Street Railway Journal

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EDITORIAL NOTICE

Street railway news, and all information regarding changes of officers, new equipments, extensions, financial changes and new enterprises will be greatly appreciated for use in these columns.

All matter intended for publication must be received at our office not later than Tuesday morning of each week, in order to secure insertion in the current issue.

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Kicking up of Track Switches

The kicking up of track switches, resulting in the throwing of the switch point by the passage of a car wheel, has not been complained of much in this country. Some statistics, recently compiled in Great Britain, seem to indicate that this trouble has been noticed more in England than in the United States. That there are such troubles in the United States is conclusively shown by the fact that a certain large interurban company has had so many troubles from derailments on city tracks, due to the throwing of the switch point by the passage of the forward trucks, that its rules now require the conductors of all its interurban cars to watch the switch point while the car is taking facing point switches in cities. The trouble has been that the passage of the front trucks over the heel of the switch caused the switch to kick up at the point, and in coming down it was likely to leave the switch point so that it would send the rear trucks of the car on a different track from the front trucks. The rules of that road now require the conductor to watch the switch point, and the motorman is not allowed to proceed after the front trucks have passed the switch point until he receives the conductor's go-ahead signal. The conductors are even provided with short switch hooks for righting switch points which are thrown by the passage of the front trucks. It may be argued that this kicking up can only occur when the switch is unduly worn, but it hardly stands to reason that a large, well operated company would tolerate such delay as the observance of the foregoing rule necessitates where it is simply a question of renewing a few switch points to overcome the difficulty. This matter is one which is worth the attention of track men, as it is likely to come up more frequently as more interurban cars are operated over facing-point switches in city tracks. There are many places where a switch normally set for the route of greatest traffic and operated by a lever sunk in the pavement, is the surest and most satisfactory solution of the difficulty.

Shop Design

As we pointed out recently, in connection with a description of the St. Louis Transit Company's shops, some of the best shops in the country vary as radically in design as is possible for two installations to differ which are intended to accomplish similar results. Any shrewd master mechanic can see in the shops recently designed certain strong points and certain weak ones. The decision of the executive committee of the American Railway, Mechanical and Electrical Association to have brought together for the next convention a number of plans for a comparative study of a number of the most recent shops, so that the strong and weak points of each can be brought out in discussion, will be of great benefit to companies which are to build shops within the next few years. Such a plan cannot but result in establishing certain lines along which future work is to be conducted.

There are certain preliminaries which should first be determined. Before the design of any shop can be properly started, the best general scheme of motor maintenance must be fully decided upon. If all of the renewal of wearing parts and maintenance of equipment is to be performed at the central repair shop, it must be provided with a large number of tracks and facilities for handling material at a large number of points at once. If, on the other hand, most of the motor and truck maintenance is to be done in car houses, and the main shops are simply for the purpose of supplying renewal parts, their location with respect to repair tracks is not so important. This subject is also to be taken up at the next convention, although separately from shop design. If any considerable number of cars are to have wheels, armatures and motor bearings renewed at a car house on the same piece of property as the repair shop, it is certainly desirable to have easy access between the repair tracks and the repair shop, even if they are not actually in the same building.

As between the general policy of making all renewals at one central shop and making the renewals at various car houses, there are mainly three things to be considered. First, is it easier to take the cars to one central repair shop than to take the repair parts to the cars at various car houses? Second, can facilities for handling cars be provided at the central repair shop which are enough more economical in operation than those which can be provided at the car houses to justify bringing the cars to the central repair shop? Third, how much is to be gained by centralized management?

A master mechanic can come more directly in touch with the repair work of the entire system if it is all under one roof than if scattered in various car houses. Very often it is not possible to provide as good facilities in the way of car hoists, pits and motor lifts in the various existing car houses as can be provided at a new central car shop. However, if the question is to be considered broadly, we should assume that first-class facilities for handling and hoisting motors, trucks and car bodies would be provided in any event, whether this handling is done at a car house or at a main repair shop. If a traveling crane is to be depended upon for all the heavy lifting, it will usually be too expensive a luxury to install at every car house, but if mechanical or hydraulic jacks are used for hoisting car bodies, together with cranes or travelers for handling motors and armatures, the cost of installing these is not necessarily greater per unit of repair track in a car house than in a central repair shop. A traveling crane does very well where but a comparatively small number of cars are to be worked upon at once. Where there are too many repair tracks to be served with one traveling crane, either more such cranes must be put in or other means of hoisting resorted to, but these other means are not necessarily inferior to the traveling crane. Assuming good hoisting facilities at the scattered car houses, it seems to settle down to a question of transporting cars vs. transporting repair parts, and centralized supervision by a few shop foremen vs. supervision through various car-house repair foremen.

Chicago Union Loop Litigation

The senseless opposition which has been aroused to the extension of the Union Elevated Loop platform, in Chicago, has been spoken of before in these columns. The result of this opposition to a much-needed public improvement has resulted in a tangle of litigation, which, to an unprejudiced observer, looks like either an attempt on the part of a few merchants to drag the city into the contest for their own selfish ends, or, what is equally reprehensible, an attempt on the part of a recently-elected corporation counsel to make a record for himself as a "champion of the down-trodden public" by persecution, or, perhaps, a little of both, of public service corporations. What a tremendous defeat said down-trodden public would administer to said corporation counsel, at the next election, if the public once realized that the corporation counsel in blocking these improvements is responsible for the discomfort, crowding and delay of traffic, which is suffered daily on the Union Elevated loop? The City Commissioner of Public Works some time ago issued permits to the company owning the Union loop to extend its platforms so that two trains could load at a platform at once, as recommended in the Arnold report; something which, apparently, the Commissioner of Public Works has full power to do. After the permits had been issued and the improvements were well under way, the present Corporation Counsel, who assumed office after the permits were issued, and who was apparently looking around to see what trouble he might make, volunteered the opinion that the Commissioner could not legally issue such permits, and the work was stopped. Now, several small property owners and tenants around the loop are trying to prevent the company from securing an injunction against interference with the work of extension. The city has now begun to club the company for the benefit of the said tenants by beginning a suit, contesting the validity of the ordinance under which the loop was built. It appears that those behind this persecution game have overstepped themselves, however, as the Mayor has been receiving letters from large property owners, protesting against the action of the city in attacking vested rights, and other large property owners on the loop are threatening to make trouble about the use of their names, without permission, on the petition before the court, asking the ordinance to be declared invalid. The Corporation Counsel seeing the questionable legal position he has placed the city in by filing a suit with ulterior motives, is now trying to make out that there is no connection between the tenants' obstructive fight against platform extension and the suit to test the validity of the ordinance, but the connection is too apparent to everyone to make these efforts more than ridiculous. This whole affair will probably result in nothing more than a continuance of a certain amount of public discomfort a little while longer.

The Properties of Single-Phase Motors

Mr. Lamme's interesting paper, published in this issue, gives a very good running comment on the practical properties of the rather novel class of alternating motors now being introduced for traction purposes. It is not easy to realize at first thought that such motors are really at the commercial stage of development, but Mr. Lamme speaks in no uncertain tone, and he is in a position to know. Broadly, the motors in question have the general characteristics of series-wound direct-current motors. They appear, in particular, to have excellent starting torque, as might fairly be expected, and when at speed and load have very high power factors, as high, in fact, as any class of alternating-current devices. In starting, the power factor is low, very much lower in fact than in polyphase induction motors, but the start is, nevertheless, accomplished with the use of a very moderate amount of energy. The curves from Dr. Finzi's motor, which we published recently, show this point very clearly, by giving the volt amperes required from the start to full acceleration. As to efficiency, the motors make a very creditable showing, lower, to be sure, than in the case of direct-current railway motors, for reasons which Mr. Lamme sets forth at considerable length. Hysteresis and eddy currents are obviously far from negligible in alternating-current apparatus, but, fortunately, there is a compensative advantage in the correspondingly greater efficiency of the regulating devices. Of course, a balance of the efficiency ledger can be struck only after the motors have become familiar in the various branches of commercial work, but enough is now evident to show that the deficit will not be large. As a matter of fact the efficiency should be reckoned clear back to the power station, and when this is done the saving in distribution will far outweigh any intrinsic losses in the motor.

It would be, indeed, a bad alternating motor that did not give as good efficiency as the combination of rotary converter and direct-current motor now in vogue. It will be hard to produce better, more efficient, or more reliable machines than the present standard traction motors. If they are to be superseded, good reason for the change must be found. We do not think it will be discovered in the regulating appliances, but rather in the very great saving in the distribution, especially in interurban work. Incidentally the general use of alternating currents will tend greatly to lessen the danger of trouble from electrolysis. It will not absolutely remove that danger, since it is well known that electrolysis by alternating currents is possible, but as a practical matter it will pretty effectively suppress it. This, of itself, is no light argument in favor of the position taken by Mr. Lamme on other grounds, that the new motors should be seriously considered for regular electric tramways. On the other hand, in using alternating currents, even of the low frequency proposed, the virtual resistance of the rails becomes several times as large as the ordinary resistance for continuous currents. In interurban work, where high voltage will generally be carried on the trolley wire, this difficulty is minimized, since both the actual current in the rails will be small, and the low-current density will keep down the electromagnetic effects. In city work the increased resistance due to alternating current cannot altogether be neglected, and something may be said in favor of direct current on this score. But there is little doubt that the regular series-wound alternating motor can be arranged for use with direct as well as with alternating current, so that interurban cars could come into a town over the ordinary lines, if necessary or desirable. The heavier class of interurban work for which alternating motors have most been needed, will more and more become independent, so that even if it were difficult to provide alternating-current distribution in urban districts it would not very much matter.

It seems to us that the vital question in regard to the new motors is that of sparking. On this point no amount of argument, pro or con, can have very much weight. It is simply a question of fact, to be decided by experience. The art of commutation has doubtless improved, as Mr. Lamme suggests, but at no time in its history has there been reason to suppose that alternating currents could be commutated anywhere nearly as easily as direct currents of similar magnitude. We regret that Mr. Lamme did not give more definite information as to the methods adopted in these motors to suppress sparking. It is, at least, safe to say on the concurrent testimony of Mr. Lamme, Dr. Finzi and Messrs. Eichberg and Winter, that the sparking difficulty has been reduced further than has before seemed possible. It is noteworthy in this connection that while Dr. Finzi's motor was small, of the common tramcar size, the others in question were of large power, large enough to show sparking if the matter of magnitude cuts any figure in the matter. The next question when the sparking matter is settled, is whether the new construction lends itself handily to the production of powerful electric locomotives, such as would be needed for high-speed work or for such tasks in heavy traction as have been laid out by the New York Central. It would be, indeed, a strange freak of fortune if the immense equipment just ordered for that great project should turn out to be of apparatus obsolescent before delivery.

It is worth mentioning in this connection that the new move in traction is highly favorable to the steam turbine. That remarkable machine is at its best in the generation of alternating current, and as both the great American electrical companies have a fair show at the turbine business, there may be compensations even if the railway motor standards have to be changed. Finally, the production of a successful alternating motor for railway work implies the easy production of the smaller motors used for general power purposes, a fact which may have a very important bearing on general methods of electrical distribution. At all events the first steps toward success have already been taken.

Interurban Terminals

This is certainly the day of the interurban terminal station, and this is as it should be. Nearly every important interurban center from which a number of interurban railways radiate is now building or has already built a central terminal station for the use of all the lines. It was recognized soon after interurban lines began to be differentiated from ordinary street railway lines, that an interurban waiting room in the central part of the city was very desirable. As a result, there are very few interurban companies which do not have depots or waiting rooms in the principal cities which they serve, even if there is no common union terminal station. The plan of having waiting rooms scattered around in various store buildings is not altogether satisfactory to the public, and the result has been the construction of the Union terminal station.

At Indianapolis a most extensive interurban terminal station, planned from a traffic standpoint, is being erected for the use of the nine interurban lines which will soon be radiating from that city. At Cincinnati, where interurban development has been held back by certain conditions that were outlined in recent articles in this paper, a fine interurban terminal station has, nevertheless, been in use for some time. At Toledo, while there is no special building devoted to a terminal station, a very large, well-fitted up waiting room is provided at a corner where all interurban cars pass. Cleveland has only recently made efforts to secure a Union waiting room for the interurbans that have been successful. A depot is now to be provided on the public square, according to the plans recently published in this journal. At Detroit, while there is a common waiting room for all lines, there is apparently not the importance attached to it that there usually is to the Union interurban station. At Muncie, Ind., which, although not a large city, is, nevertheless, an important interurban center, another fine terminal building is going up. At Milwaukee, the company is demonstrating its faith in the city and the future of its property by erecting one of the most substantial steel frame structures in the city, to be used as an interurban terminal and general waiting room as well as an office building and a place where a few reserve cars may be kept for emergencies. In most of the larger terminal buildings provision is being made to take care of both freight and passenger business. In other cities, where the passengers are taken care of by a centrally located waiting room, the freight business is handled at a separate depot in a district at one side of the main retail district.

There is one important distinction between the steam and electric railway which should not be lost sight of in this connection, especially by property owners and business men; namely, the difference in the influence exerted upon the locality invaded. The building of a passenger station or freight house by a steam road is not generally conducive to the enhancement of real estate values, but the electric road is not so obnoxious as the almost constant presence of steam locomotives, belching forth smoke and cinders and soot, to discolor everything in the neighborhood. Consequently, it should be much easier to secure favorable locations for electric terminals. We recall one case where the building of an interurban terminal had the effect of stimulating retail business so much that other localities offered inducements to change.

A freight and passenger depot combined necessarily has something of a compromise in its location, as it is rarely advisable to utilize the exceedingly valuable land in the midst of a retail shopping district for a freight terminal, and, on the other hand, if the building is located to accommodate the freight business, it is likely to be a little out of the way of the retail center whence most of the passengers come who patronize the waiting room. This compromise is evident in the location of all the large combination freight and passenger terminal buildings which are now erected or being erected. Nevertheless, most of them are not by any means a prohibitive distance from the principal retail streets, as a very judicious selection of site is usually made. Thus, in Milwaukee, the building now being erected is but one block from the principal street, and at Indianapolis the new building is one block from the recognized street railway center.

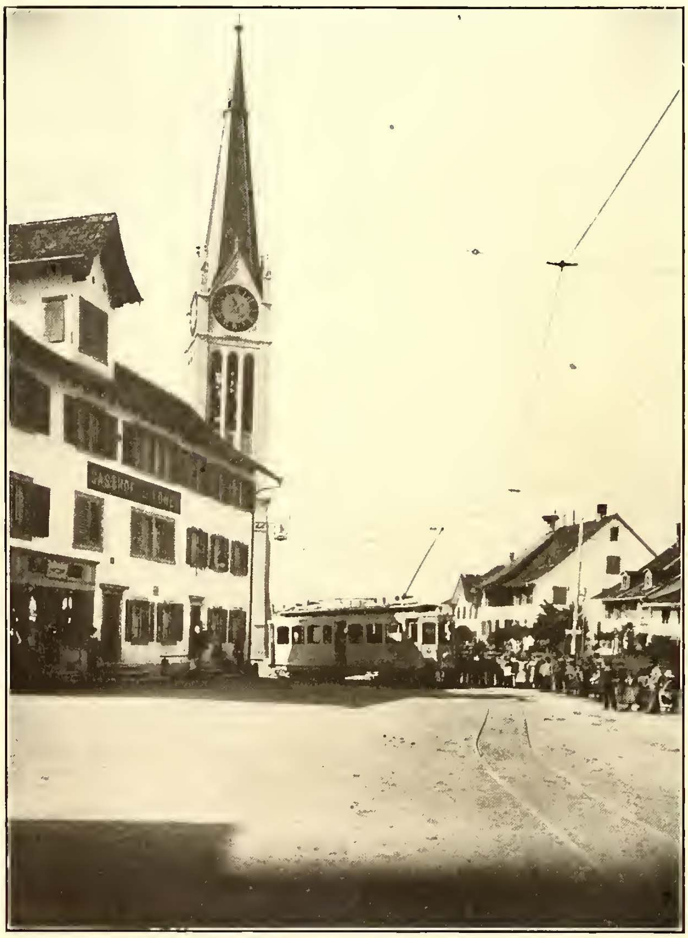
NEW INTERURBAN RAILWAY IN SWITZERLAND

BY HENRI SOMACH

Practically all of the cities in Switzerland possess electric railway systems, but up to the present time little progress has been made with interurban electric railway construction. This has been partly due to the fact that all of the trunk lines and nearly all of the steam railway companies in Switzerland belong to the Government. But in spite of this, capitalists are coming to realize that there is a certain field in Switzerland for private interurban electric lines, especially if built with a narrow gage.

One of the few Swiss interurban electric railways is that put in operation Oct. 8, 1903, between Wetzikon and Meilen. This line is 22.5 km (14 miles) in length, and traverses an extremely fertile region near the Lake of Zurich. The line has many grades and ascends an elevation of 190.79 m (626 ft.) in 7.5 km (4¾ miles). The maximum grade is 6.5 per cent for a length of 426 m (1400 ft.), not far from the terminus of the line.

The line for the greater part of its length is built on the highway, but recourse has been had to a private right of way at points to avoid too sharp curves or too steep grades. It is single track, built to 1-m gage, and with numerous switches to freight stations. It is laid with 25-kg Vignole (50-lb. T) rail in 12-m (39.3 ft.) lengths, mounted on metal ties, fourteen to the rail



TERMINUS AT MEILEN

length, which, in turn, rest on a ballast 35 cm (14 ins.) in depth. This construction, it might be said in passing, is practically the standard for all of the new interurban lines in Switzerland. Vignole rails have proved more satisfactory, even on paved streets, than either the Broca or Phœnix types. While it is true that objection has been made to these rails as constituting an obstruction to vehicle traffic, their many advantages have led to their almost general adoption.

Current is supplied to the cars in the form of continuous current at 750 volts, the usual voltage on Swiss interurban lines.

The regular service on the line is supplied by eight trains per day in each direction. Each train consists of a double-truck motor car and a single-truck combination baggage and passenger trail car. There is also a local service from each terminal station every 30 minutes, supplied by single-truck cars, also a freight service of two trains each way daily. The running time is 25 km (16 miles) per hour on a level. In descending grades the cars are not permitted by the Swiss lines to exceed a speed of 15 km, or 10 m. p. h., where the grades are from 3 per cent to 5 per cent, and must proceed at an even slower rate on steeper grades. The running time between the termini is about 1 hour and 20 minutes, including all stops.

WAITING STATION AT OLLIKON

A great deal of attention has been given to the type of car to be used, and it is interesting to note that American practice is being followed to the extent of the employment of double-truck cars. These cars, which are very long for European roads, are divided into two compartments, each seating eighteen passengers, one compartment being for smokers and the other for non-smokers. There is also room for four standing passengers on each platform. The two passenger compartments are separated by a baggage compartment about 4 m (13 ft.) square, which can also accommodate passengers if necessary. The platforms are vestibuled. Cross seats are used. The roof has a monitor deck with ventilating sash.

The main dimensions of the cars are as follows:

Length over all....................	14 meters (45 ft. 11 ins.)
Maximum width..................	2.2 meters (7 ft. 2½ ins.)
Height of car......................	3.5 meters (11 ft. 7 ins.)
Wheel base	1.4 meters (4 ft. 6 ins.)
Distance between centers of trucks..	7.6 meters (24 ft. 11 ins.)

The cars are supplied with hand brakes and with Böker axle-driven air brakes. Air brakes are also used on the trail cars, and can be operated by the motorman. A novel feature for

European cars is the adoption of electric heaters, which are placed under the seats.

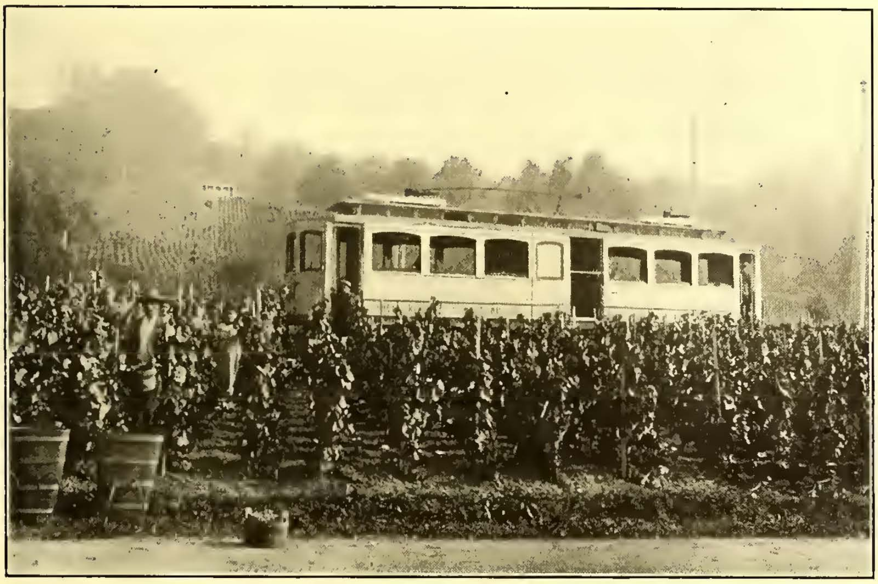
The electric equipment of the double-truck cars consists of four Oerlikon T. M. 12-22 motors of 22 hp each. These motors are designed for 375 volts each, and are operated in groups of two series with each other. The ratio of the gearing is 5 to 1. A series parallel controller with magnetic blow-out is employed. Two trolley poles are used, one for each direction of running.

The single-truck cars are very similar to ordinary European cars, having seating capacity for eighteen passengers, room for ten passengers on the platforms, and are vestibuled. They are equipped with Oerlikon T. M. 12-35 motors of 35 hp, designed for 700 volts. The electric freight cars are built to carry 5 tons, are mounted on single trucks, and are also equipped with T. M. 12-35 motors.

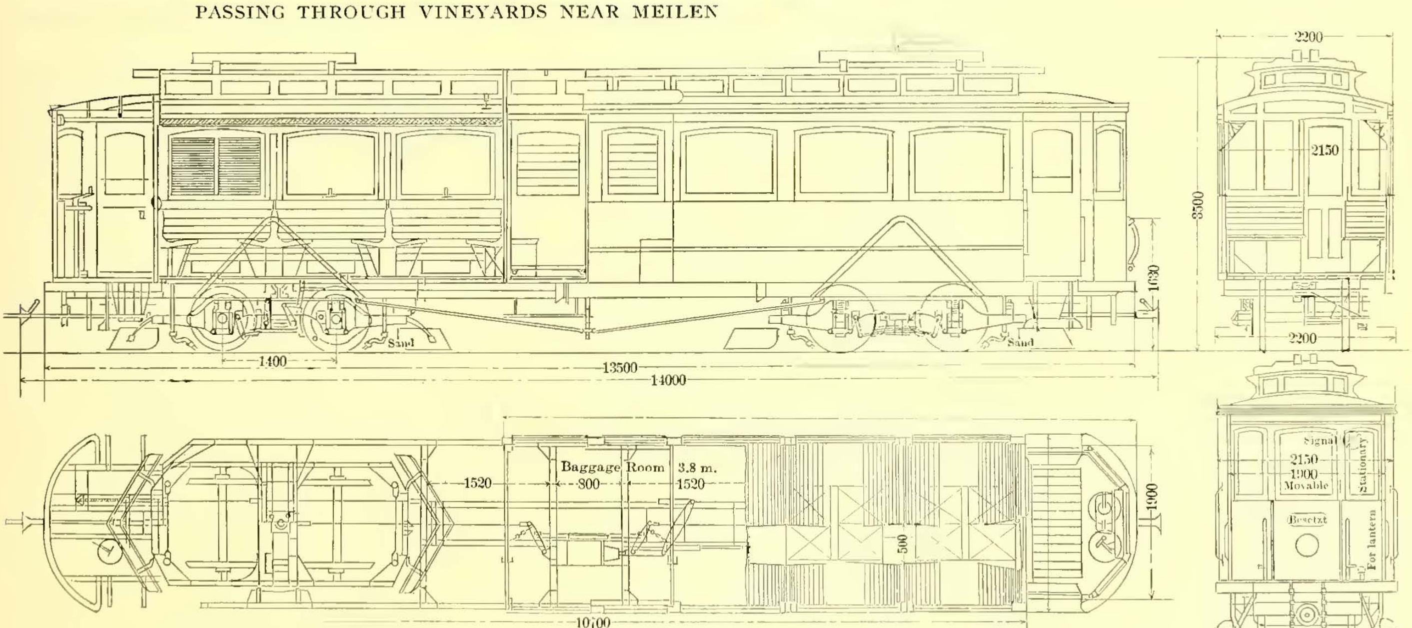
The trolley wire is No. 0 and 8-mm in diameter. The feeders are bare copper of the same size. The trolley wire is divided into fourteen sections, each equipped with a lightning arrester with a magnetic blow-out. The power required for operating the line is supplied from a water-power plant at Beznau, in the form of 25,000-volt, three-phase current at 50 cycles. This is reduced to 460 volts by 160-kw transformers, and changed to direct current by means of 140-kw, compound-wound rotary converters, operating at 1000 r. p. m. The sub-station is also supplied with a battery of 360 cells, having a capacity of 270 ampere-hours.

