the armature was rapidly rotated through one polar span first in one direction and then in the other, an alternate current would be generated in the short-circuited coil, which if the motion were sufficiently rapid and the field strong enough, would produce the same result. The short-circuited coil would make itself known by reason of its becoming hot. If the field magnets of the motor were excited with alternate currents, this would have the same effect as oscillating the armature, for the north and south poles would be rapidly exchanging positions. The alternate current method is much more convenient, for it permits of an inspection of the armature while subjected to the alternating flux, and with ordinary frequencies, say sixty cycles, the alternations obtain with more than seven times the frequency that obtains with regular rotation in the field, permitting the use of a lighter and more convenient field magnet on account of the fact that a lesser

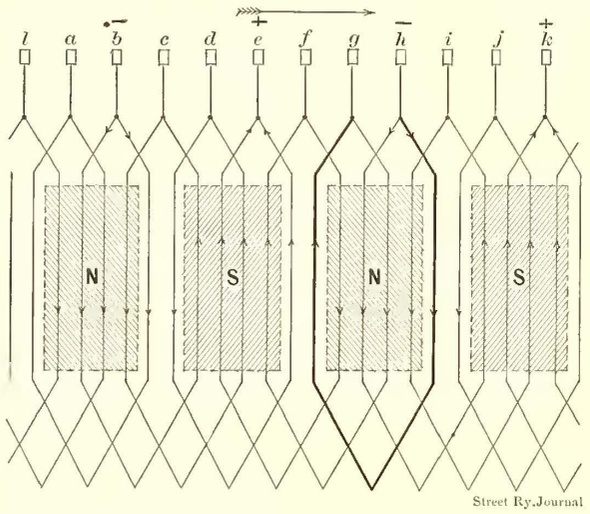


FIG. 2.—DIAGRAM SHOWING LAP FORM OF WINDING

flux will produce equal results under these conditions. Moreover the special magnet core can be built to accommodate many types of armature.

An inspection of the diagram will show that if only two of the pole pieces were thus excited, an e. m. f. would be generated in the coil, and the only effect of omitting the other two pole pieces would be that no e. m. f. would be induced in the wires under them, and current would flow in the short-circuited coil due to half the e. m. f. that it had before, which would be sufficient to warm up the coil and thereby detect its short-circuited condition. Thus one-half of a motor casing could be arranged to be excited with alternate current, the armature could be very readily laid in the same and slowly rotated by hand, and as the short-circuited coil came under the influence of the alternate flux of magnetism, it would warm up and betray its presence. It would thus be possible to test a great many armatures very rapidly and make sure that they were perfect before putting them in the machine for service.

Unfortunately for the simplicity of this arrangement it must be stated that the motor case is not properly constructed to be thus excited by alternate currents. A large portion of its structure is solid and the eddy currents that would be induced would absorb such a large amount of energy that a different design of casing for this purpose would give much better results. A mechanical consideration also enters here, for in a large railway system armatures of many sizes are to be tested and one motor casing would not fit them all, therefore a different plan is still further to be recommended although the principle that has been set forth in the foregoing may be retained.

A precautionary paragraph will be appreciated at this juncture. If an armature with a lap winding such as is used on some generators is treated in this way, the whole armature will warm up under the influence if an alternating magnetic flux be impressed at only a few of the polar positions. This will be plain on consulting Fig. 2. If for instance an alternating flux were applied to the coil terminating at the bars *g h*, it would generate an e. m. f. which would find a circuit through the balance of the winding. The wave-wound armature such as is universally used in railway motors does not encounter this difficulty, for even if alternating flux is applied at only one polar position, it

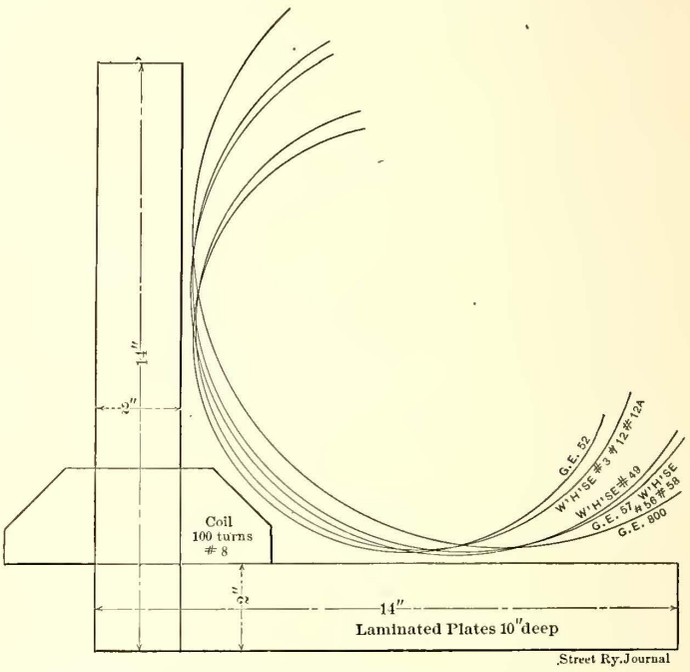


FIG. 3.—SIDE ELEVATION OF TRANSFORMER, SUITABLE FOR TESTING RAILWAY MOTORS

generates an e. m. f. in one coil which is balanced by an equal e. m. f. in an adjacent coil which it will be seen is located in the circuit through which the first coil tends to flow a current in such a way as to oppose and neutralize the flow.

A suitable alternate current magnet for such tests is shown in Fig. 3. It is made of 2-in. sheet iron strips and has a magnetic area of 20 sq. ins. The form of the magnet is right angled so that several sizes of armature, as shown by the circles, will be accommodated, and fluxed at points 90 degs. apart. The winding consists of 100 turns of No. 8 wire and will take somewhat less than 15 amps at 110 volts on a 60-cycle circuit. When testing an armature this energy will be mostly wattless as the power factor will be very low. The procedure should be as follows: First place the armature in its bearings above the magnet and apply the magnet poles, as nearly as the mechanical adjustment will permit. Second, cautiously turn the alternating current into the magnet by means of some rheostatic or reactive device, in the meantime slowly revolving the armature by hand and feeling of the coils as it revolves. After several revolutions have been made the current can be gradually increased to a predetermined maximum, and if no hot coils are found in the armature it may be pronounced free from short circuits. The current should then be shut off and the armature removed, when the apparatus is ready for the next trial.

The current taken by the coil will vary with the iron used in the magnet and particularly with the distance between the magnet and the armature during a test. With

the armature entirely removed the current will increase to several times the testing value and hence it will be well to cut off the current before removing the armature and to protect the testing circuit with an appropriate fuse.

This method has the advantage of not only detecting a short-circuited coil but one that is likely to short-circuit, for at maximum magnetization an e. m. f. is generated in the individual coil, thereby impressing upon the insulation between bars and the wires connected to them a pressure which may break down a faulty place and permanently establish a short-circuit at the weak spot. This of course is much better than to have the same trouble occur when the machine is in practical operation under a car. For this reason the device is superior to a resistance test which would have difficulty in detecting a latent trouble of this character.

Removal of Sleet from a Third Rail

BY GEORGE T. HANCHETT

A formidable obstacle in the case of overhead trolley work is that presented by clinging sleet. In third-rail systems this is a much more serious consideration, and it forms an almost fatal stumbling block to the sectional conductor systems. The sleet to which we have reference is not the shaling ice which sometimes coats the rail, and which will crumble and drop off with a blow, but is more like a coat of varnish. A blow with a sharp instrument, such as a chisel, makes a very narrow mark the thickness of its edge. Another mark ⅛ of an inch away leaves a little strip which can only be removed by prying off with a sharp point, as a pen-knife. This ice is formed at times when a light rain falls immediately after a cold snap. The metal work of the rails and wires and the lower stratum of air is below 32 degs. F., and as the rain falls into this zone it naturally freezes tightly to anything that it touches. When this occurs on a third rail even only once or twice during the year it forms a serious obstacle to traffic, and an efficient remedy is worthy of consideration.

It is hardly necessary to say that many methods have been tried. Scrapers of many forms have been used with very little success, for those that bear on the third rail hard enough to do any good and at a sufficiently sharp angle to scrape properly, are promptly broken off their supports when they strike the rail-joint.

The overhead trolley has less trouble than the third rail, partly for the reason that in operation it is bent slightly as the trolley wheel passes along it, which tends to crack the sleet off, and partly because its small area enables the currents which it carries to raise its temperature, and a very little rise in temperature suffices to prevent the ice from freezing to it. This suggests a plan whereby the third rail might be relieved of this obstacle, which is so serious as practically to tie up traffic for long periods of time. The expedient is unusual, but great evils justify unusual remedies and possibly the one to be suggested.

The plan is, briefly, to construct the line so that the overhead feeders to the third rail can be switched over and made to reinforce the ground return, thereby causing the third rail to carry full current. This, of course, causes a great drop in the third rail and an undoubted reduction of schedule speed. But if the plan is properly carried out the temperature of the third rail will be raised 8 degs. or 10 degs., which will suffice to melt the sleet already upon it and prevent the freezing of any more thereon. The proposition is rather a bold one, and it is therefore interesting to get down to figures. The specific heat of iron is .1298, that is to say, it requires .1298 B. T. U. to raise 1 lb. 1 deg. F. For 10 degs. we would therefore require 1.298 B. T. U. per pound, or in a 60-lb. rail 77.88 B. T. U. per yard. A mile of third rail would therefore require 137,000 B. T. U., from which it may readily be computed that about 3200 hp would be required to put this heat in the rail in one minute. In ten minutes, however, 320 hp would be sufficient, and if the current could be applied for an hour a little over 50 hp would suffice. Radiation need not be considered in this case, for the temperature of the third rail to start with is assumed to be lower than the surrounding air, otherwise the rain would freeze or turn to snow before it touched the rail. Consequently up to the temperature of the surrounding air the rail will retain all of the heat that it receives. A few degrees above the temperature of the air will cause very little loss of heat by radiation, and in times of sleet of this character all objects in the vicinity are gradually rising to a temperature above 32 F. Furthermore, it must be considered that in supplying 320 hp to the rail an additional amount must be impressed in order to make up for the losses in the return circuits. It would, perhaps, be better to consider a concrete case.

Assume that by properly switching over the third rail feeders to reinforce the ground return we could divide the 500 volts as follows: 10 per cent in the return, 40 per cent in the mile of third rail, and 50 per cent in the operating equipments. This is not an impossible condition of affairs, but would require a thick rail of small action and will reduce the speed of the equipments about three-eighths of their normal velocity, this figure, of course, being subject to modification according to the normal arrangement of the feeders with reference to the third rail. This arrangement would require that about 1000 amps. should flow in the third rail, the equivalent of about four ordinary elevated trains, in order to clear away the sleet in about ten minutes. Lesser amounts of power would suffice if more time for clearing away the sleet could be taken. In any event it does not seem difficult to believe that a railroad management would gladly submit to this condition of affairs for about one-half an hour or more to get rid of the coat of sleet on the third rail, which would otherwise delay the entire traffic.

Another method of applying the same remedy, which is, perhaps, more convenient and universal in its application, is the use of a transformer car. This car should be equipped with heavy shoes, capable of making substantial contact with the third rail and located as far apart as it is convenient to place them. This car should take current from the third rail and pass it through the direct-current side of a rotary converter to ground. The alternating-current side of the rotary converter should feed the primary of a static transformer, the secondary of which is designed for appropriate voltage, and has for its terminals the two shoes of the car. Such an arrangement could readily be designed to pass 2000 amps. or more through the third rail long enough to melt off the sleet and to raise it to such a temperature that it would not be likely to become coated again. This device permits the method to be applied on isolated sections of third rail, and does not confine it to continuous length, as does the other plan, and, moreover, does not require rearrangement of feeders, which in large systems would involve extensive and complicated switching. Furthermore, it will not produce a general reduction of potential on the line. It would require to have very heavy shoes and to run slowly, but it could precede a motor car, thereby leaving a clean third rail for the motor car to traverse. The shoes, while bearing heavily on the third rail, should not be too large, for it

is desirable that they become warm, in order that they may melt through to a contact surface.

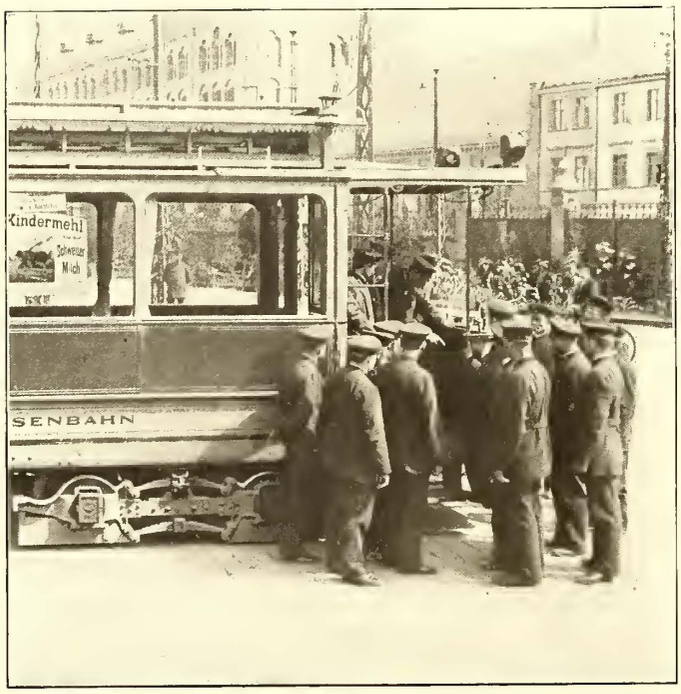
Summing up the situation, it may be said that the application of this method is by no means impossible. The necessary amounts of power are not ridiculously large, and are in all cases available where the installation is heavy enough for third-rail work.

How the Berlin Press was Educated in Street Railway Operation

BY LOUIS J. MAGEE

The company which owns practically all the street railways of Berlin, having always been the subject of criticism in the daily papers, decided about a year ago to educate the press so that future criticism would at least be fair and intelligent, if not entirely free from enmity and prejudice.

The plan adopted consisted in a "trolley ride" through the city from a special meeting-place to one of the car houses outside of the city. Representatives of the press in general were invited, the managing directors were on the ground to receive their guests, and the conductor, instead of collecting fares on the way, busied himself with passing a box of cigars. At the car house the newest types of cars and trucks were explained, experiments were made



INSTRUCTING A CLASS IN THE USE OF THE CONTROLLER

with various types of fenders, straw dummies being used for the purpose; and the course of instruction for the motormen was illustrated by putting a class through an oral examination. The party was also shown, on a neighboring street, interesting experiments with various systems of brakes. Great pains were taken to give the information in a popular way and to explain to the journalists the actual difficulties in the street railway service of a great city and the constant efforts being made to meet these difficulties.

An elaborate luncheon was then served in the car house and the general manager made a sensible speech, calling upon the members of the press to do their part in warning, helping and informing the public regarding the great transportation system upon which it is so dependent.

The success of the affair proved the advantages of introducing the public to the details of street railway work, and a second meeting has just taken place along the same lines. On this occasion the visit was to the chief repair shops, situated in another part of the city, and an entirely new set of object lessons was given. One of the most interesting features was the first horse car, No. 1, built in 1865. Another feature was a long row of fenders of discarded types. Trucks without car bodies, completely mounted with motors, air compressors and electric brakes were explained in popular language. The methods of disposing of windows to change a closed into an open car were also shown, and a

A CLASS ROOM FOR MOTORMEN IN BERLIN

walk through the extensive shops showed car bodies, armatures, controllers, etc., in every stage of repair.

The past autumn has practically marked the cessation of horse traction in Berlin, although a few cars, especially outside of the town, have still for a few months longer to be drawn by horses.

In 1893 only 182 men were engaged in keeping up the rolling stock, whereas there are at present 1060 repair shop men, of which 630 are in the main shops. In 1895 there were 1087 cars, and at present 2766, about half of which are motor cars, the other half trailers. These figures would be somewhat increased if the rolling material of another line which is owned by the company were included.

The development of electric traction in Berlin has been very rapid. Hamburg and other cities of Germany were comparatively progressive, but the introduction of the overhead trolley system presented difficulties for the chief residence city of the King, which the authorities could not see their way to overcome.

In 1896 two lines were equipped with trolleys, with the addition of certain stretches of conduit. These latter gave enough trouble (as they were isolated short pieces of conduit) to make the system seem impracticable for any great distance. The mixed system with accumulators, which had given external appearances of success in Hanover, was then adopted in Berlin. But it proved a failure, and familiarity with the trolley construction, which in Berlin has always been first-class, combined, perhaps, with some changes in the city government and more liberal views in general, brought about much more toleration. The result was that to-day the accumulators are all being thrown out and the few pieces of track over which the trolley is not allowed, about a mile in all, are being equipped with conduit. The system was equipped by the Union Electricitäts Gesellschaft.

CORRESPONDENCE

The Zossen Test

Milan, Italy, Sept. 6, 1902.

Editors Street Railway Journal:

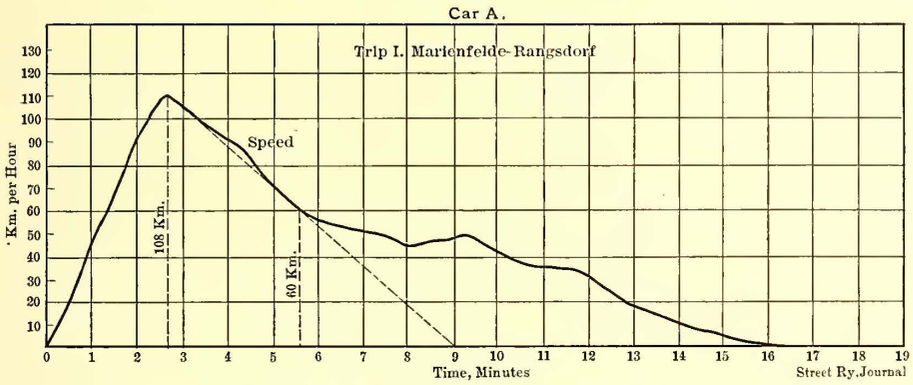
I have just read in the August number of your paper the abstract which you published of the lecture of Mr. Geh. Baur. Lochner on the experiments with high-speed electric traction on the Berlin-Zossen line, and I take the liberty of making certain suggestions in regard to the method followed during that test in calculating the train resistance of car A, taking as the basis the coasting-speed curves.

Mr. Lochner proceeds upon the assumption that the speed diminishes uniformly and in consequence concludes that the resistance per ton is 3.6 kg, although the formula

$$\left(2.5 + \frac{V^2}{1300}\right)\frac{Mg}{1000}$$

gives a value of 5.4 kg.

But it is very evident from the diagrams showing the coasting curves that the retardation is not a constant quantity. It can only be considered as constant between velocities of from 108 km to 60 km per hour.



TIME SPEED DIAGRAM OF CAR A IN ZOSSEN TEST

This will be seen by an examination of the upper curve (Fig. 2) in the article which is reproduced herewith. If now the tangent to the upper part of the curve is prolonged to the axis of the abscissæ, as has been done by the dotted line in the accompanying cut, it will give the time necessary for making a stop, provided the retardation is constant and equal to that which it has been proved to be at a velocity of about 100 km per hour. If this is also done on the second coasting-curve and we take the average of the two times of stopping, we must reach the conclusion that the car would have been stopped in 360 seconds under the conditions assumed. In other words, the train resistance at these higher velocities would amount to 8.85 kg per ton instead of 3.6 kg as given.

It is possible to check this value of 8.85 kg for the resistance of the car, with the figures given as to the power absorbed from the power station. From the diagrams published with the article it will be seen that at a speed of 120 km per hour the cars A and S absorbed from 400 kw to 500 kw from the power station. If the efficiency of the line with that of the transformers and motors is taken as about 70 per cent., which would be approximately correct, the conclusion is reached that it is necessary to supply to the periphery of the wheels from 280 kw to 350 kw, from which by a very simple calculation it will be seen that the resistance of the cars at 120 km per hour amounts to from 8.10 kg to 10 kg per ton.

From this I am lead to believe: (1) The value of 3.6 kg as derived by Mr. Lochner is too small and is opposed to the results obtained during the Zossen trials; and (2), that the total resistance of the cars at a speed of 120 m per hour was about 9 kg per ton.

A. Panzarasa.

The Lighting Circuit of the Car

New York, Oct. 20, 1902.

Editors Street Railway Journal:

The subject of railway lighting circuits is one which seems to the superficial observer stale and unprofitable. Combinations of five lamps in series seem to cover the situation, a summation of data containing nothing startling. The arrangement, however, has its objections. If one lamp goes out four others share the same fate. The wiring is all high-voltage work, and the repair man has trouble with it, even if the passenger does not. The slender filaments do not withstand either the jar or the varying voltage, and last, but not least, the light is notoriously bad when the car is pulling heavily at distant points on the line. We will preface further remarks by the words "storage battery," so that any readers of your journal who are prejudiced against the battery can pass to the next letter and leave what follows to the perusal of those who really want better light at very little additional trouble and expense.

The storage battery is to consist of five cells. Its negative terminal is to be grounded and its positive is to serve as the ground for all power circuits on the car. All current must pay toll to it before reaching the ground. The lamps are to be connected around the storage battery. Now for a discussion of the results.

In the first place the battery is automatically charged; in fact, on a car that is doing any business the battery is charged so often that sulphating is practically out of the question. Buckling, too, is eliminated, because the rate of charge and discharge never exceeds a certain quantity to which the battery may be proportioned. Even if the battery should suffer serious loss of capacity it could scarcely be placed *hors de combat*, because most of the time its voltage would be maintained by the car current, and the time that it would be compelled to deliver current on its own account would be relatively very short. This, of course, would be true only of a car doing active urban work, in which case the battery could almost deteriorate to the condition of a counter regulating cell and still give a service which would be satisfactory.

An occasional renewal of the electrolyte and a cleaning once a year would practically constitute the maintenance. What is to be had in return for this trouble? First, a multiple system of lighting not limited to lamps of uniform candle-power or multiples of five. Second, a system independent of feeder potential, which means uniformly brilliant lamps at all times. Third, short, stumpy lamp filaments practically impervious to vibration and better able to withstand varying potentials. Fourth, lights at all times even if the trolley is off, or the circuit breaker is out, a consideration in headlight work. Fifth, a reliable low-voltage source of potential for all bell work on the car. Lastly, a low-voltage system of lamp wiring safe to handle and not likely to ground. Is this sufficient compensation? There are, of course, many cases where it will not be, but perhaps a few exist where it will be worth a trial.

R. P. Gorham.

STREET RAILWAY JOURNAL

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After a somewhat protracted investigation the Railroad Commissioners of Massachusetts have officially placed the blame of the unhappy accident in which President Roosevelt was injured upon both the motorman and the operating company. It holds the former responsible for running at a dangerous speed in a particularly dangerous location, and the latter at fault for not enforcing safe speed at this point in general, and condoning by the presence of a prominent official the high rate of speed in this particular instance. We hold no brief for the railway company, but it seems to us that in distributing its favors the Railroad Commission might also very properly have censured the local authorities first for failure to enforce at all times reasonable regulations regarding the speed of cars, and, second, for very inefficient precautions for the safety of the Chief Magistrates of the Nation and Commonwealth. We should by this time have learned that a Presidential guard ought to attend to business first, last and all the time, and should not consider its functions purely ornamental. The cavalry squad of tinsel soldiers that allowed a fast-running car to plunge down upon the carriage they were set to protect ought to be held up to public scorn. Fancy a German car breaking through a squad of Uhlans and bowling over the carriage of Wilhelm the Unresting.

Of course the finding of the Commissioners will sooner or later be reviewed by the civil and criminal courts in the actions which will come to trial, but the main facts stand out with unpleasant distinctness, and will probably remain uncontroverted. The car, whatever may have been its exact speed, was certainly running at a speed which the event proved to be unsafe, and it assuredly was not under effective control when approaching a crossing. Just the degree of blame that must attach to the motorman's act in this particular instance is a matter for the jury to determine, but there is no evidence to show that he was running at a speed much, if at all, higher than was customary at this particular point, or than is often the practice on other interurban roads. The assumption that an electric car has a general right of way which other vehicles infringe at their peril is one which is rarely taken in ordinary urban traction where the street cars are more often sinned against than sinning, but is a license which is often assumed in the case of fast interurban lines. The peculiar danger of the situation lies in the fact that safe operation runs into unsafe by imperceptible gradations, and may pass from one to the other before the situation is fully recognized.

The Railroad Commission has laid down in its recent finding two principles so plain that they should not be disregarded. These are: "There can be no excuse for the frequent recurrence of accidents due to collision. No plea of economy can be properly advanced in defense of inadequate equipment, and no plea of the necessity of rapid transit in defense of dangerous speeds." These principles are thoroughly sound, and few street railway men will be disposed to question their justice. They might, of course, be unwisely applied, but in the matter of rapid transit the interests of the street railways and those of the public are coincident. No community will long permit the road that serves it to be burdened with absurd limitations of speed or oppressed by unreasonable demands in the matter of equipment. On the other hand, it will not long tolerate parsimonious management or reckless running, and the road that cultivates either vice will soon come to grief.

In large distribution systems for lighting or power it is a very common device to install sub-stations whereby alternating-current power is taken from a line and converted through a rotary and stored in a storage battery. The stored power is utilized in many ways to hold up the peak of a direct-current load or even an alternating-current load by the use of the inverted rotary. In connection with such a system there is a possibility of a disaster which is far-reaching in its results and is capable of wrecking every sub-station on the line. This is a heavy inductive circuit such as would be caused by throwing in multiple with the line a large alternator or synchronizing motor without proper regard to synchronism. The result is a tremendous demand for lagging current, which reacts on the converters and wipes out the field excitation. An inverted converter is a dangerous proposition when its field is weakened by means of its drawing a large lagging current from its collector rings. Its speed rises rapidly, and the trouble is cumulative, for the lagging current weakens the field, and the weakened field permits the cur-

rent to lag more. The passing of speed from the normal to a dangerous value is a matter of seconds only. An experienced attendant who happens to be on the alert can detect the increasing speed and may be able to reach the switchboard in time to save the apparatus, but the chances are that he will not and that serious damage will follow. This trouble may occur with currents less than full-load value, and hence will not be protected by the circuit breakers. As this arrangement is so frequently used, it seems essential that adequate forms of protection be devised and exploited. The situation can be relieved by opening the alternating-current and direct-current circuits of the sub-stations. The trouble is coincident with the appearance of a very heavy lagging current in the alternating-current rotary leads, and it ought not to be difficult to provide a device whereby the appearance of this disturbing factor shall actuate the proper circuit breakers. The following method suggests itself as being a practical device.

