Street Railway Journal

VOL. XXIV. NEW YORK, SATURDAY, DECEMBER 3, 1904. No. 23.

PUBLISHED EVERY SATURDAY BY THE

McGRAW PUBLISHING COMPANY

MAIN OFFICE:
NEW YORK, ENGINEERING BUILDING, 114 LIBERTY STREET.
BRANCH OFFICES:
Chicago: Monadnock Block.
Philadelphia: 929 Chestnut Street.
Cleveland: Cuyahoga Building.
London: Hastings House, Norfolk Street, Strand.

Cable Address, "Stryjourn, New York"; "Stryjourn, London"—Lieber's Code used.

ST. LOUIS HEADQUARTERS:
Section 1, Electricity Building, Louisiana Purchase Exposition.

TERMS OF SUBSCRIPTION

In the United States, Hawaii, Puerto Rico, Philippines, Cuba, Canada and Mexico.

Street Railway Journal (52 issues).............................. $3.00 per annum

Combination Rate, with Electric Railway Directory and Buyer's Manual (3 issues—February, August and November) $4.00 per annum

Both of the above, in connection with American Street Railway Investments (The "Red Book"—Published annually in May; regular price, $5.00 per copy)..................................$6.50 per annum

Single copies, Street Railway Journal, first issue of each month, 20 cents; other issues, 10 cents.

To All Countries Other Than Those Mentioned Above:

Street Railway Journal (52 issues), postage prepaid...................... $6.00
25 shillings. 25 marks. 31 francs.

Single copies, first issue of each month, 40 cents; other issues, 15 cents.

Subscriptions payable in advance, by check or money order. Remittances for foreign subscriptions may be made through our European office.

Entered as second-class matter at the New York Post Office.

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.

Address all communications to

STREET RAILWAY JOURNAL,
114 Liberty Street, New York.

The Effect of Transfers on Earnings

Just what the effect the granting of increased transfer privileges has on the earnings in any specific case is always a matter of much conjecture, and it is doubtful if any company or individual has ever arrived at a satisfactory conclusion as to what the effect is. Of course, it is known in a general way that a liberal system of transfers tends to increase the number of passengers carried on any system of street railways. It is further reasonable to suppose that it tends also to raise the percentage of operating expenses to gross receipts because of the longer distance that passengers must be carried for 5 cents and because of the expenses incident to picking up and discharging a passenger two or three times instead of once. There is further, the loss of revenue due to an abuse of the transfer privilege, which must be figured into the final account. That the transfer privilege is abused in many cities there is no doubt, but where abuses are carefully followed up and offenders punished, it is doubtful whether the aggregate loss of revenue from this source is as serious as some operating men think when one balances against it the increased gross receipts.

About two years ago the Chicago Union Traction Company was compelled to give universal transfers over all north and west side lines in the city of Chicago. At that time there was much speculation as to what the effect would be on the earnings of the company, and there was some discussion in these columns by various accountants as to how the real effect of this change could be determined. No two of these answers agreed as to how this should be determined, and we do not think the reports of the receivers of the Chicago Union Traction Company throw any light on the subject. So many things tend to modify the earnings of any street railway system from year to year, especially in such an unsettled state of affairs as now exists in Chicago, that it is practically impossible to analyze the earnings and operating expenses in such a way as to determine just what effect universal transfers have had. In Chicago one of the elevated roads covering part of the same territory as the Chicago Union Traction Company has apparently felt the effect of the universal transfers on the surface lines, as its gross receipts failed to show their natural increase for a time after these transfers were first given.

We are inclined to think that the matter is not one which can be determined by minute analysis; it must rather be determined, if at all, by the general results. The gross receipts should be increased by universal transfers, unless there are enough cases where passengers have been paying two fares to cover a given distance, to more than counterbalance the increased riding caused by the universal transfers. The first thing, therefore, is to determine the probable effect on the gross receipts of the change, taking into consideration, if possible, other roads similarly situated which have not made such changes. The gross receipts and the per cent of operating expenses to gross receipts being the two items in which one might expect variation due to changes in transfer arrangements, the attention should be mainly confined to determining what changes, in addition to the transfer changes, have been made which would vary these percentages. After this is done, some kind of a guess as to the effect of the changes in transfer arrangement can be made. Of course, the point of the whole matter is the effect on the net receipts.