ENTRANCE TO STATION AT WETZIKON

The entire electrical equipment was installed by the Oerlikon Machine Works.


PASSING THROUGH VINEYARDS NEAR MEILEN

The Philadelphia & Easton Street Railway has completed its line between Easton, Pa., and Riegelsville, and cars are now in regular operation. The line is almost a direct route between Philadelphia and Easton, and the fare is about 70 cents. The run can be made in about the same time as the roundabout steam car journey. The new branch also links Trenton with the Lehigh Valley Traction system. The system is operated from a power station located at Raubsville.



Seats in Car—18 in smoking compartment, 18 in non-smoking "

In Baggage compartment—6 seats and room for 4 standing passengers, or else 12 standing passengers in all

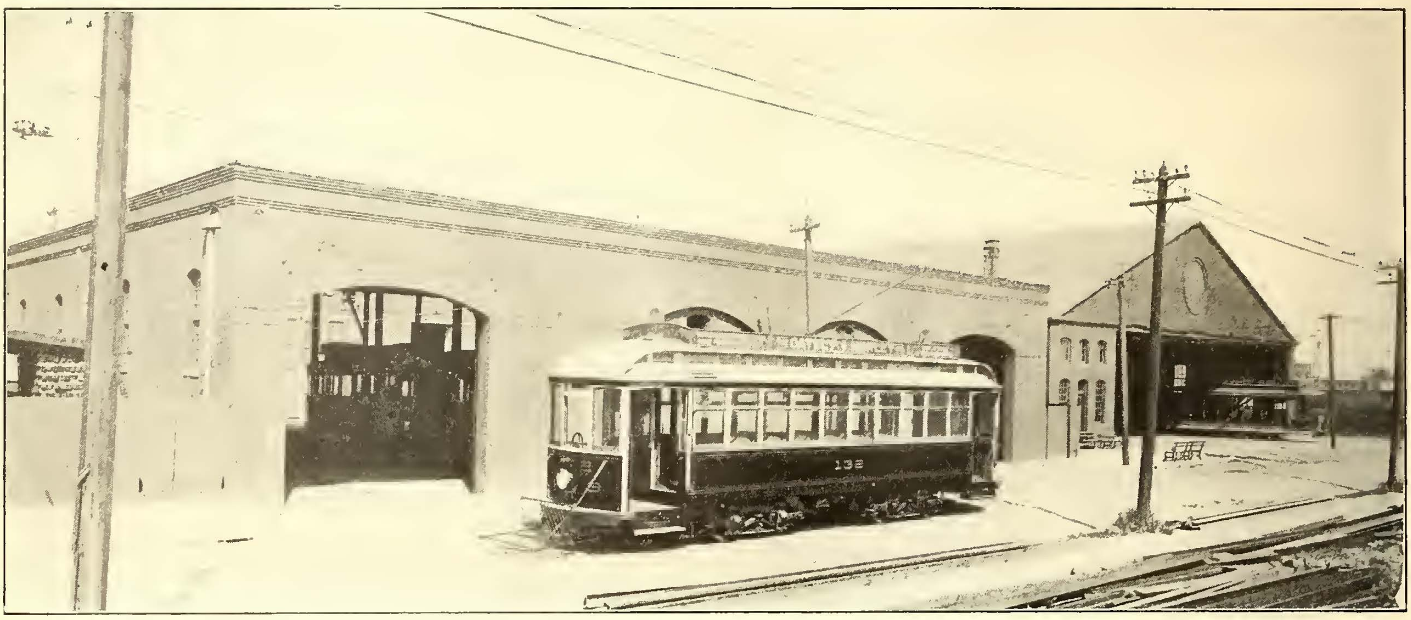
Rear Platform: Room for 6 standing passengers

Street Ry. Journal

PLAN SECTIONS AND ELEVATIONS OF DOUBLE-TRUCK CAR

REPAIR SHOP PRACTICE ON THE CAMDEN & SUBURBAN ROAD

As stated in the issue of Dec. 5, the repair shops of the Camden & Suburban Railway Company are located on Newton Avenue, and comprise an extensive system of shops, car houses and stock rooms. Other shops are to be built, however, and will be devoted exclusively to overhauling. Quite a distinction is made on the Camden & Suburban Railway between ordinary repairs and overhauling, and it will be the policy of the company, after the new shops are built, to still further accentuate this difference by having the two classes of work performed at different places.



EXTERIOR OF REPAIR SHOP AND CAR HOUSE, SHOWING ONE OF THE NEW DOUBLE-TRUCK CARS OF THE COMPANY

As already stated the company has made a so-called "contract" with its master mechanic for the repair of its cars. This contract is really an agreement fixing a certain price for all the different essential operations in car repair, which price the master mechanic endeavors to live up to. The arrangement was made in May, 1903, when the master mechanic agreed to effect a saving of 15 per cent on the net cost of repairs, which up to that time had amounted to 1.66 cents per car mile. It also includes the proviso that the average number of times in which a car shall be in the repair shop will not exceed 1.11 times per 1000 miles run.

All repair work is ordered by the chief engineer, with the approval of the general manager, when in his opinion the condition of the car requires it. A blank is first made out, as described in the last issue, stating the work contemplated and the expected cost, and this blank must be O. K'd. by the manager before the work is undertaken.

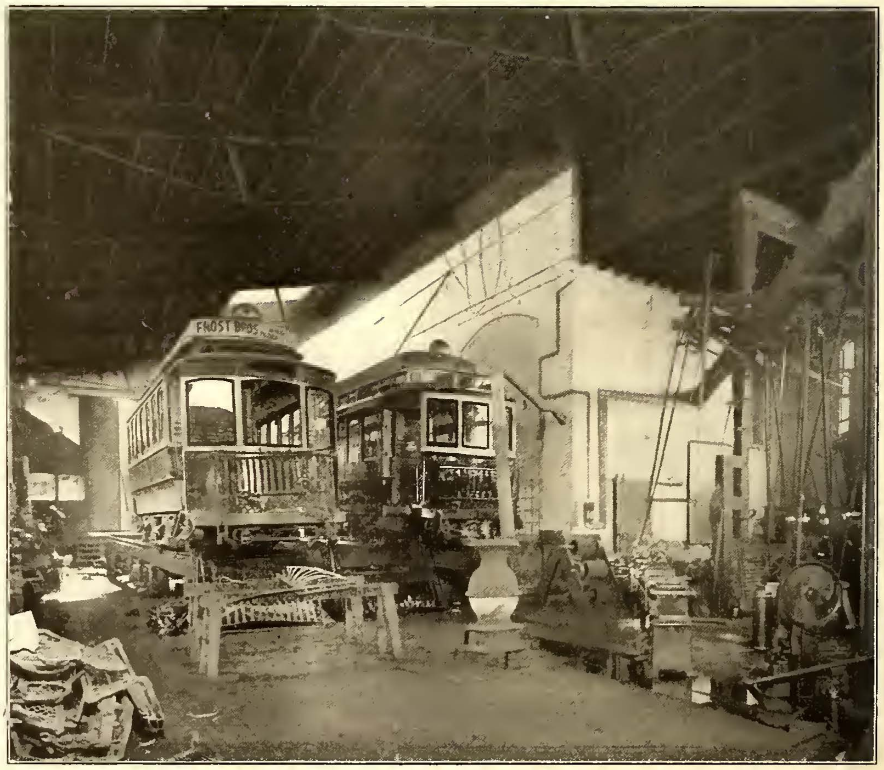
All work in the repair shop is divided into five main divisions, as follows:

1. Truck repairs, which comprise all repairs done to trucks but not including the gears. This class includes repairs done to the truck and brake rigging.
2. Motor equipment repairs. These repairs commence with the gears and end with the cables.
3. Electric equipment repairs. These begin with the cables and include the controllers, trolley, trolley base and all other electrical equipment except the headlights.
4. General body repairs.
5. Painting repairs.

For convenience, the repairs in each division are further classified under certain letters of the alphabet as follows:

CAR PAINTING

In car painting, the letter *A* is used to designate the complete overhauling of the car, as follows: Burning, scraping and pumice-stoning the outside of the car to remove the paint, when necessary; two coats of color on the main and concave panels, with at least six hours for the first coat to dry before giving the second; striping and one coat of rubbing varnish with an interval of six or more hours, according to conditions; one coat of finishing varnish with an interval of from two days to three days; a second coat of finishing varnish with an interval of three days to five days. All bare woodwork exposed to the weather receives four coats of finishing varnish, this being done in advance of the outside painting. The vestibule sashes



INTERIOR OF REPAIR SHOP, SHOWING ELEVATED TRACKS are grained on the outside and receive two coats of finishing varnish. For this outside work Valentine's best grade of coach varnish is used. The inside woodwork is given two coats of inside varnish, Schrack's varnish being employed. The roof receives two coats of oil color. The trucks and all other iron work are scraped clean and given one coat of metal paint, after which the trucks are also given a coat of Colonial green. All the other iron work is blackened and the brass work is burnished and relacquered. The metal seat frames are gilded with bronze. The cane seats are given one coat of varnish, and the floors and platforms two coats of floor color in oil. The roof signs are repainted.

In advance of all painting in class *A*, all bare, exposed woodwork is scrubbed with ammonia, and all spots and car trimmings are removed.

Class *B*, in painting repairs is not so extensive as Class *A*. In Class *B* the cars are first thoroughly scrubbed and cleaned. All paint work is then touched up and matched, cutting in between stripes. The outside of the car receives one coat of finishing varnish and the inside of the car one coat of inside varnish. The seat frames are gilded, and two coats of color in oil are placed on the floor. One coat of color in oil is put on the roof and one coat on the trucks. The iron work is blackened and the brass is polished and relacquered.

Class *C*, in painting repairs, includes one coat of varnish of the outside of the car and one coat of color on the floor, roof and truck.

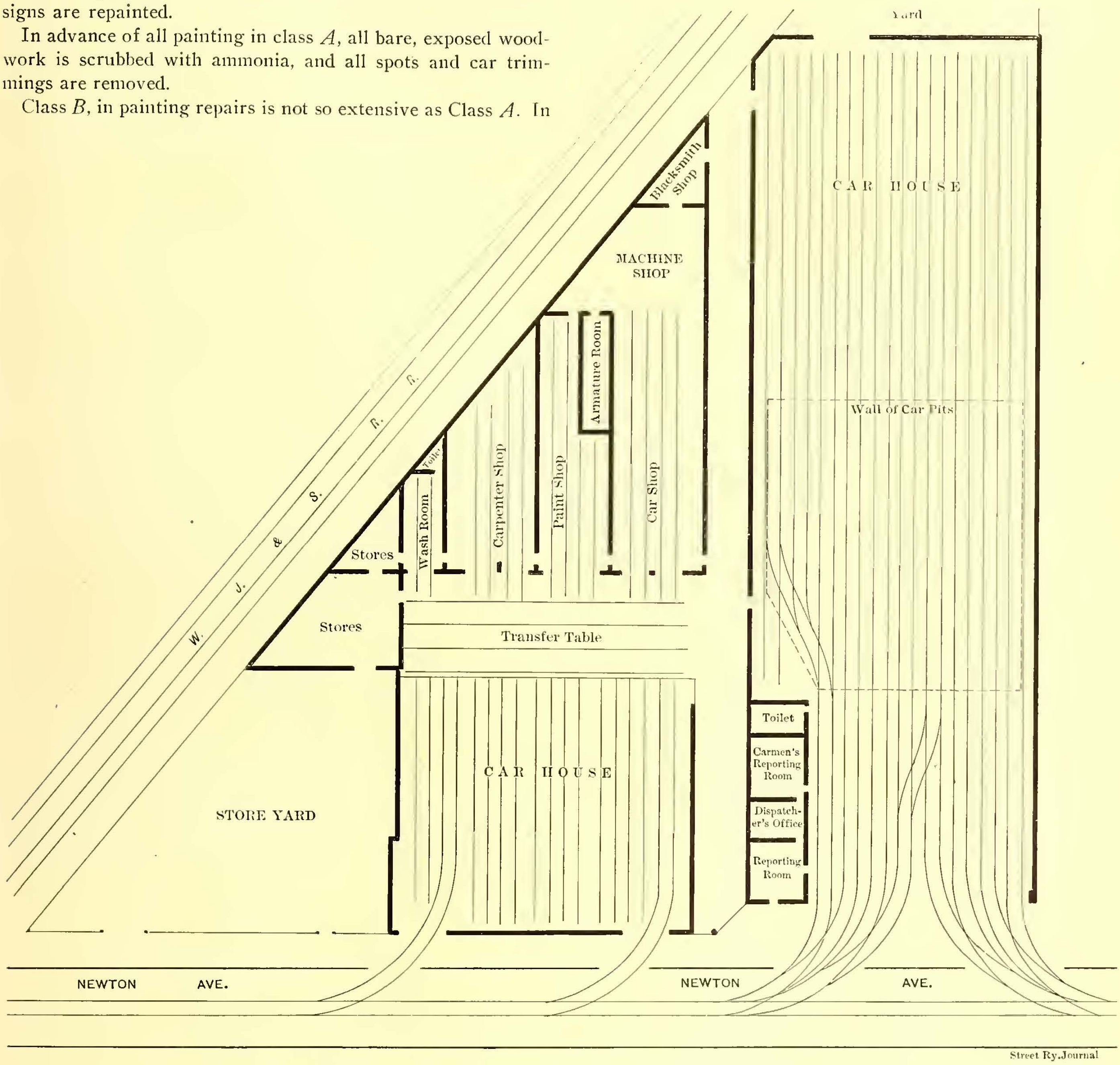
Class *D*, in painting repairs, comprises touching up the varnish, giving one coat of color to the floor, and touching up with paint any scratches or other spots necessary on the body of the car.

Class *E*, in painting repairs, comprises touching up injured parts only.

The cost in labor for these repairs, of course, varies greatly with the condition and size of car, and are set by the master mechanic and chief engineer, in council with the contracting foremen of the different departments; but the average may be said to be about as follows for cost of labor for a 28-ft. body, double-truck car, measuring 41 ft. over all:

Class *A*, painting repairs		$35.00
B, "	"	25.00
C, "	"	18.00
D, "	"	15.00
E, "	"	$1 to 12.00

Further particulars of the cost of painting and varnishing of cars on the Camden & Suburban Company's lines were presented by Mr. Harrington at the 1900 convention of the



PLAN OF CAR HOUSE AND REPAIR SHOP PROPERTY ON NEWTON AVENUE

American Street Railway Association, and form part of the transactions of the association.

It will be understood that the figures quoted above represent only the labor cost for painting, and are figured at the rate paid to painters, which is 22½ cents an hour. This rate per hour is the "contract price" paid painters, but it may be increased or reduced by a system of bonuses in force in the shops, as will be described later.

BODY REPAIRS

Body repairs are divided into only four classes—*A*, *B*, *C* and *D*. When Class *A* is specified on an order, it includes the renewal or rebuilding of all the parts of the car, which are so worn that they would further deteriorate the car if left in use for another 1000-mile run. As Class *A* in body repairs is always ordered with Class *A* in painting, it also includes scraping all plain woodwork, taking down of all inside fixtures before the painters commence their work and replacing them after the painters are through. It also includes retruing the car. The average cost of this class in labor is $75 at the "contract price" paid to carpenters, which is 22½ cents an hour.

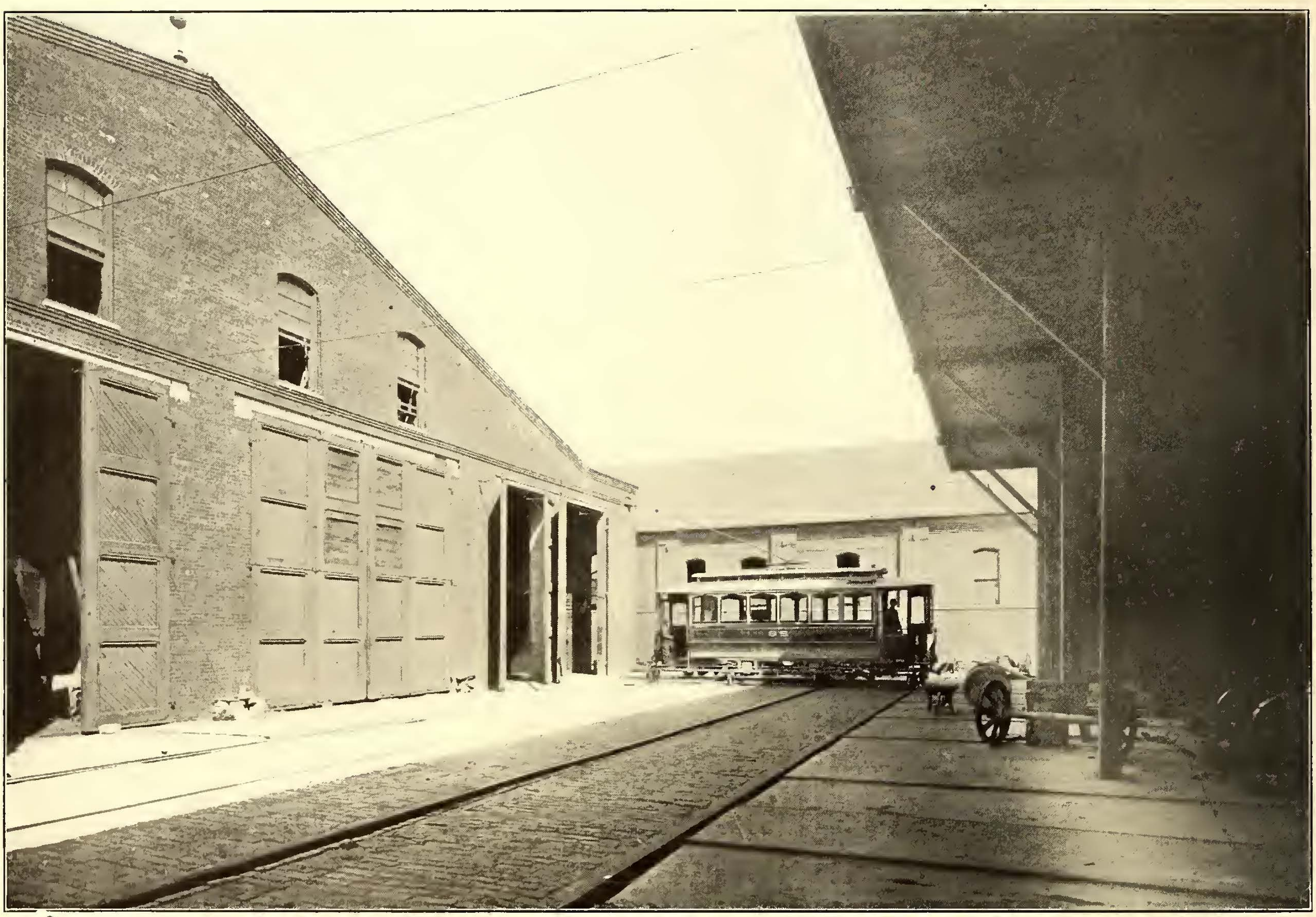
Class *B*, in body repairs, comprises repairs to the floor, putting in new floor strips, reflooring both platforms, jacking up and trussing the rigging, straightening all joints and overhauling doors and windows. The average cost for labor for this class of repairs is about $38.

Class *C*, in body repairs, includes repairs to trap-doors, platform and floor stripping, but does not include the renewal of any considerable portion of these parts. The average contract price for this work is about $6, at the contract price of 22½ cents an hour.

Class *D*, in body repairs, is emergency work.

TRUCK REPAIRS

Truck repairs all come under special orders except the complete overhauling of trucks, which comes under Class *A* in truck repairs. This comprises tearing down the truck, renewing all worn-out parts and reassembling them, placing the truck under the car and connecting it up to the car. The cost of this varies greatly with the type of truck, but might be said for the average single truck to amount for labor to $10.50, being made up of thirty hours for a mechanic at 20 cents an hour, and the same number of hours for a helper at 15 cents an hour. This work for one double truck will cost about $7, as it can usually be completed by the same men in twenty hours. Class *A*, in truck repairs, also includes replacing fields in armature, but does not include repairs to the motor, which come under motor repairs.



CAR ON TRANSFER TABLE IN REPAIR SHOP

MOTOR REPAIRS

The motor repairs are, as a rule, given out on special order, as the amount of repairs varies greatly with the condition of the motor. The following figures, however, may be quoted as representing the average contract price for some of the principal essential operations:

COST OF VARIOUS MOTOR REPAIRS

Work	Total Hours	Rate Cents	Total Cost Labor
Rewinding No. 3 Westinghouse armature	30¾	20	$6.35
" No. 38 B " "	23	30	6.90
" No. 49 " "	19½	30	5.85
Changing No. 38 B " "	5	20 and 15	0.88
" No. 49 armature and fields	11	20 and 15	2.00

As will be noticed, no figures are quoted on the cost of rewinding motor fields. The reason of this is that the company does not consider that it pays to rewind any of its fields. When a field requires more repairs than can easily be made without rewinding, it is scrapped and credited and new fields are purchased. The chief engineer believes that a field whose resistance is sufficiently changed to unbalance an opposite new field, is not worthy of repair, because, if employed, it will shorten the life of the new field in the motor and deteriorate the armature. Experience shows that about one-third more lower fields are lost than upper fields in all motors, especially in No. 3. The best results are obtained from the No. 49 motor. The average cost for labor of overhauling the electric equipment, "starting with the cables," that is, including controllers, circuit breakers, light circuit, light switches, diverters and all minor parts of the car is about $15.

WHEELS

The company does not regrind any wheels, as it has a contract with the manufacturers of the wheels used on the system by which all this work is done for the works of the wheel company. The labor cost for jacking up a car, taking out one pair of wheels and putting in a new pair is as follows:

COST OF CHANGING WHEELS

Type of Truck	Hours and Rate of Mecnanic	Hours and Rate of Helper	Total Cos of Labor
Brill No. 21 E	5 hours at 20c	5¼ hours at 15c	$1.79
St. Louis No. 13. Max. Trac.	5½ " "	6 " "	2.00

ASSIGNING REPAIR WORK AND THE BONUS SYSTEM

When a car enters the car house for repairs and it is considered necessary to give it Class *A* repairs in the paint department, the car goes through Class *A* in all the other departments. The order to the master mechanic for the work, which is made out by the chief engineer and approved by the general manager, states the class number or letter of repairs which the car will be given, the material which will be required, and also the contract price for the necessary labor. The latter price is set by the chief engineer, after he has seen the car, as closely as it can be estimated. A careful record is kept of the cost, and if it is found that the repairs have been done for less than the contract price, a bonus, limited to 20 per cent of the actual cost, is paid to the workman engaged on the job. For example, the contract price for labor upon a certain piece of work is $2.40. Suppose that the actual cost of the labor in the work when the job is finished, found by multiplying the hours required by the rate per hour paid the man, is $1. Twenty per cent of $1 is 20 cents, which is the man's bonus in addition to his regular rate of wages. The loss on contract work is figured in the same way, and it is limited to 20 per cent of the contract price. For example, suppose that the contract price for a piece of work is $2.40, while the actual cost is $3.38. The loss to the workman is limited to 20 per cent of the contract price, or 20 per cent of $2.40, which is 48 cents.