Two small transformers are installed, one a series transformer inserted in the rotary leads, the other a potential transformer across the line. The secondaries of these two transformers are to be separately led to two independent circuits on a little two-phase induction motor of special design. As long as there is no difference in phase between these e. m. fs. there will be no torque on the shaft of the induction motor, but as soon as current begins to lag the induction motor will tend to turn. This tendency to turn can be balanced by a spring so that the lag must reach a predetermined amount before it will succeed in turning the shaft. The shaft of this motor should be connected to appropriate switches, which will energize proper trip coils on the circuit breakers to relieve the situation. As long as there is a legitimate load on the rotary, even though somewhat lagging, the torque on the induction motor will be slight and can be balanced by the spring. A heavy load on the rotary of small power factor will then not affect the induction motor, but a heavy lagging load, which is a dangerous element, will instantly operate the motor and cut out the sub-station.

In spite of the fact that transfers in some form have been in use for almost as long a period as street railways have been in operation, there has been almost no time when there has been greater diversity of opinion than at present as to the proper form of transfer, the most desirable way of marking on them the various checks which experience has dictated are necessary, or the best method of registering and of otherwise keeping track of these small, but most troublesome, slips of paper. We have already commented on the discussion which followed the presentation of the paper on this subject at the recent convention of the American Street Railway Association, and which indicated a wide divergence of policy as to the treatment of transfers. But if the subject is a complicated one to the railway manager himself, it is even more so to the average passenger, who nearly always believes himself entitled, on the payment of a 5-cent fare, to ride without additional charge to his destination, wherever it may be, provided it is on the lines of the company, and if he is not given a transfer he usually makes strenuous remarks about corporations in general, and feels mortally aggrieved.

Now the passenger's desire for a free transfer is entirely natural and proper, and not without a basis of reason, but his diagnosis of his inability to get one is generally very wide of the mark. As a rule, the operating company would be entirely willing to give him his free transfer for a long extra ride if that were the only question involved, but it naturally objects to setting itself up as an easy mark for peculation or an institution for the encouragement of dead beats. Moreover, it must, as part of its plain duty to the public, conduct its traffic so as to avoid, rather than court, congestion. In this connection we fancy that Mr. Meneely's paper at the convention will be an eye-opener to the layman. When a road proposes so elaborate a system of registration of transfers, inaugurates a secret service, and even plans to offer considerable cash prizes to engage the co-operation of its patrons, it means that the misuse of transfers has become a very serious matter from the dollar-and-cent standpoint. A system like that is not introduced for fun or to exploit the ingenuity of the traffic manager. It is there because it is badly needed, and for no other reason. We earnestly wish that some experienced street railway man would at the next convention bring out the facts and figures relating to the abuse of transfers, so that there would no longer be any chance for misunderstanding on the part of the public. An "experience meeting" bearing on this topic would be of no little interest and value, and would probably disclose feats of ingenious fraud that would be almost past belief. It is the collusion between an occasional employee and a patron quite willing to "beat the company," or, quite as often, the dense moral obliquity of the average passenger himself, that makes the mischief far more than any misuse of transfers legitimately obtained, which, at the most, would secure a rather useless round trip at cut rates.

A still more considerable difficulty encountered in planning a free transfer system is its tendency to produce, unless very skilfully arranged, severe congestion at certain points in the system. This is particularly exemplified here in New York where a really liberal management is frequently abused for not granting transfers which would in fact greatly inconvenience most of the traveling public. Transfer points, whenever possible, must be so arranged as not to throw the burden of a heavy transfer business on lines which are already overcrowded. There is a physical limit to the amount of passengers conveniently accommodated on a single line, and no good comes of passing this limit even with the best intentions in the world. Now, when one adds to these physical requirements the troubles that arise from the readiness of a considerable proportion of the community to take advantage of the company when possible, the problem of getting a convenient and workable transfer system becomes serious. Each new free transfer is related, in a way sometimes very complex, to the system already existing, and it takes the wisdom of the serpent to untangle the matter. And with ever so great care it is often extremely difficult to get at the facts on which to base a sound decision. For instance, suppose a case which frequently exists. Let two fairly long suburban lines meet at an acute angle. Is it wise to give free transfers in view of the fact that transfers at their outer termini nearly, or quite, unite the lines? How serious will the misuse of transfers become, granting that the bulk of them will be used legitimately. Here is a question of amounts which it is extremely difficult to answer. It would doubtless be better to let a few beats get occasional

free rides than to inconvenience a large body of patrons who are properly within a single-fare region, and we think most street railway managers would concur in this opinion; but there might come about a serious leakage in revenue, and the whole question is one of relative amounts which only an appeal to experience could answer. All these intricacies of tramway *finesse* are quite outside the experience of the ordinary citizen, and it would be a most useful bit of missionary work to bring before the public the real conditions which arise in so plain a manner that they would make a permanent impression. And the public, when it understands a case, can usually be trusted to see fair play.

Interurban Braking

Although it is a well recognized fact that on interurban electric roads the rate of acceleration in common, every-day practice is far more rapid than on local trains on steam railroads, there is another fact not so commonly recognized, namely, that the negative acceleration or rate of braking is considerably higher than is common on steam passenger trains. There are two very simple and natural reasons for this state of affairs. One is that the necessity for such rapid retardation has been felt more in interurban work and the other is the superior control of the braking pressure which a motorman on an interurban car equipped with straight air brakes has as compared with the engineer on a steam train equipped with automatic brakes. The automatic air brakes on steam trains necessarily have their brake shoe pressures adjusted to allow a liberal margin under the slipping point of the wheels. On an interurban car it is feasible to work much nearer to the sliding point.

Recently one of our highest speed interurban roads has found it desirable to adopt measures for securing even more rapid retardation than is common on such lines,—the exceptionally high speeds and frequent stops pointing to the desirability of such a move. It has been known for years that the friction between brake shoes and car wheels is considerably less at high speeds than at low with a given brake-shoe pressure. The practical effect of this is that if the brakes are applied at a constant pressure while a train is being retarded they will not retard the train anywhere near as fast at 50 miles or 60 miles an hour as at 10 miles an hour and less, thus increasing very much the distance in which a train can be stopped. If the brakes are applied with sufficient pressure to give the maximum retardation at high speeds the friction between brake shoes and wheels will so increase at lower speeds as to make the wheels slide, since the friction between rolling wheels and rails is practically constant. The maximum braking effect can only be obtained by applying as much pressure as can safely be put on without sliding the wheels at the highest speeds and reducing this pressure as the speed falls off so as to keep it under the sliding point. Of course simple automatic means to accomplish this are desirable, but in the absence of this the motormen on the road referred to are being taught to apply maximum pressure at first at the highest speed and slowly let air out of the brake cylinder as the speed falls off. In order to do this and get the maximum braking effect, air in the storage reservoir from which the brake cylinders are supplied must be carried at a pressure high enough to slide the wheels at low speeds. This is not a practice in itself desirable because with careless use of the brakes there is a chance for flat wheels, but it is justifiable when very high speeds of over 50 miles an hour must be dealt with.

The automatic reduction of brake-shoe pressure as the speed decreases has long been recognized as desirable in steam road practice where, on account of the nature of the automatic air brake, it is not possible to do this by hand. It is only on the fastest trains and within the past few years, however, that the "high-speed brake" which after a manner accomplishes this has been used, and it is doubtful whether this will ever find much favor in electric railway practice. Of course a simple device which would vary the maximum brake-shoe pressure according to the speed would be desirable for use with a straight air brake, but the complications apparently involved in an apparatus which will really do this would seem to be great.

In connection with interurban braking it is noteworthy that a few years ago a number of interurban cars were equipped with automatic air brakes, following accepted steam railroad practice in this respect. It was doubtless considered at that time that since steam railways had found the automatic air brake the proper thing, the wisest thing for interurban roads to do was to profit by the experience. It is noteworthy, however, that at the present time, the automatic air brake for interurban electric cars has been practically abandoned in favor of straight air brakes. The reason for this seems to have been that the automatic air brake, in which the braking pressure is governed not directly by the motorman's valve but indirectly by a reduction of pressure in the train line, involves more complication than is desirable both in operation and maintenance. Where trains of many cars are operated, as on steam roads, this complication seems to be necessary, but on an interburan road, where but one or, at most, two cars are run in a train, experience seems to have shown that the straight air brake is preferable on account of its simplicity in both construction and operation. With the straight air brake the motorman can have direct and instantaneous control over the pressure in the brake cylinder at any instant. With the automatic air brake, the pressure in the brake cylinder is regulated by reducing the pressure in the train line. Letting all the air out of the train line gives an emergency application. If the motorman wishes something less than an emergency application, he must let some of the pressure out of the train line, and the pressure with which the brakes are applied depends both on the suddenness and amount of the reduction in the train line pressure. It is only by considerable practice that enough skill can be acquired to enable a man to apply the brakes with a definite pressure, and even then the motorman has not the control over the pressure in the brake cylinders where the automatic air brake is used, that is offered by a straight air brake system, where it is simply a matter of turning more or less pressure directly from the storage reservoir into the brake cylinders. With the straight air brake, the control of the brake pressure is direct, while with the automatic air brake it is indirect and depends on a number of elements, the variation of any one of which will change the ultimate result. Then, too, the automatic air brake is much more difficult for employees to understand and maintain and is in fact the most complicated mechanism that steam railway trainmen have to deal with. This is so true that steam railways have been obliged to establish air brake schools for their employees. With the straight air brake, there is but little that a man cannot master in a few hours.

Modern Switchboard Practice.

BY H. P. DAVIS

The switchboard is the most important part of a modern electrical installation and to be reliable must be thoroughly suitable in design and construction and in the selection of apparatus and instruments. Convenience, simplicity and ease of operation are factors to be considered in order to realize the ideal of operation, namely, uninterrupted service.

There is hardly an installation that does not have peculiarities of its own necessitating a most careful consideration, while station plans are being prepared, of the requirements of the switchboard and its relation to the building, in order that proper provision may be made for the most efficient and satisfactory layout of circuits and apparatus. Indeed, it often happens that a special construction of the station is necessary to obtain the best arrangement. There are many plants to-day operating with dangerous, inadequate and poorly arranged switchboard layouts, simply because of failure to recognize the importance of the switchboard when originally designing the station.

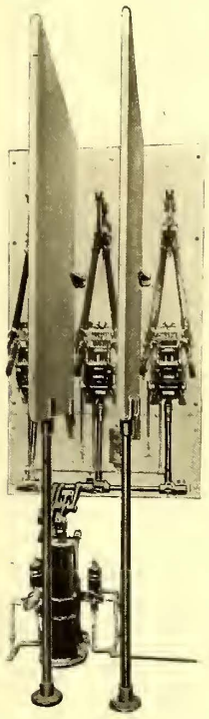


FIG. 1.—ELECTRO-PNEUMATIC CIRCUIT BREAKER FOR 550 AMPERES AT 6600 VOLTS

GENERAL TYPES

In laying out the switchboards for a large system such as are now becoming so common, the designer is immediately confronted with a fundamental question of control; that is, shall the apparatus be operated by hand or by power? Each method has applications for which it is better suited than the other, and it is sometimes a matter of great perplexity to determine which method is most desirable, especially as there is a wide difference in the matter of expense and space required.

Simplicity and reliability usually go hand in hand; it is therefore always advisable to choose the simplicity of the hand operation when possible, as a certain degree of complexity and intricacy is unavoidable with all methods employing auxiliary means for operation of apparatus.

The marble panel type of switchboard now so commonly used represents the most satisfactory switchboard practice when hand operation is allowable, as this method combines a pleasing appearance and great flexibility with maximum economy of space. This method of switchboard construction suffices for the majority of installations, but ease and safety of operation impose limits upon the e. m. f. which can be employed, and in the capacity of the apparatus, beyond which no choice is left so that auxiliary operation is necessary.

Further, it is obviously objectionable to combine so many panels into one switchboard, that its operation is cumbersome and confusing. If the apparatus and circuits are not of such a nature that the panels can be segregated into separate switchboards, it is better practice to resort to auxiliary power with control from a central point.

Hand-operated switchboards are usually built of highly polished slabs of white Italian or blue Vermont marble, 2 ins. thick, with beveled edges, and of a width sufficient to provide space for the necessary apparatus and instruments. Each panel is supported by a rigid angle-iron frame-work of L-section and the individual panels are built into switchboards by placing them side by side and connecting them

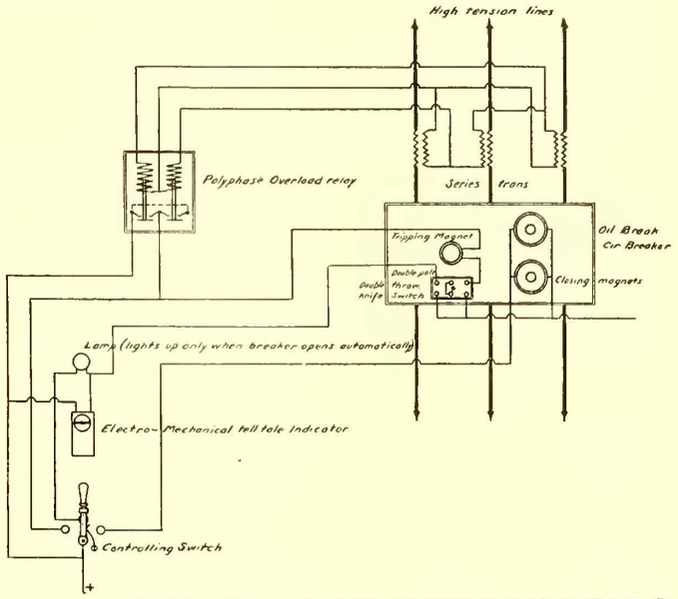


FIG. 3.—WIRING DIAGRAM FOR ELECTRICALLY-OPERATED AUTOMATIC OIL-BREAK CIRCUIT BREAKER AND AUXILIARY CONTROLLING AND INDICATING DEVICES

together by bolts through the angle iron frames at the back This iron frame-work is then bolted at the bottom to a channel iron which serves as a foundation. At the top the frame-work is bolted to an iron bar which runs the whole

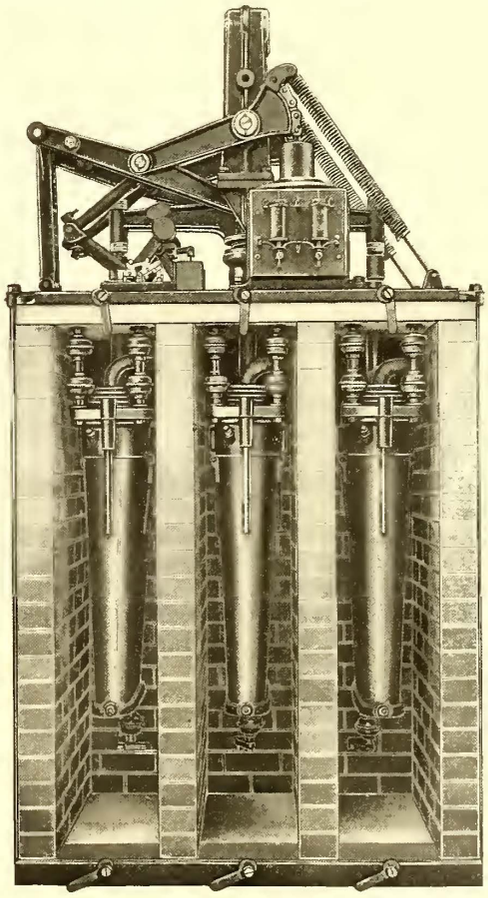


FIG. 2.—HIGH TENSION OIL-BREAK CIRCUIT BREAKER, OPERATED BY ELECTROMAGNETS

length of the switchboard. Provision is made for braces, by which the switchboard may be rigidly supported from the station wall. One panel is always installed for each machine circuit and one panel for each one or two feeders.

The apparatus and instruments are mounted on the mar-

ble and form part of the panels. The connections between the apparatus and the instruments are made directly on the back of the panels, while the bus-bars are carried on porcelain-insulated brackets supported from the angle-iron frame.

The large systems of the present day, involving as they do immense stations with generating units of great size, delivering vast amounts of power, usally at a high e. m. f., present unusual and serious problems requiring special switchboard construction, design and grouping of the apparatus and details to insure the highest degree of safety and reliability of operation. The space required, the capacity of the apparatus, the e. m. f. employed, the isolation of the switching devices, the necessity of fire-proofing and insulating the conductors, all enter as factors in switchboard design, requiring a method of treatment widely different from the marble panel construction.

It is essential in intallations of this sort that the switching and circuit breaking apparatus should be designed and located so that all arcing and current-carrying contacts are accessible for free and ready inspection, while ample space must be provided between the poles of the apparatus, and each should be in a separate and fire-proof compartment. The bus bars and all connections differing in potential must be arranged in the simplest and most direct manner and also in separate fire-proof compartments. Crossing of conductors should be avoided. All inflammable insulation, such as is usual on cables and other similar conductors, and all materials liable to deterioration should be rigidly excluded. To meet these requirements, the switchboard structure should be of brick or concrete, where fire-proofing alone is necessary, and where insulation is required, marble, soapstone, porcelain or glass must be used. The arrangement of bus bars and all conductors must be such that they will be in plain view and easily gotten at, and at the same time no bare metal or live conductors should be so placed as to be dangerous to the attendant. Much space is required for such a construction and it is usual to provide for it by the use of galleries. The cables carrying the high tension currents are lead from one gallery to another in vertical risers forming part of the masonry structure, which can be built with cells or pockets for the installation of instruments, transformers and fuses.

In general it may be said that the characteristics and important features of this type of switchboard construction is directness and simplicity of connections, with absolute safety from fire and short circuits.

In a construction of this kind, spread out over considerable space, or arranged in several galleries, the apparatus is out of the range of observation of the operator. It is necessary, therefore, that some central or convenient spot be selected from which the apparatus can be controlled by means of auxiliary power, while indicators and signals will communicate to the operator the position and movements of the apparatus.

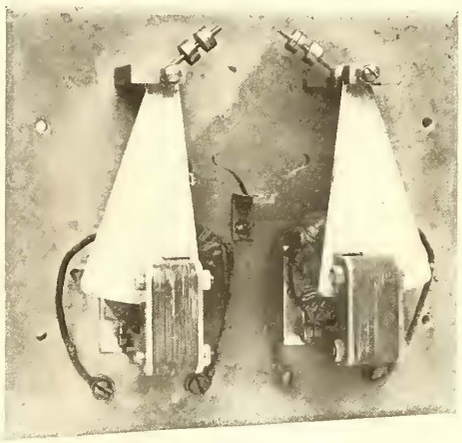


FIG. 4.—POLYPHASE OVERLOAD RELAY

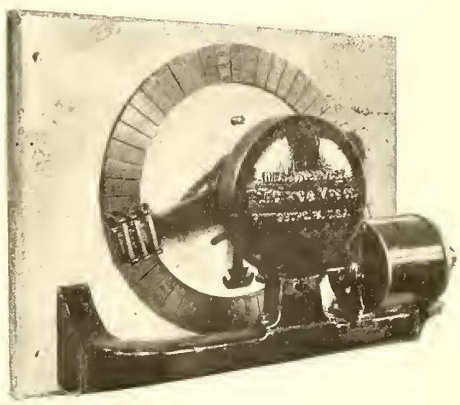


FIG. 5.—GENERATOR FIELD RHEOSTAT, OPERATED BY MOTOR

SYSTEMS OF AUXILIARY CONTROL

Three methods of auxiliary control may be employed for the apparatus, namely, straight pneumatic, straight electric and electro-pneumatic.

In the last two methods there is one fundamental feature common to both, which is, that the connections between the apparatus and the controlling board are electrical and the source of energy for the control circuits is the same, namely, the station exciters or a storage battery. So far as certainty of actual operation of the apparatus itself is concerned, there is practically no preference between the two methods, since successful operation by either can be guaranteed. The primary element of a system of straight pneumatic control is a cylinder and piston operated by compressed air, which to that extent is a simple and powerful operating device. To be controlled at a central point, however, necessitates the running of many small pipes from the cylinders, which are located at the apparatus, to the controlling station or platform where pneumatic valves must be placed. It is at once evident that a system of this kind would be impracticable, except in a small installation, since the amount of small piping would be so great as to make it impossible to keep it in an air-tight condition.

In the use of electro-pneumatic control these difficulties are overcome. The main pipes supplying air for the system can be run directly to the apparatus, and the only small piping necessary consists of short lengths required for connecting the valves on the cylinders to this supply pipe. Small wires are run from the valves to the controlling station to control them electrically, instead of the small pipes necessary in the case of a straight pneumatic control. This system is commonly used. It requires, however, as many electrical connections between the controlling platform and the switches, as the straight electric control, which will be described later. It is evident, therefore, that the use of compressed air, even when the electro-pneumatic method is used, adds a link to the chain of operation which is not required when straight electric control is employed, since it requires a source of compressed air, with the complications introduced by valves and piping.

With the straight electric control all intermediary devices can be omitted, which is a decided step towards simplification and is naturally in a layout of this kind of great importance. Two methods of driving can be used, by motors, or by electromagnets, each having applications for which it is peculiarly suited. Devices which are rotary in their operation, as for instance rheostat face plates, are best driven by electric motors. Devices which reciprocate in their action, such as switches and circuit breakers, are preferably operated by electromagnets.

A revolving motor requires some form of gearing, usually a worm, in order to transform the rotary motion of the motor armature to the reciprocating motion of the switch, and to obtain sufficient power for operation it is necessary to allow the motor armature to make a considerable number of revolutions during one operation of the switch. With an electric motor geared by means of a worm to the switch, it is necessary to throw the motor in

and out of engagement by means of an electric clutch. Again, when a switch is operated in this way, by means of a worm, there is a positive connection to the driving power and failure of the latter in operation is liable to leave the switch in whatever position it may happen to be at that time. Moreover, it is necessary to supply cut-out switches

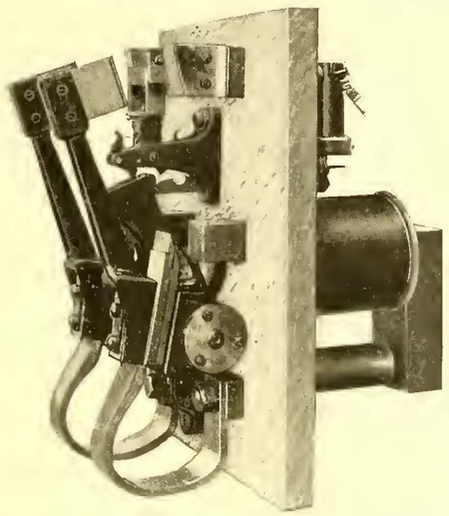


FIG. 6.—GENERATOR FIELD SWITCH, ELECTRICALLY OPERATED

to open the motor circuit at the limits of travel, devices which are small and to a certain extent increase the possibility of trouble.

The use of electromagnets obviates many of the difficulties mentioned. For this system of operation, the connection is very direct, the moving cores of the closing magnets being connected directly to the mechanism of the switch. The pull of the magnet is, therefore, exerted directly upon the closing mechanism without gearing of any kind. A switch or circuit breaker so operated has no intermediate position in which it may stay, except that of fully closed or open. When a motor is used to close the switch, should the power fail and if it be desired to have the switches open, it is necessary to disengage the worm of the motor shaft from the wheel before the switch can be operated by hand, or, if power is off and it is desired to close the switch, the same disconnections must be made. On the other hand, in case of switches operated by electromagnets, they may be readily closed or opened by hand without changing the switch mechanism in any way.

With electric control the connections between the apparatus and the controlling platform are small wires and the source of power can be either the exciters or a storage battery. As already noted the control must be centralized, for any one of these methods, at a controlling station or platform where will be suitably mounted the small switches and other devices for handling at a distance all of the apparatus in the station, while automatic indicators and signals will make known to the operator all circuit changes of the apparatus whether made by hand or automatically.

SWITCHES AND CIRCUIT BREAKERS

The most vital elements of every system are its switching and protective devices. Very great credit is due to the designers of electrical details for the way in which they have step by step met the ever increasing demand and requirements occasioned by the remarkable growth of our generating stations, until apparatus for this service is now produced and is operated with the greatest certainty and with little apparent effort, under conditions which a few years ago would have seemed beyond the bounds of possibility. A most exceptional record when it is remembered that but a very few years ago, most alternating current switchboards were operated with open knife switches.

On account of the great importance of this apparatus and the interest which naturally centers in it, and to illustrate how rapidly development progresses, and how the shortcomings of existing types are recognized and eliminated, descriptions of some of the latest designs that are recognized as approved Westinghouse practice are here presented.

Two types of switches or circuit breakers have been developed for very severe and heavy service, namely, the carbon-shunt, open-air type, in which the arc is ruptured in the open air; and the oil-break type, in which the arc is ruptured in an enclosed chamber filled with a special oil.

Fig. 1 illustrates a switch of the former type. This circuit-opening device is constructed on the general principle of employing the open arc and carbon break. It is obviously the most simple type of apparatus, and one in which the extinction of the arc depends simply on mechanical distance and not upon the character of materials used in constructing the apparatus. Whenever an arc is confined it must necessarily have a deteriorating effect upon the materials with which it comes in contact. When the currents are heavy or the voltages high, it is obvious that very great

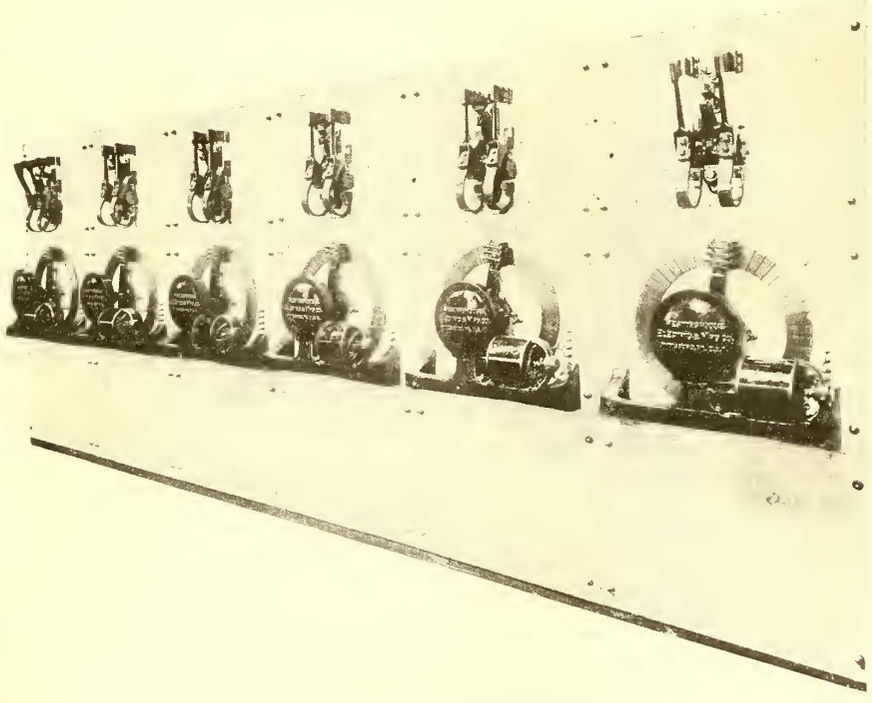


FIG 7.—FIELD SWITCH AND RHEOSTAT SWITCHBOARD, ELECTRICALLY OPERATED

responsibility is placed upon the integrity of the materials composing the switch.

The fundamental principle underlying these circuit breakers is a rational and correct one. The circuit breaker illustrated in the cut is of 500 amps. capacity, designed for use on a three-phase, 6600-volt circuit, and is arranged for electro-pneumatic operation. As will be noted, two cylinders are made use of, the purpose being to obtain a quick action in closing when synchronizing. The method of operation is first partially to close the circuit breaker with one cylinder, the air remaining in the cylinder holding the

circuit breaker in this position, and when it is desired fully to close the breaker air is admitted to the second cylinder, which, through the medium of a floating lever acting on the first cylinder as a fulcrum, quickly throws the circuit breaker into a closed position. As shown each pole of the circuit breaker is protected from the adjacent one by heavy marble barriers, making a short circuit between poles practically impossible.

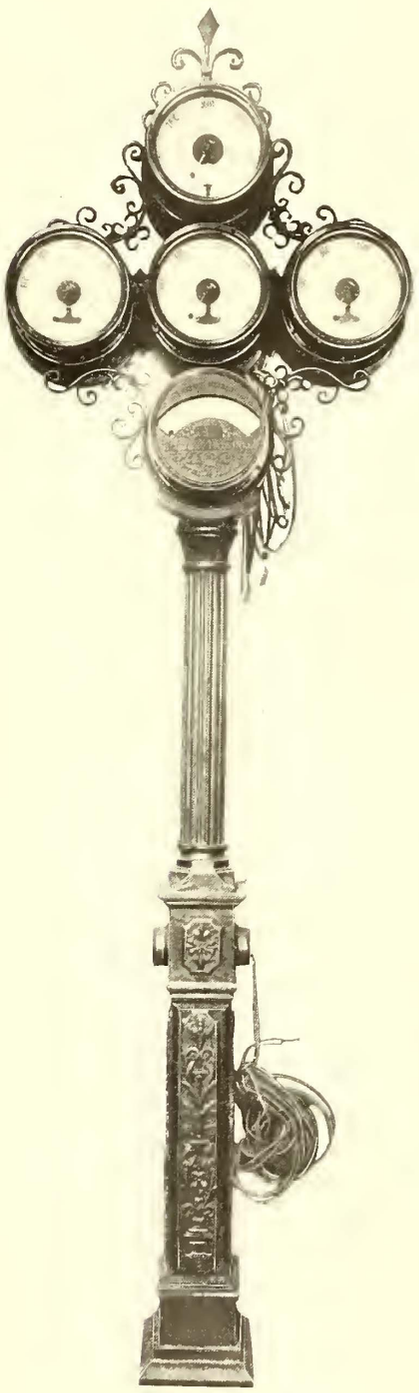


FIG. 8.—INSTRUMENT STAND

The circuit breaker is so designed that the arcing and the current-carrying contacts are in plain view, a most important feature, allowing the attendant to see at a glance the condition of the working parts. The essential features are the laminated copper brush, the swinging arm, the contact blocks, and the carbon shunts at the top. The contact is made by laminated copper brushes against a flat copper block. The contact pressure of ths brush is sufficient to help the releasing spring throw out the movable arm of the circuit breaker when it is tripped—a very important feature on heavy capacities. The current-carrying contacts are protected by copper shunts, so that, when the breaker is opened, the current is gradually shunted from the current-carrying contacts to the carbons by steps of such low resistance that no arcing can occur until the final break is made on the carbons. This feature obviates all possibility of blistering the copper or current-carrying contacts.

The length of break, or opening of the circuit breaker, is proportioned to the voltage of the circuit. The arc occurs on the carbon terminals above, and is well removed from the metal parts. This construction aids the natural tendency of the arc to rise and prevents any possibility of communication of the arc to any live parts below the carbon terminals. Each element of the set is provided with an automatic tripping coil which acts independently of the others.

As already indicated, this piece of apparatus is closed by means of compressed air and it is held in the closed position by a toggle lock. The valves which are located on the cylinders are operated electrically from the controlling station. The valves automatically exhaust the cylinders after the breaker is fully closed. In addition to the automatic tripping device mentioned, the breaker can be opened from the controlling platform, an electromagnet acting on the tripping mechanism being provided for this purpose.

Fig. 2 illustrates a three-pole, double-break automatic oil circuit breaker operated by means of electromagnets. This switch has all live metal parts completely immersed in oil, of which only a relatively small amount is required. The switch is held open by gravity. Provision is made for easily removing the oil tanks for repairs and inspection.

The switch is erected in a masonry structure, with each pole of the switch and the oil tank in which it is immersed in a separate fire-proof compartment. There are two stationary contacts per pole, one connected to the incoming

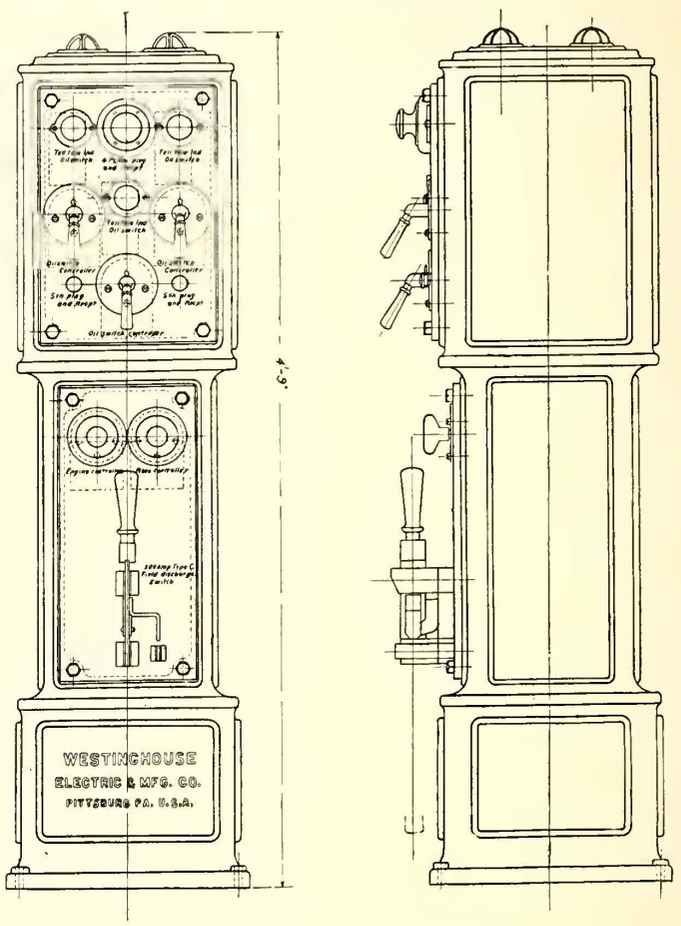


FIG. 10.—INDIVIDUAL CONTROL STAND

lead and the other to the outgoing lead of the same phase, each contact being mounted within a large porcelain insulator. These insulators are mounted on a cast-iron frame which forms the top, and supports the enclosing oil tank. In the switch illustrated there are three frames, each fastened in a separate compartment by means of strain insulators to the under side of a soapstone slab, which is placed on top of the cell structure and under the cast-iron base of the operating mechanism.

The movable contact for each pole consists of a U-shaped copper piece fastened to the end of a stout wooden rod. In the closed position of the switch this U-shaped piece electrically connects the the two stationary contacts of each pole. The wooden rods are fastened at their upper ends to a common cross bar, which, through a system of levers giving a straight line motion, is raised by means of the closing magnets, assisted at the beginning of its motion by a pair of balance springs. This system of levers is locked by a toggle joint when the switch is closed. At opening a tripping magnet strikes a blow on the toggle causing the same to pass beyond the center. Gravity then, assisted by a

powerful spring, causes the cross-bar with the wooden rods and contacts to drop to the open position. There are two breaks in series for each pole of the switch, each break in a separate compartment. The stationary contacts are each fitted with a removable plug which enters a hole in the movable contact. Contact between this plug and the movable contact is broken after the main contacts are broken, hence all arcing occurs on the plug, which can be removed and replaced when worn out. Current for the closing and tripping magnets is derived from the exciters, a storage battery, or other convenient source of low voltage direct-current supply. In case of failure of the operating circuit the switch can be easily operated by hand, without in any way disturbing the mechanism.

The oil tank is constructed of a top and bottom casting and heavy sheet metal sides. This tank is held in place to the under side of the frame casting, carrying the terminal by means of clamps. The interior of the oil tank is lined with insulating cement which is moulded in such a form as to fit closely about the terminals and moving contact piece, leaving just room enough for free movement of the parts and the oil. By this means the amount of oil is reduced to a minimum, thereby reducing the fire risk. The wooden rod interposes an effective barrier between the two terminals of each pole when the switch is open. Suitable levers are provided for moving the tanks so that they can be readily lowered away from the contacts and removed without dismantling the switch.

The construction is such that the entire switch may be set in place and lined up before the oil tanks are placed in position, with the contacts exposed to view so that they can be accurately adjusted. All sediment formed in the oil settles at the bottom of the tank, leaving the oil clear about the contacts. The oil level is readily determined by means of a small sight gage. When necessary the tank is readily drained or filled in position. The tanks themselves are insulated from the circuit and all the live metal parts are inside and in the oil, so that there are absolutely no live high-tension parts exposed.

Mounted on each oil-break switch is a small, double-pole, double-throw, knife-switch. This switch is operated by the motion of the levers of the oil switch and is used for the indicating and tripping circuits.

The controlling and indicating devices for an automatic, electrically-operated, oil-break switch consist of a controlling switch, an electro-mechanical tell-tale indicator and a lamp. These are suitably mounted at the operating station. A polyphase overload relay, connected to series transformers in the main circuits, is provided for automatic opening. The connections are shown in diagram Fig. 3.

The controlling switch, which is of the drum type, has three positions, namely, "closed," "off" and "open," but it will remain of itself in only the "off" position and the "open" position. In other words, if it is thrown to the "open" position it will remain at that position when the hand is removed, but if it is thrown to the "closed" position the switch will return of itself to the "off" position as soon as the handle is free. In this position it connects the control circuit so that, if the oil switch opens through the action of any of the automatic devices, a lamp will be lighted on the operating stand to attract the operator's attention. If the oil switch is opened by the operator by throwing the controlling switch to "open," the lamp does not light.

The mechanism of the electromechanical tell-tale indicator consists of an electromagnet which attracts a pivoted armature through an angle of about 90 degs. Attached to the armature is a disk with a pointer which indicates to the eye the "open" position or "closed" position of the oil switch.

Fig 4 illustrates the overload relay which is electrically connected to the tripping magnet of the oil switches. It is constructed on the induction principle. There are two electromagnets made of laminated iron, and projecting between the poles of each of these magnets is an aluminum sector carrying the movable element of the contact. Surrounding part of each pole of the magnet is a short-circuited turn of copper which produces a lag in the magnetic field passing through this turn and thus produces a shifting of the field across the face of the magnetic poles. This shifting field tends so to move the aluminum sector as to close the movable contacts against the stationary one. The motion of the sector is opposed by an adjustable weight, by means of which the amount of current necessary to close the relay contacts may be varied. The mechanisms of the two sectors are entirely separate, with the exception that the contacts themselves are connected in parallel, so that

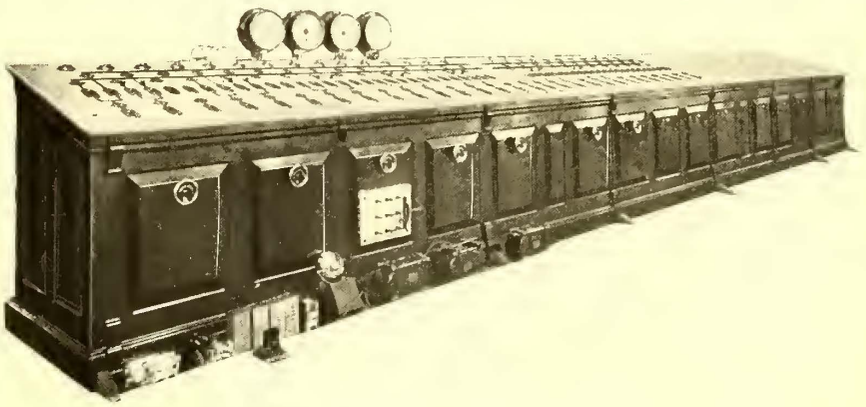


FIG. 9.—CONTROLLING BENCH BOARD

should either one be operated it will energize the tripping coil of the oil switch and thus open the latter. When used on a two-phase circuit the relay has one of the movements connected to one phase and the other to the other phase, through the medium of two series transformers. When used on a three-phase circuit, a series transformer is connected in each phase and these three transformers are so connected to the relays that when an overload in one or all of the main wires exceeds that for which the relay is adjusted, it will operate and open the switch.

The cycle of operation of an automatic oil switch with all its necessary controlling and indicating devices is as follows: Referring to diagram, Fig. 3, and assuming the oil switch to be closed, the double-pole knife-switch will be closed in position B. In this position the oil switch may be opened automatically by the polyphase overload relay, or by hand by throwing the controlling switch handle to the left or "open" position. In either case current flows from one side of the line through the tripping coil and the knife switch to other side of line. When the oil switch is opened it throws the knife switch from position B, cutting off the tripping coil current, and closes it to position A. If the oil switch is tripped automatically the controlling switch handle will be in the "off" position and as soon as it is open the control current will flow from one side of the line through the indicator and the knife switch to the other side of the line, causing the instrument to indicate open. The current will also flow from one side of the line through the controlling switch, the lamp and the knife switch to the other side of line. This causes the lamp to light up calling attention of the switchboard attendant to the fact

that the oil-break switch has opened automatically.

If the oil switch is opened by hand, the handle of the controlling switch will be thrown to the "open" position on the left. As soon as the oil switch is open the current will flow from one side of the line, through the indicator and the knife switch to the other side of the line. The indicator will then show the "open" position. To close the oil switch the handle of the controlling switch is thrown to the extreme right position. Current will flow from one side of the line through the controlling switch contacts and the closing coils of the oil switch to the other side of the line. The oil switch closes and in so doing moves the knife switch from position A to position B, cutting off the current from the lamp and the indicator, and causing the latter to indicate "closed." As soon as the indicator shows the oil switch closed, the hand is removed from the handle of the controlling switch, which then snaps back to the off position, breaking the current to the operating electro-magnets on the oil switch.

FIELD RHEOSTATS AND SWITCHES

The field rheostats and field discharge switches for a large installation can be operated by hand, if space and location permit, but usually it is found necessary to employ auxiliary control; the rheostat face plates and the field switches being arranged in a switchboard of the panel form located near the rheostats themselves, which are separate from the face plates and the wires connecting them being made into a large cable. Fig. 5 illustrates a form of rheostat face-plate designed to be operated by a motor which is controlled from a point distant from the rheostat. A cut-out switch is provided on the face-plate to open the motor circuit when the contact arm assumes either of the limiting positions. The face-plate is also provided with a device which indicates to the operator whether the brush or the contact arm is between or fully on the stationary contacts of the face-plate.

The generator field-discharge switch illustrated in Fig. 6 is electrically controlled by means of a magnet, and can be closed or opened at the will of the operator. This switch is provided with carbon tips to prevent damage to the main contacts due to arcing. The act of opening the switch closes a small auxiliary switch, which in turn shunts a resistance across the field winding. This allows the discharge of the field winding to die out gradually and prevents any undue strain on the field insulation. Fig. 7 illustrates a rheostat and field switchboard for the control of the fields of a battery of six alternators. With apparatus of this nature, manipulation becomes a simple matter and the operating devices and indicating instruments can be so located and centralized as to make the control of the circuits an easy matter for a single operator.

THE CONTROLLING PLATFORM

The controlling platform is usually, though not essentially, located so as to give the operator a comprehensive survey of the entire station. The generator instruments are located at the front of the platform, and in some cases have been worked into ornamental stands, as illustrated in Fig. 8, these stands forming the supports for the platform railing. At the back of the platform are placed the instruments for the feeders and auxiliary circuits, generally. These instruments are mounted on marble panels and combined into a switchboard. The controlling switches and other operating appliances are located in the central space of the platform. These controlling switches may be combined in a single bench board, an illustration of one being shown in Fig. 9, or they may be arranged on separate stands, as shown in Fig. 10, each stand containing the control appliances for a single circuit. The writer prefers the latter arrangement, as it is simpler and less confusing to the operator. There is not the possibility of a mistake in the selection of the proper control apparatus as there is in the case on the bench board, where there is greater concentration of apparatus. Both methods are common, however, and with proper attention and care on the part of the operator there is but slight opportunity for a serious mistake.

The apparatus for the exciter and station auxiliaries is usually hand operated and is arranged on panel switchboards. It is best located in close proximity to the apparatus controlled.

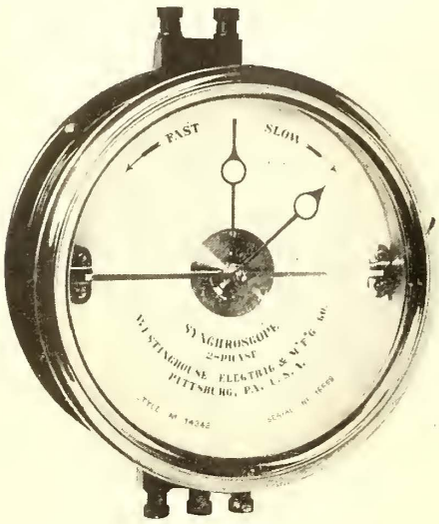


FIG. 11.—SYNCHRONIZER

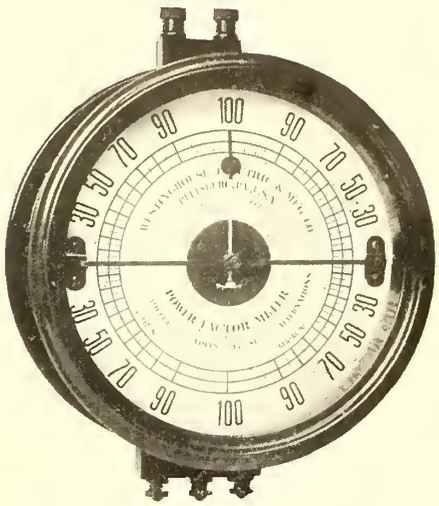


FIG. 12.—POWER FACTOR INDICATOR

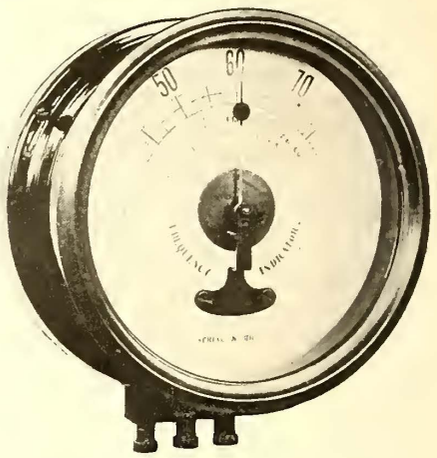


FIG. 13.—FREQUENCY INDICATOR

SPECIAL INSTRUMENTS AND APPARATUS

The conditions of operation in these large installations have brought many problems to the designer of details, and, without attempting to indicate their nature, it is sufficient to say that the solutions arrived at have added many new devices to the station's equipment. A modern electrical installation with large units and several transmission lines would not be complete without synchronizers, power factor indicators, frequency indicators, time limit relays, reversal relays, etc.

The methods generally used for synchronizing rotary converters or generators by means of lamps, permits the possibility of throwing a machine in multiple with others, while there is considerable difference of phase between their circuits. Lamps merely indicate a difference in voltage across

the switch, and not a difference in phase between the machines, except when the difference in phase produces a diffrence in voltage sufficient to affect the lamp. Moreover, a 100-volt incandescent lamp does not light up below 30 volts to 40 volts, and therefore is a very crude and sometimes unreliable method of synchronizing the machines. Again, it is of much greater importance to have the machines approximately at the same phase than at the same voltage at the moment of synchronizing. Thus, with the average generator, it takes a difference in voltage of 25 per cent to produce a rush of current equal to full load between the machines being synchronized, while a difference in phase of only 15 degs. is sufficient to produce this result.

The synchronizer illustrated in Fig. 11 indicates difference in phase directly, and it is not affected by a difference in voltage. In this instrument the angle between the machine being synchronized is always equal to the angle between the pointer and the vertical position. Thus, if the incoming machine is faster in speed, this angle will vary, causing the pointer to rotate to the right, and if the incoming machine is slower in speed the pointer will rotate in the same manner, but to the left. When the machine reaches the synchronous speed the pointer stops at a definite fixed position on the scale. When the movable pointer coincides with the dummy pointer, the machines are in phase and the main switch may be closed, thus synchronizing the machines in the shortest possible time, and with the least possible current flowing between them at the moment of closing the switch.

It is often essential in railway plants to know the power factor of the circuits, operating, as they do, a large number of rotary converters. The instrument illustrated in Fig. 12 is designed for this purpose and will indicate directly the power factor of any circuit into which it is connected. The range of indication of the instrument covers an entire circle and will indicate the power factor of the circuit with leading or lagging current, or when power is being delivered, in either the forward or reverse direction. When used with generators it serves both as a reverse current indicator and a power factor indicator. When used with rotary converters it will serve as the only indicator necessary on the alternating-current side, for by its indications the field current may be correctly adjusted, and when used in connection with the ammeters and voltmeters in the direct-current side of the converter, it will give a means of determining readily the volt-ampere input to the alternating side.

The instrument illustrated in Fig. 13 is for use where it is required to have an indicator that will continuously indicate the frequency of a circuit. In construction it consists of two voltmeter movements, which tend to rotate the shaft carrying the pointer in opposite directions. These movements are so arranged that when the shaft rotates in any direction, the torque of the movement which tends to rotate it in this direction decreases, and the torque of the other movement increases. It is thus evident that the two movements will take up a position where their torque is equal, there being no spring or other controlling force acting on them. Should the torque of one of the movements be raised by an outside influence the shaft would take up a new position, and the forces acting on it would again be balanced. In order that the instrument may indicate the frequency of the circuits, to which it is connected, the resistance in series with one of the voltmeter movements is made inductive and the other non-inductive. It thus follows that any change in the frequency of the circuit will unbalance the forces acting on the shaft of the instrument and cause it to take up a new position, when the forces would again be balanced. By a proper calibration of the instrument it can thus be made to indicate the frequency of any circuit to which it may be connected.

When the main transmission circuits from a station have branches feeding separate sub-stations or networks, it is very necessary that some selective device be provided to operate the automatic circuit breakers so that they will localize and confine trouble to the branch or network on which it occurs and leave the main circuit undisturbed. It is also necessary to have the circuits in the distributing system so protected that they will not be opened by temporary overloads or by ordinary short circuits, that will easily clear themselves, but will only be opened when the disturbance assumes dangerous proportions. A device designed to meet this condition is illustrated in Fig. 14, and it is called a time limit relay. It consists essentially of a dash pot, the plunger of which is connected to a moving arm carrying contacts which move through an adjustable distance to close

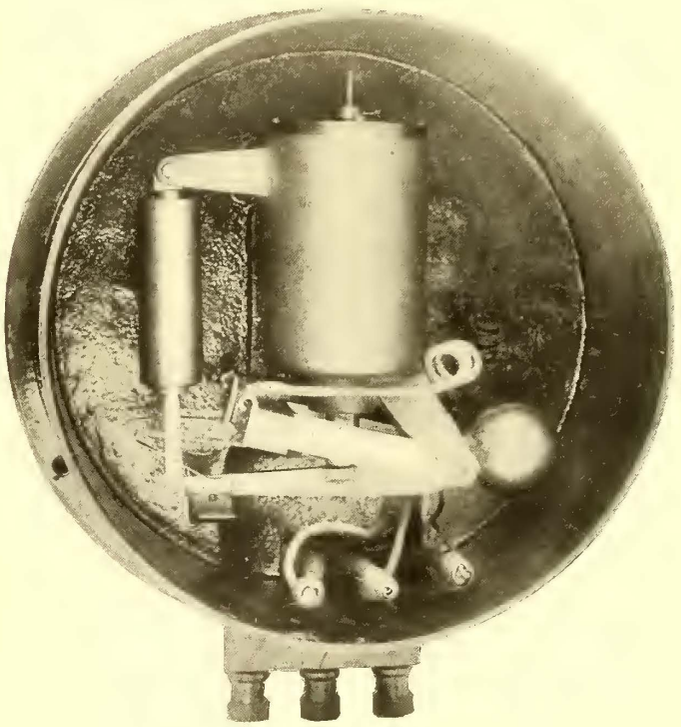


FIG. 14.—TIME LIMIT RELAY

the circuit of the tripping coil on the circuit breaker. This piece of apparatus is mounted in a round case similar to an ordinary meter case. The working parts are mounted on a single casting which forms the shell of the operating electromagnet, thus minimizing liability of the parts getting out of alignment. The air dash pot shown on the left has a carefully made plunger which is connected to a lever having a pivoted bearing in a projection on the casting. This lever is overbalanced, so that its tendency is to force the plunger into the cyclinder. This tendency is counteracted by the weight of the core of the electromagnet, which normally rests upon the lever arm, keeping it in the lower position. Upon this lever is fastened the moving element of the contact. The stationary element consists of flat spring pieces fastened to, but insulated from a bent metallic strap pivoted about the center of the lever arm. By varying the position of the bent strap, the arc through which the lever moves is varied and the time is changed. This variation is obtained by a thumb-screw on the end of a movable lever on the outside of the cover, not shown in Fig. 14. The piston of the dash pot being normally down, dust is prevented from accumulating upon its sides, thus obviating from this cause any variation of time required for the travel of piston.