DETAILS OF CAR EQUIPMENT

Some details of car equipment can properly be discussed in this connection rather than in the first article published on the system of the Camden & Suburban Railway Company, as they are closely related to repair shop practice.

The standard color of the main panels is granite red, and cream buff is used on the concave panels. The trimming is in gold with white stripes and aluminum letters. Each car carries an illuminated hood sign of metal, with stenciled letters and celluloid fillers. These hood signs are lighted by adjustable head reflectors and throw their light through an open transom in front of the vestibule.

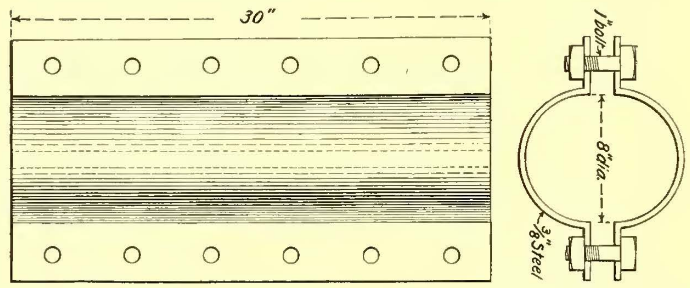
All cars also carry side destination signs fastened to the lower rail of the side panel, and also roof advertising signs, as shown in some of the illustrations of the side of the car. The frame of these signs is of wood with grooved molding. The advertisement is painted on sheet zinc strips 7 ft. long, the different sized cars being arranged for advertising signs in multiples of seven. The zinc sheets are slipped into the grooves like the cardboard signs inside the car. The advertising is all handled by the secretary of the company.

REGISTER SEALS

The company has given up the use of locks on its registers and uses in their place lead seals. This method is considered much more desirable than the use of locks, as any tampering with the seal is easily detected. Since the introduction of lead seals there has been no trouble with the registers.

REINFORCING STEEL POLES AT ST. LOUIS

The St. Louis Transit Company is using a scheme for reinforcing steel poles which have become rusted near the ground line so badly that they would be unsafe if not strengthened. The plan is to reinforce them with a sleeve or clamp, as shown in the accompanying diagram. These sleeves are pressed to the desired shape between forms by a bulldozer in the company's repair shops. They are of ⅜-in. steel, 30 ins. long. The sleeve is fitted around the pole and about one-half of the sleeve projects above the ground line.



CROSS SECTION AND ELEVATION OF ONE SIDE OF POLE CLAMP

The two parts of the sleeve are drawn together with six 1-in. bolts, and after hammering the sleeve with a sledge and drawing the bolts as tight as possible, it is considered that the pole is as strong as new.

TERMINAL STATIONS AT DAYTON

The Union Terminal Company, which has been formed for the purpose of building a terminal in the heart of Dayton, to be used by all the interurban roads, will commence work at an early date. The plans contemplate the erection of three buildings. One of these will be on the east side of Kenton Street, extending from Third Street to Fourth Street, and will be used for cold storage purposes. It will be seven stories or eight stories high, and at one side will be tracks for the electric lines which will supply produce to the company. The cold storage branch of the enterprise expects to draw supplies from all over the district traversed by the Dayton interurbans. Adjoining this building, and facing the canal, will be located a power plant which will supply electric lighting and power and operate ice machines for the storage house, as well as furnishing light and heat for the Union Passenger Station, which will be located on Fourth Street and St. Clair Street. This station will be built on an elaborate scale. It is the plan to have the cars run through an arcade from Third Street to Fourth Street, stopping between these streets at the passenger waiting rooms. The station itself will be designed to furnish every comfort for passengers. The station building will be eight stories high, of heavy mill construction, and will be designed as a power block for small manufacturing establishments.

The plans announced for these buildings are indicative of the extent of the freight business carried on by the electric railway companies centering in Dayton.

APPLICATION OF SINGLE-PHASE ALTERNATING-CURRENT FOR TRACTION AND RAILWAY SERVICE

BY B. G. LAMME

The present direct-current railway system has limitations in voltage, speed control, etc., which have long been recognized by the electrical profession. Many systems have been devised with more or less success—generally with less—in order to overcome these limitations, so that the possible field for the direct-current systems could be extended. It has also been recognized by some of those familiar with the problem that a single-phase alternating-current motor, having the characteristics of a direct-current series motor would at once furnish a means of attaining many results now impossible with the direct-current system. Such a motor obtained, the voltage limitation can at once be removed, as the transforming properties of alternating current can be brought into use. Economical operation at any desired speed can also readily be obtained through the same property of alternating current. Furthermore, the use of single-phase permits a single overhead wire where track return is used, thus retaining a most valuable feature of the direct-current system. It is thus evident that a motor of this character will permit the retention of most of the present advantageous features of the direct-current system, and also enables the use of other features not permissible without great complication and expense with the present direct-current system.

There has been perfected only one class of single-phase motors which possesses the characteristics of the direct-current railway motors, and this one class of motors very closely resembles the direct-current machine in the general features. These motors may all be given the general name of commutator type single-phase motors, as all of them have commutators on the armature or rotating member, and the armature is provided with a direct-current type of winding. Some variations from the usual types of armature winds have been proposed, but the various direct-current types have proven most successful.

All these commutator types of motors, which have the variable speed characteristics suitable for railway service, may be broadly classified as belonging to the series type. By this we mean that the field or exciting current is in series with the armature circuit, either directly or through transformer action, either in the motor itself or outside the motor. The series type of motor can be sub-divided into two classes, viz., the straight series motor, in which the current in the field wholly or partly passes through the armature, or vice versa; and those in which the field or armature forms a secondary circuit, the primary of which can be either part of the field structure of the motor, or may be outside of the motor. All these motors—whether of the straight series or of the transformer type—have the property that the field magnetism varies with the load, although not necessarily in direct proportion. Hereafter we will refer to these two types, as the straight series and the transformer types of motors. All these motors are related to a greater or less extent in their characteristics, and in many instances one type can be readily changed to the other type. In fact, by closing a single switch, we have changed a straight series motor into the transformer type with the armature closed on itself, forming a secondary circuit, with a change in performance, apparently due only to the amount of material in the magnetic circuit being insufficient for the best performance as a transformer type.

In these commutator type single-phase motors, the two most important elements, besides the speed characteristics, are the efficiency and the power factor. The efficiency of such motors will usually be less than that of a direct-current railway motor of the same output. The losses in one of these alternating-current motors can be considered as made up of the following elements:

First.—Iron loss due to reversals of magnetism in armature and field at the frequency of the supply circuit.

Second.—Armature iron loss due to variations in magnetism dependent upon rotation of the armature.

Third.—Iron loss in the surface of field and armature due to the bunching of magnetic lines from the teeth of either element.

Fourth.—Losses in field windings.

Fifth.—Loss in armature windings.

Sixth.—Brush losses.

Seventh.—Friction and windage.

Comparing these losses item by item with those of a direct-current motor, we see at once that certain losses will necessarily be greater than in the direct-current motor.

First.—Iron loss due to the frequency of the supply circuit and induction in the primary element. No such loss exists in a direct-current motor, as the machine is excited by continuous current. This loss in the alternating-current motor will not be a relatively large per cent, unless the motor is worked at a very high induction, or unless the construction of the magnetic circuit is such as will allow eddy current losses. It is at once evident that the field magnetic circuit must be laminated as completely as the armature circuit, and that there are no local circuits permissible in the field structure. It is also evident that a field structure of a straight series motor will, in general, have lower losses than of the transformer type, where the field itself forms part of the transformer, as in this latter case the total induction in the field structure will generally be greater than in the series type.

Second.—Armature iron loss due to variations in magnetism dependent upon rotation of the armature. There will be a loss in the armature due to the alternating magnetism from the primary or field circuit. This can be charged against the field loss or primary loss, as maintained above. In addition to this loss, there is a loss due to the rotation of the armature in the field. This will be dependent upon speed of rotation, inductions in the core, teeth, etc., and in general will practically average the same as that of a direct-current motor of the same capacity.

Third.—Iron loss in the surface of field and armature due to the bunching of magnetic lines from the teeth of either element. This is a loss which appears to some extent in the field pole face of direct-current machines, due to the bunching of the lines from armature teeth. This loss is relatively small on direct-current machines, if the poles are properly laminated and if the air gap is relatively large compared with the width of the armature slots. This loss in direct-current motors is included in the armature iron loss measurements, due to the methods generally used for determining iron loss on such motors. This loss will appear in the field surface or face of the alternating motor, and may be considerably greater than in the direct current, if a smaller air gap is used than in direct-current practice. By air gap we mean clearance from iron to iron.

If the field structure is of the slotted type, the slots being of such form as to give bunched lines, then there will also be a loss in the armature surface due to the bunching of these lines. It should be noted that the frequency of the secondary currents set up by the bunched lines from armature or field teeth is generally very high compared with the frequency of the supply circuit, or of that due to the rotation of the armature in the field. We believe that in general the loss due to the bunched lines will not be much greater in the alternating-current single-phase motor than in the direct current, except where very small air gaps are used on the alternating-current motor.

Fourth—Loss in Field Windings—This loss is very similar to that in direct-current machines, as the amount of copper in the field windings will generally be no greater than on direct-current motors of same capacity, and may even be considerably less. The straight-series motor will generally have a lower copper loss than the transformer types where the field structure is used as the primary of the transformer.

Fifth—Loss in Armature Windings.—The loss in the armature windings will be very similar to that in a direct-current machine, as far as the working current is concerned. In addition to the working current, there may be secondary currents in the armature turns short circuited by the brushes, which still further increase the armature loss. The resultant armature loss may, therefore, be somewhat greater than on a corresponding direct-current machine, unless the normal resistance of the armature winding is reduced below that of a corresponding direct-current machine. In practice, the loss in the armature winding is made practically equal to that of the direct-current machine, in order to avoid increased heating.

Sixth—Brush Losses.—The brush losses due to the reversal of current in the single-phase alternating-current motors are generally somewhat greater than in a direct-current motor. Such motors are usually wound for a comparatively low voltage on the armature, and thus greater brush capacity is required than in direct-current practice. The brush losses are thus increased, due to the greater number of brushes, and in addition there may be local currents in the short-circuited coils, which may produce additional loss in the part of the brush next to the commutator. In practice this loss is evidently comparatively small, as our experience shows no signs of deterioration in the brushes in regular service. Therefore, the increased brush loss may be considered as principally due to the increased number of brushes required.

The brush loss due to the local currents in the short circuited turns can be reduced considerably by the use of very narrow brushes, a brush spanning one bar or even less. With such a brush there would be short circuiting only while the brush is bringing two bars, while at intermediate positions there would be no local current. As, in general, the commutators of such motors have a relatively large number of bars, this would mean a very thin brush, possibly less than ¼ in. in thickness. Such brushes we consider too thin for street car purposes, as any roughness on the commutator would tend to break the brushes. In some of our very early experiences with such motors, we used brushes of ¼ in. in thickness, but found they required entirely too much attention, and, therefore, they were abandoned in favor of brushes of a thickness corresponding to direct-current practice, the later designs of motors permitting the use of such brushes.

Seventh—Friction and Windage.—The friction in bearings and the windage loss in such motors will be very similar to the corresponding losses in direct-current motors, but the brush friction loss will, in general, be somewhat greater, due to the increased brush capacity. Also the large number of commutator bars generally used, tends to increase brush friction to some extent.

It is evident from the above considerations that the various losses in different parts of the single-phase alternating-current motors are either equal to or greater than the losses in the corresponding direct-current motor, although no individual loss, except that due to the reversal of magnetism in the field, may be much greater than in the direct-current motor. The sum total of the slight increases make a difference of from 1 per cent to 5 per cent in the efficiency of the motor, this difference being less with larger motors.

The frequency of the supply circuit also has a small effect on the efficiency, although the relation of the losses in the various parts is so involved that no definite figure can be given for this effect.

The losses in the single-phase motor are, to a certain extent, dependent upon the speed at which the motor is operated, with a given current and torque. Assuming a given current, with the motor running at reduced speed, we can note the effect on the losses as follows:

The iron loss due to the frequency of the supply circuit is changed but little. The iron loss due to changes in magnetism in the armature and due to bunching of lines from the teeth are very considerably decreased, due to the lower armature speed. The losses in the field and armature winding are practically unchanged, and short-circuit loss in the brushes is not greatly changed. Friction loss in brushes, bearings and windage are all decreased. Therefore, at lower speed, the actual losses in the motor are considerably decreased, but not in proportion to the decrease in output of the motor. Therefore, the efficiency decreases slightly with the reduction in speed with a given torque, this efficiency decreasing more rapidly the more nearly the zero speed is approached.

With changes in load, with a given voltage applied, the efficiency curve has very much the same shape as the efficiency curve of a direct-current motor, starting low at light load and high speed, and rising to a maximum, and then falling off considerably at very heavy overloads.

After efficiency, the next most important consideration in the performance of such motors is the power factor. This is a feature which does not appear at all in direct-current machines, as the apparent input in such motors represents true energy. In the single-phase railway motor the apparent input in general does not all represent true energy, as a certain component of the input is required to magnetize the motor, and this component represents practically no energy. Also magnetic leakage in the alternating-motor represents a component of the apparent input which is practically wattless.

In a straight series motor a certain magnetizing current is required with a given field winding. The alternating flux through the field winding set up alternating e. m. f.'s which lag practically 90 degs. behind the energy component of the motor, and the product of the field current by the field voltage thus represents a wattless component of the input of the motor. With increase of load, the field current increases, the induction increases, and therefore the field volts also increase. The wattless component in the field thus varies with the product of two values which are both increasing with the load. The energy supplied to the motor increases approximately in proportion to the current supplied. Therefore, the wattless component in the field increases more rapidly than the energy component. Consequently, if this were the only wattless component in the motor, the power factor would decrease with the increase of load, and would be highest at no load. Other wattless components of the input are represented by the cross magnetizing effect of the armature, if such exists, and by the stray field around the windings. As these effects will also increase more rapidly than the energy component, it is therefore evident that the power factor in this type of motor will be highest at no load or at highest speed, and will decrease with the load or speed with a given voltage applied. But if the windings are so proportioned that the wattless component at the rated capacity is relatively small, then a high power factor will be obtained at the rated load and speed. At lighter loads and higher speeds the power factor would be considerably higher. Such a motor can give very high power factors at half loads with correspondingly increased speed. If the motor is operated at lower voltages, then the power factor at a given speed will be very nearly the same as when operated at the same speed at a higher voltage and higher load. Therefore, it is evident that as the speed is reduced, no matter what load is carried, the power factor will be decreased, and at start the power factor will be lowest, as the energy component in this case represents only the losses in the motor. We have tested a 100-hp motor showing 92 per cent power factor at 100 hp, and approximately 98 per cent power factor at one-half load, the voltage being the same in both cases. This question of power factor is largely a question of design, as the magnetizing or exciting compound of the input depends upon the air gap, amount of material, etc. In general, larger air gap means more exciting current.

The magnetic leakage in these motors may be relatively high, or may be comparatively low, this being to a considerable extent a function of the design of the motor, just as in all alternating-current machinery. Generally it is made as low as possible without sacrificing other important features.

If the armature cross induction in a series motor is large, due to excessive armature ampere turn per pole, small air gap, etc., the armature self-induction will be large. Increasing the number of poles will reduce the cross-magnetizing effects, but at the same time will require somewhat smaller air gap, or increased excitation. These two features are, therefore, to a certain extent balanced against each other.

There are various schemes for improving the power factor of the commutator type single-phase motors. These are generally most effective at high speeds, but at start or at very low speeds the improvement is small. In certain designs of both straight series and of the transformer type motors, the magnetizing current can be supplied in whole or in part to the armature circuit instead of the field magnetic circuit by means of brushes on the commutator. At certain speeds, this current can be supplied at a considerably reduced voltage, thus requiring a reduced magnetizing input compared with excitation applied to the field. This excitation can be supplied from the secondary of a series transformer, the primary being in circuit with the primary winding of the armature. The armature excitation will thus vary as the field excitation would normally vary, thus giving the varying field induction and the series speed characteristics. While this arrangement is effective in improving power factor at certain speeds, yet, as a rule, this gives the least effect at the time when it is most required, viz., at start and at very low speed. This method also requires a second system of brushes on the commutator, thus spacing the brushes on the motor the same distance apart as if double the number of poles were used. For instance, a four-pole motor would have brushes spaced 45 degs. apart, instead of 90 degs. At start there should be practically the same input required for magnetizing, whether the current is supplied to the armature or to the field.

Comparing the straight series with the transformer type of motor, it should be noted that the straight series motor requires less magnetizing current, as the magnetizing current is only supplied to one element of the field. With the transformer type of motor a magnetizing field must be furnished, as in the straight series, but there is also a second field set up due to the transformer action, and this also requires a magnetizing current. In other words, it may be considered that there are two magnetic fields set up, approximately, 90 degs. apart, each field requiring a certain magnetizing current. These two fields may be considered as forming one resultant field of higher value than either of the components, with a magntizing current of higher value than either component. In the series motor the transformer part of the field can be made to practically disappear, only the exciting field remaining; the resultant induction is, therefore, much less than with the transformer type, the field having an approximate average value of 70 per cent of that of the transformer motor, the magnetic circuit being reduced in proportion.

It thus appears that the straight series motor can be made to give a somewhat higher power factor than the transformer type, with the field used as a transformer, and this is obtained with somewhat less weight. This difference in power factor could be compensated for at higher speeds by some means of excitation applied to the armature through the commutator, as indicated above. But for traction service, where the least weight with great compactness of design is desirable, it appears to us that the straight series motor possesses some advantages. The transformer type of motor, with the transformer in the motor itself, can be compared with the straight series motor with a separate transformer, if high voltages are to be used on the line. We consider that a number of more compact motors under a car with one separate reducing transformer forms a more suitable combination than a similar number of larger motors, each with its transformer inside itself.

There is one other method of improving the power factor on these motors, and that is by the use of resistance in series with the motors. If the voltage on the motors is controlled by the use of an external rheostat, as in common with direct-current motors, then the power factor with a given torque will be constant and independent of the speed. With a given torque the wattless component of the input of the motor is practically constant independent of the speed, and if the speed is controlled by rheostatic loss, then the energy component will also be practically constant, and the power factor can be made higher at all loads. This may appear to be a good feature to those who have not considered the problem carefully, but it is a fact that high power factor obtained in this way represents a less desirable condition than the low power factor, which would be obtained if the rheostatic method of starting were not used. With a given wattless input from the circuit, the best possible condition as regards effect on the supply system is that represented by the minimum expenditure of energy. A wattless component has a certain effect on the regulation of the system, and any improvement in power factor by increasing the energy component, means that much additional effect on the supply system.

It is surprising that so many are so imbued with the idea of high-power factors that they are even willing to obtain it by increasing the losses in the apparatus, thus in reality increasing the load on the system. A high-power factor obtained by rheostatic control would represent no more advantageous condition than the use of resistance in series with an induction motor, when running, to increase its power factor. If a permanent resistance connected be parallel with an inductance motor, it will not increase the power factor of the motor itself, although any measurements of the input to the motor and resistance will show a higher power factor than that of the motor itself; but anyone can readily see the absurdity of this combination, although it does raise the power factor. The use of resistance in series with a motor in order to give higher power factor at starting would represent a similar absurdity, although it would not be as evident on the face of it.

Leaving out the question of power factor, the rheostatic method of starting and controlling the motor will, in certain instances, possess advantages over other methods, especially where the loss in the rheostat will average but a small part of the total power expended over a given period. This method of opration should not necessarily be abandoned in all cases, simply because voltage control can be obtained.

The next point, and one which is of considerable interest to the electrical fraternity at large, is the question of commutation in the commutator type of single-phase alternating-current motor. In the early times in the electrical business it was discovered that there were many things that could not be done with alternating-current, and among these was the commutation of alternating-current without excessive sparking. This opinion has become so well established that at the present time many engineers are very doubtful of this point. This opinion is based principally upon experiments in commutation of alternating current, mostly made many years ago, and not upon the theory of commutation itself. In many cases it was considered that the alternating current had some mysterious property which caused sparking when attempts were made to commutate it.

If we go back to the early periods we also find many things which could not be done with direct current, but which are done at the present time. I well remember the time—about thirteen years ago—when I was informed by a number of the leading engineers of that time, that it was useless to consider the construction of slotted armatures for railway generators of the then gigantic size of 200 kw. At that time the Westinghouse Company had a railway armature of this size almost completed, and this advice was very discouraging. But as the armature was so nearly ready to test, it was decided to assemble the machine and find out how badly it would work. The result of the tests was such that the Westinghouse Company immediately abandoned the surface-wound type of direct-current armature in favor of the slotted type. Other companies probably had similar experiences, for the slotted type is now almost universally used. The above is merely given as an illustration that in direct-current apparatus many early opinions have been abandoned. It one of the 200-hp New York Subway motors had been attempted ten or twelve years ago, conclusions undoubtedly would have been drawn by many engineers, showing the absurdity of attempting to make high-class motors of this size.

In the same way advances in the art have led to a more complete understanding of the underlying principles of commutation among those interested in the design of commutating apparatus, although such knowledge, except in a general form, is limited to a small number of engineers. Very few of all those who handle modern direct-current generators or motors, really know why their machines commutate so much better than some of much older designs which were apparently built on the same lines.

Motor designers with a wide experience in the problem of commutation are now awakening to the fact that commutation of alternating current does not furnish a set of new and mysterious phenomena, but that the laws which apply to direct-current commutation also apply to alternating-current commutation, and that the problem is one of degree principally. If a continuous current of X amperes have its direction reversed in a coil without sparking as the coil passes under the brush, then there should be no difficulty in reversing this current if it varies periodically from X amperes to zero and up to X amperes again. The trouble is that when opinions on commutation of alternating current were originally formed, it was not known how to communicate the current of X amperes.

The principal difficulty in commutation of alternating-current motors has been the presence of local secondary currents in the coils short-circuited by the brushes, such currents being due to pulsating or alternating magnetism through the short-circuited coils. Various arrangements have been tested at different times for lessening the effect of these secondary currents. Such motors are usually built with a comparatively large number of commutator bars, with a very small number of armature turns per bar, to lessen the effect in the short-circuited coil. Very narrow brushes have been tried in order that the period of short-circuit may be lessened, and two or more parallel windings forming the so-called "Sandwich" type have been tried. These windings lie side by side on the core, but are practically independent of each other and connect to alternate commutator bars, or to every third bar, etc., dependent upon whether two or three parallel sets are used. With two of such parallel windings on a core a commutator brush of a width slightly less than one bar could be so placed that it would never short-circuit a coil of either winding. In this case the brush passes from one winding to the next, and breaks connection with the first winding before passing to the next bar of the first winding. With this arrangement, the short-circuiting of the coils would be diminished, but the type of winding is one which we do not consider satisfactory for railway motors. We consider that this is simply transforming the trouble due to the short-circuited coil to another trouble, which would in the end be just as serious, viz., the tendency of such windings to produce blackening and pitting of the commutator bars. Such an arrangement would require very thin brushes, if but two parallel windings were used, while with three parallel windings the brush could have a thickness corresponding to two commutator bars.

A number of other devices have been tested at various times by different experimenters, but these are attempts to cure an existing difficulty rather than to lessen or eliminate the cause of the difficulty.

Within the past year or two there has been a great awakening to the possibilities of this problem, with the consequence that there is now a world-wide appreciation of the field of operation for commutator types of single-phase motors which will accomplish results not hitherto attainable. Single-phase motors having good commutating properties are now on the market in this country for the commercial frequency of 25 cycles per second. Higher frequency motors could probably be built with reasonably good results, but as 25 cycles has become a commercial frequency in this country, it is probable that this will become the standard for traction service for single-phase motors.

A single-phase motor having series characteristics having been obtained, it is at once evident that it opens up various methods of control hitherto not utilized in railway service. Having the motor which can be controlled in speed by variations in the voltage supplied to it, then voltage control can at once be obtained due to well-known properties of alternating-current transformers. Such methods of control are dependent upon the use of alternating current, and have not been applied in railway apparatus heretofore, because there was no suitable motor on the market.

Many forms of apparatus for varying the voltage on alternating-current circuits have been known and used, and most of these devices permit voltage variations with comparatively small loss in power. Therefore, with an alternating motor with the series characteristics, it is at once evident that we can obtain a traction system in which the power expended is practically proportional to the work done, and therefore the least power will be consumed at starting at low speeds. This is an ideal condition for railway service, but has not been permissible with the direct-current system, except by great complication.

There are a number of ways in which the various single-phase commutator type of motors can be controlled in speed. With the straight series type, the voltage applied to the terminals can be varied, the field windings can be varied, commutated, etc., or the relative values of armature and field strength may be varied. With certain designs of motor, exciting brushes may be placed on the commutator, as we have indicated before, and the voltage applied to these brushes may be varied. All these methods may be used also with the transformer types of motors.

By shifting the polarity of the fields to one side or the other of the normal position, the speed can be also affected to a greater or less degree, and similar results can be obtained by shifting the armature brushes. The latter method we do not consider a suitable one for traction motors. Series-parallel control can also be used, if desired, just as on direct-current motors, and rheostatic control can also be used. These two methods have practically the same effect on economy as found with direct-current motors with these methods of control.

The single-phase motors of all types, in common with polyphase induction motors, have one feature which is not shared by the direct-current motors, viz., there is an active voltage between the field turns. The alternating magnetic flux through the field of the alternating motor generates an e. m. f. in the field windings, just as in the case of an alternating-current transformer. In the direct-current motor the only voltage in the field coils is that represented by the current flowing against the resistance of the windings. Therefore, in a direct-current motor a short-circuit can occur between one or more turns of the field coil without immediate disastrous effects on the motor. Those who have had a wide experience in the operation of electric railways and are familiar with the extremely high temperatures momentarily obtained under certain conditions, will appreciate the importance of this good feature of the direct-current motors.

If direct-current motors were so designed that short-circuit between two turns, due to overheating or other conditions, would immediately disable the motor so that it could not be operated, then it would be necessary to very considerably increase the dimensions of such apparatus in order to get emergency capacity. It will at once be appreciated that the alternating-current motor, with an active voltage between field turns, must be designed to stand heavy overloads without danger of short circuits between field turns. Therefore, either these motors must be designed with more margin of temperature than the direct-current practice, or the windings used must be such as will permit of more perfect insulation between turns than is used in direct-current practice. If such motors are wound for voltages corresponding to direct-current railway practice, then there is a greater danger from short circuits in the field than with direct-current motors, and if the motors themselves are wound for comparatively high voltages—say 3000 volts, for instance—then the danger from this source is very considerably increased, for with a 3000-volt motor a large number of comparatively small wires must be used in each coil, and these must be well insulated from each other, and the entire winding must be well insulated from the ground. Experience with alternating-current, high-voltage stationary motors has shown that such motors are not nearly as safe as those wound for 200 volts or 400 volts, and we believe that for motors under a car, subjected to the extreme variations of traction service, the danger from short circuits and grounds will be very much greater than in the case of stationary motors. If such traction motors are wound for low voltages, say 200 volts approximately, then heavy conductors and but a very small number of turns will be necessary on the field, and each conductor can be separately insulated both from other conductors and the ground. Therefore, the alternating current permits the use of a low-voltage motor, with the consequent advantageous construction of field coils where the conditions of operation in direct-current practice prevent the use of any lower voltage on the motors than that supplied by the line. Troubles from oil and dirt, such as frequently occur with direct-current motors, will become of great importance in alternating-current railway motors wound for very high voltages. We believe that, except for very special cases, it will be found safer to step down the voltage on the car by a transformer, thus supplying the motors with low voltage from the secondary circuit rather than to wind each motor so that it becomes a transformer subjected directly to the high voltage of the system. In cross-country work, where high voltage would preferably be used, the step-down transformer method also furnishes additional protection from lightning, as it is well known that it is easier to insulate one transformer from lightning than to insulate two or four motors. The question of safety to the passengers and apparatus in the car must be considered in this matter.

A large number of estimates have been made comparing the general performance, cost, etc., of equipping roads with single-phase alternating-current motors, instead of direct-current motors, supplied from rotary converter sub-station. In all these cases the advantage has appeared decidedly in favor of single-phase, except in a small number of cases where some small limiting condition was placed upon the alternating-current system. If the starts are very infrequent and the running periods long, then the gain in efficiency by elimination of the rheostatic losses at start may be more than compensated for by the slightly lower efficiency of the motors themselves. Where such conditions apply, generally high trolley voltage will be used, and there will be enough gain in efficiency in the transmission and distributing to more than balance the loss in the equipment. Furthermore, the elimination of the rotary converters will furnish a still further gain in efficiency. In estimates made up to the present time, we have in practically all cases found higher total efficiency for the single-phase railway than for the direct-current railway with sub-stations. In cross-country work the gain in the transmission and distributing system and the rotary converters compensates for other losses. In city work where starts are very frequent and low speeds necessary at times, the gain by elimination of the rheostatic control has appeared as a very important item in the efficiency.

It thus appears that, while suburban work was once thought to be the most important field for the single-phase railway, it has now become evident that city work, where traffic is very congested in parts of the system, will prove to be one of the best fields for this system. Of course, it is recognized that for heavy railroad service, where all kinds of speeds should be obtained economically, the single-phase railway system will undoubtedly show to great advantage compared with any known direct-current system. But as considerable time will be required to equip any railroad service, it is probable that the single-phase railway system will be well tried out before there is a good opportunity to give it a thorough trial for heavy work. There is no difficulty in designing single-phase motors for sizes up to 300 hp or larger, and of sufficiently small dimensions to be used with a single reduction gear on locomotives. There is also no difficulty in designing regulating devices for controlling the power of such motors. For example, a 600-kw induction regulator manufactured by the General Electric Company has been in commercial operation at Niagara Falls for many years, and a regulator of this capacity would be sufficient to control a 2400-hp locomotive. The induction regulator furnishes an ideal method for locomotive control, as the voltage supplied to the motors can be varied over a wide range without making or breaking the circuit.

In conclusion, we would say that the subject of the commutator type of motor is now being thoroughly studied by engineers in all the principal manufacturing companies in the world, and there is no longer any question that such motors can be built successfully for commercial service. When it is once shown that such motors are feasible and that, therefore, a new field of development is opened, there is immediately a willingness on the part of most of the manufacturing concerns to undertake the perfection of such apparatus. What is needed in any line of development is a promise of success, and it may be taken as true that success will then be obtained.

DOUBLE-TRACK CURVES FOR SINGLE TRACK ROADS

The Appleyard syndicate has adopted the practice of laying double tracks on practically all of the curves of its single-track roads. This precaution makes head-on collisions practically impossible, as with high-power headlights the danger of head-on collisions on a straight track is almost negligible. The installation of double track on all curves is comparatively inexpensive, as these lines are, for the most part, built on their own right of way. Great attention is also paid toward eliminating curves as far as possible and toward constructing the lines so that they will contitute the shortest distance between the different points. The practice of constructing double-track curves mentioned is probably unique, and is of interest to all operators of single-track high-speed lines.

THE COST OF PILOTS ON INTERURBAN CARS

The interurban cars of the Muncie, Hartford & Fort Wayne Railway have all been equipped with pilots or cow-catchers, which were made in the companies' shops. H. J. Lake, master mechanic, gives the cost of these pilots, including all labor and material, as $17.09 each. This includes, also, putting on and painting.

GAS-POWER FOR CENTRAL STATIONS *

BY J R. BIBBINS

It is intended in the following to offer testimony upon four contentions, viz.:

(A) That present gas-power machinery is suitable for central-station service.

(B) That a well-equipped gas-power electric plant can operate with far better economy than a steam plant under similar conditions.

(C) That its operation is much simpler and requires less running expense for the same results.

(D) That gas works, laboring under low load or output-factor, can profitably install a gas-power electric generating station, and become its own largest customer, selling both gas and electricity at competitive rates.

The basis of this paper consists of data collected from various electric light and power plants in the United States, using gas engines as their principal motive power. A number of these plants being operated in connection with illuminating-gas works, it has been possible to observe the somewhat unique position of the gas-engine station as a direct, though affiliated, competitor of the gas works.

Equipment.—Table 1 presents the most important data upon the general equipment and service rendered by the first twelve plants considered. The identity of the exhibitors is withheld, in most cases by request, thus making available more complete and valuable data. These plants are located in centers ranging from 2,000 to 20,000 inhabitants, and, in most cases, where the cost of fuel is high. The equipments average about 315 brake horse-power capacity and operate every standard form of generator for arc and incandescent lighting and for railway or general power service. All the generators are belted, the majority directly, but a few through the medium of a jack-shaft, the latter arrangement being employed in order to obtain the desired flexibility of service without installing a number of engines of small size.

Plants 13 to 15 are somewhat larger and generate polyphase power for industrial works. These three plants average approximately 570 brake horse-power, and the units are all direct-connected and run in parallel. Operative results have been obtained from plants 1 to 11, inclusive, the first and last furnishing excellent data upon the comparative economy of the present gas engines and the steam engines which were replaced.

In general, the character of electrical equipment is not all that could be desired for furnishing results of great accuracy; but owing to the more or less uncertain calorific value of the fuel gas used, errors of a few per cent in particular cases will not have much effect upon the general result. In any event, the average cost of power charged against the station is the desired figure.

Service Requirements.—In considering the subject in hand from an unbiased standpoint, it is important to enumerate the qualifications imposed upon the gas engine, in order to determine its actual merits.

1. Continuity of service at any cost.
2. Simplicity of operation, conducing to the above and securing low cost of attendance.
3. Reasonable cost of equipment.
4. Economy of fuel and supplies.

A 65-hp, two-cylinder vertical engine of the type employed in the plants here considered, and operating a fan blower, has run 8230 hours out of 8472 hours, and of the 3 per cent time in which the engine was not in operation only 43 hours, or 0.6 per cent of the total time, was attributable to the machine, being for changing igniters and taking up bearings.

* Abstract of paper presented at a meeting of the American Institute of Electrical Engineers, New York, Dec. 18, 1903.

During this period the engine ran, without stopping, 1157 hours, and was then shut down to repair a broken belt.

In a pumping station located on the Allegheny, a short distance from Pittsburg, five 85-hp engines of the same type operate regularly at full load through the week without stopping, except on Sunday, when the units are shut down in rotation for inspection and repair. Each engine operates from 96 to 98 per cent of elapsed time. It is needless to state that such service would not be required in central stations, as reserve capacity should be available for use during peak loads. In the present exhibit, the majority of the plants operate from 18 to 22 hours per day, giving ample time for inspection and repair, even if no reserve capacity were provided.

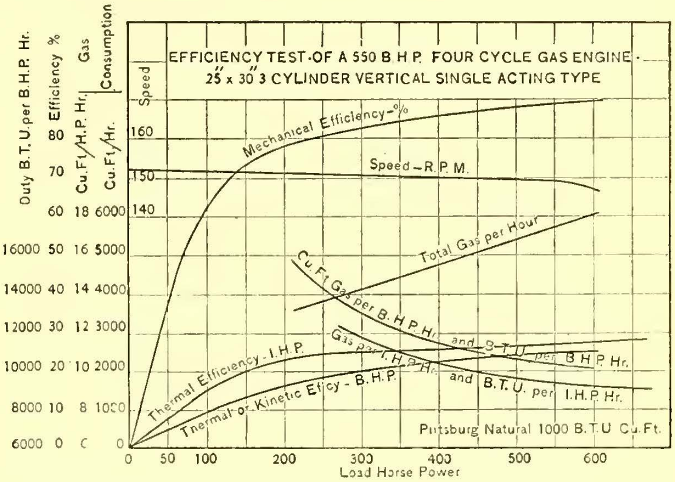


FIG. 1.—RESULTS OF EFFICIENCY TEST OF 550-HP GAS ENGINE

The skill required for operating a gas plant is apparently no greater than for steam plant. In several instances where the latter have been replaced, the old employees have been retained. In newly-established plants steam engineers have invariably taken charge after short preliminary instruction from the builders' erecting engineer.

In plant No. 11, weekly inspection of bearings, igniters and valves were at first carried out. This was found to be unnecessarily frequent, and is now done once a month. The cylinders are inspected occasionally throughout the year. This plant, 800-hp capacity, is operated by three day men and one night man, ten hours to a shift.

In cost, the gas-engine equipment is quite comparable with that of a steam plant. The engine itself costs more than a steam engine of corresponding size, on account of the increase in metal required by the higher pressures dealt with. With the cost of condensing machinery charged to the steam engine, however, this disparity is much reduced. With natural, or illuminating-gas supply available, the equipment cost would fall considerably below that of a steam equipment of boilers, engines, condensers, heaters, pumps, etc. In the case of a producer-gas plant installed to supply the gas engines, the cost of the respective equipments, each of 1000-hp is at a parity, although depending somewhat upon the gas-storage capacity provided. This, however, amounts to much less than electric storage. For producer gas the former costs in the neighborhood of $7.35 per hp-hour and the latter $100.[1] Considering the increase in productiveness of labor, which is stated by a prominent gas engineer to be fully 100 per cent (owing to the fact that one man can handle twice the amount of coal), the advantage, if any, held by the steam plant disappears.

In economy of fuel, the gas engine admittedly has no rival. The present limit of steam-engine practice is 10 lbs. water per ihp, or 11 lbs., per bhp. With an evaporation of 10 lbs. of water per lb. of good coal (14,000 B. T. U. per lb.) a performance of 1.1 lbs. coal, or 15,400 B. T. U., per bhp is realized. The gas

[1] $100 per M cu. ft.

engine at present delivers, at full load, a bhp upon 10.5 ft. to 11 ft. of gas (of 900 to 1000 B. T. U. per cu. ft., calorific value) which is equivalent to 10,000 to 11,000 B. T. U. per bhp; Fig. 1 shows a typical test-log upon a 550-hp engine of the three-

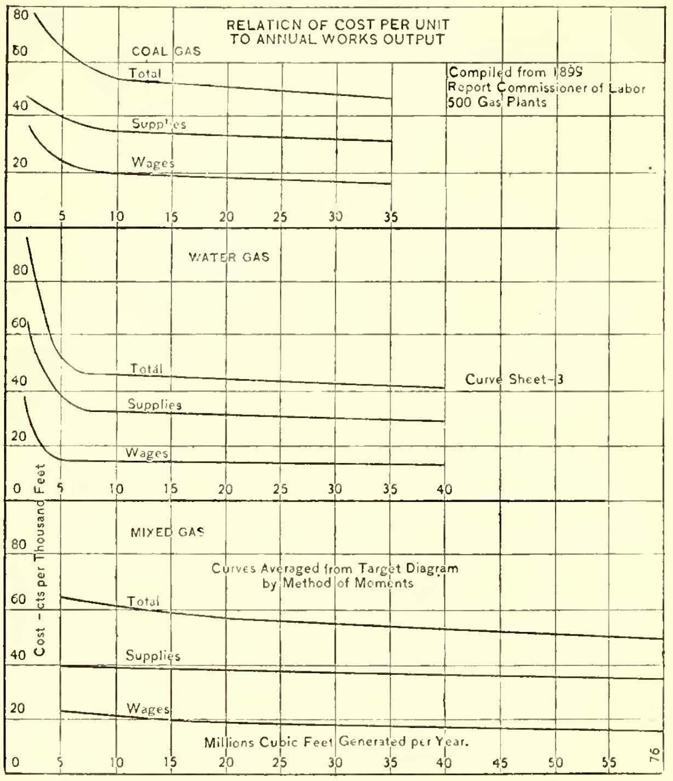


FIG. 2.—RELATION OF COST PER UNIT TO ANNUAL OUTPUT

cylinder vertical type, employing the four-stroke cycle. The thermal efficiency shown is the true or "kinetic" efficiency, viz.:

$$\frac{\text{Output}}{\text{Input}} = \frac{\text{B. T. U.: equivalent of work done}}{\text{B. T. U.: value of gas}}$$

At full load this appear at 25 per cent, considering the comparative remoteness of the theoretical limit of gas-engine efficiency, and the fact that the theoretical efficiency of a steam engine working between the usual units of 150 lbs. boiler, and 3 lbs. condenser pressure, has already been exceeded, there appears to be an encouraging future for internal combustion motors.

Advantages.—The advantages of the gas engine for central stations may be summarized thus:

1. Minimum fuel and heat consumption.
2. Light load efficiency higher than steam engine of corresponding size.
3. Low cost of operation and maintenance.
4. Simplification of equipment.
5. Small number of auxiliaries required.
6. Absence of "standby" losses.
7. Quick starting.
8. Waste heat in jacket-water suitable for building heating.
9. Ease of extending equipment.
10. Absence of high pressure, except in engine cylinder. No danger from explosion outside, as a mixture of proper proportions is required.
11. Power can be stored during light loads at small cost in the form of gas in holder.
12. Sub-division of units more easily accomplished, yielding higher all-day economy.

An important source of economy in gas plants is the fact that as soon as an engine is shut down all heat losses cease. Also, during operation no heat is lost by the gas in transit from the producer, and the plant is not hampered by inefficient auxiliaries such as steam pumps, condensers, return traps, etc., all of which largely increase the general complexity of the system. Steam-pipe and cylinder condensation losses, radiation, leakage in piping and fuel loss in banking fires have no parallel in the gas plant. The only auxiliaries required are the igniter generators and air compressors. The former are negligible as affecting the economy of the station, and the latter operate at full capacity at regular intervals. In cases where artesian wells supply jacket-water, a pump is, of course, required preferably operated by a motor or small gas engine, to which the air compressor may also be belted.

In quick starting, the gas engine fulfils every requirement. The 280-hp pumping units of the Philadelphia high-pressure fire system have been repeatedly started cold, brought up to speed and the pumps loaded to the required pressure (300 lbs. per sq. in.) within a period of 40 seconds from the starting signal.

A number of plants make use of hot jacket-water for heating buildings, ordinary cast-iron or coil-pipe-radiators being used for this purpose. One station partly supplies a municipal heating system resembling Yaryan, thereby deriving direct revenue from a waste product. Part of the return water is sent again through the jackets, the temperature being lowered to the proper degree by adding fresh water from the station supply main.

In the matter of parallel operation of alternating-current generators, plants 13, 14 and 15 have been distinctly successful, particularly in view of the variable character of load incidental to large industrial works operated by induction motors. All the units are of the direct-connected type with standard flywheels. A spring-coupling provides a flexible connection between engine and generator, to absorb cyclical speed variations. The usual copper dampers on the pole pieces assist in preventing hunting. In general, a low frequency seems to be desirable, with high peripheral speed and moderate reactance in the generator to assist in damping current fluctuations. The suddenness of the impulse in a gas engine cylinder offers, to be sure, greater difficulties than in the case of a steam engine, but the remedy has apparently been found.

Fuel Gas.—Several distinct fuel gases, suitable for gas engine use are available. When reduced to calorific values per foot of

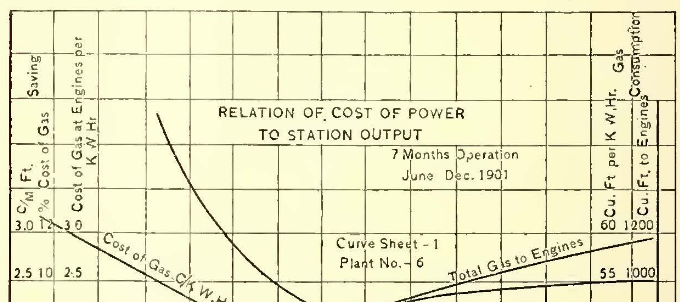


FIG. 3.—RELATION OF COST OF POWER TO OUTPUT IN PLANT NO. 6

explosive mixture of proper constituency, the ratings are nearly equal.

	Approximate B. T.U. per cu. ft. Gas.	Mixture.
1. Natural gas	1000	91.0
2. Coal gas	650	91.7
3. Water gas	300	88.0
4. Carburetted water gas	600	92.0
5. Producer gas	120 to 145	60 to 68
6. Coke-oven gas	600	90.0
7. Blast-furnace gas	90	53.0

The power to be developed by an engine of given proportions does not therefore vary within appreciable limits, except on producer gas and blast-furnace gases, when larger engines are required, or larger cylinders on the same engine frames. The rate of combustion is, however, less rapid with these than with other gases, due to the large amount of inert gases, such as N and CO_2 present in the mixture. The compression may also be carried much higher without risk of pre-ignition or "back-

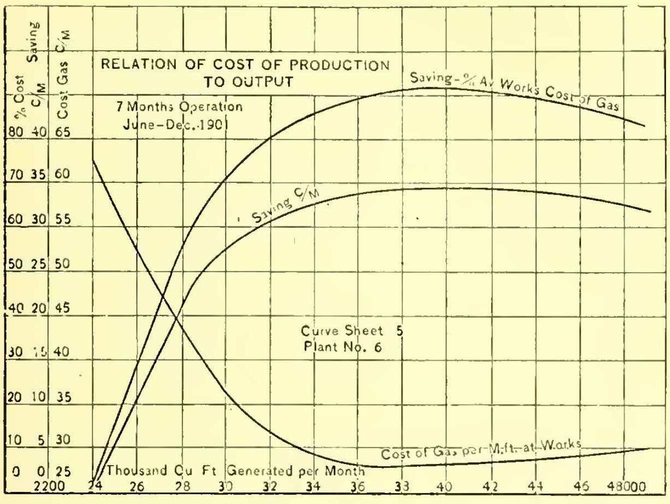


FIG. 4.—RELATION OF COST OF PRODUCTION TO OUTPUT IN PLANT NO. 6

firing," thus increasing the efficiency of the cycle. With water gas the high percentage of hydrogen occasions quicker combustion and higher flame temperatures with so considerable a tendency to pre-ignition and back-firing that this gas is not well adapted to gas-engine work.

Water gas can be used to great advantage for power purposes, however, by mixing with the air or blast furnace gas made during the period when the producers are under blast.

A comparison of the approximate thermal efficiencies of the various processes gives the following results:

Coal gas (without coke)	24%
Coal gas (with coke)	60%
Water gas	60%
Water gas, special quick-blast	75 to 80%
Producer gas	80 to 85%

Assuming the calorific value of coal as 14,000 B. T. U. per pound and the efficiency of the gas-making process 80 per cent, the heat available at the engine is 11,250 B. T. U., which is equivalent to about 1 bhp. This duty, 1 bhp per pound of coal, should, therefore, be expected from a well-equipped gas power plant.

Station Economy.—Returning to the consideration of the plants under exhibit, the average station economy observed is shown in Table 2. Although in some cases "over-dynamoed," the engines are generally underloaded and frequently so much so that good economy could hardly be expected. The average gas consumption per kilowatt-hour is 39.0 cu. ft. Assuming an average calorific value of 625 B. T. U. per foot for coal gas, water gas, or mixed gas, the heat consumption is 24,400 B. T. U. per kilowatt-hour, 18,200 B. T. U. per ehp-hour, and 14,500 B. T. U. per brake horse-power-hour. The average cost of gas charged to the engine is 33.9c/M, which is in nearly all cases considerably above the cost in the holder to companies operating both plants, with the result that the gas works realizes a handsome profit from the electric station in addition to the decrease in cost per unit with increased production. Assuming an average production cost of 20c/M, the average cost of power is 0.83c. per kilowatt-hour, equivalent to .0495c. per brake horse-power-hour at 80 per cent combined efficiency.