The operation of the relay is as follows: An overload or short circuit in the main circuit sends current by means of a relay through the electromagnet, causing it to lift the core from the lever. The lever now being overbalanced causes the graphite plunger to move upward in the dash pot cylinder until the movable element makes contact with the stationary element. As soon as this contact is made the circuit through the tripping coil on the circuit breaker is completed and it is tripped. Current through the electromagnet is then automatically cut off and the core drops until it rests on the lower arm, causing the plunger to descend and the contacts to separate. The relay is then ready to repeat the cycle when necessary.

The time elapsing between the closing of the circuit and closing of the contacts in the relay can be varied from one to eight seconds. Thus it can be seen that if one of the

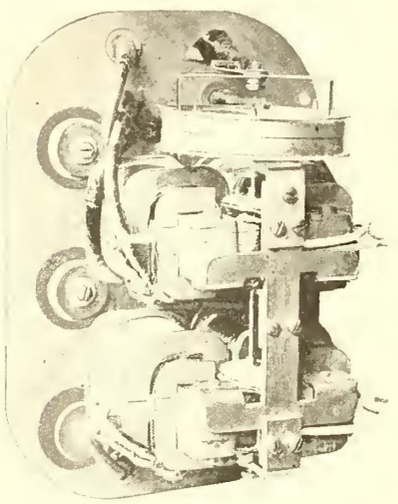


FIG. 15.—POLYPHASE REVERSE CURRENT RELAY

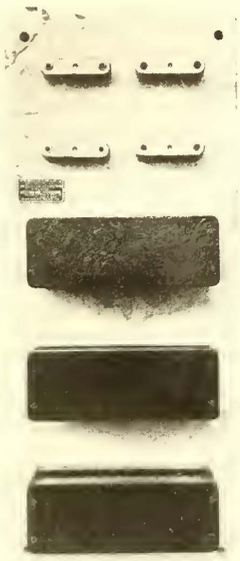


FIG. 16.—LOW EQUIVALENT LIGHTNING ARRESTER

relays installed in the main feeder is set, say for the maximum time of eight seconds, and similar relays connected into the branch circuits are set for a shorter time, if an overload or short circuit should occur in one of the branch circuits and continue a sufficient length of time, to allow the relay to work, it would only open the branch circuit without disturbing the main circuit. If the trouble does not continue a sufficient length of time to cause the relay to act, it resets itself when the core of the solenoid adds its weight to the contact arm. With a system so protected the main circuit relays would only be operated by an overload or short circuit occurring between the protective devices in the branch circuits and the power station. Time limit relays have several other applications, but the foregoing is the most important one.

Another form of relay largely made use of on transmission lines is the type illustrated in Fig. 15, and it is called a reverse current relay. This device is automatic in its action, and is required at the sub-station, when it is fed by two or more transmission lines operating in parallel. A short circuit or ground occurring on either line would affect all similarly, and open the overload breakers at the station, thus cutting off the entire supply of current. To prevent this occurring the lines are protected at the station, with time limit overload relays, and with reverse current relays at the sub-station ends. A short circuit or ground occurring on one line, the station ends of the lines are held in by virtue of the time relay, while the line on which trouble has occurred will open at the sub-station end by the current coming into it in a reverse direction from the other line or lines. Being thus disconnected from the other lines the point of trouble can receive current only through its own connection to the main station from which it is disconnected as soon as the trouble has lasted long enough to cause the time relay to open the circuit breakers. Thus it will be seen that trouble on a line operated in parallel with others, causes it to open up automatically at both ends, without seriously disturbing the supply of current. Another application of the reverse current relay is on machine circuits, where it is used to prevent one machine being operated as a motor by others which are running in parallel with it. The form of relay most commonly used is shown in the illustration and is adapted for either single or polyphase circuits. It works on a principle similar to the induction wattmeter, retaining the same sensitiveness and reliability in operation. By means of movable scales it may be adjusted to operate for any predetermined load.

LIGHTNING PROTECTION

In nearly every electrical installation the matter of adequate lightning protective apparatus is of prime importance, and it becomes greater with increased size of the system, for not only do the possibilities of trouble increase, but also the amount of damage resulting from a breakdown. The location of this apparatus in the station and the means furnished for fireproofing and insulating should receive the same careful consideration as the other elements of the installation.

In general the complete protection of electrical apparatus from injury by lightning and related causes requires devices for two distinct purposes; first, to prevent an abnormal rise of potential of the line above the earth. Such strains, which manifest themselves by the grounding of apparatus, may be avoided by the use of lightning arresters. Second, to prevent the local concentration of potential upon a few turns or layers of a coil, which may be produced by lightning discharges and in high tension circuits by other causes of static waves, the use is made either of choke coils or static interrupters, the former for low voltage and the latter for high voltage circuits, where especially good protection is required.

The simplest form of effective lightning arrester is a single spark gap connected between line and ground. It has been found, however, with alternating-current circuits that if the single gap is replaced by its equivalent in several small gaps, and if these gaps are of non-arcing metal the tendency to maintain an arc is successfully resisted. The low equivalent arrester illustrated in Fig. 16 is mounted in such a manner as to give the very best insulation, a fact of especial importance in apparatus exposed to the full force of lightning disturbances. The best quality of marble is used for the panels, and, for the higher voltages, porcelain is used as an additional safeguard. The low equivalent arrester consists of the following parts: A number of small air gaps connected to the line (series gaps); a second similar series of air-gaps (shunted gaps) shunted by a resistance (shunt resistance); and a low resistance in series (series resistance). These parts are connected between line and ground in the order named.

A lightning discharge passes the series gaps and meets opposition in the shunt resistance, and, therefore, jumps the shunted gaps passing freely to earth through the small non-inductive series resistance. When the line is discharged the generator current which follows is withdrawn from the shunted gaps by the shunt resistance which has the same effect as reducing the power of the generator and cuts down the current following the discharge so that the series gaps can readily suppress the arc.

On high voltages an auxiliary adjustable gap gives a

means of adjusting the arresters to the special conditions of the circuit; moreover, by placing in this gap a plate of marble or heavy glass the arresters can be inspected while connected to a live line. The shunt and series gaps consist of one or more "gap units" connected in series. A "gap unit" includes seven cylinders of non-arcing metal, forming six gaps, the cylinders being held in position by porcelain end pieces. The resistances are made from material of high specific resistance wound and assembled on asbestos spools and thoroughly insulated with mica to render them fireproof. The resistances are so mounted as to be thoroughly ventilated.

The properties and advantages of choke coils are well known, and a reference to the illustration, Fig. 17, will show a form which represents the very latest practice, and has for its special features unexcelled qualities of insulation and ventilation attended with an exceptional high choking power.

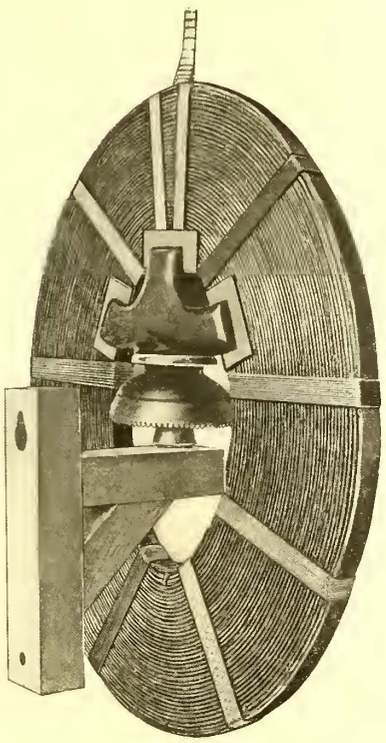


FIG. 17.—CHOKE COIL

During the last year there has been introduced a device called the static interrupter, Fig. 18, which may be considered as a choke coil with magnified power. It has been devised for cases requiring special protection, such as apparatus connected to high-tension circuits. Like a choke coil it serves to prevent the local concentration of potential which results from abrupt static waves. The power of the interrupter to reduce the abrupt waves of static electricity is very much greater than that of a plain choke coil.

When static interrupters are installed, they are usually placed in the leads from the transformers, or machines, and inside the switches, so that protection is secured from switching which, though causing only slight strains in low-tension circuits, may become dangerous on high-voltage circuits, such as require static interrupters. The static interrupter is then substantially a part of the apparatus to be protected, not of the line.

The interrupter consists of a choke coil, which is connected in series with the line and a condenser, which is connected between line and ground on the apparatus side of the choke coil. The function of the condenser is to absorb as much as possible of the static wave which succeeds in passing the choke coil. The static interrupter is usually constructed single pole, and each interrupter is placed in a self-cooling fluted oil tank. Leads are brought out at the top for connection to the circuit and ground. The choke coil is wound without an iron core, and is very heavily insulated. The condenser is made of thin metal plates separated by sheets of carefully treated fibrous material. The insulating material is provided with ducts which give a circulation of oil through all parts, thus maintaining a uniform temperature. The oil also serves as an insulator.

Lightning or static protection includes either choke coils or static interrupters, as well as lightning arresters. Whether choke coils or static interrupters should be used depends on the apparatus to be used, as well as upon other conditions.

SUB-STATION

Although the power may be generated in one large station, it is not available for use until it has passed through the sub-stations, located at points where they can most economically feed the service mains, which, in railway practice, are direct-current circuits, operating at 500-650 volts.

In the construction and design of the sub-station the consideration of making the building fit the apparatus, and closely conform with the necessities of the switchboard requirements, is of too great importance to be ignored in even the slighest degree. For, in the sub-station, no compromises are required with other types of apparatus, as its equipment is entirely electrical. The switchboard circuits should be laid out to follow each other in successive steps in the direct course of the power through the station.

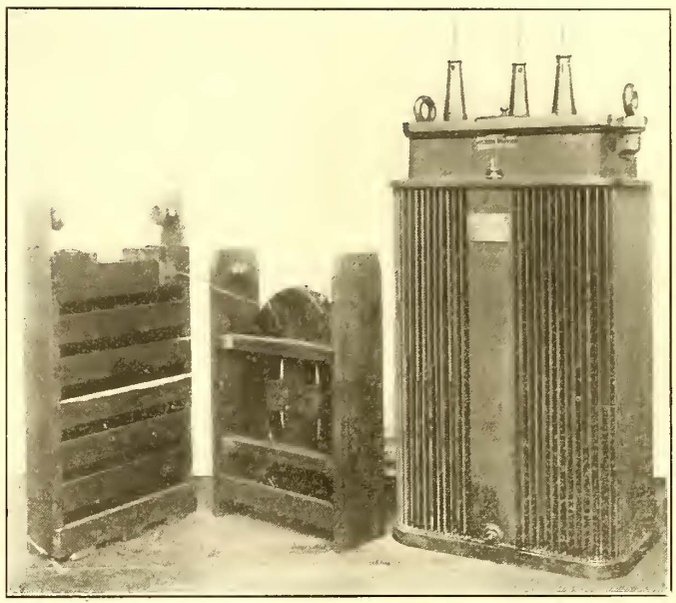


FIG. 18.—SINGLE POLE STATIC INTERRUPTER WITH CHOKE COIL AND CONDENSER REMOVED FROM CASE

The power from the incoming high-tension cables should lead at once, after passing through the lightning arrester circuits, to the high-tension switching devices, then to the high-tension bus-bars, from which the power divides to the separate rotary converters circuits, passing successively through the high-tension switches and the stationary transformers to the low-tension switchboard, from which the alternating-current sides of the rotaries are controlled, and also from which the high-tension switches are controlled, when they are power operated. The current on being delivered from the direct-current sides of the rotary converters passes on to the direct-current switchboard, and from it is distributed to the feeder circuits. This arrangement of the switchboards and apparatus is safe, simple and non-confusing. It is safe, because the high-tension apparatus is separate and isolated from the low-tension switchboards, and so located as to allow plenty of space for insulation and fireproofing; simple because all the wiring can be straight or direct without bunches and crosses, and non-confusing because there will be no mixing of apparatus and circuits which might perplex an operator.

Of course, it is not always possible to provide sufficient space to arrange a layout and build a station in this manner, and it then becomes necessary to resort to gallery construction to provide room for the switchboards and apparatus, but the same thought should not be lost sight of, and, whatever the construction adopted, every precaution should be

taken to make the layout simple and direct and to segregate and separate the low-tension and high-tension switchboards and circuits.

Large units and consequent heavy capacity of the low-tension circuits necessitate special construction and location of the apparatus, and in some instances require auxiliary control, with the circuit breakers each in fireproof and cellular masonry structures. To consider these features in detail would be beyond the limits of this article.

In the selection of protective switching apparatus for the incoming high-tension lines, especially if fed from a large station, the breaking capacity rather than the carrying capacity of the apparatus should be considered, since a large station can supply a heavy flow of power on short circuit, with consequent destructive results, should the switch not prove equal to the occasion.

To provide proper protection it is then often necessary to install switch or circuit breakers like those previously described for the power station, which means that to be operated to the best advantage some form of auxiliary control is required. This can be supplied from the direct-current bus-bars. In the case of starting a sub-station, when no direct current is available, one of the high-tension switches can be closed by hand, thus throwing current on the high-tension bus-bars. Then any high-tension switch connected to a set of transformers may also be closed by hand. This gives low-tension alternating current, which may be used in starting a motor generator set, if one is provided, or else for starting the rotary converter itself by its starting motor. In either cases, direct current will be immediately available and all high-tension electrically operated apparatus can be controlled at will by power.

In the sub-station, for the same reasons as in the main station, the high-tension apparatus, if it is of large size, should be installed in masonry structures with all conductors, bus-bars, carefully insulated and in separate and fireproof compartments, yet so arranged that they are easily gotten at for inspection. In small sub-stations the masonry structures are not necessary, but plenty of room should be provided for the insulation of the apparatus and conductors, and each piece of apparatus should be carefully insulated, and the framework upon which the apparatus is mounted should be of wood, so carefully dried and treated as to be as free from the effects of moisture as possible.

Trolley Lines for the Philippines

On Oct. 21 the Philippine Commission at Manila passed a bill providing for the construction of a standard gage electric railway and for a lighting and power plant. The bill provides that advertisements for tenders shall be inserted in two New York papers, one in Chicago, one in Washington, one in Manila, and in an engineering journal. Maps and specifications will be exhibited in Manila and in Washington at the Bureau of Insular Affairs. The bids will be opened at Manila on March 5.

The line will be 35 miles long, and will cover all the important streets of the city.

The life of the franchise is not to exceed fifty years, and the fares will be 7½ cents gold for first-class passengers, and 5 cents for second-class passengers.

Compensation is to be paid the city for the franchise at the rate of not less than 1½ per cent on the gross earnings of the street railway. After twenty-five years the rates of fare are to be readjusted by arbitration and the city will then have the privilege of purchasing the entire plant at a price to be fixed by arbitration based on the net earnings.

Novelties on the Grand Rapids Street Railway System

The Grand Rapids Street Railway Company has introduced a great many interesting devices for the reduction of labor and the improvement of the economy of the operation. Most of these wrinkles are due to W. W. Annable, electrical engineer and master mechanic of the road, and some particulars of the directions in which the practice of the company differs from that usually followed may be of interest.

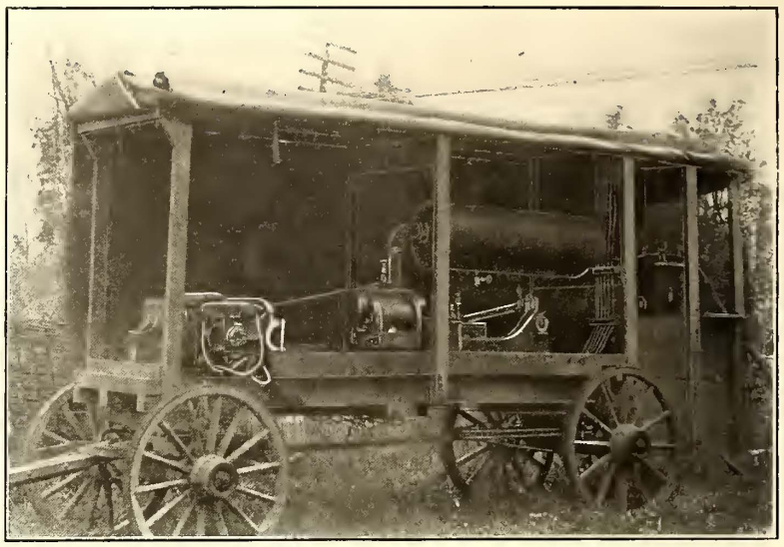


FIG. 1.—SAND MIXER AND SAND BLAST FOR CAST WELDING

Considering first the special applications to track work, Mr. Annable has developed a complete cast-welding outfit, including a sand blast for cleaning the joint. This equipment is mounted on a truck, as shown in Fig. 1, using an old Edison 14-motor belted to an air compressor, and on the same truck is mounted Clingman's sand mixer. The apparatus can then be easily hauled to the point of use. The joint is first cleaned by means of the sand blast until the bright metal shows for some 12 ins. on each side of the joint, then it is also sanded just before the moulds for the cast weld are placed around it, so as to eliminate entirely any oxide film which may interfere with an integral contact between the cast metal surrounding the rail and the steel of the rail itself. The novelty of this cast-weld joint lies in the fact that the weight of molten metal surrounding the joint yields up enough specific heat to reduce the rail surfaces in contact to a temperature which approximates that requisite for melting. In order to produce this

FIG. 3.—CAST WELDED JOINT AND MOLD

with a given mass of metal, the weight of the metal must approximate 180 lbs. for a 90-lb. rail. Mr. Annable allows the metal to pass through the cast-iron mould which surrounds the joint, and in this way adds to the temperature of the joint sufficient heat to produce the metallic union required between the cast joint and the rail. He then reduces the amount of metal required to stay around the joint

so only enough is left to make it mechanically as strong as the rail. One hundred and forty pounds is found ample for this result. It is found that the passage of this extra metal through the mold does not change the chemical composition at the head of the rail, which is subject to the attrition from the blow of the rolling car wheel. The tests on a rail joined in this way show that it requires 60 tons hydraulic pressure on 18-in. centers to fracture the rail, and the fracture occurs at points not adjacent to the joint of the rail itself; practical operation also conclusively proves that the strength of the joint is greater than the rail; the permanent flecture point is reached at about 20 tons for an 80-lb. rail, and the joint shows no sign of weakening until after the elastic limit of the rail has been reached.

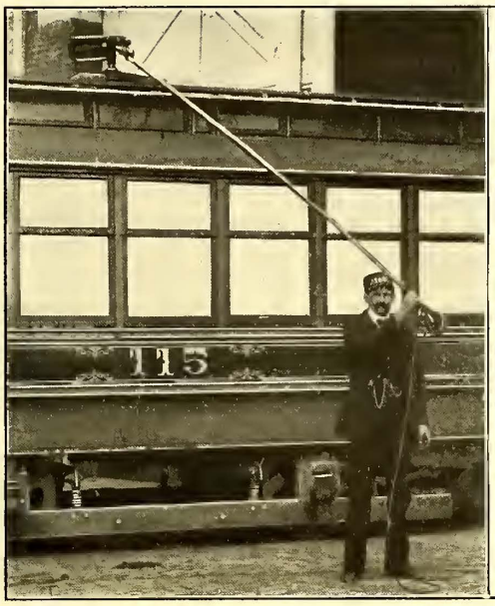


FIG. 10.—ADJUSTABLE TROLLEY POLE

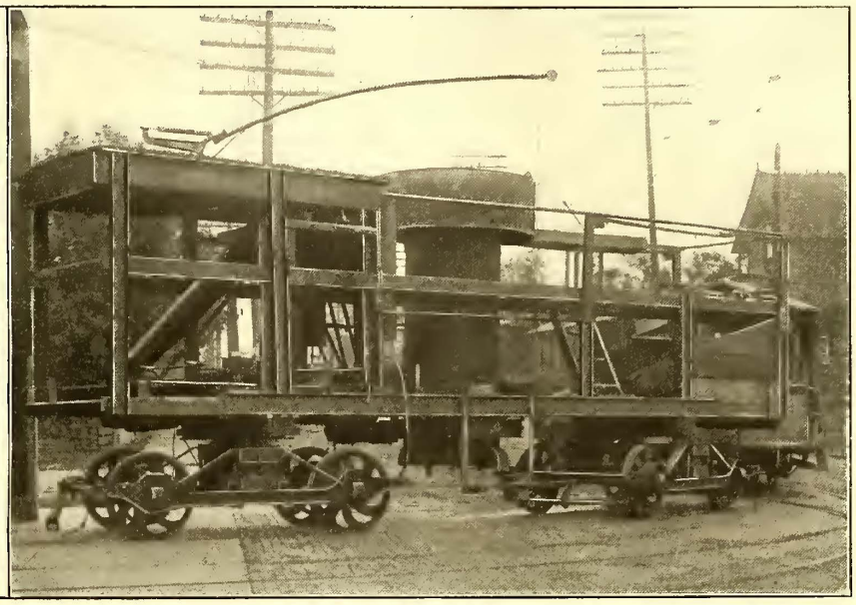


FIG. 2.—HOME-MADE CAST WELDING CUPOLA CAR

The cupola in which the iron is melted is shown in Fig. 2. The iron used is scrap, consisting of brake-shoes, broken frames and miscellaneous castings, and the tests cited above were made from iron produced from this mixture of scrap. The cupola shown in Fig. 2 will handle about 14,000 lbs. in one heat, or enough to pour the required amount for joint and spill, for from seventy-five to one hundred joints. The cupola as shown is mounted on a double truck frame made by Mr. Annable, the coke and iron being on separate platforms. A tuyere is provided on each side of the cupola, so that joints can be poured on either track with the least possible movement of the molten iron. The regular form of ladle is used for pouring the metal into the joint, and the matrix or mold for forming this joint is shown in Fig. 3. The blower for the cupola is 30 ins. in diameter, and is driven by an old type of railway motor with the fields connected in series. The speed is 3800 r. p. m., and is maintained constantly during the heat, more or less iron being introduced into the furnace to give the proper temperature to the molten metal.

The joints of about 8 miles of track have been cast-welded in this way in Grand Rapids, and examination indicates that the joints answer every purpose as mechanical and electrical connections. It is well known by those experienced in measuring the electrical conductivity of cast-welded joints that the higher the temperature at which the metal is poured into the mold, the lower the resistance of the joint. As these joints show under test a conductivity greater than that of the rail, nothing more could be desired in the way of ground return conductor.

Before leaving the subject of track work, reference should be made to the use by the Grand Rapids Company of a corrugated cast-iron surface plate, adjacent to the rail at crossing and street in sections. The plate, which is shown in Fig. 4, is employed on the grooved side of the rail and is designed to prevent heavy traffic from damaging the toothing blocks at the points, where they are subject to excessive street traffic wear. Some of these plates have been down five years and do not yet show any wear from vehicle abrasion.

In other departments of its system the company has also introduced novelties in construction which are of considerable interest. For instance, Fig. 5 shows a form of trolley wheel for which Mr. Annable has just secured a patent, and which has been in use for some time. The end of the harp, which otherwise is of the ordinary kind, terminates in two hubs projecting inwardly, while the trolley wheel has extended hubs which project into the annular recesses in the hub of the trolley head. The wheel rotates around a hollow shaft which has inside oil holes. Oil is injected into this hollow shaft through a hole in the end, and flows along the inside of the axle of the trolley wheel, and then along the outside of the axle, giving a large oiling and bearing surface, both for conductivity between the trolley wheel and harp, and also for the pressure of the trolley wheel. The bearing has a long life without chattering or side play to the trolley and avoids the use of side springs for the purpose of conducting a current from the trolley wheel to the

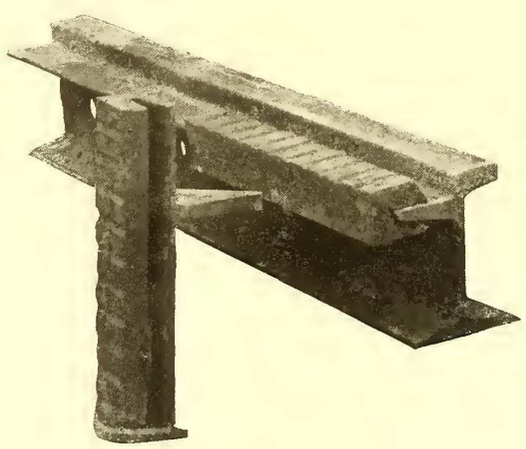


FIG 4.—CAST IRON WEAR PLATE FOR GIRDER RAILS

pole. The sand box used is also novel, as well as ingenious. It consists of a rectangular box, 10 ins. x 10 ins. x 7 ins., shown in Fig. 6, provided with a spout through which the sand is introduced into the box, and also distributed on the track. The box can be rotated on an axle 120 degs., by the motorman, who presses his foot on a button located

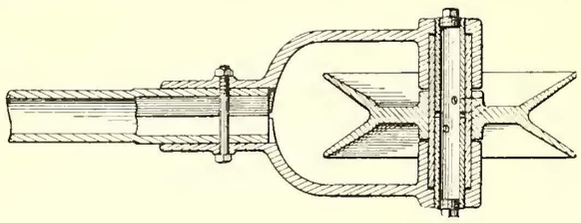


FIG. 5.—NEW TYPE OF TROLLEY WHEEL

at a convenient point near the controller. A pair of sand boxes is used at each end of the truck.