The comparative cost of steam and gas power is well shown in Tables III and IV. In Table III two independent stations were operated during 1902, together with the gas works. The cost of coal in the steam plant was 1.38 cents per kilowatt-hour, against 0.75 cents per kilowatt-hour in the gas plant, representing a saving of 45.5 per cent. although the cost per thousand B. T. U. of gas was 3.4 times that per thousand B. T. U. of coal. Assuming calorific values of 14,000 and 625 B. T. U. per pound and cubic feet, respectively, 92,000 B. T. U. were required per kilowatt-hour in the steam station, against 29,100 in the gas station, or a saving in the latter of 68½ per cent.

In Table IV the general balance of economy is on the side of the gas station. The steam plant started operation on natural gas at 10 cents per thousand, with a minimum of $3,000 per year. It employed boilers fired by gas. One year after starting the gas plant this minimum was reached, and the company is now paying at the rate of over 16 cents per thousand feet. The saving in total operating cost amounted to 40.5 per cent. In the face of a 30 per cent increase in station output the gas consumption has been reduced by 93 per cent.

Combined Gas and Electric Stations.—The theory of increase of profits from the operation of combined gas and electric plants is based upon the fundamental principle of reduction in cost per unit with increased output. Fig. 2 shows the cost of coal gas, water gas and mixed gas for approximately 500 gas plants in the United States, taken from the report of the Com-

TABLE I.—GAS-POWER PLANT EQUIPMENT

Plant No.	Engines: Rated Capacity Full Load BHP	Engines: No.	Engines: BHP	Transmission: Character	Transmission: Efficiency	Generators: Incandescent Power	Generators: Railway	Generators: Arc	Total kw Generating Capacity	BHP Gen. ÷ BHP Eng.
1	685	3	125-280	Belt	82.5	1-φ	550V.D.C.	----	370	.845 (a)
2	170	2	85	"	80	--	------	230 lts.	112	1.00 (b)
3	110	2	55-	Jack-shaft	75	2-.	------	----	75	1.2
4	90	2	35-55	Belt	80	1-.	------	----	40	0.93
5	320	4	55-125	Jack-shaft	75	3-.	------	60 lts	232	1.18 (c)
6	340	4	55-125	"	75	2-.	------	----	215	1.14
7	305	3	55-125	Belt	82.5	1-.	------	----	260	1.38
8	280	1	280	"	80	1-.	------	50 lts.	152	0.91
9	...	2	55-85	"	--	1-.	------	----	----	----
10	85	1	55	"	80	1-.	------	----	60	1.17
11	803	6(x)	125-210	"	82.5	1-.	------	200 lts.	476	0.97 (d)
12	255	3	85	"	80	2-.	------	----	116	6.78 (e)
Av.	314									
13	375	3	125	Direct-con'ct d	85	2-.	------	----	75	0.94 (f)
14	491	4	125	"	85	2-.	------	----	75	0.96 (f)
15	840	3	280	"	85	2-.	------	----	150	.85 (f)
Av.	568									

(a) Largely railway load—running 15-18 hrs. per day.
(b) Exclusively arc.
(c) Monocyclic system—runs 24 hrs. per day.
(d) Plants operate 24 hrs. per day—Natural gas.
(e) Natural gas.
(f) Operates in parallel—Natural gas.
(x) 8-hp engine belted to air-compressor and pump.

TABLE II.—COST OF OPERATION, FUEL ONLY.

Plant Number	Character of Load	Kind of Gas	Per Cent of Total Gas Gen., Used for Engs.	Manufacturing Cost Gas	Cost Charged to Engines	Gas per Kw-h. at Switchboard	Cost per Kw.: Gas Only	Cost per Kw.: Per Cent Steam Stat'n	Remarks
				c/m	c/m	ft.	c.	%	
1	Railway	Mixed	54	18	37.57	43.75	1 65	--	Av. 6 mos.
						28.40	1.07	81.	All day run
					at 18	46.57	0 84	63.5	Gas at cost
2	Arc.	Coal	--	18	18	33.64	0.61	24.5	Av. 4½ mos.
3	Incan.	Coal	31	..	62	53.2	3.3	--	Av 6 mos. '02
4	"	Water	30	--	59.3	41.6	2.46	--	Av. 20 mos. 1901-1902
5	Arc, and Incan.	Mixed	37.5	..	34.6	----	--	--	Output not metered
6	Incan.	Coal	26	..	39.8	48.4	1.93	--	Av. 9 mos. '02
8	"	Coal	5	19	33	28.5	0.94	--	Night run 65% rating
9	"	Mixed	19.5	--	29.5	41.7	1.22	--	Av. 6 mos.'02
10	"	Coal	15.0	--	20	41.9	0.98	--	Av. 19 days Aug. 1902
11	Incan. and Arc.	Natural	100	10	15.0	12.4	0.18	--	Special test
				10	16.0	21.5	0.34	26	Av. 6 mos.
Aveage					33.9	30.0	1.4		

Average cost per kw-h. at 20c., gas (excluding No. 11) .875c.
" cu. ft. gas per kw-h 38.17

mission of Labor on Gas and Electric Plants for 1899. The curves bring out the following points:

1. Cost per unit decreases as output increases, most rapidly in coal gas plant and less rapidly in water gas plants.

2. Decrease in cost per unit in small plants of 2,000,000 to 10,000,000 per year output is very marked, being greatest in water gas plants and least in mixed gas plants.

3. The greatest opportunity for increasing revenue from combined gas and electric stations appears to be in the case of small coal and water gas plants under 10,000,000 output. The smaller the plant the greater the profit.

Fig. 3 is a diagram taken from the results obtained in plant No. 6, and represents the saving due to increased production, part of which is traceable to the electric plant and part to consumers. In this plant a saving of 24 per cent was realized, and in plant No. 9 the remarkable amount of 92 per cent of initial works-cost.

In order to bring out clearly the character of this saving, due to increased production, the following case has been estimated along the lines already discussed and indicated from the results obtained from stations in operations: A 10,000,000-ft. plant has been taken generating gas at 40 cents per thousand, works-cost, including coal, bench fuel, labor, repairs and miscellaneous material, residuals not deducted. Fixed charges have purposely been omitted. The gas is charged at works-cost to the electric station. It is assumed that the cost of gas for this plant, previous to absorption of the electric plant, was 50 cents per thousand, and that the electric plant generates electricity at twice the fuel cost, 3.2 cents per kilowatt-hour. During normal operation with an output to the electric plant of 30 per cent of the total amount of gas generated, the total net revenue of the combined works was about $13,300; 45 per cent of which was due to the electric station and 55 per cent to the gas station. The operating costs will then amount to 46.4 per cent of the net revenue.

Comparing the operations of the gas station per se, previous to and following the acquisition of the electric station, there is a net revenue of $5,835 and $7,344 respectively, or an increase of $1,509; 25.8 per cent of the original revenue. Figuring in the saving of 10 per cent per thousand, due to increased production, the total increase amounts to 43 per cent of the net revenue upon the original gas station.

Considering, finally, the combined works, the increase is $7,449, or 127 per cent of the original revenue, and adding again the saving 10 cents per thousand, the total increase is 145 per cent of the revenue of the original gas works.

Although these percentages will be considerably reduced by the consideration of investment charges, depreciation, sinking fund, etc., the fact remains that the saving due to combined operation is material and should appeal particularly to companies operating independent gas and electric generating stations.

TABLE III.—COMPARATIVE OPERATING ECONOMY.—PLANT NO. 1

	Steam Station 1250 IHP. Averages for 6 mos., April-Sept. Load, Railway, Incandescent, Arc. 1901.	1902.	Gas Station 685 BHP. Average for 6 mos., May-Sept. Load, Railway	
Kw-hour per mo	......	122733	Kw-hour per mo	39508
Lbs. coal	761058	802507	Cu. ft. gas	1726400
Per cent ash	8.2	7.7		
Lbs. coal per kw-hour	......	6 52	Cu. ft. gas per kw-hour	43.75
Cost coal per ton, f. o. b	......	4.02	Gas charged per M ft.	37.67c.
Handling	......	.19	Price gas per kw-h	1.65c.
Total	......	4.21	Cost gas, actu l	17.2c.
Cost coal per kw-hour;	......	1.375	Actual cost kw-hour	0.75c.
			Per cent saving cost per kw-hour	45.5%
Cost per M.B.T.U	.00091	......	Cost per M.B.T.U	.036c.
Watt-hours per lb. coal—A.M	138.20	134.65	Watt-hours cu. ft. gas—A.M	24.33
Ditto—P. M	164.40	166.02	Ditto—P. M	21.40
Ditto—24 hours	159.97	159.08	Ditto—24 hours	22.23
B.T U. per lb., estimated	14000	14009	B.T U. per cu. ft., est	625
Watt-hours per M	......	11.35	Watt-hours per M	......
B.T.U. 24 hours	......	......	B.T.U.—24 hours	35.6
B.T.U. per kw-hour	......	92000	B.T.U. per kw hour	29100
B.T.U. per E.P.H. hour	......	68600	B.T U. per E.H.P.	21700
B.T.U. per B.H.P. hour at 80%	......	55000	Per B.H.P. at 85%	18400
			Per cent saving heat	66.5%

SPECIAL TEST, GAS STATION

All Day Run:		Five-Hour Run:	
Max. Watt-hrs per cu. ft gas	35.3	Max. Watt-hour per cu. ft	40.9
Cu. ft. gas per kw-hour	28.40	Cu. ft. gas per kw-hour	25 0
" " " " E.H.P. hour	21.20	" " " " E.H.P hour	18.6
(1) " " " " B H.P. "	18.02	" " " " B.H.P. "	16 65
(2) B.T.U, per B.H.P	11250	B T.U. per B H P	10400

Note.—Both plants run 15 to 18 hours per day. Gas plant started April 1, 1902. Steam station consists of compound condensing engines and water tube boilers. Average load factor of steam station higher than gas station.

TABLE NO. IV.—COMPARATIVE COST OPERATION STEAM ENGINES VS. GAS ENGINES ON NATURAL GAS.—PLANT NO. 11.

Year.	Gas ft.	Labor.	Repairs.	Oil and Waste.	Total.	Remarks.
		Steam	Plant.	Gas Fire	d Boilers.	575 IHP = 490 BHP. Gas rate, 10c. per M-ft., minimum reached in 1900. Avg. 1902 15.9 c/m.
1897	9753.20	9725.26	600 00	1485.06	......	
1898	9320.70	8258.33	400.60	306.14	19924.34	
		Gas	Engine	Plant.		800 BHP Increase Revenue.
1899	6318.92	6828.74	239.85	533.56	......	1897 % ; 1898 5.75
1900	3000.40	6782.01	499.09	592.92	......	1899 7.5 ; 1900 11.0
1901	3000.00	7678.83	196.90	407.01	......	1901 13.5 ; 1902 18.5
1902	3000.00	7626 67	261.04	379.70	......	
					11836.41	Increased load 1898-1902, —30%

Saving .... $087.93 = 40.5 per cent.

Operating cost { Steam . $36.40 per year per hp. capacity of station.
{ Gas .... 14.80 " " " "

Saving $21.60=59.4%

ECONOMY TESTS

Steam station
1898—24 hours
Gas per IHP-hour .... 51.09 ft.
" kw-hour .... 86 "

Gas station
Gas per kw-hour, av. 6 mo., 21.50 cu. ft.
Calorific value gas, 1175 BTUc/u. ft.

THE EVOLUTION OF THE ELECTRIC RAILWAY MOTOR*

BY S. T. DODD

The early investigators of the electric railway problem, Edison, Field and others, made the mistake of attacking it from the locomotive standpoint, and, consequently, their efforts contributed little or nothing to the solution of the problem. The first electric car to be driven by a motor placed under the car floor was put into operation in 1884 in Cleveland, Ohio, by the Bentley-Knight Company. A Brush arc machine was used as generator, and a machine of the same type was used as motor, the latter being connected to the car wheels by a wire rope drive. The Brush type of machine later proved itself eminently unfitted for this service, but, at that period, it was the only successful high-voltage machine, and it was believed that in this type lay the promise of the coming long-distance transmission of power. This combination of Brush machines worked reasonably satisfactorily when there was but one car on the line, but when other cars were added the generator behaved very badly, as was inevitable, since the attempt was being made to run the motors in parallel from a constant-current machine. Troubles were experienced with the wire rope drive which was first used, and bevel gearing was substituted with the conduit. The experiments on this road made it evident that further developments must be along one of two directions. Either the current must be supplied to the cars at a constant potential, or the motors along the line must be operated in series. The Bentley-Knight Company followed the former of these alternatives in its later work. It is interesting to note, however, that these experiments were made with series-wound motors, while other companies, before and after, were experimenting with compound wound or shunt motors.

In 1885 and 1886 various experiments were made by Messrs. Daft, Sprague, Van Depoele and Short. It is noteworthy that in Mr. Sprague's equipment of this period one end of the motor was supported directly on the axle, while the armature was connected to the axle by single-reduction gearing. Mr. Short

* Abstract of paper read Dec. 16 before New York Electrical Society.

attempted to develop a series railway system, and built a road in Denver which was abandoned. To Mr. Short should be given the credit of recognizing the value of the series-wound motor, as demonstrated by the earlier Bentley-Knight experiments, but not used by other designers of this time; also of seeing that for motors of the normal speed of that date, double-reduction spur gearing should be used. He built a conduit-series road in Denver in 1886, and overhead roads on the same system in Columbus, Ohio, and Huntington, W. Va., in that or the following year. The multiplicity of contacts required, however, prevented the success of the series system of distribution. By 1887 or 1888 both the Bentley-Knight and the Sprague companies had developed bipolar series-wound motors especially for railway service. The Bentley-Knight Company was using a rheostatic control, while Sprague employed commutated fields for securing a variation in speed. Sprague used also inside-hung motors, while the Bentley-Knight motors were outside hung. It was about this time also that public attention began to be attracted to the work, largely through the successful operation of Sprague's Richmond road.

The years 1888 and 1889 were very eventful; the Sprague and Edison interests consolidated, the Bentley-Knight and Van Depoele interests were acquired by the Thomson-Houston Company, and there appeared on the market a Westinghouse double-reduction motor and a Short double-reduction motor. We might say that the standard railway motor at this date was bipolar, running at a normal speed of 1000 to 1500 r. p. m. It was connected to the axle by double-reduction gearing. It was series wound, and with the exception of the motor of Sidney Short, who, by this time, had abandoned his series distribution system, was of the smooth core drum type. The high speed of these motors was a serious disadvantage. The railway managers were bitterly complaining of the expense of maintaining gears and pinions. It was seen that the electric railway motor could not be a final and permanent success until some method was found of obviating this difficulty.

The Wenstrom motor of 1890 offered the solution of this difficulty. Although this motor never attained any commercial importance, it had two marked characteristics which affected the future development of the motor. It had four poles, and, like Short's motor, was designed with slotted armature, thereby making possible the reduction of motor speed and the change to the single reduction type of motor. All of the manufacturing companies were quick to appreciate the value of these features, and it appeared on the market soon thereafter with single-reduction motors. The Westinghouse Company then introduced what might be called the first of our modern motors, its No. 3, which, with the minor modifications introduced in the No. 12 and No. 38, remains to-day the standard Westinghouse type. As is apt to happen, two of the companies went to the other extreme of bringing out gearless motors. The objection to the gearless motor of that date was its weight, its rigidity, its inaccessibility and the fact that it was not adaptable to various speeds.

The Thomson-Houston W P motor of 1892 and the General Electric 800-motor of 1893, were attempts to make an absolutely enclosed and waterproof motor. With the appearance of the enclosed motor a new problem was introduced; namely, ventilation, a factor which had previously received but little attention, and which even to-day is not always given the consideration which its importance deserves. This motor is noticeable from its use of the Eickemeyer interchangeable coil. In 1894 appeared the General Electric 1000, wherein they followed the lead of the Westinghouse No. 3, and had four poles, abandoning the consequent pole design. This motor used the straight-out or barrel winding, which has since become standard in motor armatures. In 1895 the Walker Company brought out its No. 3, which marked a decided advance, in that better provision was made for ventilation than in any previous type of motor. In 1899 the Westinghouse No. 38 introduced laminated poles. In 1896 there was a change in the character of the service demanded of railway equipments, brought about by the beginning of interurban roads and by the extension of city roads into the suburban districts, the new conditions calling for continuous service at moderate loads. In order to meet the new requirements the General Electric Company brought out its No. 52, the feature of which was the ventilated armature, which has since become standard. The Walker 15-L, a 100-hp motor which was built for the Brooklyn Elevated, and the General Electric No. 51 illustrate the limitation imposed upon motors of the standard type when built in large sizes. This limitation called for a change in motor construction, which was met by such motors as the General Electric No. 50, and particularly the General Electric No. 55, built for the Nantaskett Beach line and the Metropolitan & West Side Elevated. The latter had a solid box frame, with waste-packed bearings, from which the armature could be removed by sliding it out through one end. This type has since become popular for very heavy service.

The S. K. C. type of motor represents a still further development of the principle of motor ventilation. For the first time in a street railway motor, both ends of the armature are left open for the entrance of air into the armature, and there are ducts in the pole pieces and through the frame of the motor, which register with the ducts in the armature perpendicular to the shaft. As a result of this unusually good ventilation the all-day load of this motor is about 50 per cent of its hour rating (with the same heating), as compared with an all-day capacity of but 35 per cent of the hour rating for other motors of the same grade.

In the General Electric No. 74 motor is preserved the compactness of the General Electric No. 55, with the added advantage of increased accessibility of the armature. The General Electric No. 69 for the New York subway and the two makes of German motors used upon Berlin-Zossen line, are the most modern types of motors for heavy service, and in each of them it should be noted increased attention is being paid to ventilation. As is well known the Berlin-Zossen motors are alternating-current motors, and mark a reversion to the gearless type discarded ten years ago.

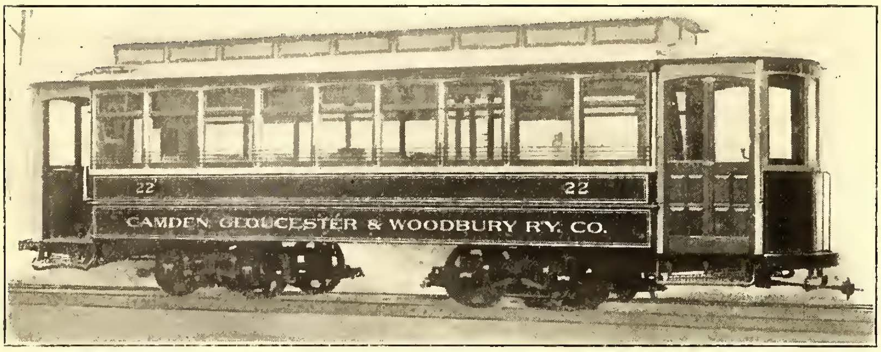
I have attempted to show you how our present type of motor grew from the stationary motor of twenty years ago. It is a series motor, a characteristic which was inherited from the Brush motor used by the Bentley-Knight people in 1884. It is hinged upon the axle and geared to it by spur gearing, for which we are indebted to Messrs. Sprague and Short in 1886; it is a multipolar motor, with slotted armature, which is derived from the Wenstrom motor of 1890; it has concentric fields, with salient poles, projecting inwardly from the surrounding case, and the armature is series-connected so that one pair of brushes suffice for a multipolar motor, characteristics which are derived from the Westinghouse No. 3 of 1891. It has machine-wound coils and a barrel armature, which are due to a development through the Westinghouse No. 3, the General Electric No. 800 and the Walker. It has laminated fields, which were introduced by the Westinghouse No. 38 in 1895; it has a ventilated armature, for which we are indebted to the General Electric No. 52 of 1896.

At the present time increased attention is being paid to disposing of the heated air from the interior of the motor and the ventilation of the motor for long-time service. This means that the motors of the future will have reduced weight of electrical parts, magnetic iron and conductors, and more attention will will be paid to the bearings, gears and other mechanical parts.

Considering the changes in motor design during the last twenty years, which I have sketched above, it would be idle to assert that we have yet reached a permanent standard type, or that new motors will not be produced from year to year, as new improvements are suggested and new problems confront us foi solution.

COMBINATION CARS FOR THE CAMDEN, GLOUCESTER & WOODBURY RAILWAY

The J. G. Brill Company, Philadelphia, has delivered four combination passenger and smoking cars of its patented semi-



COMBINATION PASSENGER AND SMOKING CAR USED BY THE CAMDEN, GLOUCESTER & WOODBURY RAILWAY COMPANY

convertible type to the Camden, Gloucester & Woodbury Railway Company, one of the systems controlled through the South Jersey Gas, Electric & Traction Company by the Public Service Corporation of New Jersey. The line is 25 miles in length, and reaches, among other popular resorts, Washington Park, much patronized by the people of Philadelphia and Camden.

The cars are divided into two compartments, the passenger compartment having 34-in. seats, placed transversely to the car, leaving the aisle 20¾ ins. wide; and longitudinal seats in the smoking compartment, making a total seating capacity of thirty-six. The interiors are handsomely finished in natural cherry, with bird's-eye maple ceilings. The partition between the compartments is of hardwood, with glass in the upper parts and a swinging door with 21¼-in. opening. Distance from floor to center of monitor deck is 8 ft. ½ in.; length of cars over end pieces, 26 ft. ⅛ in., and over vestibules, 36 ft. 4⅛ ins.; from panels over crown pieces, 5 ft. 2 ins.; length of smoking compartment, 8 ft. 8⅞ ins.; width over sills and panels, 7 ft. 11½ ins., and over posts at belt, 8 ft. 2 ins.; sweep of posts, 1¾ ins.; from center to center of posts, 2 ft. 10⅛ ins. The side sills are 4½ ins. x 7¾ ins., with sill plates on the inside 12 ins. x ⅜ in.; side posts are 2¼ ins, corner posts 3⅝ ins. The cars are equipped with radial draw-bars, ratchet brake handles, gongs, sand-boxes, angle-iron bumpers and other specialties of the builders' make. The trucks are Brill 27-G, with solid forged side frames, 33-in. wheels, 3¾-in. axles, and equipped with four 30-hp motors, per car.

HOT-WATER HEATERS IN SINGLE TRUCK CARS

The South Chicago City Railway Company is now installing hot-water heaters in a number of its single-truck cars. This is a rather unusual practice, as while hot-water heaters have been used extensively in interurban work, stoves and electric heaters have heretofore been principally relied on for use in short cars. A very small type of Peter Smith heater is being used for this purpose, and it is placed on the front platform, which is vestibuled.

The platform supports have been strengthened to provide for carrying this extra weight continuously. The cars in which these heaters are being placed have 20-ft. bodies, and are equipped with cross-seats. Heretofore, electric heaters have been used in them, but owing to the increased demand for power, it has been a question of installing more generating machinery for the winter peak load or substituting something else for the electric heaters, and the alternative chosen was the hot-water heater.

PORTABLE CAR TELEPHONES

Telephone manufacturing companies have apparently, in some cases, failed to realize the rough usage which a portable telephone instrument for use in despatching or for other purposes on an electric car must be able to stand. This has not been true, however, in the design of the new portable car telephone just put out by the Stromberg-Carlson Telephone Manufacturing Company, of Chicago. This instrument has all parts heavy to adapt it to the rough handling it is likely to receive. Convenience of operation and the conditions under which it will be used have also been taken into account.