Mr. Annable has also designed his own track drill, which consists of a 1-hp motor mounted in a box, one end of the motor being provided with a flexible shafting running the full speed of the motor, see Fig. 7. The reduction for the drill speed takes place in the head of the drill device, where there is a worm gear which reduces the revolutons in the ratio of 27 to 1. This brings the speed down to 40 r. p. m., which is about right for a 1-in. drill. The drill head clamps the rail and the drill is pushed forward in its feed by an automatic or hand feed as desired.

The bonds for the Grand Rapids road are also made in the company's shop. Scrap copper wire, which is usually old field wire, from which the insulation has been removed, is used for the flexible portion of the bond. The head is a copper thimble, as shown in Fig. 8. The outside of the thimble is tapered and is inserted in an inch hole in the web of the rail, where it is riveted over and in this way securely fastened to the rail. The current density on the contact surface between the rail and the thimble does not exceed 60 amps. per sq. in., which is certainly well within the limits of good practice. The bonds are 160,000 circ. mils. capacity, and two of them are used at every joint which is not cast-welded.

The Grand Rapids Company builds its own trucks, and has adopted a wheel base for single trucks of from 8 ft. to 9 ft. The car body, as shown in Fig. 9, is supported by

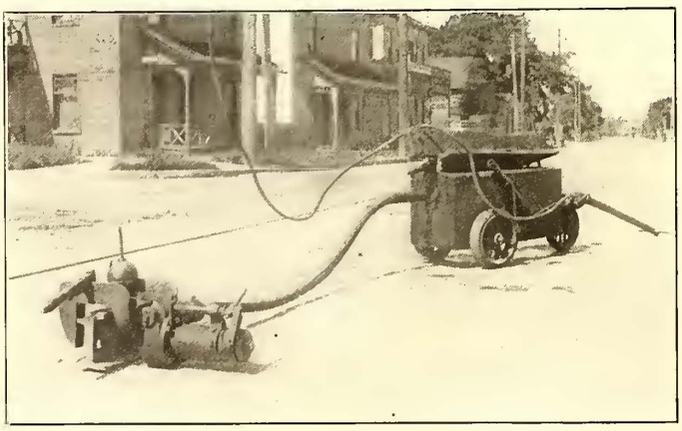


FIG. 7.—PORTABLE ELECTRIC RAIL DRILL

elliptic springs at the ends of the truck frames. The side-bar is formed of two pieces of flat iron $\frac{7}{8}$ in. x 7 ins., riveted together so as to make a truss completely around both wheels and extending to the car bolster. The distance between the wheel center and bolster is 4 ft. on an 8-ft. wheel base. The brake rigging is secured on the outside of this frame, and the brakes are applied by a single compound lever, equalized by rods connecting both compound levers together. In this way the brake pressure is distributed equally on all four wheels, as is shown by the uniform wear on all brake-shoes under one equipment. On some of the

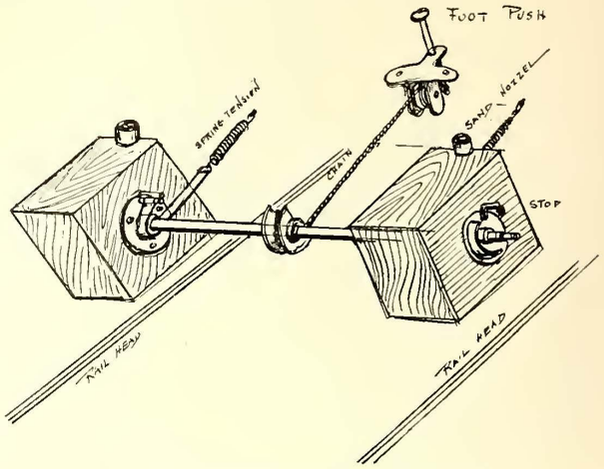


FIG. 6.—REVOLVING SAND BOX

cars the Westinghouse standard electric brake is used as an emergency and traffic brake.

The convertible car made by this company has the following features. A curtain is provided for the summer car and slides inside of the curtain groove, making the car rain-proof in times of wet weather. As the window-sill is 30 ins. from the floor of the car, and the window is 36 ins. high, all the effect of an open car is obtained. When used as a winter car, the sash frames are placed on the outside of the car under a furring strip, which is permanently screwed over them. Before leaving the car, attention must be called to the arrangement of the seats in the new cars that are now being built. Brownell & Wright reversible seats are used. There are also four permanent seats located in the corners of the car. The turnover seats are located opposite the middle of the windows, which give an aisle room of 25 ins. instead of 18 ins. if the seats were located opposite the side posts of the car. This arrangement increases the seating capacity from thirty-two to thirty-six.

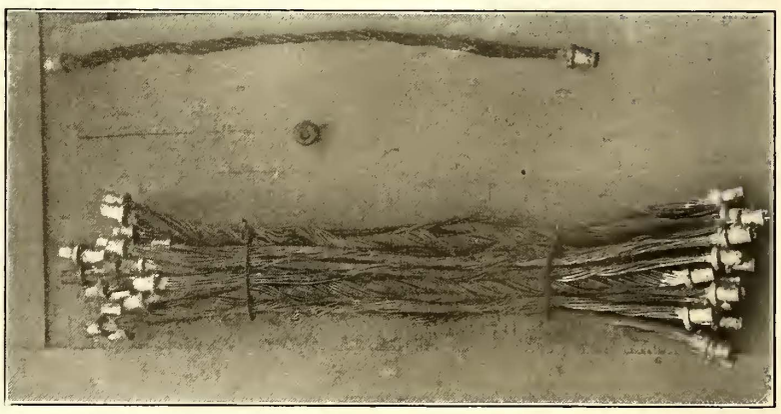
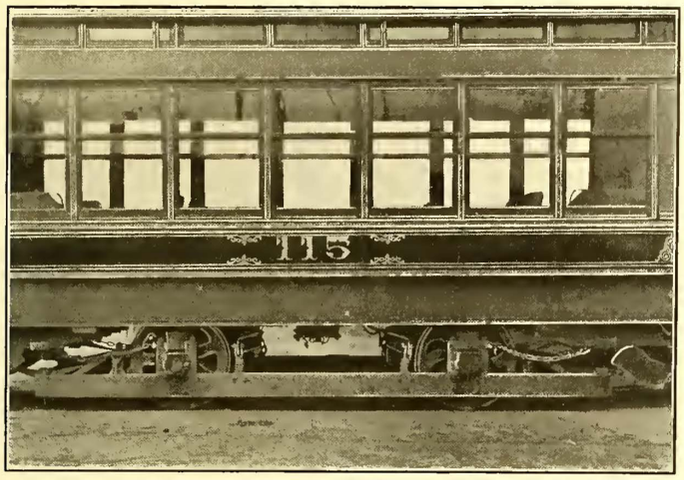


FIG. 8.—RAIL BONDS

The trolley pole, with its stand, is a novel construction, and is arranged so the trolley can be pulled to the ground for the replacement of trolley wheels, as shown in Fig. 10. This gives a great range of flexibility of the pole, and does not make it necessary for the motorman or conductor to climb to the top of the car, except in the case of a broken trolley rope.

Mr. Annable has found that breakage of pinions is largely due either to an inherently weak gear, or else that the bolts

that clamp the two halves of the gear together become loose, which puts the split gear out of mesh with the pinion, and consequently sooner or later the split gear and pinion, or both, will be wrenched from this cause. In the Grand Rapids shops the gear is made whole, and is forced on a car axle by a hydraulic press before the wheel on that side



GRAND RAPIDS CAR AND TRUCK

is pressed in place. This gives much longer life to gears and pinions and reduces trouble from this part of the equipment.

The Grand Rapids Railway Company also manufactures its own car wiring cables. To make connections the company uses a cast copper trough. The stranded ends of the wire are first turned, and are then introduced into the T trough. The lips of the latter are then bent over by a hammer, and the joint is soldered. When tapped the joint is the same size as the insulation of the original insulated cable.

The Nashville & Columbia Electric Railway and the Nashville & Gallatin Electric Railway have been consolidated as the Tennessee Interurban Electric Railway, and the capital stock of the companies has been increased to $3,000,000. The road that the company proposes to build has been surveyed. It will extend through Nashville as a center, from Gallatin to Mount Pleasant, touching Brentwood, Franklin, Spring Hill and Columbia to the southward, and Goodlettsville, Edgefield Junction, Hygeia Springs, Ridgetop and Eldorado Springs on the north. The road will be 119 miles long, and will pass through a densely populated country, known as one of the most magnificent agricultural and stock-raising sections of the United States. It will constitute a strong factor among the railway interests of Nashville and the tributary country. The traffic in passengers, freight and express, it is estimated, will be very heavy. The incorporators of the company are: C. W. Ruth and Frank Haskell, of Pittsburgh, Pa.; J. H. Connor, J. P. Fulcher and John H. McMillin, of Nashville; Van Leer Polk, of Paris, France; D. D. Spillers, of Gallatin, Tenn.; J. M. Dedman and Major W. J. Whitthorne, of Columbia, Tenn. The officers of the company are: Frank Haskell, president; C. W. Ruth, vice-president and treasurer; Frank P. Bond, secretary; J. H. Connor, general manager.

It is said that a bill to give electric railway companies operating in Pennsylvania the right to carry freight and express matter, and in many other ways to allow them the privileges similar to those now held by steam roads, is being prepared by eminent corporation lawyers of Philadelphia. The granting of the right of eminent domain to street railways will be another clause in the bill.

Comments on the Proceedings of the Accountants' Meeting at Detroit

BY A MEMBER OF THE ASSOCIATION

The saying, "you can't keep a good man down," applies as well to a body of men as to an individual.

The association is fast becoming of great value. While, perhaps, it is putting it too strong to say it is a recognized authority on matters which pertain to it, it at least may be proud of the fact that its assistance is welcomed, not only by the National Association of Railroad Commissioners, but by the Census Department of the United States. We think the association richly deserves the success with which it is meeting. Certainly no association could have executive officers who would devote more time or thought to the work than have those who have had charge of the affairs of this one, and we doubt if any body of men could attend more strictly to business while in session.

Commencing with the address of welcome we shall try and give our impressions of the papers read and the discussion that followed. The association is to be congratulated at being privileged to listen to the able address of Hon. F. A. Blades, Comptroller of the city of Detroit. The facts of his having excused himself from a previous business engagement, and of writing his address, distinctly show that he fully appreciated our calling, but did he not attach greater importance to us than is as yet recognized by those who employ us? True, we "handle the money and account for it," but will not the man who earns the money and economically expends it always be considered the most important factor, and rightfully so? We may be a link in the chain, which should be strong, but it's the executive officer who pulls the chain. "Pride goeth before a fall." We don't give our show in the big tent yet awhile, and care must be taken that some of the tribe of Brutus do not arise and say "upon what meat does this our Cæsar feed that he has grown so great," and cut us off in our youth.

The above is not designed to belittle our calling, for it is no doubt an undisputed fact that the president or general manager who gives his accountant the greatest opportunity to become thoroughly familiar with all the details of operation, and requires from him such statistics as will enable him, as the head of the organization, to get in as concise a statement as possible the cream of the information, and requires the heads of departments under him to consult with the accountant as to details, is the one who is getting the greatest amount of income from his property, and expending that income the most economically. Still we are part of the chain, possibly the hook, but we don't do the pulling. With this idea in mind we will take up that part of the president's address which deals with the subject of the paper he stated he had intended to have had "prepared and presented to the convention on 'Correct Accounting Methods for Electric Railways,' being a treatise on the broad underlying principles of accounting, including depreciation, injuries and damages, sinking fund, etc., with the object of instilling into the minds of those who have the guidance or direction of street railway affairs, the vital necessity of making adequate provision for depreciation."

While Mr. Mackay would have been perfectly justified in having had such a paper prepared and read, after it had received the approval of so many of the members and the disapproval of but one, still we cannot help feeling that the one who advised against the discussion of the subject by our association may have helped steer it away from a rock which might have wrecked it. That the writer is not alone in his views is shown by the following communication from

a gentleman who has been for a long time very prominent in the financial affairs of the country, and whose advice is eagerly sought on all matters of public interest. Being a large investor in street railway securities, he is particularly qualified to speak on the subject. He says:

"I think your association will be of great advantage to those who attend the meetings and are thus enabled to interchange ideas, and that it will result in much good to the companies you represent, but I do not think it would be wise for you to discuss in your convention matters which pertain to the policies of your companies; those matters concern the stockholders, who choose boards of directors to represent them, and either elect executive officers themselves or delegate that power to the directors, and it is these representatives who dictate the policies. The accountants are one part of the machine that carries out the policy. The matter of reserves is one of policy, and it occurs to me that you would be overstepping the bounds of propriety if you were to discuss it."

There has been for a number of years a bankers' association whose meetings are attended by the presidents and directors of some, if not all, of the large banks of the country. They discuss matters of policy. Let us suppose, for instance, that an auxiliary association should be formed, composed of the cashiers or tellers of these institutions. The purpose for which they were formed was to secure uniform and economical methods of transacting the routine of office work. Would it be proper for this last-named association to discuss the amount of reserve the banks should carry? Among the numerous charts of the organization of the various companies we have seen published, are there any which place the accountant's circle above that of the president or the general manager? They have an association. Let it be granted that the subject is one which should be discussed; are they not fully competent to decide when and where they will take it up, without suggestions from us?

"Little boats must keep the shore,
Larger ships may venture more."

It was fortunate for the president that his address came near the opening of the convention, instead of at the close, otherwise he would have had to alter his remarks regarding the "Standard Classification" to read something like this: "Although it 'has met the requirements of the various interests represented from all parts of this great country, and has stood for several years the test of actual practice without the necessity of amendment,' this convention has recommended many changes of vital importance." These changes will be taken up later in this article. The remarks of the president regarding the necessity of a standard classification of construction and operating accounts, covering the lighting department of those companies which have absorbed lighting systems, brings to mind the fact that there was presented at the New York meeting in 1901 a report of a committee on a standard system for electric lighting companies, which was a copy of a report made to the National Electric Light Association at Niagara Falls in May of that year. No action was taken on the report by our association at that time, nor has any been taken since. The recommendation of the president would seem to be apropos, and it may be a topic that will merit discussion at future conventions.

The discussion of the paper prepared by Mr. Sampson, treasurer of the Union Traction Company of Anderson, Indiana, on the "Collection and Reporting of Fares on City and Interurban Lines" was interesting, and showed plainly that the members are continually seeking the most up-to-date methods of conducting their department, and brought out very forcibly the benefit to members from the interchange of ideas. It also brought out the fact that roads are very generally abandoning the old plan on through lines of making numerous collections. In connection with the reading of this paper discussion followed on various matters, one of which was the length of time that trip-sheets or day-cards should be preserved. There seemed to be no unformity in the matter, but in the writer's opinion they should be kept until the legal time has elapsed in which a suit for damages could be brought that might require the use of the day-cards.

The discussion on the paper of J. R. Shurtz, auditor of the South Jersey Gas, Electric & Traction Company, of Camden, N. J., on "The Stationery Storeroom," brought out the different methods employed in the arrangement of stationery.

The report of the committee on "Standard Blanks and Accounting for Material and Supplies" brought out a discussion which bid fair to take up all the time of the convention, until brought to a close by the timely remarks of a member who suggested that no matter how much we might discuss the subject, local conditions are such that no committee would be able to prepare a system which all could adopt; that the best plan was to accept the report and get each for himself such points as he could make use of. This seemed to be the opinion of the majority and it was so decided.

The association has reason to feel highly flattered by the attendance at their meetings of two representatives from the Census Department, W. M. Steuart and T. C. Martin, as well as A. L. Judson, the accountant of the Board of Railroad Commissioners of the State of New York, each of whom addressed the convention and took part in the discussion of such subjects as interested them.

It is unfortunate that Mr. Tripp was unavoidably prevented from attending the convention, otherwise the discussion of a chart of forms he had prepared would have undoubtedly brought out ideas that would have been highly beneficial.

The form of income account as presented by the committee appointed to prepare a standard form of report for electric railways, was such a radical departure from that which had been adopted by our association and approved by the National Association of Railroad Commissioners, that it is most unfortunate that it was not printed and in the hands of members a sufficient length of time before the convention to enable them to digest it thoroughly and realize the significance of the changes. Had they had this opportunity they would have been in a position to present arguments against some of the changes proposed by the committee who had had these matter under consideration for months and were ably prepared to sustain their position. There is no intention on the part of the writer to intimate that the committee was not as capable as any which could have been selected, nor that they did not give the matter the careful consideration the subject deserved, and that they handed in their report as soon as they could possibly finish it. Still I think the association was too hasty in adopting it.

When the subject of "revision" is broached, it is possible the admonition to "stand pat" will be found sound advice.

Of what advantage is it to the companies we represent to have made the changes from "income" to "earnings"? Some of us put the classification, including the forms recommended for monthly and annual report, into effect even before the same were formally adopted by the association, having good reason to believe that the same would be adopted since it had been endorsed by the Railroad Commissioners at their Denver meeting. It upset comparisons for a year, but we thought we were getting something

that would be generally adopted, and something that would be a fixture for a long time, so were willing to make the change. At the end of three years we are told it was radically wrong and great changes are recommended. It will probably be said that we don't have to change our system unless we wish, but is that a very good argument among those who are striving for uniformity?

We are an organization of street railway companies; what are the real earnings of those companies? Are they not the receipts obtained through its franchises? We obtain the rights to operate cars in the public ways and to transport passengers, possibly mail, express and freight also. Do not these items really constitute all our earnings? Is not advertising a side issue, a perquisite, if you will, and more properly an income than an earning? Would it not be much better to deduct rent of land and buildings from expense account number 36, than to show it as an earning? Suppose you hire a building for a passenger station and sublet a corner for a newsstand, is there any doubt that the net rent should be shown in account 36? Is it not equally proper if you rent a part of a building you own, to deduct any rent you may receive from expense account number 3? Are not rents of tracks and terminals based on a proportion of the interest on the investment, added to a fixed rate for maintenance and depreciation? Should not that portion based on the capital go to income and the balance credited to expense? If a company is in a position to rent cars, does it not mean that there has been an extra outlay of capital, and is not the return from that outlay an income? Suppose the same company, in order to accommodate its business at certain seasons of the year, temporarily hired equipment, would it not be perfectly fair to include in income the balance, if there had been more income received than hire paid out? or, if the reverse were true, deduct the income received from the expense account? Is not the above also the case if a company has surplus power to sell? Presumably the rate received is based on the cost, including depreciation plus profit; should not the profit be counted as an income and the balance be deducted from expense?

Why should we deduct taxes paid on real estate purchased or conducted as an outside investment from income from same and show the net as income? Have we not decided that taxes are not expenses, and would it not be just as appropriate to deduct the interest on capital invested in this real estate? Is not the public interested in knowing the total amount of taxes we pay and are we not anxious that they should? Why then bury any part of them in this item? We think the balance sheet and the various schedules presented are very concise and cover the ground in good shape, except that possibly under "track" (page 21 of the report) it might be well to define by notes if under "length of road" is to be included tracks in yards, car houses and shops, or whether those tracks should go under sidings and turnouts; also when a siding ceased to be such and became second main track. Both of these points the writer has had to take up with the commissioners. Under "cars," is it not going to be a little confusing to define which have or have not electric equipment? Most companies shift their motors and controllers from open to closed cars and back again, as the seasons require, but with this exception the cars remain electrically equipped. Would not more explicit directions help us out? I think the thanks of the association are due to the committee for their work, and feel certain it will receive the commendation of the joint committee from the Railroad Commissioners. It is a thankless job, as a rule, and the writer is very glad, indeed, that after having adopted the report as presented, with but slight amendments, the association showed its willingness to trust the matter of making such slight changes as the Railroad Commissioners may require to them. We can't go before that body as a committee of the whole, but they have very generously allowed us to have three representatives, to be chosen by our president. It would be folly to make dummies of them. We think President Mackay has every reason to feel proud of his meeting, and the association certainly has occasion to feel pleased at the manner in which he conducted it. He certainly kept the discussion going on every subject that was brought up. If no one volunteered to speak, enough were invited to be heard to make it interesting.

The writer regrets that other pressing duties have prevented his giving this article all the thought it deserved, but possibly if it had been more extended, readers might have decided with Ray that "he that uses many words for the explaining any subject, doth, like the cuttle-fish, hide himself for the most part in his own ink."

Cincinnati Traction Interests

It is reported from Cincinnati that the papers in the alliance between the Pomeroy-Mandelbaum syndicate, of Cleveland, and the Widener-Elkins syndicate, of Philadelphia, controlling the Cincinnati Traction Company, were signed Oct. 22. The causes which led up to this alliance may briefly be stated as follows: The Pomeroy-Mandelbaum syndicate controls the Cincinnati, Dayton & Toledo Traction Company, formerly the Southern Ohio Traction Company, which has operated to College Hill, 7 miles from the heart of Cincinnati. Here it has been blocked for years by the Cincinnati Traction Company. Some time ago the syndicate purchased a steam road operating to within 3 miles of the heart of the city, but up to very recently its plans to operate cars over the steam road have been successfully blocked. The syndicate is also back of the Miami & Erie Canal Transportation Company, which has a franchise for the use of the canal banks from Cincinnati to Toledo.

To accomplish this the Traction Terminal Company has been incorporated with $100,000 capital to build traction depots and street railways. The incorporators will be J. B. Foraker, Jr., Randolph Matthews, Frank Wilcox, George H. Warrington and Dana Stevens. Mr. Foraker is the vice-president of the Cincinnati Traction Company, and Mr. Wilcox is the vice-president of the Miami & Erie Canal Transportation Company and also the legal representative of the Cincinnati, Dayton & Toledo Traction Company and the Mandelbaum-Pomeroy syndicate; Mr. Stevens is the assistant general manager of the Cincinnati Traction Company, and Mr. Warrington and Mr. Matthews are legal representatives of the company.

The company will organize at once, and contracts will be made by it with the Cincinnati Traction Company and the Cincinnati, Dayton & Toledo Traction Company for entrance into the city of the cars of the latter company. This Traction Terminal Company will also build a traction terminal station for the accommodation of these cars and other interurban cars that come into the city. The question as to the route of entrance of the Cincinnati, Dayton & Toledo cars is to be decided by this terminal company, although it is merely a legal formality to carry out the decision and agreements arrived at between the officials of the Cincinnati Traction Company and those of the Cincinnati, Dayton & Toledo Traction Company. It is stated that the entrance agreement with the Cincinnati, Dayton & Toledo Traction Company is practically the same as those of other interurban roads that have recently secured such contracts, and that the Cincinnati Traction Company will get a percentage of all fares collected and on passengers hauled inside the city limits.

Appropriate Car Decoration

BY H. ARNOLD FRENCH

A street car, with absolutely no ornamentation to relieve its appearance, would be an object of deservedly adverse criticism. Its extreme plainness would not only make it unattractive but actually unsightly and offensive to all public-spirited persons who take an interest in the beauty and tasteful appearance of the streets of the city in which they live. At the same time many of these people, certainly those whose artistic principles have been farthest developed, would, no doubt, prefer the appearance of cars of this description to some which may be seen—though in fewer numbers than formerly. Cars which, instead of being devoid of all decoration, are covered with a copious intermingling of stripes, united with a convolution of broad and fine lines, distributed in every available space on the body, and which have incorporated into this medley of design a mixture of fantastic lettering, which has evidently no value except that of filling a vacuity to which the fertile mind of the designer failed to respond when called upon to furnish more material for design.

But a sensible medium can always be found if diligently sought between the two extremes. Simplicity and artistic taste is much more essential to a master painter in the arrangement of his ornamental work than ostentatious display. Simplicity, in fact, is demanded by most managers, though often more from economical rather than artistic grounds. This has, nevertheless, had a good effect, and has often prevented the master painter from employing a multiplicity of motifs in his designs, for which extravagant waste of time and material there is no possible apology.

Questionable taste in car decoration cannot always be attributed to the master painter, however. This imputation in many cases would be erroneous, for admitting that the painter draws the designs and supervises the application of the colors, the fact must not be forgotten that in many cases, being conversant with the ideas and fancies of those in higher authority, he selects what he knows will be pleasing to them. He is seldom allowed to exercise his own taste exclusively. It is true, that his views are often solicited by his superiors, but for obvious reasons he usually advocates those ideas that experience has taught him will be most acceptable, regardless of his own ideas, which are often compelled to lie dormant for the want of artistic appreciation.

As has been stated, simplicity should be the predominating element in the construction of all ornamental designs used on street cars. This in no sense implies that simplicity is advocated to secure cheapness or that simplicity is in all cases synonymous with beauty. A simple design, painted with color alone, might present a most unsightly appearance, but if executed with gold leaf the same design might be transformed into a very pleasing ornament.

Gold leaf cannot be improved upon by any material used in decoration, whether on a street car or any other vehicle. Its known "sociability," which allows it to intermingle with all colors, shades and tints, without the least danger of violating any of the laws of harmony or disturbing any color scheme, however delicately arranged, proclaims it to be the most valuable of all decorative material in existence. Furthermore, the fact which makes it still more desirable, is, that if necessary, it can be used alone upon any color, without fear of its presenting that incomplete appearance that often accompanies any other leaf or color when similarly employed. Let it be added, in passing, that where gold leaf is used alone for the decorative painting of street cars it denotes, in a most emphatic manner, a vast degree, a keen conception of the propriety of things, combined with much appreciation of artistic results; for the appearance of a car decorated after this manner—with a touch of asphaltum shade here and there, if you please—is very neat and attractive.

The appearance of aluminum leaf ornaments on cars convey to the mind of a stranger, when they are first seen, that the company operating the cars are not absolutely prosperous, especially if gold is used upon cars in the city where he resides. Still, it is extensively used by many companies, chiefly on account of its low cost, when compared with gold leaf. While it cannot by any means be said to give the rich effect produced by gold leaf, yet it is possible to make it quite attractive by a clever combination of harmonious colors with it. In all cases where it is embraced with color in one design, it is very important that it should predominate, as color in this arrangement should not be too much in evidence, for if the color stands out so prominently as to be conspicuous, then its appearance is similar to an "all-paint" decoration.

The persistent use of paint alone for car decoration is evidence, in many cases, that it is preferred to leaf ornamenting or the leaf and color combinations. This preference, which, to the true lover of art, seems a perversion of opportunities, is evidently not always chosen on account of economy alone, for it is seen in many instances where elaborate panel scrolls were "worked out" with color entirely—all of the detail executed with many blends and lines, all of which makes the expense excessive. Again, where light colors are used over dark ground work it requires two and frequently three coats to "cover," so as to give the ornamental colors their full value. This necessitates so much time in the final completion that the cost of this method in time alone would overbalance the expense of even gold leaf. So it is fair to presume that in many cases where the use of "all-paint" ornamentation is in vogue it must be a matter of past ideas, confounded with up-to-date practice on the part of those who are responsible for these costly and antiquated displays. If I should wish to pose as a reminiscent I could relate how, way back in the seventies, it was the fashion to ornament street cars in a similar manner.

The more simple method of ornamenting cars with color exclusively, such as straight striping, or even turning these stripes on the ends into flat scrolls, is hardly worth discussing. Cars painted after this style are very unsightly. Certainly the presence of this kind of decoration on cars fails to conceal the fact that it is only tolerated by its apparent cheapness, and would be far more preferable if it was dispensed with entirely and the cars used in service without any ornamentation whatever. It is more refreshing to note that street car decoration is slowly but surely nearing that point where rich simplicity is the predominating feature, a characteristic also which is noticeable in the high-grade coaches of large steam roads during late years.

Meeting of New York Railroad Club

At the meeting of the New York Railroad Club, held on Oct. 16, President Vreeland, as chairman of the special committee on new quarters, reported the very thorough search his committee had made for a suitable meeting place; the only location recommended was in Carnegie Hall, which, however, was not obtainable on the club's regular meeting night. Having thoroughly considered the matter in all its phases, the executive committee of the club recommended to the membership that the regular meeting night be changed in order to secure permanent and adequate facilities. This recommendation was approved by unanimous vote, and the club will hereafter meet on the third Friday of each month, except June, July and August, at Carnegie Hall, 154 West Fifty-Seventh Street, New York city.

At the meeting of the club, held Sept. 18, there was an interesting discussion on the subject of track construction, which, owing to the pressure on these columns, due to the publication of the proceedings of the Detroit convention, has not been presented in an earlier issue. The principal speakers were J. C. Brackenridge, chief engineer of the Brooklyn Heights Railroad Company; R. Trimble, principal assistant engineer of the Pennsylvania lines west of Pittsburgh, and W. Boardman Reed, engineer of track of the Metropolitan Street Railway Company, of New York. Mr. Trimble confined his remarks to steam railway practice, the others to electric railway practice. An abstract of the remarks follows:

Mr. Brackenridge.—In preparing the roadbed to receive the ties care should be taken to excavate as little as possible below the finished grade line of the bottom of the tie. When the holes are dug carelessly, some being deeper than others, it is impossible to tamp up the track in such a manner that it will retain a perfect surface and line. After the tie holes have been dug and ties laid, the rail should be distributed, then driven up tight to the abutting rail and spiked (no allowance being made for expansion). The ends of the rails being in close contact, the friction between the faces of the ends will help support the joint, prevent working, and the consequent loosening of the electric bonds. Before tightening up the joints, the rail ends should be in surface and line. This latter is a matter that track foremen are very apt to be careless about, and when this is the case a kink will result which it is difficult to get out. The rail is then buried within the pavement which restrains movement of the rail laterally and protects it from sudden temperature variations.

When the track is laid with "T"-rail without paving, surfaced and lined, it should be filled in to within about 1½ ins. of the top of head of rail and to a distance of about 30 ins. outside the gage line. This method of covering the ties prolongs their life, and furnishes lateral support for the tracks. Should the rail buckle or get out of line, due to expansion, it can be remedied by taking off a joint at the place affected, and putting in a trailing-point split-switch; this, however, we find is rarely necessary if the track is

properly lined and surfaced in the first place. Apropos of this, just a suggestion for steam railroad work—when the rails and ties are left exposed, the rails are apt to creep, espccially on grades, thus making it difficult to keep crossings with other tracks in line, particularly so if the crossing be at right angles. This difficulty can be overcome and the crossing maintained in perfect line by putting in switch points on either side to take care of the movement of abutting rails. This is a simple method and will double the life of a crossing at points where there is much movement of the connecting track.

The most expensive as well as vexatious question in track work is that of maintaining joints, especially in paved streets; this is due to the poor design of nearly all makes of joints or fish-plates. In designing a fish-plate, advantage should be taken of every square inch of bearing area that a rail affords for a distance of 10 ins. from its end. This all-important fact is overlooked in the design of most of our standard fish-plates used on railroads today. The only satisfactory joint that has come under my observation takes advantage of the horizontal area offered by the base of the rail. It stands to reason that a rail can be better supported by using the 50 sq. ins. or 60 sq. ins. of bearing area offered by the base of the rail than by the angular bearing obtained by most fish-plates under the rail head and on the flange of the rail.

In street railroad construction, where the best pavements are used, such as granite block, brick or asphalt on a concrete foundation, as I said before, the paving costs more than the actual track work. It is, therefore, of first importance that the track, once laid and paved up, should not be disturbed until such time as the rail is worn out. This would not be difficult were it not for the joints, which, with the ordinary fish-plates, give way long before the rail is half worn. I have found that by using a sole-plate similar to the old stringer joint-plate in connection with the regular fish-plates or above-mentioned joints, placing ties 5 ins. between faces at the joints (making a suspended joint), and driving the rails up tight together, tightening the joints, then paving the street with as tight longitudinal joints between the stones as possible from the head of the rail toward the curb, being careful to see that the stone next the rail is fitted up close to it in order to prevent the rail from getting out of line (due to expansion)—on such track there will be no necessity for repairs until the head of the rail is worn out. I am a believer in wooden tie construction, having used the longitudinal concrete beam with steel tie-rods and found that the rigid foundation shortened the life of the rail more than 25 per cent.

One of the difficulties I have found with the 9-in. girder-rail track under heavy traffic was that it always became wide gage, no matter how carefully the track was laid. After giving this subject considerable thought, I came to the conclusion that this was due to the fact of the web being in a perpendicular line with the gage, which threw the weight outside the center of gravity, resulting in the tipping out of the rail, and the consequent widening of the gage of the track. This difficulty I overcame by designing two rail sections, known as the standard Brooklyn Heights Railroad section, which is a tram rail, and a grooved rail on the same principle. In these sections the web was moved back from the gage line about ½ in., and no more difficulty was experienced. The design of the groove rail is such that the flange of the wheel forces the dirt over the lip of the rail and insures a good contact between the head of the rail and tread of the wheel. In other types of grooved rail there is a tendency for the flange to pack the dirt in the bottom of the groove, thereby lifting the tread of the wheel off the head of the rail, making poor contact and causing a greatly increased power consumption.

In closing, I realize that the discussion may deal largely with the wisdom of laying the track with tight joints but my experience has been that, even where the joints are left open, it was found that the friction between the plate and the rail was great enough to prevent the expansion from closing up the joint.

Mr. Trimble.—Assuming that we have a perfectly constructed roadbed, the following points in their natural order of construction are mentioned:

First, Ballast.—This should be of good quality, its purpose being (*a*) to secure solid bearing for the cross ties; (*b*) to hold them in position; (*c*) to provide a uniform support for the track as far as possible; (*d*) to distribute the train load over a large surface, and (*e*) to give good drainage.

In order to provide solid bearing for the cross-ties and to secure uniform support for the track, the ballast should be of some hard, durable material. As a general rule, the writer believes that stone is better than gravel. In order to distribute the train load over as much surface as possible, it is necessary to have a deep bed of ballast under the ties. This bed varies on different railroads from 6 ins. to 10 ins. Owing to the very heavy rolling stock now in use on steam railroads, the writer believes that the time has come when the bed of ballast should be very much increased, and advocates that 14 ins. under the bottom of the ties is not too much. Some engines now in use concentrate on a wheel base of 16 ft., about 225,000 lbs. Considering that this load is distributed over an area of about 200 sq. ft., we have an average load on the supporting roadbed of 1100 lbs. per sq. ft. These are not quiescent loads, but on account of the high speed at which these loads travel ov r the track, the effect toward depressing and distorting the supporting roadbed must be largely increased over the figures above given. These figures certainly show the necessity of having a good bed of ballast to distribute the loads over as much area as possible, and it has been demonstrated that 6 ins. or 8 ins. of ballast under the bottom of ties is not sufficient to make a perfect distribution.

Second, Ties.—No satisfactory substitute has yet been found for the wooden tie. In order to provide for the loads, the ties should be placed as close together as practicable to allow sufficient room for tamping. The writer believes that with a good sized tie, say not less than 10-in. face, eighteen ties to a 33-ft. rail should be used for standard construction. A treated tie with tie-plates should give very good results.

Third, Rail.—100-lb. rail should be used for perfect track under existing conditions. It should be well manufactured. One of the greatest difficulties encountered by the railroads is the securing of good rail. Our rails are wearing badly, and this is believed by people who have given the subject serious consideration, to be caused by the mills not giving proper attention to the process of manufacture. The writer believes that best results have been obtained from rails laid with broken joints and suspended angle-bars.

Fourth, Joints.—Perfect track, of course, should have a pe fect joint. A great many people claim to have a perfect joint, but the writer has not yet seen it. On account of the ease of application and general utility, although the angle-bar is not a perfect joint, yet it is probably as good as any joint we have in use. Better results would probably be obtained were a better quality of material used in the angle-bars. Some experiments with better material have been very satisfactory. In laying rail very particular attention should be paid to the joint spacing, and at the present time many railroads are giving this matter close consideration. Formerly these joints were guessed at, but it is now the practice in laying rail, in order to provide for spacing, that the temperature be taken and the opening be allowed for the degree of temperature of the rail at the time it is laid.

Fifth, Track Fastenings.—Track fastenings are an important feature in a perfect track, and the writer believes for a long time to come rails will be secured to cross ties by means of spikes as at present. These seem to answer the purpose very well, and it looks as if they are fully as good as lag screws.

Mr. Reed.—I must differ with the first speaker as to the best track construction for electric railways, especially for paved streets. As the power applied to the wheels emanates from a revolving armature, there is, or should be, an even application at all points of the circumference, and there is nothing to cause a pound or hammer blow, therefore, I believe, no necessity for a flexible roadbed; I consider a perfectly rigid roadbed by far the best. Especially is this true on paved streets, for every movement of the rail is imparted to the pavement and tends to raise it off its bed. It is impossible to maintain asphalt in even a safe condition unless the track is as nearly rigid as possible and the repairs to any first-class pavement alongside of a flexible track will exceed the extra expense of rail renewals, if there is any such extra expense, which I doubt.

In Manhattan all electric tracks built since 1898 by the Metropolitan Street Railway Company are constructed on a perfectly rigid foundation. In lieu of ties, cast-iron yokes, bedded in concrete, 5 ft. between centers, are used, so that with a 9-in. 107-lb. rail, and twelve-hole 36-in. joint plates there is but little or no give to the structure even with the heaviest cars. This same result can be obtained on the ordinary trolley roads by laying a good concrete foundation under and around the ties or laying the rails on a concrete beam of sufficient cross-section. To be sure, at crossings, switches and frogs there is always a pound, and consequently excessive wear, but that this is increased by having a solid foundation I doubt.

On steam railroads, where the power applied to the locomotive drivers is conveyed by reciprocating parts, no matter how much care is used in balancing there is always a hammer blow struck with each revolution of each driving wheel. The experiment of laying a copper wire on the head of a rail is old, but it illustrates the effect of these hammer blows perfectly. With a solid foundation, therefore, for steam railroads there would not only be excessive wear on the track structure but upon the locomotives as well, so that a flexible track is desirable; I believe for this reason

joint plates should not be too long and should be supported and fitted as well as possible to the rail, so as to prevent any lateral motion, and to prevent the drop of the drop rail. Track for steam railroad has been laid experimentally on concrete foundation, but did not prove a success, for the concrete was not sufficiently elastic to withstand the pounding of locomotives.

The joint has always been the weakest part of any track, whether on a steam or electric road; the 36-in, twelve-hole joint so generally used on 9-in. girder rails for electric railways is strong enough and should never break, yet it will not hold up the rails during their life. The theory of supporting the rail at the base as well as the head by the joint plate is, like many others, better than the practice owing to the variation, slight as it may be, in the height of adjacent rails. Welding, whether cast-iron or electric, makes as nearly a perfect joint as can be had, but it is not suitable for rails exposed to great changes of temperature, and even on rails buried by pavement it has its drawback. The necessary heating of the rail-ends makes them brittle, so that either rails or joints will break in cold weather or track will get out of either line or surface, and is likely to play havoc with intersecting lines. Could ends of rails be machined and joint plates of almost any of the existing types be machined to fit them, a perfect joint could perhaps be obtained and joints would hold up during the life of the rails, thus lessening materially the worry and labors of all track masters.

Christensen Air Compressors for Shop Work

As stated in a recent issue, N. A. Christensen, who has been superintendent of the Christensen Engineering Company, of Milwaukee, since its organization, has personally undertaken the manufacture and sale of Christensen air compressors for miscellaneous work. This will not interrupt in any way Mr. Christensen's connection with the Christensen Engineering Company, with whom he is still engaged as consulting engineer, and with his other interests remain undisturbed. The air compressors furnished by Mr. Christensen will be manufactured by the Christensen Engineering Company under his own designs, specifications and inspection, insuring the same excellency in design, detail and workmanship which the products of this company have always possessed. The new arrangement, however, leaves him free individually to extend the introduction of his system of air compressors in a rapidly extending field. There are now in use over 7000 of these compressors, of all sizes and capacities, constructed under his patents and used for various purposes, such as sand blasts for cleaning rails, air blasts for cleaning cars, motors, generators, etc.

Mr. Christensen's engineering and sales offices are located in the Herman Building, corner of Wisconsin Street and Broadway, Milwaukee.

Tramways in France

The accompanying two tables give statistics for the year ending Dec. 31, 1901, of the light railways and tramways in France, and are taken from the official list of the French Government published Aug. 21, 1902. Properly to understand the tables, it should be stated that the classification of railways and tramways by the French Government differs considerably from that followed in this country. A distinction is made in France between main trunk steam railroads and those which are not part of the main trunk systems. The latter are called "lines of local interest" or "light railways," and all of the roads given in Table I., with the exception of the mountain railways, are operated by steam.

Under the heading of "Tramways," the French classification includes a number of short interurban lines, which carry freight. Most, if not all of these roads, which are referred to in the first three lines of Table II., are operated by steam. Tramways for passenger business only—that is, city and suburban lines—are given in the two final sub-divisions in the tramway table. The totals given under the heading "number" apply to operating companies, and not to roads.

A brief character sketch of Alfred Beit, a member of the firm of Wernher, Beit & Co., of London, Eng., who, besides their other interests, control street railways in South Africa, Mexico, Chili and Portugal, appears in "Everybody's Magazine" for October. Mr. Beit is only about forty-five years old, and a bachelor. People say he is worth $375,000,000. He came of a Hebrew family in Hamburg, went to college and served an apprenticeship in a Hamburg bank. After his apprenticeship he went to Kimberly and rapidly built up a fortune in the diamond fields. From the time that Cecil Rhodes consummated his great consolidation of the Kimberly diamond mines in 1889, he and Beit were in close business association. Mr. Beit is very small in stature, and when he was seen, as it often happened, in company with Mr. Rhodes, the contrast was almost ludicrous. He is as thorough and precise as Mr. Rhodes was general and heedless of details. He is very blonde, with prominent eyes of steel blue, and is almost dandyish in his dress. The actual figures of Mr. Beit's wealth are probably known to no man; but it is certain that he is one of the richest men in the world, and almost the only man to whom the Rothschilds are willing to play second fiddle, as in the great De Beers Company, where his holdings much exceed their own. Those who do come to know him find him personally a very sunny-tempered man, well read, well traveled, well groomed, by no means the typical millionaire of fiction or the stage.

The recent wreck on the Lake Shore Electric Railway at the crossing of the Nickel Plate steam road is said to have been one of the most expensive in the history of electric operation, and, if the electric company is obliged to pay for the damages, it will make a sorry hole in the earnings of the company. Brakes on the electric car failed to work and it plunged into a freight train, demolishing eight Armour refrigerator cars, said to be worth $10,000 each. The cars were loaded with hams and bacon for export shipment, and the total loss is said to aggregate $200,000.

Table I.—Light Railways

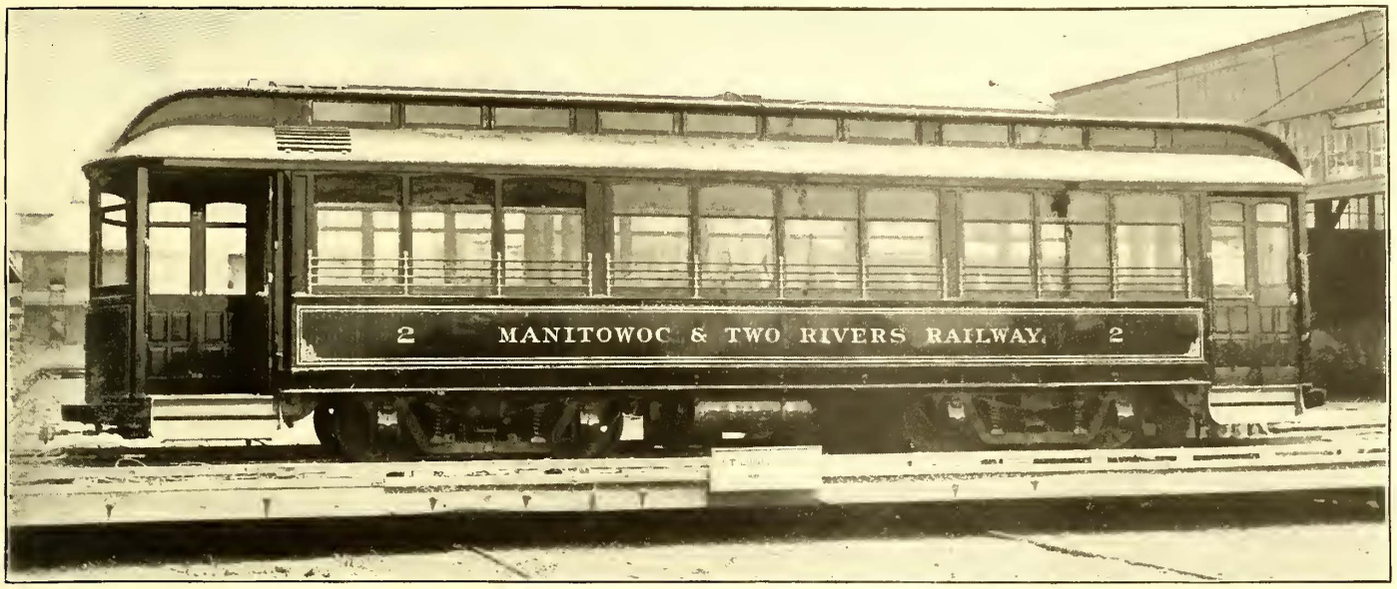
	Total	Length		Cost of Installation	Gross Receipts		Expenses		Profits	
		Built	In Operation		Total	Per km. of Track	Total	Per km. of Track	Total	Per km. of Track
		km.	km.	fr.	fr.	fr.	fr.	fr.	fr.	fr.
With State guarantee	37	4,179	3,834	273,729,551	14,391,022	3,797	13,006,461	3,432	1,384,561	365
Without State guarantee	31	1,206	1,217	230,257,462	19,285,377	15,886	14,290,165	11,771	4,995,212	4,115
Totals	68	5,385	5,051	503,987,013	33,676,399	6,739	27,296,626	5,455	6,379,773	1,275
Mountain railways	12	30	30	22,588,606	1,234,407	12,566	772,673	26,644	461 734	15,922
In Tunis and Algiers	1	43	43	2,687,836	182,547	4,245	--------	------	--------	----

Table II.—Tramways

	Number			Length		Cost of Installation	Gross Receipts		Expenses		Profit	
	Total	Partly or Entirely Electric	Entirely Elec.	Built	In Operation		Total	Per km. of Track	Total	Per km. of Track	Total	Per km. of Track
				km.	km.	fr.	fr.	fr.	fr.	fr.	fr.	fr.
For passengers and freight with State guarantee	31	0	0	2,578	2,437	132,053,357	7,679,593	3,151	7,196,846	2,953	482,747	198
For passengers and freight without State guarantee	25	4	4	436	411	38,520,296	3,977,403	9,677	2,938,683	7,150	1,038,720	2,527
For passengers, baggage and parcel business	22	8	8	252	254	33,692,833	4,117,813	16,212	3,529,240	13,895	588,573	2,317
For passengers only, in Department of Seine	11	10	6	459	613	240,125,758	42,639,866	69,559	37,398,411	61,009	5,241,455	8,550
For passengers only, outside Department of Seine	56	53	47	1,178	1,194	317,982,961	41,133,133	34,479	30,635,417	25,679	10,497,716	8,800
In Tunis and Algiers	--	--	--	220	214	22,192,394	3,016,770	14,097	2,424,609	11,330	592,161	2,767

Convertible Interurban Cars

The accompanying engraving shows one of four convertible cars for interurban service recently built for the Manitowoc & Northern Traction Company, by the St. Louis Car Company.



CAR FOR MANITOWOC & NORTHERN TRACTION COMPANY

The cars have a steel channel bottom frame work, and are mounted on St. Louis Car Company's No. 23 truck. The car bodies are 34 ft., and the length of the cars over all is 45 ft. The roof is of the steam coach pattern. The interior finish is mahogany throughout, and the cars are fitted with the St. Louis Car Company's latest style of walkover seats. The cars are also equipped with the St. Louis Car Company's arc headlight and interior arc lamps.

These cars are also provided with smoking compartments in the rear end, and are in great favor for trolley parties. They are lettered "Manitowoc & Two Rivers Railway."

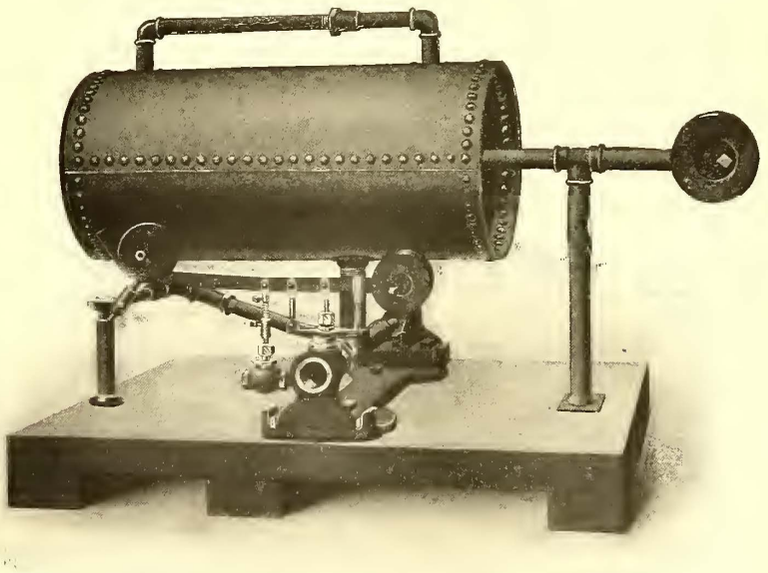
The Morehead Return Trap

The Morehead return trap, which has given good results in a number of electric railway plants, is constructed of steel, the heads and longitudinal seams being closely riveted and calked, to withstand any pressure carried on the boiler without breaking, which is impossible with cast-iron traps. It is the embodiment of simplicity, there being no rubber joints to blow out or leak, and and only one valve, which is on the outside. All working parts are on the outside, in plain sight and easily accessible. There is no ball or globe float inside the receiver to collapse, leak, rust or stick.

This trap is usually located 6 ft. or more above the water line of boiler. The water from the condensing surfaces is forced by the pressure of steam from behind, through a pipe leading to the trap, with a swing check valve close to the latter. As soon as sufficient water has entered the receiver to overcome the weight on the arm, the receiver tilts down, allowing the water to pass through the discharge pipe, at the same time opening the steam valve, which has a pipe connected with the dome of the boiler. As soon as the receiver is empty it tilts back, as before, and again refills. The trap is prompt in opening and closing, its action being due entirely to gravity, and when once set up it requires no further attention. It takes water from the condensing surfaces, whether they are above or below the water level in the boiler. It also supplies all the water needed in the boiler from the main water pipe, providing there is enough pressure on the main to lift the water to the trap, thus performing the duties of a pump or an injector. It operates equally well with high or low pressure coils, or coils using exhaust steam, allowing no condensation to collect in them.

Where a return trap is not employed the usual way of handling condensation is by means of a pump. The advantages in favor of the use of a trap can be enumerated briefly as follows: A pump will not lift water at a temperature exceeding 212 degs., a return trap will. A pump consumes a considerable amount of steam. For example, an ordinary duplex boiler-feed pump requires from 90 lbs. to 120 lbs. of steam per horse-power hour. A common slide valve engine seldom consumes less than 40 lbs. per horse-power. The Morehead return trap consumes less than 10 lbs. per horse-power. The pressure is admitted to the surface of the water and is automatically shut off before the tank is empty. The steam used is only such as is condensed by the latent heat passing from it into the water in the tank, which is all put back into the boiler.

The Morehead return trap requires practically no attention; needs no lubrication; will not race or run away; never sticks; is noiseless; requires little room and no foundation. The trap is manufactured by the American Blower Company, of Detroit, Mich.



RETURN TRAP

The Montgomery (Ala.) Traction Company is laying its track on Dexter Avenue, the principal street of this city. The line is practically completed to Pickett Springs, 4 miles north of Montgomery. This company has five new first-class cars, and will start running regularly within ten days. W. H. Ragland is the president, and John G. White & Co., of New York, are the contractors. The company is having difficulty in crossing the tracks of the Montgomery Street Railway; but it is presumed that all matters of difference between the two railways will be satisfactorily settled within a few days.