Fig. 1 shows the telephone instrument complete, as it would be hung in the motorman's cab of an interurban car. Fig. 2 shows the instrument open, and Fig. 3 shows the portable part or instrument proper removed, as would be necessary it it were to be used away from the car or if an exchange of instruments were to be made. The top box contains the telephone transmitter, magneto for

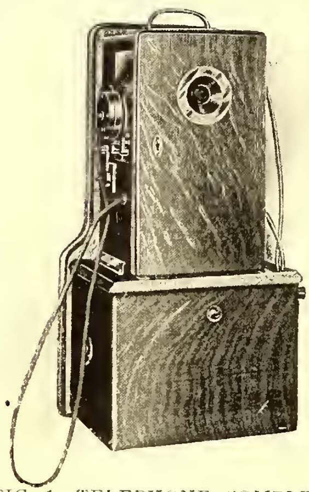


FIG. 1. TELEPHONE COMPLETE

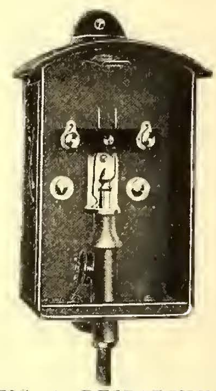


FIG. 4.—DESPATCHING PLUG BOX

calling and transmitter battery. The bottom box has a reel of flexible cord. When the upper or telephone box is in place it is connected to the cord in the reel in the bottom box through contact plates on top of the reel

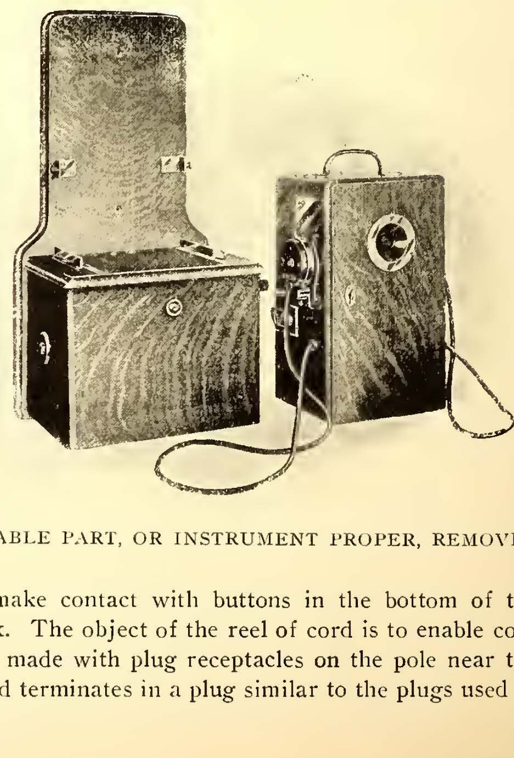


FIG. 3.—PORTABLE PART, OR INSTRUMENT PROPER, REMOVED

box, which make contact with buttons in the bottom of the telephone box. The object of the reel of cord is to enable connection to be made with plug receptacles on the pole near the car. The cord terminates in a plug similar to the plugs used in telephone exchange switchboard work. This plug, however, is much larger and heavier. There is a guide for the cord as it is wound onto the reel, and a crank on the outside of the reel box for winding up the cord. The receiver is of the watch-case type, and when not in use fits in a substantial receptacle, which operates like the usual receiver hook switch to cut out

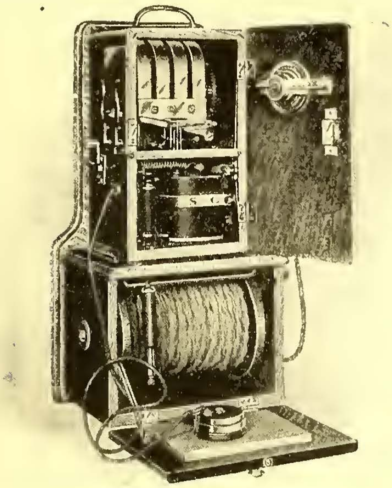
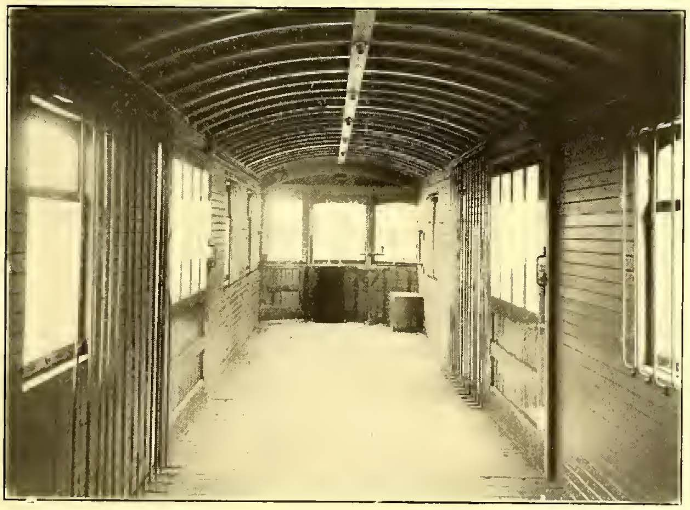


FIG. 2.—TELEPHONE OPEN

the transmitter when the instrument is not in use. The box is heavy and well put together, and all parts are securely fastened in it. The portable part of the instrument or telephone box has a plug and short cord attached to it, for use when the telephone is used on the line away from the car. Fig. 4 is the plug receptacle containing the jack, which is placed at the pole, and through which connection is made with the line.

ELECTRIC LOCOMOTIVE FOR BRAIDENTOWN, FLORIDA

The Manatee Light & Traction Company, of Braidentown, Fla., has received from the American Car Company, St. Louis, the car shown in the accompanying illustration, which is intended for carrying baggage and freight and is also to be used

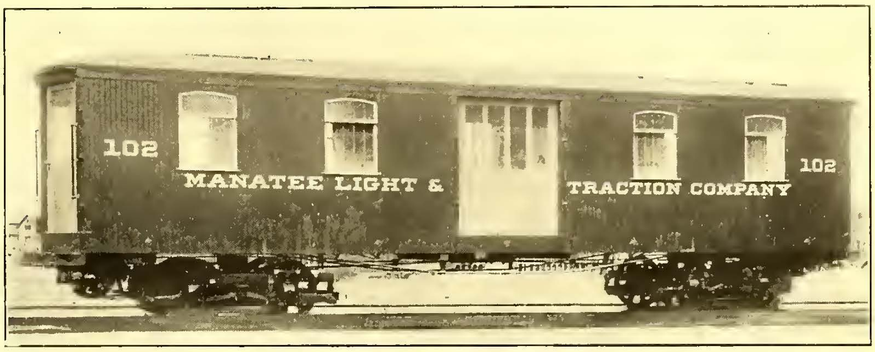


INTERIOR OF MANATEE FREIGHT CAR AND LOCOMOTIVE

as a locomotive. In the Street Railway Journal of May 30 a description was given of the Brill type of convertible cars built by the American Car Company for the Manatee Light & Traction Company, in which it was mentioned that Braidentown is an important shipping center for quite a large district, and is at the mouth of the Manatee River, on Tampa Bay.

The doors are placed at diagonally opposite corners of the car, to admit rails and long pieces of material, such as may be used in road construction. The floor is powerfully framed and trussed to carry heavy loads. The windows at the sides are arranged to be raised in the usual fashion; those in the ends have pockets in the wainscoting, into which they may be dropped.

The length of the car is 40 ft. over crown pieces, and width, including sheathing, is 8 ft. 4 ins. The side sills are 5¾ ins. x



ELECTRIC FREIGHT CAR AND LOCOMOTIVE FOR MANATEE LIGHT & TRACTION COMPANY

7⅞ ins., with sill plates on the inside 7 ins. x ⅝ in. The car is equipped with angle-iron bumpers, radial draw-bars, alarm gongs and sand-boxes of Brill manufacture. The trucks are Brill 27-G, with 4-ft. wheel base and 33-in. wheels, and are equipped with 38-hp motors.

ALTERNATING CURRENT FOR SIGNALING ON INTERURBAN ELECTRIC RAILWAYS

Upon invitation a party of railway signal experts, representatives of the technical press and others interested in the operation of suburban and interurban electric railways, visited Rochester, N. Y., last week, and was offered an opportunity of examining into the operation of the automatic block signaling system of S. Marsh Young, which is owned by the Pneumatic Signal Company, of that city. This, by the way, was the first public demonstration that has been made. The party included the following railway men:

C. W. Hotchkiss, president, Indiana Harbor Railroad Company.

J. M. Waldron, signal engineer, Interborough Rapid Transit Company.

R. G. Siegel, signal engineer, Brooklyn Rapid Transit Company.

H. H. Hillborn, electric department, Brooklyn Rapid Transit Company.

Azel Ames, signal engineer, Boston & Albany Railroad.

J. C. Irwin, signal engineer, New York Central & Hudson River Railroad.

J. S. Gillespie, superintendent, Albany & Hudson Railway.

Charles R. Barnes, engineer, New York State Railroad Commission.

George W. Aldrich, secretary, New York State Railroad Commission.

Fitzhugh Townsend, professor electrical engineering, Columbia University.

D. F. Carver, chief engineer, Public Service Corporation of New Jersey.

On the arrival of the party the members were taken in hand by the following-named officers of the Pneumatic Signal Company: J. N. Beckley, president; Charles Hansel, vice-president and general manager; S. Marsh Young, manager, electric railway department; John T. Cade, sales manager; F. L. Dodgson, chief engineer; Aaron Dean, signal engineer.

R. E. Danforth, assistant general manager of the Rochester Railway Company, placed that company's handsome special car, "Genesee," at the disposal of the visitors, and personally attended to the transportation arrangements.

A section of the Rochester & Sodus Bay Railway, near Float Bridge, and several miles from the city, had been equipped, two blocks having been installed on a portion of the line that presented an opportunity for a very severe test. There are heavy grades and sharp curves at this point, and an exposed portion of track enabled the company to determine whether the system would be affected in severe snow storms or after the tracks had practically suffered a wash out. The records of the railway company, it may be said, show that under all conditions when it was possible to operate a car, the signals worked satisfactorily; likewise abnormal conditions, which were devised to illustrate these features during the test last week, had no apparent effect on the working of the signals.

The essential features of this system which distinguish it from others that have been commonly employed are:

1. The use of alternating current for signaling, and the employment of the traffic rails for the signal circuit as well as for the return power circuit.

2. The use of a special bond for connecting the sections of adjacent blocks around the insulated joints, and also cross-connecting the tracks, which offers little resistance to the direct current, but effectually chokes back the alternating currents.

3. The use of special relays at the entrance of every block, which control the operation of the signals.

The accompanying diagram, Fig. 1, shows the arrangement of the apparatus as employed in the demonstration last week. By reference to the cut it will be seen that X represents the block rail, Y the common rail, L the alternating-current transmission line conveying power from A C, the alternating-current generator at the station, to the signaling apparatus on the line. The signal blocks are represented in their order as 1, 2 and 3. T is the transformer furnishing current for the track circuit

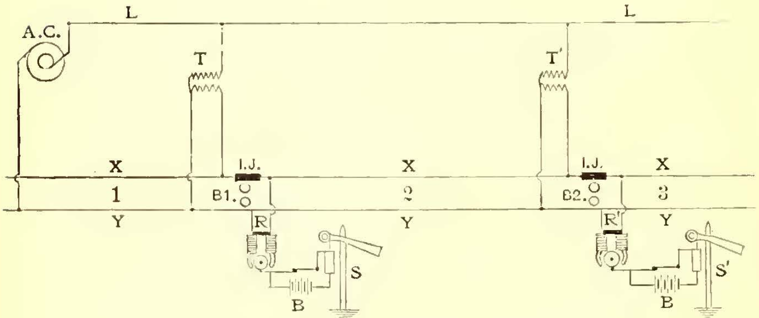


FIG. 1.—DIAGRAM OF TRACK CONNECTIONS

to block No. 1, and T′ performs the same service at block No. 2. R and R′, respectively, are the relays governing signals S and S′, while I J indicate the insulated joints in the block rail, around which the special bond is utilized, and B_1 and B_2 are similar bonds, which make the block rail (X) electrically continuous.

Fig. 2 shows that portion of the signal mast carrying the case containing the operating mechanism which can be readily understood. The door of the case is represented open in the cut, thus exposing the mechanism to view. It should be mentioned in this connection that the operation of the system is not limited to the use of this type of apparatus. The operating mechanism consists principally of an electric motor with a train of gear wheels, and an electrical control for making and breaking the connection between the motor and the blades. The motor is entirely enclosed, the commutator end having a glass shield. The power is transmitted through a train of gear wheels. The operation of the mechanism has been very carefully worked out, both electrically and mechanically, and it has been subjected to very severe tests.

The principle upon which this system is based is that while it is impossible to keep two direct currents of different potentials separate on the same conductors, an alternating current may be introduced to perform one of two given functions, and if proper apparatus is supplied to keep each current from interfering with the instruments designed to be operated by the other current, the track circuit becomes feasible and practicable. The apparatus must, of course, become operative only under

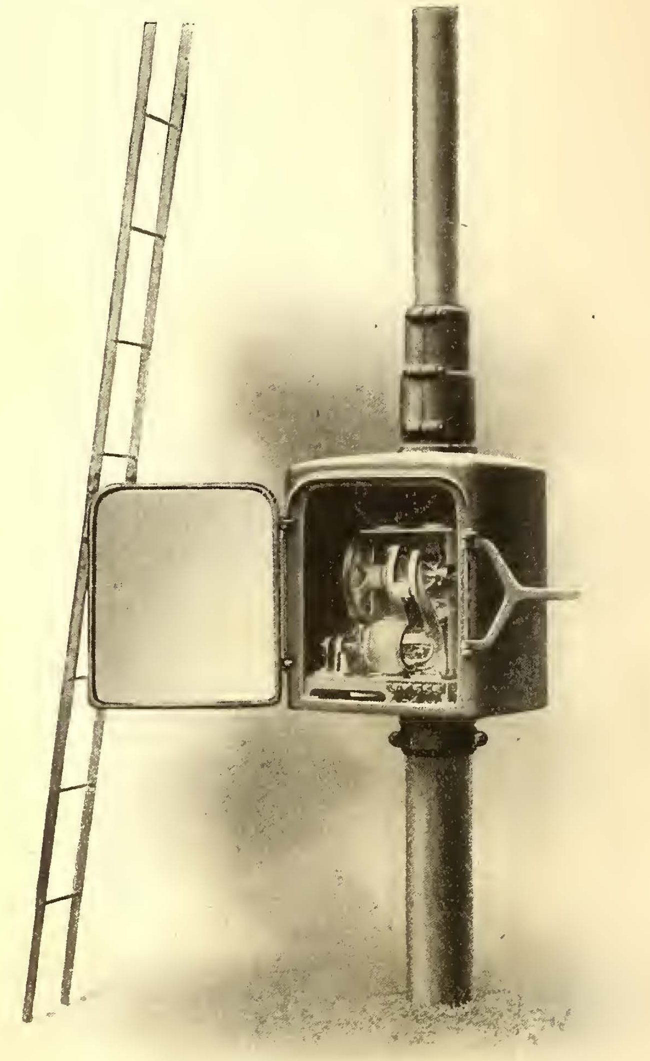


FIG. 2.—INTERIOR OF CASE OF ELECTRIC MOTOR SIGNAL

the influence of one current, and must remain inoperative in the presence of any other current, and while it may be called upon to afford a path to the direct current, it must effectively choke back the passage of the alternating current. By this arrangement one current may be used to operate the car, and the other to operate a track circuit to control the signals without interference or interruption.

On a direct-current road, an alternating current is impressed on the direct-current line for signaling, and a road employing alternating current may also be operated if the power current and the signal current have different characteristics. In the test last week the road employed direct current at 500 volts, and the signaling circuit carried alternating current at 300 volts, which was reduced at the transformers to 3 volts.

In the main power station and in each sub-station a small alternating-current generator should be placed to provide this alternating current, and in the experimental work on the Sodus Bay Railway a motor-generator was employed. As each block only requires about 20 watts for track circuit purposes, a double-track road, 15 miles in length, with 1-mile blocks, would only require a 1-kw machine. A No. 10 wire is carried along the entire length of the road for furnishing the alternating current to the signaling system.

It has already been mentioned and shown in the diagram how the divided traffic rail is made continuous electrically as a return path to the direct-current generator, and the other traffic rail is uninterrupted. The track is divided into blocks as it is on steam roads, although but one of the traffic rails is broken for block signaling purposes. The other rail is used as a return for both direct current and alternating current. To one end of each block is fed alternating current transformed to the proper voltage, and at the other end of the block the relay is connected across the two track rails. Between the relay and the track is interposed one of the special bonds, preventing the relay from being affected by the direct current. Between the ends of adjacent block sections are also placed bonds, which offer a free path for the direct current to return to the station, but effectively choke back the alternating current and likewise prevent its escape into adjacent blocks, thus making the operation of the signals in each block independent. While the two traffic rails are of the same direct-current potential, there is maintained between them a difference of alternating-current potential for the operation of the track circuit of the signal system, but this does not interfere with the operation of the motor circuits. Cross-bonding between the traffic rails or between the block rail and the feeder return is accomplished by the use of devices similar to those used across the ends of the blocks.

The necessity of using both rails for the direct-current return is appreciated by all electric railway men, as the conductivity of a 100-lb. rail is equal to more than 1,000,000 circ. mils, and if one rail is given up for signaling, its conductivity must be replaced by copper in the return feeder, at a cost of $2,000 to $3,000 per mile. There are other difficulties, like the interruption of the motor circuit, where only one rail is used as a return circuit.

The theory of signal engineers until very recently has been that inasmuch as the traffic rails on an electric road were occupied by the 500-volt direct-current return circuit to the station, it would be impossible to maintain between the rails a uniform difference of potential in the operation of a track circuit for signaling purposes, and if one of the two traffic rails was devoted entirely to this purpose and properly insulated from the other rail, the maintenance of such a difference of potential would be impractical, in addition to the serious objections that would present themselves to the sacrificing of one of the two traffic rails as a direct-current return.

In the Rochester exhibition the road was divided into two blocks, one of about half a mile in length controling the operation of the signals shown, and the other a short block to show that there was no interference between blocks, and that the direct-current return was made continuous through both rails of these blocks.

In the station the motor-generator was operated from a 500-volt trolley circuit, and generated a 300-volt alternating current of 100 cycles. The number of cycles employed was determined by practical considerations wholly, the adoption of this particular standard, for instance, being occasioned by the desire to strike a mean between the ordinary lighting circuit as well as to prevent synchronism between the current-operating signal apparatus and that which will probably be used on the roads employing alternating-current motors.

A No. 10 copper wire runs the entire length of the road, and feeds the primaries of transformers located at the farther end of each block. These transformers are of 100 to 1 ratio, and the secondaries are connected directly across the rails, which sets up a difference of potential between the rails of about 3 volts. The secondaries of these transformers practically take the place of a primary battery on the steam railroad track circuit.

At the entrance to the block was shown one of the relays of special construction, which are only susceptible to the action of alternating current of a proper frequency, while current of different frequency does not affect it. The relay is also independent of any difference of track-current potential that may exist between the rails.

In the demonstration, as has been mentioned, one rail was uninterrupted through the entire length of the road, the other being divided up into blocks corresponding to the signal locations, and insulated by means of standard insulated joints, the same as are employed in steam railroad work. Up to this point the system would present an insulated rail for signaling purposes, owing to the insulated joint between the sections, but this divided rail is made continuous electrically by means of the bond, which is one of the essential features of this system. This bond bridges the insulated joint, and its design and construction are such that while it presents a perfectly free passage for the direct current around the joint it chokes back the alternating current, and thus keeps each block perfectly independent. Similar bonds are placed across the traffic rails in each block.

The signal shown was of the electric motor semaphore type, and operated from the 500-volt trolley line. The resistance, consisting of five incandescent lamps, was interposed between the line and a storage battery of six cells. These lamps were utilized to illuminate the blade, and the storage battery performed the double function of operating as a reserve in case the trolley circuit was cut off, and also enabling the signal circuit to be broken between the points of the relay. The electric motor operated at 12 volts, and took 5 amps. for 5 seconds to pull down the semaphore arm. It was held down by means of a mechanical clutch, taking about .02 of an ampere.

One of the features of the system shown was that even after the insulated joints between the blocks were broken down by a special arrangement, making the polarity of adjacent blocks opposite, the current from one block would rotate the relay in the direction opposite to that which it would normally take, open the signal circuit, and produce a danger signal. This relay is in reality an alternating-current motor without brushes. Its armature is connected to traffic rails, and its field is energized from the same source of alternating current. It will thus be seen that a car, entering the block and short circuiting the secondary of a transformer supplying current for that block, will cut off the current of the armature, and thereby cause it to assume its normal position, which opens the local signal circuit. It will be seen that the presence of foreign currents in this relay will have no turning movement, and that it would require a synschronous current from an outside source to produce such a result. Beyond this it requires a quarter of a volt to operate the relay.

In operation it was shown that where there was no car in the block the track circuit was completed from the secondary of the transformers through one rail, through the relay and over the other rail back to the transformer. This circuit, when completed, holds the relay points closed, and closes the local signal circuit, which holds the signal to clear. The entrance of a car into a block short-circuits the transformer, thereby de-energizing the relay and opening the signal circuit, causing the signal to go to danger. Any interruption to the track circuit from any cause will rob the relay of its current and will result in a danger signal..

With a battery track circuit, as used on steam roads, if the leakage between the rails is excessive, owing to the limited output of the battery, the relay will fail to work and the signal will go to danger. This may occur during bad weather, when the leakage across the rails increases rapidly, and it necessitates governing the length of the blocks by the condition of the roadbed. A claim is made for the electric railway, where alternating current is furnished from transformers, and the supply of current available is such as may be ordinarily expected, that roadbed conditions which would prevent the use of battery track circuit, will give satisfactory results with the alternating-current system.

Aside from one alternating-current generator for the entire road and the signal mechanism, which may be of any desired form, the complete apparatus for each block comprises only one 50-watt transformer, the relay and bonds.

It has been the aim of the inventor to have the system so arranged that no possible combination or failure of parts can produce a clear signal when a danger signal should be shown. For instance, the breaking down of the insulated joints between the blocks will result in the giving of a danger signal, and direct-current from any foreign source cannot affect operation, while the presence of stray alternating currents will also fail to operate the relay.

Where electric motor semaphore signals are used, six small cells of storage battery are connected through a resistance to operate the signal motor. The battery also provides a reserve which will operate the signals while the motor current may be off. The battery is charged with about ¼ amp. continuously. Incandescent lamps are used as a resistance to cut down the 500-volt trolley circuit in charging the battery, and these lamps may also be used in the signal lantern and to outline the semaphore arm.

At the conclusion of the experimental test the visitors were taken back to the city and were entertained at luncheon at the Genesee Valley Club. The afternoon was spent at the works of the Pneumatic Signal Company, in Lincoln Park, a western suburb of the city. This plant is modern and very complete, and the visitors had an opportunity to examine the details of construction of the signaling apparatus made by this company. The "Young" system may be operated in several ways, and the modifications required for the different applications were explained and illustrated in operation. Other important features of construction were investigated.

CLEANING THIRD RAILS IN OPEN COUNTRY

Successful experiments for cleaning the third rail in a sleet storm have been made by the Grand Rapids, Grand Haven & Muskegon Railway Company, which has an exposed rail and is operated through an open country. The company claims to have demonstrated that a solution of chloride of calcium poured on the third rail will instantaneously remove a covering of ice or sleet, and, moreover, will protect the rail so that it will not be covered again with ice for at least three hours. These tests have also shown, it is said, that the solution will not injure either the steel rail or the copper bonding.

Three cars on that line have been equipped with reservoirs, located in the motorman's vestibule, from which tubes extend to a point directly over the third rail. In this reservoir the solution is placed. A stop-cock regulates the flow of the fluid. The first practical test was made early this month, when the road was to all intents and purposes tied up because of the worst storm of sleet it had ever experienced. Ice formed on the third rail to the thickness of ⅛ in., preventing the current from being transmitted to the motor.

A car supplied with the calcium solution was placed in operation. After the car had moved along for several miles without hindrance from the ice on the third rail, the flow of calcium was stopped.

Immediately the car was brought to a standstill. The solution was again applied to the rail, and instantly the car moved forward again.

Since that time additional tests have been made, and with much success, so that the officers of the company decided to make public the facts in the case, so that others who had similar troubles might take advantage of this experience.

CHRISTMAS CELEBRATION AT ROCHESTER, N. Y.