Johnson's Trolley Retractor

This device is intended to furnish protection to the overhead construction, trolley poles and wheels by instantly retracting the trolley about 15 ins. below the wire whenever it gets off the line. It has operated successfully through severe storms and 10 degs. below zero without being out of service a minute.

It is made entirely of steel, is simple of construction, and every adjustment can be made from the outside of the car.

Fig. 1 shows the retractor in position on the dash of a car, connection being made with the regular trolley rope by means of the clamp I, Fig. 2, the latter cut showing the position when the trolley is retracted.

The machine consists of rotatable casing, mounted in a suitable frame and containing a tension reel provided with an automatic adjustable locking device and a retractor arm of suitable length, receiving the power of the springs E through the medium of the arm F and yoke G. In Fig. 1 there is a maximum of spring power and a minimum of leverage. In Fig. 2 the order is reversed, the minimum of spring power and maximum of leverage at H, which in this machine gives 75 per cent more power in the last position. As the retractor springs can be wound up by the ratchets D to agree with the trolley-pole tension, the vicious action of unnecessary power on the start is obviated in case the harp should be pressed against the wire.

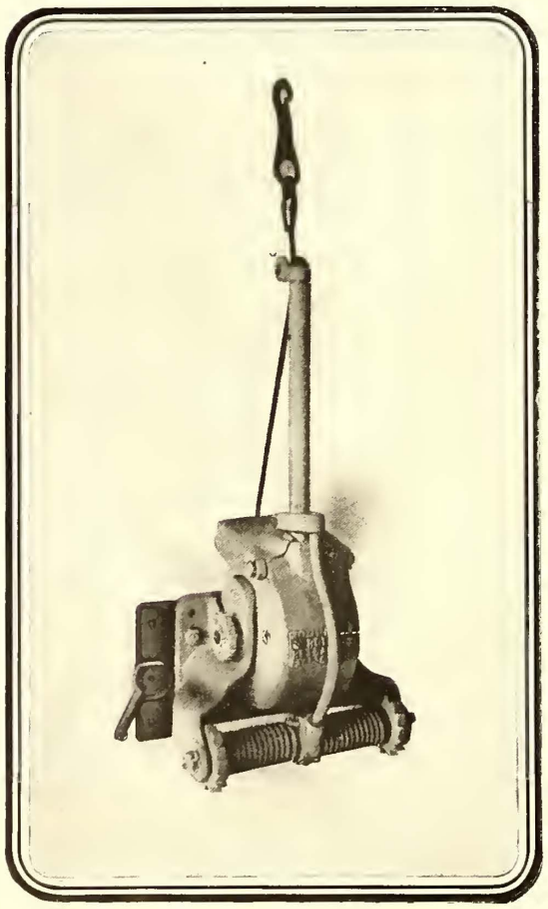


FIG. 1.—RETRACTOR READY FOR SERVICE

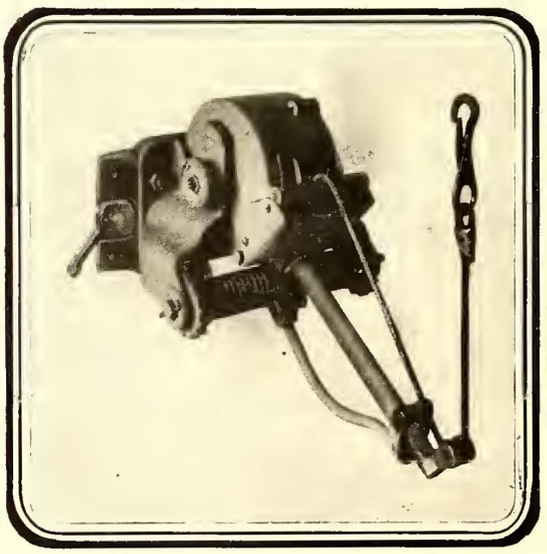


FIG. 2.—TROLLEY RETRACTED

The spring power at E is divided, and should one of the springs break it still leaves energy enough in the remaining one to get the trolley out of danger. It is claimed that the breaking of both springs would merely change the machine into a trolley catcher, and that a broken spring can be replaced in three minutes without removing the device from the car.

The action may be breifly described as follows: When the car is running and the trolley is on the wire the tension-reel accommodates the variations in heights of line, but when the trolley jumps from the wire, a sudden upward movement of 3 ins. or 4 ins. locks the reel and raises the latch C. The arm then swings down like a movement of the human arm, and carries the trolley with it, the reel remaining securely locked while in that position. But when a small lever, which is raised to an upright position behind the button B, so that it can be readily found in the dark, is moved to the left about three-fourths of an inch, and a downward pull of an inch or two is given on the trolley, the locking device is thrown out of gear and the trolley can be manipulated with the utmost freedom. After the trolley is replaced on the wire the arm is raised to an upright position, and the locking device set in action, the small lever being locked so that it cannot be tampered with. Fig. 3 illustrates the locking device, which permits the conductor to manipulate the trolley with freedom.

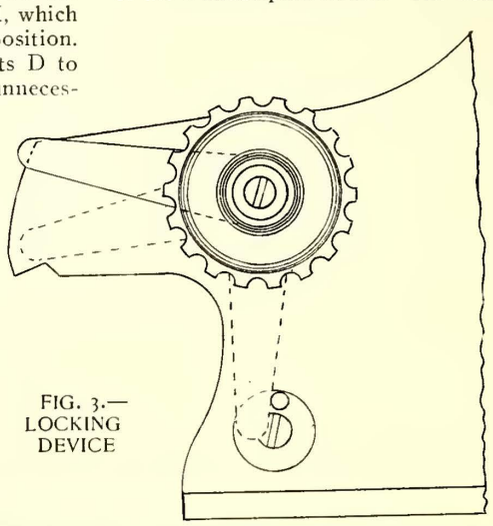


FIG. 3.—LOCKING DEVICE

Plans of the American Car Company

The purchase of the plant of the American Car Company, of St. Louis, by the J. G. Brill Company, of Philadelphia, was reported in September in the Street Railway Journal. The reorganization recently effected included the election of an official board, composed as follows: President, John A. Brill; vice-president, Samuel M. Curwen; secretary and treasurer, James Rawle.

It is the purpose of the new company to build the cars and trucks of the Philadelphia house. The companies will work conjointly, the St. Louis concern taking care of the Western and Mexican business, which of late has so far exceeded even the large capacity of the Philadelphia plant that some such move as this was imperative. The Brill Company is particularly fortunate at this juncture to secure the affiliation of a plant so admirably situated and well equipped. The heavy special machinery for the manufacture of the solid forged truck frames has been increased in the Philadelphia shops to provide for the extension of business, and for the present all the truck frames will be made there. The difficulties attending the process necessitates a force of men of long experience in handling these large and intricate forgings.

The high quality of material and workmanship and the minute attention to every detail of manufacture which has always characterized the product of the Brill Company will be duplicated in the output of the American Car Company by the adoption of the same methods of employment of expert workmen, supervision by foremen of long experience in special lines, and by the intimate association in all matters on the part of the officials, themselves inventors and practically versed in everything connected with car and truck building. The American Car Company has commenced under the most favorable circumstances, and will undoubtedly be successful and prove a valuable extension of the parent concern.

Electric Railway In Corea

The electric railway in Corea, which was partly wrecked in 1898, owing to the superstition of the inhabitants, has been re-equipped by Messrs. Collbran & Bostwick, the owners, and a power station for the supply of current for the line as well as for lighting purposes, has been installed. The station is equipped with Babcock & Wilcox boilers, and engines made by the Ball & Wood Company, of Erie. The road is about 9 miles in length, with a 3-ft. 6-in. gage.

Systematic Protection of Fare Collections

The development of interurban and suburban traffic in conjunction with street railways for city service, taken together with other modern conditions which make it necessary for city lines to issue transfers, tickets, etc., calls for a larger classification of collections from passengers carried than is now generally the practice. The Ohmer Fare Register Company, of Dayton, Ohio, has recently perfected its new No. 3 machine, which is intended to meet these requirements.

With this register no trip cards are necessary, and no receipts of any kind are punched or passed from one conductor to another. When not in service the register is always locked, and it cannot be operated until the individual key of one conductor is inserted in the register. After inserting the key the printing device is unlocked, and with the first printed statement taken, which will include the conductor's number, the register can then be operated. The conductor's individual key must remain in the register as long as he has the car, and his number will be printed with the statement taken every half trip. At the finish of his run he removes the key, and by so doing locks the register. The key cannot be removed until the registration is complete and the mechanism returns ready for the registration of another fare. The succeeding conductor follows the same operation.

For ease and understanding of the operation of the register a duplicate of the record given by this machine is shown in Fig. 1, in which fares are recorded as indicated by the headings at the top of the respective columns. From this it is very easy to determine the total collections in detail for each conductor, thus, conductor 34 is shown to have collected 175 5-cent fares, 58 3-cent fares and 37 2-cent fares, making a total of $14.19, in addition to 102 tickets,

	.5¢	Tickets	Transfers	3¢	10¢	Passes		
★	6625	6156	5981	5837	5733	5736	3 MAR	4 INS2
9	5625	6156	5981	5837	5733	5736	3 MAR	4 25
8	6566	6124	5954	5819	5722	5733	3 MAR	4 25
7	6485	6077	5920	5795	5701	5731	3 MAR	4 25
6	6422	6040	5894	5776	5685	5729	3 MAR	4 25
	203	116	87	67	48	7		
6	6422	6040	5894	5776	5685	5729	3 MAR	4 19
5	6372	6013	5871	5762	5675	5726	3 MAR	4 19
4	6317	5981	5848	5744	5663	5724	3 MAR	4 19
	105	59	46	32	22	5		
4	6317	5981	5848	5744	5663	5724	3 MAR	4 34
3	6252	5942	5822	5720	5650	5722	3 MAR	4 34
2	6202	5912	5802	5704	5639	5719	3 MAR	4 34
1	6142	5879	5775	5686	5626	5717	3 MAR	4 34
★	6142	5879	5775	5686	5626	5717	3 MAR	4 INS
	175	102	73	58	37	7		

	5¢	Tickets	Transfers	3¢	10¢	Passes		
★	6625	6156	5981	5837	5733	5736	3 MAR	4 INS2
★	6142	5879	5775	5686	5626	5717	3 MAR	4 INS.
	483	277	206	151	107	19		

RECORD GIVEN BY REGISTER

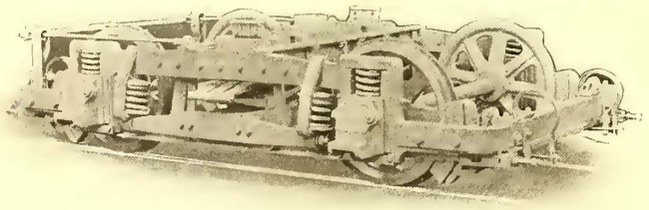
73 transfers and 7 passes. Conductor No. 19 has collected 105 5-cent fares, 32 3-cent fares, and 22 10-cent fares, making a total of $8.41 in addition to 59 tickets, 46 transfers and 5 passes.

The printed figures at the bottom are simply duplicates of the first and last impressions shown on the record, and it may be optional with the management to have two or more copies for distribution. It will be observed that the first statement was taken by the inspector March 4. A duplicate of this statement must be taken by the conductor entering the car on his first trip. In this case conductor No. 34 took the car at trip No. 1 and left it at beginning of trip No. 4. Conductor No. 19 succeeded No. 34 at trip No. 4 and finished at the beginning of trip No. 6. Conductor No. 25 succeeded No. 19 and finished at trip No. 9, when the car was run into the barn and inspector No. 2 took the last statement.

The Ohmer register is considered by some to be designed particularly for interurban roads, but is claimed by the manufacturers to be equally well adapted for large city lines. With one copy of the register record sent to the general office the work of each conductor can be computed and entered without waiting for the report of the local cashier or receiver. It gives the company a complete statement of all transactions on each car and makes a most positive check over cashier as well as conductor. As the register contains duplicate reports of the day's receipts, and as the cashier has only one, the other report can be referred to by the managing office to ascertain if the cashier is faithful in his duty. With this system the cashier can be eliminated, the conductor making reports directly to the company by depositing his collections in a safe at the local station provided for the purpose. The register will keep a complete record of all the fares in the denominations in which they have been received from passengers.

A Large Electric Truck for Italy

What are said to be the largest and most powerful trucks ever built for electric service are those of an order recently completed by the J. G. Brill Company, of Philadelphia, for the Mediterranean Thomson-Houston Electric Company, of Paris, for use on the Milan-Gallarte Third-Rail Electric Railway, Italy. These trucks are considerably larger than the standard four-wheel steam railroad trucks, and because of their solid forged frames and the strength and disposition of the springs, have a carrying capacity equal to the large six-wheelers used under the heaviest steam



HEAVY ELECTRIC TRUCK FOR MILAN

coaches. It is interesting to note that enormous strength is obtained without bulk. The type is the Brill No. 27-E.

The frames are 12 ft. ½ in. long, and are composed of solid forged sides—that is, the side-bar, yokes and extensions are a single solid forging, angle-iron transoms, end pieces and tie-bars. The transoms, besides having ends bent at right angles, each secured with two bolts to the side-bars, are further strengthened by brackets bolted to the side-bars with and to the insides of the transoms. The end pieces are bent around the side-bar extensions and bolted thereto. The side-bars are 1¾ ins. thick and 7 ins. wide at the center, tapering to 6 ins. at the yokes. The pedestals are 4 ins. thick and the extensions 1½ ins.

The system of equalization combines a swing bolster and a cushioned connection with the frame by means of spring-link suspended equalizing bars. These spring links are supported by the frame at points near the yokes, relieving the strain upon the frame and giving a wide suspension to the centrally borne load, theoretically and practically the correct method of equalization. Not only is the load distributed equally upon each wheel, but a leverage is obtained in favor of the frame against the wheels and brakes, preventing tilting or kicking up, no matter how violently the brakes are set. Another advantage of the cushioned side swing is the softness of contact of the wheel flanges with the rail heads. The equalizing bars are 2½ ins. thick and 5½ ins. wide at the center. Equalizer and box springs are heavy double coil, and triple elliptic springs carry the bolster.

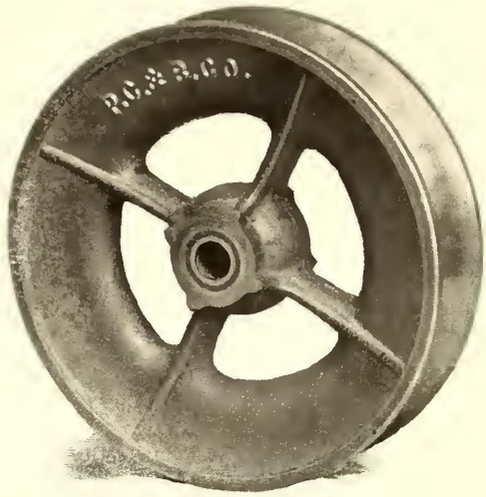
Outside brakes are connected with the upright levers by brake-rods placed outside the wheel treads, allowing the entire width between the wheels for the motors. Extra large journal boxes have a strong lip for the bar holding the third-rail contact apparatus. The total weight without wheels and axles is 7400 lbs.; wheel base, 7 ft.; gage, 4 ft. 5⅝ ins. between flanges; diameter of wheels, 41 ins.; length of axles, 7 ft. 3 13-16 ins.; journals, 5⅛ x 9 1-16. G-E 55-H, 160-hp motors will be used, and the maximum speed will be about 62 miles per hour. Weight of empty car bodies 44,000 lbs.

The practice of operating funeral cars has become quite common, both on steam and electric roads, and especially in the larger cities, where it is inconvenient and expensive to use carriages. It remained for an enterprising electric railway manager, however, to suggest that the trolley roads should go a step farther and lay out a burial ground or graveyard, thus ensuring a source of revenue to the company and affording the people an opportunity of visiting the last resting place of their dead friends and relatives as well as an inexpensive and convenient method of attending the funeral Daily newspaper paragraphers, no doubt, will find this a very attractive subject, but when they have exhausted it others will doubtless recognize in it a very sensible movement. Many of the discomforts that attend the burial of the dead will be eliminated by the adoption of this plan.

Pure Copper Trolley Wheel

The accompanying illustration shows the 1902 model of the 6-in. pure copper trolley wheel manufactured by the Process Copper & Brass Company, of Boston, of which T. Raymond Pierce is sales agent. This wheel can be used in connection with all types of overhead wires, but is designed especially for high speed roads, and it is stated will take all frogs and switches and do the work accomplished by a 4½-in. wheel with less than half the wear.

This wheel, as well as the Process Copper & Brass 4½-in. wheel, is made by a special process, which toughens the copper,



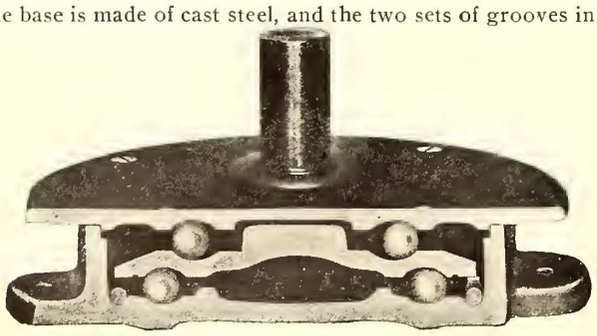
PURE COPPER TROLLEY WHEEL

and the company guarantees that it will outwear by 50 per cent the ordinary composition wheel, while the cost is only 25 per cent more. The wheel is of a special design, such as has been found to be most desirable, and is in use on about fifty roads throughout the country.

Ball-Bearing Trolley Base

The accompanying illustration shows a new type of trolley base, designed to give the maximum amount of horizontal flexibility so as to enable the trolley wheel to follow easily any variations in the alignment of the trolley wire. As will be seen, this is accomplished by the use of ball bearings, and it is claimed that the friction on the pole and on the trolley wire are much reduced, that the strain on each is greatly relieved, especially at the curves, and hence the principal cause of the trolley wheel leaving the wire is eliminated.

The base is made of cast steel, and the two sets of grooves in the



BALL-BEARING TROLLEY BASE

base are case hardened. The arrangement of the base is compact, so that there is no increase in height in the base illustrated over the standard trolley base. The weight of the base is in the neighborhood of 75 lbs. The base was exhibited at the Detroit convention by the Detroit Trolley & Manufacturing Company, which is manufacturing the device. The Eastern selling agency for the base has been secured by the General Supply Company, of 40 John Street, New York.

A Quick Repair Job

The Massachusetts Chemical Company recently received the following story of rapid repair work from a young factory electrician located in Western New York.

The proposition was a 60-hp 500-volt direct-current motor, which had given a good deal of trouble, as it had been insulated with supreme indifference to common sense. The armature coils had been dipped once in shellac, baked, dipped in linseed oil varnish, baked again, assembled and painted with some black varnish. The fields had been dipped in black paint, baked, taped with strips of duck, shellacked and finally painted black.

The persistent leakages in the armature had been taken care of by frequently heating it with the current and then dipping it in armalac. On several occasions short circuits, which had been caused by chafing of the crossed windings, had been temporarily stopped by lifting the wire slightly and jamming in a bit of cotton waste which had just been saturated with armalac. In the present instance, under the expansion of a heavy overload one of the binding bands burst, and before the machine could be stopped the armature and four fields were badly smashed. Export orders were behind, transatlantic cables were demanding immediate deliveries, and the cessation of work by that machine meant idleness for $75,000 capital and fifty operatives.

The smash occurred at 2 p. m., and by a hasty consultation the factory committee decided that as the sending of the repair job to a repair shop would entail a delay of at least a week, at an expense of $200 and a net loss of at least $1,000, it would take a chance and try to patch up the machine as it stood. Armature and fields were quickly removed, two men detailed on each piece, and the work of stripping the fields begun. The armature abrasions were mended by prying out the coils and covering the denuded wires with the very thinnest of armalac tape, cut on the bias. It was "puttering" work, but at 1 o'clock the next morning all the breaks were covered and tested out O. K. with the current. The armature was then set back on its bearings and the new bands put in place, turning the armature by hand.

A pail of water resistance had been got ready long before, and the current was admitted into the armature until it was hot. The armature was then put on wooden horses and turned over slowly with one-third of its diameter in a soap-box (made temporarily tight with shellac and sand) and full of armalac. The old windings soaked up the insulating material, and the operation was continued until the armature was nearly cool. The soap-box was then taken away and the slow turning was continued, to make the compound dry in an evenly distributed state, until the fields had been put in position.

The work on the fields had been of an especially exasperating character. They were of small wire, and at least a dozen wires on each field had been smashed. The work of soldering them and putting each one into a little trough of fine armalac tape was a long one. They were then heated with the current and sent into the dipping tank, then wound with thin bias armalac tape painted with armalac, wound with thin bias armalac duck, 1¾ ins. wide, and again painted. Before morning the motor was left running under the eye of the night man. The motor is running yet, though there is a swelling on all four fields. The rush orders are filled, a heavy expense bill was avoided and the motor will not be disturbed until January, when it will get another baptism in the soap-box.

A Take-Up Device for Steam Engine Indicators

The great trouble experienced when using the detent on the steam engine indicator is that of the slack given up by the cord between the paper drum and reducing bushing on wheel. This slack, if not properly guided when throwing on the detent, is liable to get foul, and a device has been brought out by James L. Robertson & Sons, of New York, to take up this slack.

It consists of a short horizontal arm, at one end of which is a vertical bearing, in which sets a steel pillar on the upper end of which there is a frame holding a double set of loose steel rollers, between these the cord from paper drum passes. On the lower end of vertical pillar there is a light spiral spring enclosed. This spring causes upper frame to revolve when cord becomes slack, and is so arranged that cord winds on frame, to be given up again when tension is applied. The object of the device is to permit the operator to take as many cards as desired without unhooking from the crosshead or stopping the engine, no matter what speed. This, of course, pertains to indicators that are fitted with a detent and using a direct-connected reducing motion, the latter being the most popular in modern engineering practice.

Where an indicator is used in connection with pendulum, lazy tongs or reducing motion attached to engine frame, not so much trouble arises, and generally a rubber band is employed to take care of slack cord, which works fairly well. In this case the take-up device is in the shape of a regular guide pulley to connect direct to indicator. The guide pulley is removed and this put in its place, wound up, and it is ready for use, and immediately the detent is engaged it picks up instantly what slack cord occurs.

London Letter

(From Our Regular Correspondent.)

The tramway system of the city of Leeds may be taken as a very typical one of the best conditions which exist in Great Britain. There are over 20,000 acres within the city boundaries, and up to the present the policy of the Corporation has been not to go outside the various boundaries. Gradual increases in the number and length of lines within these boundaries are being carried forward as fast as street improvements, which are also in active progress, will permit. At present there are now 77 miles of track, or 40½ miles of street open for public traffic. The Corporation has 245 cars in stock, and from 183 to 230 are in operation as required.

Seven miles of track were granted in the last session of Parliament, and proposals for extensions of routes and for new routes which, if adopted, will amount to 9 miles additional, are presently being considered by the tramways committee. These additions, with those already sanctioned, will enable the lines to come into immediate contact at the various boundaries with lines already sanctioned in other townships, such as Bradford, Halifax, etc., as well as with the lines of the British Electric Traction Company from Dewsbury, etc.

Unfortunately, in Bradford and Halifax the gage is different from that of Leeds, which is 4 ft. 8½ ins.; consequently running powers cannot be arranged, but common waiting rooms and timing cars to meet are arranged by the various corporations. The routes are arranged to pass from one extreme of the city right through the center to the other, so there is very little switching on to other lines in the center, and thus congestion is avoided. The fares are graded on distance and average about 2 miles for 1d. At present the box system of collection is in operation, but under the new management this and other obsolete, or practically obsolete, methods will no doubt be dispensed with and more up-to-date practice adopted.

The tramways department is just on the point of vacating the old premises in Bow Lane, which have been the location of the tramways department since taking over the lines in 1894, and previously of the company for about twenty years, to very large and handsome offices in City Square. This change, which has been necessitated by the rapid growth of the departent, will no doubt enable the staff to carry out its duties better and further the reorganization of the department.

All the current is at present being furnished from one power station, which is very centrally situated on the banks of the River Aire. The equipment at the power station consists of two engines from J. Fowler & Co. of 1300 hp each, three engines from Hick, Hargreaves & Co. of 1450 hp each, two generators from Greenwood & Batley of 750 kw each, three generators from Electric Construction Company of 850 kw each, twelve boilers from Clayton, Son & Co., of Lancashire type, of 400 hp each, stokers by Bennis & Co., two coal elevators by Graham, Morton & Co., a switchboard by J. Fowler & Co., three boosters from Greenwood & Batley of 300 amps. each, two boosters from Mather & Platt of 600 amps. each, and one turbine from Parsons of 250 kw.

The cost of power per unit during the last year was .38d. This sum includes all the station operation and maintenance expenses.

As showing the development of traffic, it may be noted that the increase from March 25 to Sept. 6 is £20,773-3-10 on a total income of £124,682-0-3, or equal to a weekly increase of £883-19-3.

As is now well known, the whole system of the Leeds tramways is under the management of J. B. Hamilton, who was appointed general manager early in this year and took over the management the first of April. Mr. Hamilton has already inaugurated many improvements in the traffic problem, and better results in car mile receipts are already in clear evidence, and everything so far shows that his appointment has been a good one for the tramway department.

The Harrogate Corporation having decided to introduce tramways into the borough, the committee appointed to consider the matter has now drawn up a scheme as to the routes. The proposed routes include from Oatlands Mount, on the south of the borough, to Little Wonder and Bilton, on the north, and to Starbeck, on the east. Electricity from the corporation's own works will be the motive power, and each of the routes will enable the cars to run through the center of the town.