The Rochester Railway Company, which has long been noted for its philanthropic work among employees and their families, has added a new feature this year by providing an elaborate entertainment on Christmas for them. The officers of the company and representatives of the employees have worked together in this matter, and during the month have distributed many circulars among those interested and their friends, of which the following is a copy:

DON'T FORGET THAT CHRISTMAS, THIS YEAR, COMES DECEMBER 25th.

DON'T FORGET

that on that day we (which means you and every other employee of the Rochester Railway Company) are planning to have a

BIG CHRISTMAS CELEBRATION FOR THE CHILDREN

at the Employees' Association Rooms and we want you to feel that you are just as much *in it* as any of the Committee.

A light lunch for the men will be served all day, the expense of this being borne by the Company; all other expense will be paid by such subscriptions as each man may feel that he can give—whether it is 5 cents or $5.00 cuts no ice. We want you all there, withl wife and children, and, as the rooms will be open from 10 a. m. to 11 p. m., it will give all a chance to come in for at least a few minutes sometime during the day.

DON'T FORGET

that you are just as much interested in the success of this Celebration as the other fellow.

Don't forget that you are contributing to it.

Don't forget that you will be making somebody happier by so doing, and that it will make you a happier and better man as well.

Don't forget to show up and have a sandwich and some coffee and see what's doing.

Don't forget that Santa Claus will be on hand all day, distributing presents to the children, and for that reason

DON'T FORGET

to give us the name and age of each of your children, so that Santa will know how to provide properly for them.

Don't forget any of the children—better take this home with you and talk it over with your wife, she can help you count them up and see that you don't forget their names, ages, etc.

DON'T FORGET

to fill in the blank at the foot of this notice and return it at once to G. G. Morehouse, Secretary Rochester Railway Company.

Where more than one child in family, make out separate slips for each, similar to the printed blank below, sending all in at the same time.

Yours for the best Christmas we can possibly give the children,

T. J. Nicholl,	A. F. Phillips,	F. McCann,
R. E. Danforth,	W. C. Montignani,	H. J. Chase,
J. W. Hicks,	A. L. Wolfert,	C. H. Bauer,
Geo. G. Morehouse,	S. C. Alberts,	H. E. Hicks,
E. J. Wilcoxen,	J. F. McCabe,	W. Snyder,
	P. H. Arthur,	P. J. Clair,

Arrangement Committee.

....

Name of Child..................................

Age of Child (nearest year)...................

Father's name..................................

Return to G. G. Morehouse, Secretary Rochester Railway Company.

The company found the plan an excellent one, and the contributions were of a varied and valuable character. The men entered heartily into the plans, and it was because of the interest awakened among them that the event proved so successful.

PROTECTION FOR GRIPMEN IN CHICAGO

The Chicago City Railway Company has equipped a number of grip cars with a cab surrounding the gripman's aisle for protection against cold. This company's grip cars have always been operated heretofore as open cars.

FINANCIAL INTELLIGENCE

Wall Street, December 22, 1903.

The Money Market

The most noteworthy incident of the week in the money market is the sharp recovery in sterling exchange, which has carried the rate above the point at which gold imports are profitable. No further engagements, accordingly, have been announced, and it is the general opinion in banking circles that the movement is over for the season. Gold importations, however, have thoroughly fulfilled their purpose in tiding the money market over the most critical period of the year and in building up local bank reserves to an exceedingly comfortable level. Last Saturday's statement showed an increase of over $7,000,000 in cash holdings, half of which was due to the arrival of specie from abroad, the other half to the return of currency from the West. This latter movement is steadily increasing, and, inasmuch as the demands from the South appear to be pretty well satisfied, it is fair to assume that the regular accumulation of reserve funds resulting from the return of the crop-moving money is now fairly under way. With only two weeks remaining before the termination of the New Year settlements, the New York institutions hold the unusually large sum of $14,000,000 in their surplus reserve. This is abundant assurance that whatever strain there may be in supplying the 1st of January requirements, will be felt very little in the market. Looking ahead still further, there is not the slightest doubt that a considerable term of easy money is in store after the end of another fortnight. Money rates have already begun to discount the coming change. Call money is now lending freely at 4 per cent. Time money is easily attainable for the longer dates at 5 per cent, and for the shorter dates, at 5½ per cent. The only cloud on the horizon is the possibility that the railroads and other corporations, which have long been holding back schemes for raising capital, will feel that the opportunity which they have been waiting for has arrived. The first significant suggestion of such a demand has been furnished during the past week by the offering of $10,000,000 of new bonds for the Atchison Company. It is to be hoped that the lessons of the past year have been well enough learned for the banking community to give a very short rope to these borrowing applications.

The Stock Market

The Wall Street dealings have returned to a state of comparative dullness. This is quite often likely to be the case around the holiday period. So far as a general measure of sentiment is possible, the feeling as the year draws to a close is one of cheerfulness, mingled, however, with a very positive conviction that no great rise in prices is in store. Railroad earnings in most instances are exceedingly well maintained. Except in the companies which, having large improvements under way, are charging extra sums to operating expenses, net earnings are making as good a showing as at any time in the last few years. The enormous trade balance which the country has rolled up during recent months is also a source of great satisfaction. It has enabled us to liquidate our remaining foreign indebtedness, and even to establish a surplus credit in the foreign markets. Money rates, as already pointed out, are steadily relaxing, and a long period of easy money is promised after the first of the year. With the more favorable reports recently received regarding the iron trade, the business outlook, which has been a matter of anxiety for some time past, has assumed a more hopeful phase. These causes suffice to explain the confidence felt in important financial circles as to the soundness and stability of the market's present position. The attitude of the leading financial interests appears to favor continuance of the recovery by easy stages. Even if the public are reluctant to buy, and outside investors are not at all free about employing their capital in securities, there appears to be no good reason why prices should not work slowly higher. At this writing the rather alarming reports from the Far East are having a deterring effect upon the markets, both at home and abroad. While opinion locally is that the troubles between Russia and Japan will not lead to actual hostilities, still the possibility of a war, the first results of which might be liquidation among foreign holders of American securities, is enough to provide an additional incentive to caution.

Dealings in the local traction group this week have occupied a less prominent place in the general market than they did a week before. No further efforts have been made on the part of the various speculative cliques to continue operations for the rise. On the other hand, prices have been well sustained, and the action particularly of the Brooklyn Rapid Transit and the Metropolitan shares gives the impression that they are well under the control of the forces making for higher prices. There is no special news in connection with any of these properties. The latest tale in explanation for the recent advance in Brooklyn Rapid Transit is that the stock will be guaranteed at 4 per cent dividend by the Interurban Company, but this, on its face, is so ridiculous that even the most credulous refused to treat it seriously. Brokers in touch with the inside party in Manhattan Elevated claim that there has been some rather good selling of the stock on the recent rise.

Philadelphia

Following the course of the general speculation, dealings in the majority of the Philadelphia traction stocks have again become merely nominal. Only two issues have shown any approach to activity. These are Philadelphia Electric, which ranged between 6¼ and 6, and Philadelphia Company common, which sold up as high as 39¼, and later reacted to 38¾; the strength in the latter is partly referable to the favorable report put forth by the company for the month of November. The pool manipulating the shares has, however, shown no inclination to do much while the rest of the market was so dull. The record for the week includes sales of American Railways at 43 and 43⅛, Union Traction between 45¾ and 45¼, Philadelphia Company preferred at 43, Fairmount Park Transportation at 19, Philadelphia Traction at 96, Rochester Passenger from 74 to 74½, and Consolidated Traction of New Jersey at 65. Philadelphia Rapid Transit touched 9¾ in yesterday's dealings—the lowest it has ever sold—on the call for the new $5 assessment. Payment is due on Jan. 20.

Chicago

The Union Traction Company, in its contest with the city, has received something of a blow in the order issued this week by Judge Grosscup for the installation of two trunk trolley lines on Lincoln Avenue and Blue Island Avenue. It is also admitted by the traction leaders that they have failed to obtain permission to open up the great through routes to the North and West Sides, which were contemplated. Some reflection of these unfavorable developments was witnessed in the market, particularly in the case of City Railway shares, which reached a new low level at 155. Union Traction common was not materially affected, selling at 6. The attempt to stimulate speculation in Lake Street Elevated securities, on the strength of the success of the preliminaries in the organization plan, met with failure. Lake Street receipts, after selling as high as 2⅜, dropped back sharply to 1¾, and the stock sold at the same figure. The Corporation Counsel has reached the opinion that the Union Elevated loop has no rights in the downtown street it now occupies, and property owners along the line of the road are urging that it be put out of existence altogether. The city's action is an answer to the bill filed by the Northwestern Elevated Company, asking that the municipality be restrained from interfering with the extension of loop platforms. Metropolitan Elevated common sold at 17, and North Chicago at 85.

Other Traction Securities

Some idea of the paucity of the traction dealings in Boston during the week may be gained from the fact that not a single sale of the usually active Massachusetts Electric common stock has taken place. Massachusetts preferred sold at 76 in odd lots, Boston Elevated at 140¾, West End common from 89½ to 89, and the preferred from 111 to 110⅛. Only a few transactions occurred in United Railways of Baltimore stock at 8¾ and 8⅝. The income bonds were steady, between 57 and 56¾, but the general mortgage 4s lost half a point, from 91¾ to 91¼. Other Baltimore sales included Lake Roland Street Railway 5s at 118, City and Suburban 5s (Baltimore) at 112, and Atlanta Consolidated Street Railway 5s at 105 and 106. On the New York curb Interborough Rapid Transit, after getting up as high as 94, sold down 3½ points to 90⅝, with 600 shares changing hands. Brooklyn City

Railroad went up to 239, and reacted to 238. Fractional lots of American Light and Traction sold at 35 and 40. Chesapeake Traction 5s recovered 4 points to 90. New Orleans Street Railway 4½s sold at 80¼ and 80, and Washington Traction 4s at 71⅜.

Security Quotations

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

	Closing bid	
	Dec. 15	Dec. 21
American Railways	42½	43
Aurora, Elgin & Chicago (preferred)	a55	a55
Boston Elevated	140	140
Brooklyn Rapid Transit	49⅝	50⅞
Chicago City	*159¾	160
Chicago Union Traction (common)	5¾	5½
Chicago Union Traction (preferred)	25	25½
Cleveland Electric	67	65½
Consolidated Traction of New Jersey	64	64
Consolidated Traction of New Jersey 5s	105	105½
Detroit United	69⅛	68
Elgin, Aurora & Southern	a38½	a38
Lake Shore Electric	—	—
Lake Street Elevated	2	2
Manhattan Railway	*141	141¼
Massachusetts Electric Cos (common)	18½	18½
Massachusetts Electric Cos (preferred)	76	75
Metropolitan Elevated, Chicago (common)	16	16
Metropolitan Elevated, Chicago (preferred)	51	51
Metropolitan Street	121¼	122¼
New Orleans Railways (common)	9	10⅛
New Orleans Railways (preferred	30¾	30½
New Orleans Railways 4½s	—	80
North American	75	75½
Northern Ohio Traction & Light	12¼	13¼
Philadelphia Company (common)	—	39
Philadelphia Rapid Transit	10½	8½
Philadelphia Traction	96	96
St. Louis Transit (common)	13	11½
South Side Elevated (Chicago)	93½	90¼
Third Avenue	115	112
Twin City, Minneapolis (common)	92	91½
Union Traction (Philadelphia)	*45½	45½
United Railways, St. Louis (preferred)	59	55
West End (common)	—	89
West End (preferred)	—	110

Iron and Steel

Interest in the iron trade centered in the recent meetings held in this city to determine whether prices of the leading steel products should, or should not be maintained. The decision has been reached in the case of steel billets and structural steel that no further concessions are necessary at this time. It is contended that the present market is a waiting one, and that business can be secured after a while, just as well at these as at lower prices. The "Iron Age" notes the interesting fact that outside makers of steel billets are offering their product $2 below the official pool prices, and are securing what limited orders there are. Trade in pig iron is very dull. Quotations are as follows: Bessemer pig $14.50, Bessemer steel $23, steel rails $28.

Metals

Quotations for the leading metals are as follows: Copper 12⅜ cents, tin 27⅝ cents, lead 4¼ cents, and spelter 4⅞ cents.

SUBURBAN LINES ENTER TRENTON, N. J.

Three companies have recently opened new suburban lines to the very center of Trenton, N. J. The New Jersey & Pennsylvania Traction Company began running the cars from its Trenton, Lawrenceville & Princeton Railroad through North Willow and West Hanover Streets, to the corner of Warren and Hanover Streets, one block from the City Hall, the early part of the month. A few days later the Camden & Trenton Railway brought in its first car from Stanton Street, or rather from the extension at Cass Street bridge, and a day later the New Jersey & Pennsylvania Company brought in a car upon its Yardley, Morrisville & Trenton Street Railway. The Camden & Trenton cars terminate at State and Warren Streets, one block from the terminus of all the New Jersey & Pennsylvania Traction Company's lines, and one short block from the City Hall, which is passed by every car, local and suburban, that is run upon the Trenton Street Railway. Less than thirteen months ago the first foreign car ever run upon the streets of Trenton was No. 209, of the Trenton, Lawrenceville & Princeton line, which ran upon North Willow Street for a distance of 200 feet. Three lines are now running into the city, and the Trenton & New Brunswick Railroad Company will soon be running in on the Camden & Trenton's Liberty Street extension, to Liberty and Adeline Streets. All of the independent suburban lines were brought in only after a fight, and the extraordinary conditions imposed upon the New Jersey & Pennsylvania Traction Company have been detailed in former issues of the STREET RAILWAY JOURNAL. The Camden & Trenton had a fight with some of the property-owners en route, and finally with the Pennsylvania Railroad Company at the Cass Street crossing. The Pennsylvania Company changed its policy, however, and allowed the electric railway tracks to be constructed under the Union Street bridge, in South Trenton, before the depression of that thoroughfare, undertaken by the railroad to avoid grade crossings, was completed. This saved the Camden & Trenton Company a couple of month's time, as the new street will have to be completed and be approved by the city authorities before the Pennsylvania is released from its obligations.

MR. HUNTINGTON ENTERTAINS PRESIDENT RIPLEY OF THE SANTA FE.

When President Ripley of the Santa Fe Railroad and his associates were in southern California recently on a trip of inspection, for one day they were the guests of Henry E. Huntington, who tendered the distinguished party a ride over the interurban lines of the Pacific Electric Railway Company out of Los Angeles. The party traveled in a private car. Their first destination was Long Beach, whence the return trip was made in the remarkably fast time of twenty-seven minutes—a distance of a little less than 20 miles. Then they went to Whittier, San Gabriel, Monrovia and Pasadena. The return trip from Pasadena was made in twenty-one minutes. In a little less than four hours the party traveled more than 100 miles over the system. "Great thing for Los Angeles and southern California," is the way Mr. Ripley referred to the many modern electric lines that Mr. Huntington is building, and he was profuse in his compliments to the latter. There was no business significance to the trip, according to Mr. Huntington, who says that Mr. Ripley belongs to the class of progressive railroad men who look upon the electric roads kindly.

CHANGE IN ROUTES IN NEW YORK

An important change of routes has just been made by the Interurban Railway Company, operating all the surface lines in Manhattan, whereby cars of the Sixth and Eighth Avenue lines now run to the Brooklyn Bridge. Heretofore one of the downtown terminus of these lines has been at Canal Street and Broadway, but cars now continue across Broadway on Canal Street to Centre Street and along the latter thoroughfare to the Bridge and Post Office. As the addition of these cars to the already congested traffic on Centre Street might result in considerable delay, the Second Avenue cars will be withdrawn from Centre Street and sent down over the Third Avenue tracks from Grand Street. This is the realization in part of plans which have long been in contemplation for affording continuous trips along natural routes of heavy travel without the necessity for transferring. The change is expected to result in a considerable increase in business. Ultimately, it is said, all congestion of traffic on Centre Street and Broadway may be lessened by utilizing the new Elm Street, which runs between these two thoroughfares practically from the Bridge to Astor Place, above which traffic conditions offer no serious problem.

DAMAGE FROM HIGH-TENSION WIRES

A 16,000-volt, high-tension wire used to transmit power from the station of the Economy Light & Power Company at Joliet to the substations of the Chicago & Joliet Electric Railway Company between Chicago and Joliet, broke Dec. 15, and did considerable damage by falling across some Western Union Telegraph wires. The break occurred at Ruby Street in Joliet. The high-tension current started fires simultaneously in the railway station of the Santa Fe Railroad at Romeo and at Joliet, and in the Michigan Central station at Spencer. The railway stations at Romeo and at Spencer, 25 miles apart, were burned to the ground. The accident, of course, demoralized the Western Union service wherever the current had its effect, as a large number of fuses were burned out. The accident serves to emphasize the importance of an effective system of guards in the shape of grounded guard wires or netting wherever high-tension wires cross other lines.

CHICAGO UNION TRACTION EXTENSIONS

Judge Grosscup has ordered the receivers of the Chicago Union Traction Company to place over-head trolley wires above cable lines in three short stretches, which will give that company an opportunity to operate a new electric line from the heart of the city over Halsted Street and Lincoln Avenue to the north side, and will shorten the Twelfth Street electric line. These improvements, it is admitted by the Council for the city, are permissible under ordinances granted in 1895.

Judge Grosscup did not, at the hearing on Dec. 17, order the receivers to go ahead with the extensive improvements which have been mentioned in spite of the refusal of permits by the city. It was thought that possibly he might give orders to the receivers to go ahead with the improvements, which would indicate that he considered the claims of the company under the 99-year act to be sufficiently strong to justify this action. Judge Grosscup declared he could not pass upon such an important matter until all the rights of the company and the city had been adjudicated by the Supreme Court of the United States. He arranged that the company should go before the City Council pending that decision and ask as a favor the privileges which in the hearing before him it had claimed as a matter of right. Should the Council grant permission, improvements could be made during the litigation over the 99-year act.

Judge Grosscup desires to make better service possible by constructing two loops in the downtown district. One of these loops would be on Van Buren, Dearborn, and Lake Streets and Fifth Avenue. To complete this as an over-head trolley line, it would only be necessary to construct a trolley from Randolph to Van Buren Street in Dearborn. A smaller loop on Franklin, Adams, La Salle and Washington Streets is also proposed. Plans showing what the company desires to do are to be submitted at once to the Council acocrding to the judge's instructions.

REORGANIZATION OF LAKE STREET "L," CHICAGO

The securities committee of the Lake Street Elevated Railroad, of Chicago, met Dec. 19 and declared the reorganization plan operative. For the time being, at least, this is presumed to mean an end of the financial troubles of the corporation. The committee extended the time for deposits of securities until Jan. 15, 1904. This extension was granted because of the fact that it will take that long to work out the reorganization details, and it was thought opportunity might as well be given security holders to come into the plan in the meantime.

In the new company there will be preferred and common issues, the capitalization being as follows:

First mortgage 5 per cent bonds	$5,000,000
Preferred stock non-cumulative, 5 per cent	3,200,000
Common stock	6,000,000

The reorganization provides for an assessment of $2 per share on the present outstanding stock of $10,000,000.

A comparative report of the company for the years ending June 30, 1903, and June 30, 1902, follows:

	1903	1902
Gross receipts	$834,059	$794,042
Operating expenses	465,491	388,969
Net earnings	$368,568	$405,073
Charges, taxes, etc.	417,738	401,380
Deficit	$49,170	sur. $3,693

ANOTHER MOVE IN THREE-CENT FARE SITUATION IN CLEVELAND

Constituents of Mayor Tom L. Johnson, of Cleveland, have proposed an ordinance in the City Council fixing the terms of rental to be paid by the so-called 3-cent fare company for the use of the tracks of the Cleveland Electric Railway on the portion of the system known as "free territory." The route over which the low-fare company desires to build includes portions of Rhodes Avenue, Detroit Street and the Viaduct, which would enable its cars to reach the Public Square. The proposed ordinance provides for the payment of $5,000 in cash prior to the use or occupation of the tracks. It further provides that the low-fare company shall bear one-half of the cost and expense of repairs, maintenance, and replacements of tracks and foundations, and shall also pay half of all taxes, charges, costs and other expenses that may be assessed or charged against the owners of the tracks used by the other company. This ordinance is the first attempt that has been made in Cleveland to determine the rental that a new company shall pay for the use of tracks on the so-called "free territory."

COMPETITION IN OHIO

For some time past the Cleveland & Southwestern Railway, the Lake Shore Electric Railway and the Lake Shore & Michigan Southern Railway (steam) have been having lively competition for the business between Cleveland and Norwalk. The Lake Shore Electric put on limited cars making the run of 57 miles in two hours and twenty minutes. Then the Southwestern put on a Norwalk limited, but was unable to arrange a schedule of less than two hours and thirty minutes. The Southwestern started selling special round-trip excursion tickets for $1.00, good on the limited cars. For a time it got the business, because the Lake Shore Electric was charging $1.25 for the same service. Then the Lake Shore Electric dropped its special excursion rate to $1.00. This spurred the Lake Shore (steam) to action, and it advertised special holiday shopping excursions at $1.00, round trip. Both specials on the electric lines left about the same time one day recently, but the Southwestern stole a march on its rival and did a sharp piece of advertising by sidetracking every car on the line and running the special at top speed the entire distance. The 57 miles were covered in exactly one hour and thirty minutes. On both the events of the Elks' memorial service both companies again ran specials. The cars left at the same time, and both companies sidetracked all other cars. The Southwestern car made the run in 1 hour and 30 minutes. The Lake Shore Electric car made a record run to Vermillion and was stopped there by a broken trolley wire, which took some time to repair. The car proceeded at high speed, and it is claimed that the actual running time for the 57 miles was 1 hour and 20 minutes. The two roads are doing some remarkable high speed work with their limited cars.

NEW ENGLAND STREET RAILWAY CLUB MEETING

On Thursday evening, Dec. 17, the New England Street Railway Club met at the Revere House in Boston. A very substantial dinner was served at 7 o'clock to those present, including some of the most prominent street railway men in New England. About one hundred and thirty members were present. After dinner had been served, President Farrington presiding, introduced Robert A. Parke, special agent of the Westinghouse Air Brake Company, of Minneapolis, Minn. Mr. Parke read a very interesting paper on the history, invention, development, application, use and maintenance of the various brake mechanisms which have been applied to railway vehicles since they came into existence. He paid particular tribute to Mr. George Westinghouse, to whose genius was due the invention and successful application of the air brake, now in universal use upon all passenger and freight cars in this country, as well as upon the majority of railway cars outside of the United States. He gave a thorough and exhaustive exposition of the technical details of manufacture, operation and maintenance of the Westinghouse air brake, as applied both to steam and electric railway cars. The Westinghouse magnetic traction brake for street railway service received, of course, a good deal of attention in Mr. Parke's paper. Particular attention was called to advantages of this brake in emergency instances, when cars must be stopped in the shortest possible distance to avoid serious accidents; attention was also called to the economy of this brake, in the fact that the current used in its application can also be utilized in heating the car to which the brake is attached.

After Mr. Parke had finished reading his paper, Mr. Farrington introduced F. W. Sargent, of the American Brake-Shoe & Foundry Company, of New York. Mr. Sargent gave an interesting talk on brake-shoes. He said that enough attention was not paid by designers of trucks to the proper application of the brake mechanism. One result of this was that shoes would wear unevenly, one end of the shoe becoming worn through before the other end was hardly worn at all. This entails great waste. Another point brought out by Mr. Sargent was that, although the soft cast-iron shoe is the ideal shoe under all conditions, on high-speed roads a shoe of much harder composition can be used, and will be found to give as good satisfaction as a soft shoe. The reason is that the shoe, when applied to wheels at very high speed, becomes softer by the heat developed between the shoe and the wheel. Of course the advantage of using a hard shoe is its wearing qualities. Mr. Sargent also spoke of the importance of the proper inspection and maintenance of the shoe, as well as the brake mechanism. The rattling of the brake-shoe is due in almost every instance to loose bolts. This is inexcusable, and should never be allowed on any road.