At a meeting of the Liverpool tramway committee it was stated that the general manager of the tramways (Mr. Bellamy) had designed and produced a car with the upper deck covered in. The roof of the cover was 6 ft. 2 ins. from the deck, and consisted of a light frame, principally of steel work and canvas at the side and the top, to be moved easily in sections. The whole could be adjusted in half a minute. It has the additional advantage of removing the trolley standard to the outside of the cover. So far from losing seating accommodation, the new car would give some ten additional seats for passengers. While abolishing overcrowding outside and limiting it inside, the cars would carry seventy-three passengers. It was proposed to apply the system to thirty cars that were now on order and to twelve that were approaching completion in the works of the committee, which would test the practical value of the new arrangement. No part of the invention was to be patented, and it would be available for the whole tramway world without anything in the way of royalties.

Hampstead is well in the throes of work in connection with the construction of the Hampstead & Charing Cross Electric Railway. The junction of Adelaide Road and Haverstock Hill presents a busy scene, and this point will be one of the chief centers of the excavating work. The work at present being done is that authorized under the old acts, which will be available for the new scheme. For the upper part of Hampstead, where deeper levels and slight deviations are being sought for the tunnels and the extension to Golder's Green, a delay is necessitated till the new bills are passed. The contractors for the work are Messrs. Price & Reeves, who constructed a portion of the Central London Railway.

Satisfactory progress has been made since the recommencement of operations upon the new subway that is to connect Waterloo Station and Baker Street. At the present time only about one and a half miles of single tunnel remain to be constructed, so that three-fourths of the subway between the points named are now finished. Lift shafts are already completed at Waterloo, Piccadilly Circus and Baker Street, and a similar shaft at Oxford Circus is now started. Staircase shafts at Waterloo and Oxford Circus are sunk, and the booking hall at Waterloo is covered in, ready for internal fittings. Land for all the station sites is in the possession of the company, with the sole exception of that in Trafalgar Square, and as financial difficulties are now removed there is reason for hoping that the works will be pushed to a speedy conclusion.

The linking up of a score of mining and manufacturing towns and villages in South Lancashire by the South Lancashire Electrical Tramways Company is proceeding apace. The entire system, with its various junctions and branches, will cover nearly 80 miles, and, inclusive of equipment, will entail an outlay of nearly £1,500,000. The lines will run from Parr, near St. Helens, to Swinton and Eccles, where connections will be made with the Salford Corporation's system. Among other places which will be tapped by the South Lancashire Company are Newton-le-Willows, Haydock, Lowton, Leigh, Tyldersley, Atherton, Little Hulton, Astley, Boothtown, Worsley and Walkden.

On the invitation of the assistant secretary of the Board of Trade, representatives of corporations and companies operating tramways had a meeting recently with representatives of the Board of Trade and of the home office at Whitehall Gardens, Westminster. The subject of conference was the proposed Board of Trade regulations, especially with regard to carrying a red light on the rear of all cars. Mr. Young, Glasgow, made the opening statement, and was followed by the representatives of Manchester, Newcastle, Liverpool, Cardiff, Hull, Leeds, etc., and also by Mr. Sellon for the operating companies. It was pointed out that at night electric tramway cars of the present day present such a blaze of light that a red rear light was quite unnecessary, and, further, that on account of the adoption on all large systems of distinctive route colors, with lights at night colored to correspond, a regulation requiring a red light on the rear of every car would be so confusing as practically to do away with the system of distinguishing route colors, which have been found so popular and convenient wherever adopted. Sir Herbert Jeykil, for the Board of Trade, explained at the outset that since the suggestion had come from the home office, and his department had no special views on the matter, he would allow Mr. Cunninghame, as representing the home office, to deal with it. Mr. Cunninghame, after hearing the various speakers, said, in effect, that his department had no desire whatever to fetter or harass electric tramways, but quite the opposite. Their idea, if it could be carried out, was to have all road and street vehicles carrying a red light on the rear. He saw, however, from what had been put forward by the deputation, that there might be a difficulty in making such a rule quite general, and, in any case, they would now consider whether electric tramway cars should be excepted in the event of such a rule as proposed being adopted. He mentioned that in any case the home office would not deal with the rules applicable to Scotland, so that his friends from the North might have any lights which suited them so far as they were concerned.

Mr. Challenger, the traffic manager of the Bristol Tramways Company, has adopted a new means of safely ventilating the cars during hot weather. When the cars are traveling at full speed, to have the front doors wide open causes a strong current of air to rush through the car. Mr. Challenger has had the whole of the

cars which are provided with double doors fitted with brass rods, which hang from the handles of the doors, and which are provided with slots at intervals, and these are so arranged that the driver can secure the doors a little way open, the opening varying within several inches, according to passengers' requirements. It is found that a very small opening on the hottest day allows ample fresh air to enter and obviates the excessive and dangerous current inevitable when the ventilation was not so easily regulated.

The Mayor, aldermen and burgesses of the county borough of Croydon intend, subject to the approval of the Board of Trade, to lease to the British Electric Traction Company, Ltd., or their approved nominees, the existing tramways running from the Red Deer to the borough boundary at Purley, from the Thornton Heath Pond to the borough boundary at Norbury, and from Station Road, West Croydon, at its junction with North End, along Station Road and Wellesley Road to its junction with Whitehorse Road, for the term of eighteen years and seven calendar months from June 1, 1902.

It is now possible to go to Twickenham Bridge by the London United Electric Tramways. Then there are the authorized extensions of the electrical tramways to Hampton Court, Thames Ditton, Surbiton, Hook, Maiden, Cromford and as far as Uxbridge. The fares from Hammersmith to Hounslow, a distance of 8½ miles, are 4d.; to Twickenham, 4d.; Shepherd's Bush to Southall, 3d. In each of these cases workmen's tickets are issued by certain trains at 1d. the journey. It is possible for a workman to travel from Southall to the Bank, a distance of 14½ miles, for 2d. The opening of the new Twinkenham route has proved intensely popular, as the route passes through most interesting and picturesque country and was a famous drive in the old coaching days.

C. M. Atkinson, stipendiary magistrate for the city of Leeds, yesterday delivered judgment in the case in which a Leeds tram car conductor was summoned by the police for overloading his car on the occasion of the recent lifeboat procession. The town clerk, W. J. Reeves, prosecuted on behalf of the police, and the defendant was represented by W. Wright, instructed by the Gas Workers and General Laborers' Union. At the outset the town clerk stated that when the case was last before the court it was adjourned in order that he might ascertain what position the corporation was going to take under the tramways act of 1870. After fully discussing the matter the corporation had decided that they would not for the purpose in question—the prevention of overcrowding—make any by-laws under section 48 of the act, but would deal with the matter only as undertakers under section 46, as they would thus be able to exercise greater powers in this way than would otherwise be the case. The learned stipendiary magistrate expressed his indebtedness to the town clerk for his information, which, however, did not affect the present case, as he had only to deal with the statutes and by-laws in force when the case was before the court. In the course of a lengthy judgment Mr. Atkinson alluded to the powers possessed by the corporation for licensing and regulating hackney carriages, omnibuses, etc., and said the same powers extended also to tramways. In 1875, when the trams were in the hands of a private company, a by-law was in force prohibiting the conductor from allowing any person beyond the licensed number "to enter or mount or remain in or upon any part of a carriage." The corporation subsequently purchased the undertaking and become invested with all the rights, powers and authorities of the original promoters, and if the by-law was enforceable against a conductor in the service of the company it would be enforceable against the present defendant. It was now suggested that, as the corporation had not enacted a by-law in relation to tramways similar to that relating to hackney carriages and omnibuses, consequently they did not possess, and never had possessed, the right to impose a limitation on the number of passengers carried, and therefore that the by-law under which the information was laid was useless and unenforceable. He was glad he was not constrained to adopt this view, and he would therefore convict the defendant, subject to its being proved that he did allow more than the licensed number to remain on the car; but as the man acted under express instructions, and this was only a test case, he should only impose a nominal penalty of 5s.

A. C. S.

The Columbus, Buckeye Lake & Newark Traction Company, the Columbus, London & Springfield, the Dayton, Springfield & Urbana, the Columbus, Grove City & Southwestern, the Springfield & Western, and the Cincinnati, Lebanon & Dayton Railways, all of which are controlled by Tucker, Anthony & Co., and A. E. Appleyard, of Boston, have placed on sale at their several offices mileage books for 500 and 1000 miles, good an any road of the system. The books are sold at the rate of 1¼ cents per mile, and can be used by any member of the family purchasing the book.

Letter from Italy

(From Our Regular Correspondent.)

The Italian government has at last granted permission to begin electric operation on the Valtellina Railway lines from Colico to Sondrio and Colico to Chiavenna, which have already been described in the columns of the Street Railway Journal as equipped by Ganz & Company, of Budapest, on their high-tension three-phase system. Tests and experiments on these lines have been made for several months, and the last tests were so satisfactory that the Italian government decided to grant permission to start electric operation. Among other experiments one of the most interesting was the fire test, which consisted in cutting off one of the trolley's wires and letting it fall on top of the car. It was expected that the car would burn at once, but the safety devices operated so satisfactorily that nothing of the kind happened. The line from Lecco to Colico has not yet been completed, but in a few weeks it will be ready for electric operation.

The Milan-Gallarate Railway has been equipped with an automatic block system as a result of the collision which took place a few weeks ago.

The Edison Electric Company, of Milan, which is operating the street car system of the city, is gradually substituting brass hand wheels for the ordinary handles of the mechanical brakes of its cars. These hand wheels, about 12 ins. in diameter, are placed vertically, connected through gearing to the vertical rod of the brake, and are operated by the motorman with the aid of a brass handle. This new system seems to be more satisfactory than the old one, and motormen are satisfied with it, as it permits them to utilize the weight of the body in applying the braking power. The wheel is removed with the controller handle when the car is at the end of its run.

The sum collected for the sufferers of Martinique amounts to 22,000 lire ($4,400). Through the initiative of the local press on the Sunday following the terrible accident of the Antilles the cars were smartly arranged with Italian and French flags and the words "oggi-tutti in tram" (to-day everybody is to ride in the tramways) were displayed in large letters on both sides of the car. Besides the usual 2-cent tickets, passengers were invited to buy an additional 2-cent ticket for the benefit of the sufferers. Upon these extraordinary tickets was printed, "Pro Ankle."

The new experiment of using post office boxes, for letters only, secured to the street cars in Milan is giving very good results, and the boxes prove so useful to the public that Mr. Galimberti, the Italian minister of post and telegraph, has decided to adopt the new system all over the peninsula wherever street cars are installed.

The proposal of Messrs. Cook to construct a light electric railway connecting the Naples street railway system to the lower station of the existing cable road, is assuming practical shape, and work has commenced. The line, which is intended to afford facilities to the 50,000 tourists visiting the crater annually, starts from Pugliano, at the foot of the mountain. The power station contains two gas engines of 90 hp. each, coupled to two direct-current generators feeding the line at 550 volts. The design of the plant is due to Mr. Strub; the contract for the electrical equipment has been secured by the Brown & Boveri Electric Company. The gas engines were furnished by the Winterthur Maschinenbau Company. The faculty of science in the University of Naples forwarded to the Italian government a protest against the construction of this railway, which is running in close proximity to the Royal Observatory, and, therefore, would seriously interfere with seismic observation and records.

The employees of the Florence Street Railway Company joined the general strike of the working classes of the city numbering 15,000 people, and which lasted over a week.

The Spezia Electric Railway, in spite of the critical financial situation of the Helios Company, of Cologne, has at last been completed and begun operation. A number of years ago the Helios Company, of Cologne (Germany), secured the concession for constructing and operating an electric tramway in Catania (Sicily) and one in Como (Lombardy). On account of the critical situation referred to, the construction work on both has been suspended. A very heavy fine is to be charged to the Helios Company by the Catania municipality, as the time limit stipulated for completion of the work has expired.

Electric locomotives do not seem to be favored for hauling trains through the Gotthard tunnel between Italy and Switzerland. During the last trip of the Italian King to Germany the steam locomotives of the royal train were fitted with the new Langer's smoke destroyer, which is giving satisfactory results. This apparatus has now been working for some time in several Swiss mountain railways, viz., on the Thun-See, Viege-Zermatt, Righi and Central Bahn lines.

NEWS OF THE WEEK

The Ever Exacting Public

In Birmingham there is a striking example of the inconsistency of the general public. When the Birmingham Railway, Light & Power Company put into operation its transfer system last month the sale of books of 100 tickets for $4 was stopped. The suburbanites have been greatly distressed because of this, and at a meeting held a few days ago protested and passed a set of resolutions calling on the company to return to the sale of books, if possible. President Jemison, of the company, heard them patiently, and told them the company could not possibly sell tickets at the reduced rate and grant transfers also. He said the company would take off the transfers and begin again to sell tickets at the reduced rate, if the people so desired. There will be no profit in the street railway service of the company, Mr. Jemison declares, if transfers are granted and tickets are sold at the reduced rate.

Indianapolis as an Interurban Railway Center

Indianapolis is rapidly coming to the fore as an interurban railway center, and will, before long, compare favorably with Detroit and Cleveland, if it does not actually outstrip them. Already six lines enter the city, and within one year this number will be increased to eleven, which will all enter one great terminal station. The lines now entering the city are the Union Traction Company, the Indianapolis, Shelbyville & Southeastern Railway, which will later connect with Cincinnati; the Indianapolis & Greenfield Railway, which will be extended to Richmond and thence to Cincinnati; the Indianapolis & Plainfield Railway, which will, when completed, tap the coal fields of Sullivan and adjoining counties; the Indianapolis & Martinsville Railway, which may be extended to Bloomington; the Indianapolis, Greenwood & Franklin Railroad, which will be extended to Columbus next year. Of the projected electric lines already being built the Indianapolis Northern Traction Company is probably the most important. This is a branch of the Union Traction Company, and will invade the Lake Erie territory. This will come to Indianapolis by way of Kokomo, Tipton and Noblesville. Another important line will connect Indianapolis, by way of Lebanon, with Lafayette. In addition to this there are now coming into the Union Station sixteen steam railroad lines.

The Hudson Valley Strike

A meeting of the directors of the Hudson Valley Railway Company was held in New York city on Oct. 3, at which the action taken by the officials of the road in the strike was indorsed. The directors present were John W. Herbert, Addison B. Colvin, George B. Wilson, G. Tracy Rogers, Lewis W. Emerson, Watson N. Sprague, Charles E. Brisban, Peter McCarthy, George E. Green and John McNamara. John W. Herbert, who is Mayor of Helmetta, N. J., was elected vice-president of the company to succeed J. A. Powers, resigned; J. A. Kellogg, of Glens Falls, was chosen secretary and counsel to the company, and George H. Helms, president of the American Snuff Company, of New York, was elected a director to succeed Thomas O'Connor, resigned. The following resolution was passed: "Resolved, That the action heretofore taken by the president and general manager in relation to the matters growing out of the difficulties with our late employees be and it is hereby approved, and they are hereby authorized to operate cars on the several divisions of the road by the employment of competent operators on such terms as they may deem proper and just."

The strikers, having rejected all offers to settle by arbitration all questions in dispute, and having undertaken to dictate their own terms for reinstatement, the contention is likely to continue for some time to come, and may lead to further acts of violence on the part of the lawless element. There are no visible prospects for a settlement, as neither side is making any move toward arbitration, and the citizens' movement for an adjustment of the differences has fallen through.

Improvements at Nashville—The Defeat of the City

The plans of the Nashville Street Railway Company for the improvements that are to be made in the system, now that an agreement has been reached with the city, call for the complete reconstruction of the system. It is planned to relay nearly 40 miles of old track and to extend practically all the old lines. The Buena Vista line will be extended beyond the city limits out the Hydes Ferry Pike for some distance, opening up a large new territory, and the Jefferson Street line will be extended to the city limits, and on to West Nashville, a distance of about 2 miles, giving car service to the Clifton and Mt. Nebo.

In the West End the West Nashville line will be double tracked, and the Church Street line will be extended out the Richland Pike to the Continental Park. The Overton Street line will be entirely abandoned, and the Kayne Avenue line extended for more than a mile beyond its present terminus. The improvements in South Nashville will be the most sweeping of any division of the city. The Wharf Avenue line will be straightened so as to run directly out Wharf Avenue and Fillmore Street to Mt. Olivet and Mt. Calvary Cemeteries. The Fairfield line will be extended for a little more than a mile out the Murfreesboro Pike to Jim Town. All the other South Nashville lines will be straightened and improved, and a new line will be built in this section. In East Nashville the Lischey Avenue line will be extended to the city limits, and probably beyond, and the tracks of all the lines will be greatly improved. Fatherland Street will be double-tracked to the city limits, as will also the ends of the Woodland Street line. A new line may be built to serve the section southwest of Vanderbilt University and the Hillsboro Pike neighborhood, but it has not yet been mapped out. A new power house is now being constructed.

In the settlement of the controversy between the city of Nashville and the Nashville Street Railway Company, mention of which was made in the STREET RAILWAY JOURNAL for Oct. 18, there is furnished an example of the almost disastrous results that followed a war of extermination by the city on the company operating the street railways of the city. Both sides to the controversy, of necessity, made concessions before the settlement was effected. It would seem, however, that the company marched out of the fray triumphant, for the main contention of the city—the fight on the charter rights of the company—was waived by the city. In fact, it would seem that the ultra-conservative guardians of the public rights, after inflicting on the innocent population untold misery because of the inadequate railway service, emerged from the fray with the main contention waived in favor of the company.

An Important Ruling in Massachusetts

The Railroad Commissioners of Massachusetts have recently handed down their decision on the petition of the Greenfield, Deerfield & Northampton Street Railway Company for a grant of location in Whately. It is the first case of its character to emanate from them, being rendered under recently enacted provisions of the law, and is considered an important ruling.

The petition of the company for a location was brought under Section 11, Chapter 112, Revised Laws, and at the hearing, given after due notice to the Selectmen and to all persons owning real estate abutting upon the way in which the location was asked, two of the Selectmen and other residents appeared as remonstrants. Now, the statute, in certain cases, empowers the Railroad Commissioners to grant a location in a city or town in order to connect existing locations in adjoining towns, and the petitioner claimed that the statute applied in this case for the reason that its petition to the Selectmen of Whately for an original location was neither granted nor refused within three months after the filing thereof, and also for the reason that the location which was finally granted by the Selectmen was declined by the company. The remonstrants insisted that the Selectmen acted within the required time, and that a location having been granted the Railroad Commissioners have no jurisdiction. The company filed its petition

with the Selectmen of Whately March 13, 1902, and on May 31 the Selectmen notified the company in writing that they would grant a location provided the company would build a certain branch track. On June 5 the attorneys of the company submitted to the Selectmen a form for order or location, and on June 7 the Selectmen held a meeting at which the chairman said that he was ready to sign the order of location in the form submitted. The other two members said that before they signed the order they would like to inquire further in reference to conditions and restrictions. Inquiries were subsequently made by them, as a result of which certain additional conditions were embodied in the order of location. This order bears date June 7, but was not signed until June 26. No vote was passed or action taken or meeting held by the Selectmen after June 7 until June 26. In their decision the Railroad Commissioners say:

We find, therefore, as a matter of fact, that the Selectmen did not either grant or refuse the location within three months after the filing of the petition. We are also of the opinion that the board would have jurisdiction had the grant of location been made within the statutory time. The literal wording of the statute supports this construction, and it is easily conceivable that the Legislature may have had in mind cases where a grant of location is accompanied by conditions which make it equivalent to a refusal of location, and this without bad faith or improper conduct on the part of anybody. The promoters of this enterprise contemplated a railway between the town of Greenfield and City of Northampton, through the intervening towns of Deerfield, Whately and Hatfield. In planning it, it was necessary for the company to study economy in construction, safety in operation, and the accommodation of the largest number of probable patrons. The route selected calls for the smallest capitalization, avoids railroad crossings, and affords on the whole the largest accommodation to the different communities in the towns through which the railway is to pass. The necessary locations have been secured with the single exception of the one asked in Whately. Giving due weight to the natural and proper wish of the Selectmen of Whately to secure all possible advantages for their townspeople, we do not believe it consistent with the public welfare to now bind the company to the construction two years hence of 2½ miles of railway with so little assurance that conditions will then justify an expenditure which is admittedly unwarranted at the present time. It is enough to require the company to build the extension as soon as circumstances warrant the outlay. To secure the best service for the largest traveling public we feel that public necessity and convenience demand that the location asked be granted to this petitioner to connect the locations which it has in the adjoining towns, and we so find. It is accordingly ordered, that there be hereby granted to the Greenfield, Deerfield & Northampton Street Railway Company a location for the track of a railway with turnouts, poles, wires and other appliances necessary for operating the same by the overhead electric system, upon the easterly side of the so-called "River Road" in Whately from Deerfield to Hatfield as shown on a plan upon file with this petition and made a part of this order.

Yerkes Scores Against Morgan

There is reported from London a dramatic development in the fight for the control of London's "tube" railroads. It has transpired that Speyer Brothers, who are financing Charles T. Yerkes' plans, have bought control of a large company hitherto allied with the Morgan scheme of transportation, thereby not only reducing the scope of the Morgans' projected line by many miles, but actually threatening it with legal obliteration. This latest move in the Morgan-Yerkes controversy was announced on Oct. 21, at the session of the House of Commons' "tubes" committee, by Sir Edward Clarke, who, as counsel for the London United Electric Railways, withdrew the bill providing for the construction of the road. This road had always been part of the Morgans' line, and covered the district westward between Hammersmith and Piccadilly, and southward between Clapham and the city. The Morgans had originally intended to cover these points, but as the London United already had certain powers from the amalgamation effected a year ago, and as the Morgans' project had passed through Parliament under the title of the London United & Piccadilly & City Railroad, Balfour Browne, who is counsel for the joint bills, expressed surprise in behalf of the Morgan interests at Sir Edward Clarke's announcement, which left him scarcely half the length of the road over which he had been arguing for nearly a year. Mr. Browne at once requested time to consult his principals, and amid a sensation the committee adjourned. Mr. Browne then announced that the Morgan interests were ready to go on with such road as they had left, namely between Piccadilly and the city, and that they would take the earliest opportunity to introduce a new bill asking for the powers which they had so unexpectedly been deprived of by the defection of the London United, owing to the Speyers securing control of it.

A continuous chapter of misunderstandings led up to what Mr. Yerkes terms his "coup." The promoters of the London United say that though they were willing to pool their interests with the Morgans, they believed they were better fitted to control the traffic management of an English line than the American firm. Sir Clinton Dawkins, a partner in the house of J. S. Morgan & Co., through whom the negotiations were conducted, refused to agree to this, and the United officials then demanded control of the arrangements of their own section of the line, which was also denied in a way, it is hinted, that people took to be slighting, and Sir Clinton went to the United. It is intimated that the promoters were indignant at what they considered to be their ill treatment, and cabled to Mr. Yerkes offering him the road. Mr. Yerkes thereupon cabled them to go to the Speyers, and shortly after Mr. Yerkes' return the Speyers bought up the road, thus blocking the Morgans' scheme.

A report from London, dated Oct. 23, says that the committee upheld the contention made by the counsel for Charles T. Yerkes before the House of Commons' railroad committee, that the bill providing for the construction of a Piccadilly and City road must be withdrawn, as the Morgans' "tube" scheme had no legal status through having been presented to Parliament as part of the London United plan, which became non-existent that day through the withdrawal of its bill.

It is learned that the Morgans do not propose to abandon their underground projects. In spite of the decision of the committee, they will have a bill introduced in 1903 giving facilities similar to those of the scheme just quashed by the defection of the London United, control of which was purchased by Speyer Brothers, who are financing Charles T. Yerkes' plan.

PERSONAL MENTION

MR. F. C. BANGS, assistant treasurer of the Cleveland Electric Railway, of Cleveland, Ohio, has been appointed general manager of the Cleveland Clearing House. Mr. Bangs will retain his position with the Cleveland Electric Railway Company.

MR. RICHARD STOCKTON has resigned as purchasing agent of the South Jersey Gas, Electric & Traction Company, of Camden, N. J. Mr. Stockton, it is announced, will become connected with a prominent manufacturing company in New York.

MR. D. CLARENCE DURLAND, who has been elected second vice-president of the Sprague Electric Company, has, for the past three years, been assistant general manager of the Sprague Company, and his promotion is evidence of his engineering and executive abilities, which he has combined to a marked degree.

MR. F. D. RIDGE has resigned as superintendent of the Clarksville Electric Street Railway Company, of Clarksville, Tenn., to accept a position with the Jackson Electric Railway, Light & Power Company, of Jackson, Miss. Mr. Lee Orrel, who has been in the service of the Clarksville Company for a number of years, will succeed Mr. Ridge.

MR. C. R. HAYES, assistant to Mr. William Pestell, superintendent of motive power and machinery of the Worcester Consolidated Street Railway Company, of Worcester, Mass., has resigned that position to become electrical engineer with the Ludlow Manufacturing Company, of Ludlow, Mass. Mr. Hayes is a graduate of the Worcester Polytechnic Institute.

MR. W. G. WAGENHALS, who recently retired as general manager of the Mill Creek Valley Street Railway Company, of Cincinnati, Ohio, was surprised at his home a few evenings ago by a large number of his former employees, who presented him a handsome gold watch and chain, appropriately engraved. Mr. Wagenhals, as has been stated, is general manager of the New York & Philadelphia Traction Company.

COLONEL ALLAN C. BAKEWELL, who was recently elected president of the Sprague Electric Company, has long been identified with the electrical industry, and has won many friends through his executive ability and honorable business methods. He was vice-president and general manager of the old Interior Conduit & Insulation Company, which was absorbed by the Sprague Electric Company some years ago. Previous to his present office he was for three years second vice-president and general manager of the Sprague Company.

MR. HENRY S. PARMELEE, president of the Fair Haven & Westville Railroad, of New Haven, Conn., who died a few days ago in New York, was one of the most influential business men in New Haven. He was born in Ohio fifty-eight years ago, and spent most of his early years in New Haven, New York and Edinburgh, Scotland. His father, Spencer T. Parmelee, who died in 1875, was prominently identified with the street railway companies in New Haven, being a director of the Fair Haven & Westville Railroad. It was in 1884, following the death of Hoadley B. Ives, president of the company, that Mr. Pamelee was elected to the presidency of the company. Under the direct supervision of Mr. Parmelee the road was equipped with electricity.