At the close of the meeting a rising vote of thanks was extended to Mr. Parke and Mr. Sargent for their able exposition of the subjects under discussion.

The next meeting of the club will be held on Jan. 28, at Hotel Brunswick. On that evening the annual banquet and the election of officers will take place.

MIAMI & ERIE CANAL BANK FOR STEAM RAILROAD

Daniel J. Ryan, attorney for the Miami & Erie Canal Transportation Company, better known as the "electric mule" company, has made formal announcement that a bill is being prepared to be presented to the Legislature, asking that the canal bank, now leased to the transportation company for canal-boat towing purposes, be leased for steam railroad purposes. It is now frankly admitted that the electric mule project can never be made a success unless a large amount of money is spent in improving the canal. The company will ask the State to fix a valuation on the property, and the company will offer to pay the State an annual interest, the rate to be fixed by law. The bill will provide that the company build a tow path for the live mule on the berme bank and shall pay the cost of raising and rebuilding all canal bridges. Of course, the most important phase of the deal would be the entrance of a steam road into the very heart of Cincinnati above high water mark. The fact that the canal company is taking even ground with the old line canal boat operators, and is advocating the expenditure of a large amount of money to improve the canal, is one that will deprive the opponents of the measure of some of their ammunition. Coincident with this application comes the report of State Engineer Perkins, who states that the time has come for the abandonment of the canals, or else the expenditure of a large amount of money to convert them into modern waterways of large dimensions.

PROPOSED ELECTRIC RAILWAY FROM MONTREAL TO OTTAWA

An electric railway is projected from Montreal to Ottawa, to run through the counties of Argenteuil, Two Mountains, Terrebonne, Laval and Jacques Cartier. The district is closely settled but without anything like a satisfactory transportation service. Three branch lines are already definitely decided upon by the promoters, so as to cover as large a field as possible, and others may be built if the demand arises. These branch lines will run to St. Rose, St. Ann and St. Genevieve. Surveys have already been made along a portion of the projected route, and it is assured that there are few natural obstacles to a road being built. The president of the company that plans to build the line is Col. McMullen, of New York, who represents a company of American capitalists interested in electric roads. Further than that, it is expected the road will be subsidized by the Dominion Government at the usual percentage. The directorate is composed of F. D. Monk, M. P., T. W. Raphael, Thomas Christie, M. P., J. A. Ethier, M. P., J. E. Leonard, M. P., Thomas Gauthier, and Mr. Wells, of New York. It is proposed that the new railway will enter Montreal at the north end and run down St. Urbain and up St. Charles Borrommee. A large terminal station will be erected in the city, but the site is not yet decided upon. The head offices will be located at Montreal.

ADDITIONAL POWER FOR THE LAKE SHORE

The Lake Shore Electric Railway Company has taken steps to provide additional power equipment as soon as possible. Contracts have been placed with the General Electric Company for a 1200-kw alternating-current generator and with the C. & G. Cooper Company for a 1500-hp cross-compound condensing engine. Dean condensers will be ordered. The new equipment will be installed in the Beach Park power house, which at present supplies direct-current exclusively, operating the section from Vermillion to Cleveland. The Sandusky power station of the company will be abandoned and a sub-station will be installed at that point. The division from Lorain to Cleveland will be supplied by direct-current, as heretofore, and the new unit will feed the sub-station as far west as Norwalk, leaving the Fremont power station to operate the Toledo-Norwalk line, for which it was originally designed. The Fremont station has been giving considerable trouble during the past few months because of bad water and overloads, and the company has just completed the work of installing two new boilers at that point. With the completion of these improvements the power on this system will be in very good shape. The company is planning to double track its line from Cleveland to Lorain during the coming year. Travel on this line is especially heavy during the summer months, when numerous special cars are operated to the pleasure resorts along the lake front. The subject of running two or three-car trains has been gone over very carefully, but it has been abandoned as impractical because of the long run over the tracks of the Cleveland city system; also because some of the highway bridges are not considered strong enough for such service.

NEW CARS FOR CLEVELAND, OHIO

The Niles Car & Manufacturing Company, of Niles, Ohio, has just completed an order for twenty-five electric cars for the Cleveland Electric Railway Company, of Cleveland, Ohio. The cars are 38 ft. 7 ins. long over all, 28 ft. long over corner posts; 8 ft. 2 ins. wide, 8 ft. 6¾ ins. height inside. Each car has a monitor deck and steam type hood with enclosed vestibules, and is finished in quartered white oak.

The contract for these cars was made on Nov. 18, 1903, and was to be completed Dec. 16, 1903. The first three cars were shipped Dec. 1, and the last of the twenty-five cars were shipped on Dec. 15, 1903, thus completing the contract for the twenty-five cars in twenty-eight days. The Cleveland Electric Railway Company reports the cars as being satisfactory in every respect. These cars are to replace some of those burned in the recent fire which destroyed the car barns of the Cleveland Electric Railway Company.

UTICA & MOHAWK BENEFIT ASSOCIATION

At the annual meeting and election of officers of the Employees' Mutual Benefit Association, of the Utica & Mohawk Valley Railway Company, Secretary Harry Van Vleit made an interesting report, showing the affairs of the association in a most favorable condition. The following officers were elected: President, W. J. Root; vice-president, S. E. Patterson; secretary, Harry Van Vleit; treasurer, Ben Frankle. General Manager C. Loomis Allen, who was present, made an informal address that was received enthusiastically.

The association was formed nine months ago. The board of trustees consists of one motorman and conductor from each terminal station, making six representatives from the transportation department. There is also one representative from each of the following departments: Express, overhead, track, shop, sub-station and office, making twelve in all, seven constituting a quorum. The president of the Association also presides at trustees' meetings.

The monthly sick benefit fee is 50 cents, and for death benefit of $300 the cost is $1.00 per day for the first seven days after a member's death. During its first nine months the association has spent $600 for sick benefits, but fortunately has had no deaths in its ranks. The present reserve is fully $1,700, and the number of members is 250.

The association enjoys the use of a fine headquarters, and the social features, which are distinct from the benefit purposes, are well taken care of by a house committee composed of road employees.

WESTERN DIVISION OF BUFFALO, DUNKIRK & WESTERN OPENED

The western division of the Buffalo, Dunkirk & Western Railroad, extending from Dunkirk via Fredonia and Brocton to Westfield, N. Y., a distance of 20 miles, was opened to the public on Thursday, Dec. 10. In addition to the section of the line just placed in operation, the company has completed substantially all of the grading between Dunkirk and Buffalo, has completed all of the concrete work, laid the ties and erected poles, and is now erecting its high-level, double-track steel bridges. Under the basis of the Federal census of 1900 and exclusive of the city of Buffalo with 400,000 people—which is its terminus—the road averages 1200 people to the mile between Buffalo and Westfield. It goes through the rich section of the county in western New York familiarly known as the "grape belt." Its cars will start at Westfield, where it will be fed by a through line from Cleveland, Ohio, as well as the line from Jamestown and Chautauqua Lake and travel to the city of Buffalo, terminating upon Main Street opposite the Iroquois Hotel. It is expected to have the entire line completed and in full operation by Oct. 1, 1904.

NEW TRANSFERS IN PITTSBURG

An entirely new transfer system on all Pittsburg lines of the Pittsburg Railway Company has just become effective. It consists of extending the system adopted in Allegheny last October into Pittsburg and making the plan general on all lines operated by the Pittsburg Railways Company. Briefly, the new system is to be in the form of transfer checks with one color for morning and another color for afternoon and evening. Instead of the conductor punching for a transfer north, east, south and west, the names of the various lines will be on the check and the passenger must designate the particular line he wants. It is claimed that the new system greatly simplifies the business of the company and prevents much fraud that has been steadily worked on the company in the past.

METROPOLITAN AND FUTURE TUNNEL CONTRACTS IN NEW YORK

As a result of a letter submitted to the Rapid Transit Commission, of New York, by Alexander E. Orr, on Thursday, Dec. 17, a definite statement was obtained from Metropolitan Street Railway interests that that company would, under certain conditions, compete for contracts to construct additional tunnels in New York. Mr. Orr, in his letter, said that he had received an informal communication from Metropolitan interests, asserting that the company was willing to compete for tunnel contracts. Later in the evening the following official statement was issued by Thomas F. Ryan, of the Metropolitan Street Railway Company:

"The Metropolitan Securities Company, which, through its ownership of all the stock of the Interurban Street Railway Company, now controls the entire Metropolitan Street Railway system, is not anxious to add to its responsibilities. At the same time we realize that the control of all the surface lines in Manhattan and the Bronx places us under a grave responsibility to the city and the public. More than 622,000,000 passengers rode in Metropolitan cars during the year ending June 30, 1903, and the traffic is increasing each year at an enormous rate. Of the aggregate daily passenger traffic in Manhattan and the Bronx, including the suburban traffic, about two-thirds are carried by the Metropolitan lines.

"We appreciate our duty to take advantage of every opportunity to increase our facilities for the comfortable transportation of this great number of passengers, and especially to relieve the overcrowding along the lines running north and south. While many of our lines will be able, for some years to come, to take care of the increased traffic, some of the longitudinal lines, such as those on Broadway and the Bowery, and Third, Sixth, Eighth and Ninth Avenues, during certain hours of the morning and evening encounter a congestion of traffic so great as to be justly termed intolerable.

"In this situation it seems that the only relief possible must come from the construction of tunnels extending the entire length of the island, and so connected by transfer arrangements with our crosstown surface lines as to attract a substantial portion of the long-haul riders from the lines running north and south, thus making room for the great numbers of people who are now compelled to choose whether they will ride in overcrowded cars or walk.

"Convinced, as we are, that some such plan as this, by which passengers can be brought under a comprehensive transfer system to the tunnel in the morning, and distributed to their homes at night by our crosstown surface lines, will furnish the only real and permanent relief from present traffic conditions. Metropolitan interests are prepared to become competitors for the construction and operation of a rapid transit tunnel on Manhattan Island in connection with their system of over 400 miles of surface lines, provided the Rapid Transit Commission will lay out a route which will meet the requirements of the situation and the terms of the contract prescribed by the Commission do not place undue burdens."

QUICK DELIVERY OF RUSH ORDER FOR CARS

The Cleveland Electric Railway Company placed a large order for cars with 30-ft. bodies with the J. G. Brill Company on Nov. 17—the day after the destruction by fire of the Holmden Avenue car house and seventy-three cars. The order was given with the understanding that the cars would be delivered in thirty days, but that time was so short that some of the officials doubted the ability of the builders to make delivery on time, and were considerably astonished when they were notified that a number of the new cars were shipped on Dec. 8, just three weeks after the order was placed. Shipments were made every day thereafter till Dec. 11, when the last lot left the Philadelphia works. It is claimed that this breaks all records for fast building, and the railway company is much pleased to have the cars in time to help them handle the holiday crowds.

STREET RAILWAY PATENTS

[This department is conducted by W. A. Rosenbaum, patent attorney, Room No. 1203-7 Nassau-Beekman Building, New York.]

UNITED STATES PATENTS ISSUED DEC. 15, 1903

746,691. Sanding Device; Louis A. Gardner, Providence, R. I. App. filed Jan. 5, 1903. Details.

746,692. Life Guard for Railway Cars; Gottlieb Geiger, Cleveland, Ohio. App. filed Oct. 5, 1903. A car fender of the double or tandem variety.

746,751. Current Collecting Device for Electric Railway Systems; Abraham A. Shobe & William Embley, Jerseyville. Ill. App. filed Apr. 10, 1903. The current collecting device is adapted to enter a conduit, and is so constructed as to compensate for vertical movements of the car, thus constantly maintaining good connection with the conductor.

746,860. Trolley Catcher; Horace R. Martin, East Bloomfield, N. Y. App. filed Aug. 7, 1903. The trolley cord is wound up by a pneumatic device is case the trolley wheel leaves the wire.

746,987. Convertible Car; John O'Leary, Cohoes, N. Y. App. filed Mar. 9, 1903. Details of construction.

747,075. Street Car; John A. Kratz, Baltimore, Md. App. filed Apr. 3, 1903. A folding, two-step running board is so connected with an awning and guard rail that when the step is folded, the guard rail and awning will be simultaneously lowered.

747,090. Carrier; Max E. Schmidt, New York, and George A. Mayland, Brooklyn, N. Y. App. filed Oct. 31, 1902. A moving platform in which displacement relative to the general direction of motion is prevented by the coaction of downwardly projecting friction rollers and a centrally grooved and disposed guide rail.

747,106. Trolley; Milford J. Wilson, Painesville, Ohio. App. filed Sept. 2, 1902. Relates to the lubrication of the bearing through a hollow axle, and to the contact between the wheel and stationary parts.

747,142. Railway Signal; Henry M. Cogan, New York, N. Y. App. filed Apr. 28, 1903. A signal adapted for either single or double track trolley roads, by which more than one car moving in the same direction are permitted on a block at the same time, the first car setting a danger signal ahead on entering a block, which is not cleared until the last car leaves the block.

747,155. Trolley Switch; Lloyd E. Elwell, Los Angeles, Cal. App. filed Aug. 17, 1903. A frame having two grooves, one of which is depressed and acts in conjunction with a guiding flange to direct the trolley wheel onto a branch wire.

747,177. Electric Railway; Maurice Hoopes, New York, N. Y. App. filed Apr. 29, 1903. A third rail formed with a ridge or corner from which ice or sleet may be easily removed by means of a blade of any character, the shoe being shifted to make contact with the ridge only, whereby current sufficient to keep up the headway will be collected by the various shoes of a train.

747,217. Electric Motor; Leroy S. Pfouts, Canton, Ohio. App. filed Mar. 5, 1903. Two armatures mounted upon separate shafts in line with each other are located in the field of a single magnet, the armatures being independently geared to respective wheels of the vehicle.

747,277. Electric Railway System; Sivert Udstad, Aurora, Ill. App. filed Feb. 21, 1903. A covered third rail and feeders duly protected above it.

747,342. Railway; John Dew, Chicago, Ill. App. filed Mar. 5, 1901. Details of construction of a double deck elevated structure.

PERSONAL MENTION

MR. F. H. ELLSWORTH, general superintendent of the Pennsylvania & Ohio Railway Company, of Conneaut, O., has tendered his resignation, to take effect Jan. 1.

MR. LAWRENCE O'TOOLE, formerly assistant superintendent of the Canton-Akron Railway Company, has been appointed superintendent of the Eastern Ohio Traction Company, of Cleveland.

MR. SAMUEL S. HOFF, of Reading, Pa., has been made general superintendent of the Wilmington City Railway Company and Wilmington City Electric Company, and will assume his new duties shortly.

MR. ARTHUR BROWN has succeeded Mr. Paul Dohrman as division superintendent of the Michigan division of the Detroit United Railway, Mr. Dohrman having been promoted to assistant general superintendent.

MR. E. B. TAYLOR has succeeded Mr. Albert Eastman as a division superintendent of the Detroit United Railway, Mr. Eastman having resigned to take a position with the Public Service Corporation, of New Jersey.

MR. GEORGE BRANSON, assistant superintendent of construction on the Canton-Akron Railway, of Canton, Ohio, has taken charge of line construction work for the Pittsburg, McKeesport & Connellsville Railway, of Pittsburg.

MR. RICHARD E. McCLURE, of Connersville, Ind., has been appointed auditor of the Columbus, Greensburg & Richmond Traction Company, of Richmond, Ind., and has already assumed the new office with the company at Indianapolis.

MR. WILLIAM BIRD, for many years treasurer of the Broadway & Seventh Avenue Railroad Company, of New York, died a few days ago in his sixtieth year. Mr. Bird was born in New York and was educated at the New York University.

MR. ARCHIE MACNANEMY, formerly chief mechanical and electrical engineer of the Cleveland Southwestern Traction Company, has been appointed to the same position with the Indianapolis, Columbus & Southern Railroad Company, with headquarters at Greenwood, Ind.

MR. ELLIS BARTHOLOMEW, president and general manager of the Toledo, Columbus, Springfield & Cincinnati Railway Company, of Toledo, Ohio, was injured in a wreck on the Pennsylvania Railway near Lima a few days ago. It is thought that his injuries will not prove serious.

MR. J. L. GREATSINGER, ex-president of the Brooklyn Rapid Transit Company, of New York; Peter Kimberly, the iron man of Sharon, Pa., and associates have proved up a valuable copper mine in the wilderness sixty-five miles west of Port Arthur, Ontario, and fourteen miles south of the Canadian Northern Road.

MR. A. C. HARRINGTON, who has acted as manager, purchasing agent and superintendent of the Erie Rapid Transit Company since that railway was built from Erie to North East, has resigned. Capt. G. D. Howell, who represented the Vandegrift Construction Company, has been chosen to fill the vacancy.

MR. ISIDOR NEWMAN, of New York, has donated $1000 to the Young Men's Christian Association of Nashville, Tenn. Mr. Newman is one of the most prominent street railway men in the South. He is largely interested in this character of enterprises in Little Rock, Ark., Memphis, Birmingham, Nashville and New Orleans.

MR. ALEXANDER McCORD, for many years superintendent of the Mission Street line in San Francisco before it became merged into the Market Street Railway, and at one time superintendent of the Sutter Street Railway, is dead. Mr. McCord was a native of Canada, sixty years of age, and an old-time resident of this city.

MR. BURTON R. STARE, general manager of the Railway Journal Lubricating Company, of Chicago, and Chicago agent for the Peckham Manufacturing Company, was married at Chicago Dec. 14, the bride being Miss Ruth Isabel Braymer, daughter of Mr. and Mrs. F. A. Braymer, of Chicago. They will be at home at Chicago after Jan. 20, 1904. Mr. Stare has made many friends in Chicago since he went West.

MR. G. R. MITCHELL, formerly general superintendent of the Jersey Central Traction Company and the Middlesex & Monmouth Electric Light, Heat & Power Company, with headquarters at Keyport, N. J., has accepted the position of general superintendent of the Olean, Rock City & Bradford Railroad Company and the Bradford Electric Street Railway Company. Mr. Mitchell entered upon his new duties on Dec. 15.

MR. FRANK S. GIVEN, of Lancaster Pa., has been appointed general manager of the Erie Rapid Transit Street Railway Company, of Erie, Pa., and has already entered upon the duties of his new office. He succeeds Capt. Howell, who filled the position temporarily, after the resignation of Mr. A. C. Harrington, the former general manager. Mr. Given formerly was general manager of the Lancaster County Railway & Light Company.

MR. J. C. BRACKENRIDGE, who has for several years past acted as chief engineer of the Brooklyn Rapid Transit Company, will resign that position to accept that of Brooklyn Commissioner of Public Works under the incoming administration. It is believed that the vacancy thus caused will remain unfilled, but that Mr. H. S. Wilgus, Mr. Brackenridge's principal assistant, will be appointed engineer in charge. Mr. Wilgus was formerly connected with the Pennsylvania Railroad, and is a brother of Mr. W. J. Wilgus, fourth vice-president of the New York Central & Hudson River Railroad.

MR .GEORGE ST. PIERRE has been appointed to succeed the late Mr. George W. Spink as master mechanic of the Oakland Transit Consolidated and of the San Francisco, Oakland & San Jose Railway Company, of Oakland, Cal. Mr. St. Pierre has been connected with the street railways of Oakland for the last 18 years; in fact, since the first road was built, and has recently held the position of shop foreman at the Piedmont car shops of the Oakland Transit Consolidated. The position of assistant superintendent of transportation of the San Francisco, Oakland & San Jose Railway Company, held by the late Mr. Clark Yerrick, has been filled by Mr. Piper, of the Telegraph Avenue Divison of the Oakland Transit Consolidated.

MR. WALTER H. WHITESIDE, manager of the detail and supply department of the Westinghouse Electric & Manufacturing Company, has also been made the general manager of the Sawyer-Man Electric Company and has added the duties of this new office to his former ones. Mr. Whiteside has been connected with electrical trade interests for nearly twenty years, being a special salesman for the Westinghouse Electric & Manufacturing Company in Chicago in 1898, a year later being sent to Washington, D. C., to take charge of sales to the government, and in 1900 named as manager of the company's office for that district. From the Washington office Mr. Whiteside acquired the management of the detail and supply department, with headquarters at Pittsburg.

MR. CHARLES H. COX, resident manager of the Middleboro, Wareham & Buzzard's Bay Street Railway Company, of Middleboro, Mass., has tendered his resignation, to take effect Dec. 15, and he will immediately start for Lincoln, Neb., where, on Jan. 1, 1904, he will assume the duties of general manager of the Lincoln Traction Company, of that city. Beside the street railway, the company operates an electric light plant, furnishing city and commercial lighting and power, as well as a steam heating plant, which furnishes heat for upward of fifty buildings in various parts of the city. In 1874 Mr. Cox obtained a position with the Metropolitan Horse Railway Company in Boston. He was with that company sixteen years, and then entered the employ of the West End, remaining there till thirteen years ago, when he bcame connected with the Worcester Construction Company. He was with that company for some time, building roads all over New England. Before he became superintendent and later resident manager of the Middleboro, Wareham & Buzzard's Bay Street Railway Company, he was the superintendent of the Easton, Palmer & Bethlehem Company in Pennsylvania. He left that company to go to Dayton, Ohio, as superintendent of the Dayton & Xenia Traction Company.

MR. JOHN B. ALLAN, who was recently elected a vice-president and the general manager of the Allis-Chalmers Company, was born Jan. 14, 1860, in Davenport, Ia., where he received a common and high school education. He then spent some time in a general machine shop, and afterward completed a course in the Worcester Polytechnic Institute of Worcester, Mass., graduating as a mechanical engineer in the class of 1880. Upon completing his college education, Mr. Allan spent a year at lumbering in Minnesota. In May, 1881, he entered the services of the Edward P. Allis Company as a draughtsman in the engineering department, remaining at the Milwaukee works about four years, dividing his time as draughtsman, machinist and erecting engineer. During this time, Mr. Allan had general charge of making economy tests of engines and steam plants. In January, 1885, the company opened a general sales office in Chicago, of which Mr. Allan was made manager. There he had charge of the engineering, as well as the selling department. During the time that Mr. Allan was in charge of the Chicago office he succeeded in largely increasing the business of the company. After the formation of the Allis-Chalmers Company, Mr. Allan was placed in general charge of the engine sales department of the company, which position he has held up to the present time. In his new position, Mr. Allan has general charge of manufacturing, selling and general operations under the president, which is indeed a fitting tribute to his ability.

MR. THOMAS CYPRIAN FRENYEAR, sales manager of the New Canadian Westinghouse Company, died of typhoid fever at Fort William, Canada, on Dec. 10. He was a man of exemplary life, unusual business judgment and ability, and much experience in electrical work. Mr. Frenyear was born on March 16, 1865, at Middletown Spa, Vermont. He began his business career before he was 15 years old, in the office of the Boston Electric Company, under his uncle, Mr. W. R. Nutting, who was manager of the company. While there he entered the Latin School, doing his studying at night, then taking a course at Phillips Exeter Academy, graduated in 1885, and entered Harvard that autumn, but did not finish the course. He afterward entered the Boston University, but a business reverse put an end to his efforts to gain a collegiate degree. For several years after that he was in the employ of the Thomson-Houston and Brush Electric Companies as a salesman, with his headquarters in Buffalo. From 1892 to 1895 he was superintendent of the Cayadutta Electric Railroad. In the fall of 1895 he entered the employ of the Westinghouse Electric & Manufacturing Company. He was connected with the sales office of that company until Nov. 1, 1903, when he was placed in charge of the sales department of the new Canadian Company, with headquarters in Toronto. He was married to Miss Emma L. Chase, of Exeter, on June 23, 1893. Mrs. Frenyear and three children survive him. Mr. Frenyear was a deacon and trustee of the Delaware Avenue Baptist Church, of Buffalo, and had been superintendent of the Sunday School. In announcing the death to the officials of the Westinghouse Company, Vice-President Taylor said: "The management desires to place on record its thorough appreciation of his able and loyal service and of the loss to the Westinghouse interests by the untimely removal of a young and zealous official whose future seemed so full of promise."