Opening Semi-Convertible Cars

The great point that has always been urged in favor of the semi-convertible type of car is the ease with which it can be changed from a closed car to a nearly open car upon a few moments' notice. On roads where it has been introduced, however, we think a little more attention on the part of the company to the condition of the windows as they leave the car house would be very beneficial to the service. We mean by this that in warm summer weather a semi-convertible car should not be allowed to leave the car house without having its windows opened so as to make the car as near an approach to an open car as is possible. This fact is worth considering at this time of the year, because while most semi-convertible cars are being run closed, some managers may be debating whether to adopt the semi-convertible type or to use double equipment. It is all very well to say that the passengers can raise and lower the windows as they please and that this matter should be left entirely to the passengers. The fact is that the majority of passengers will leave the windows as they find them unless the weather is so extreme one way or the other as to almost force them to open or close the windows. Some would probably argue that if passengers do not care enough about having the windows to open them themselves there is no need for the company to bother itself about the matter. But this reasoning is far from correct. In the first place, many passengers are not entirely familiar with the method of raising and lowering of street car windows, as they usually differ essentially from the steam coach and the house windows which they are accustomed to handle. Then, too, there may be a little disinclination on the part of a passenger to open a window for fear of causing discomfort to some one behind him. But most of all, we must insist that many passengers do not stop to consider why a car may seem close and uncomfortable, even though the closeness may be due to the fact that the passengers themselves do not lower the windows. Consequently, if the company does not look after the windows in warm weather, the passenger is apt to get an impression that the cars are unpleasant without really knowing the reason why.

Some companies have always stood out against the adoption of the semi-convertible car on the grounds that nothing can quite take the place of the regular open car for pleasure traffic. There is much in this argument, and it behooves companies operating semi-convertible cars to recognize this and make their cars as nearly open cars in summer as they can possibly be made. We have in mind several excellently operated systems where the windows of the semi-convertible cars are usually left just as the passengers place them from one day to another. The result is that on some very warm and pleasant days when the cars should be fully open, cars will be sent out from the car houses with half or two-thirds of the windows closed. They may continue in service for many hours before various passengers will take the trouble to open up the windows to really make the car pleasant for summer riding.

Another point to be remembered on semi-convertible cars having upper sashes which can be raised or lowered is that these upper sashes are very seldom touched either by passengers or conductors. If these sashes were lowered, the effect would be practically that of an open car, but since they usually are not, they are practically of no use. What we have said so far about opening windows wide, of course, applies mainly to the warmest summer weather. On cool evenings and during the spring and autumn, there will be plenty of times when many of the passengers will want the windows closed, and it is the ease with which the semi-convertible car can be changed from closed to open that makes it so popular. It is this very ease of change which has been responsible for the fact that the most is frequently not made of its possibilities as an open car. The companies which are looking closely to the maintenance of the highest standard of service, and as much summer pleasure riding as possible, would do well to look into this detail of operation and see that conductors keep the windows of semi-convertible cars in a state as nearly as possible suited to the weather. It is, of course, impossible to suit the ideas of all the passengers all the time, but a good approximation can be made of suiting the ideas of most of the passengers most of the time.

A Few More Train Resistances

Some day, when the lion and the lamb lie down together, when the mystery of Gilgal is solved and the author of the brutal assault on the late William Patterson is jailed, we shall expect to get a logical and rational general formula for train resistances. Meanwhile light on the subject is welcome and every attempt to co-ordinate experiments dealing with it is commendable. Mr. Davis' new formulæ, which we are glad to present to our readers in the current issue, are the latest attempt to clear up some of the difficulties of the subject. They are in substance similar to the formula published by Mr. Davis more than two years ago, but tempered by some further experiments, and with the constants modified to suit various cases. The advent of electric traction, with its heavy and fast running motor cars or short trains, has tended greatly to discredit the formulæ of the early days of railroading, already in disrepute from failure to meet high-speed work on modern roadbeds. All such formulæ are empirical, but of late years a serious effort has been made to base them on correct principles and to give their various terms rational values. To begin with, any increasing relation of resistance to speed can be represented by a formula involving powers of V, and within more or less narrow limits by a formula involving only the first power. Most resistance formulæ take the form $A + BV + CV^2$, and the trouble with them has come from the fact that the generally rather rough experiments over a somewhat limited range can be represented almost equally well by a small value of B and a large value of C, or the reverse. Either device for a short distance on the curve will run within ordinary experimental errors. The early attempts were in the direction of a large C, and so broke down at high speeds. An example of later practice is Sinclair's formula, $R = 2 + .24V$, and Vauclain's, $R = 3 + .166V$. These give excellent results for trains at ordinary railway speeds on fair and extra good tracks, respectively, but are less successful for short trains or long single cars as used in electric railroading.

Mr. Davis, for these modern cases, has used a smaller coefficient of V to take account of the relatively smaller axle friction, and has added a term $m V^2$, like many other experimenters, to take account of the increasing influence of air resistance. But in such case there enters a perceptible but very uncertain factor, depending on the added air resistance due to the length and character of the train, which leads to difficulties. Hence, at this point the formulæ become empirical. In Mr. Davis' earlier work, he was led, probably, as we suggested at the time, by the unfortunate method of coasting, to a value of the coefficient of V^2, quite too large—.004, in fact. The various results obtained since then have led him to the value .003, which could be still further reduced to .0025 to advantage. In his formula D, this coefficient is increased, not, however, to indicate a larger coefficient per se in heavier trains, but to compensate for variation in m of the factor $[1 + m (n - 1)]$, which can thus be retained as a constant. Of course, lateral and rear-end air resistances can be taken care of within moderate speed limits by changing either m or the coefficient of V^2 proper. The nature of the air envelope of a train certainly varies with the speed, but whether with the first or a higher power seems to be uncertain. Probably the real relation is very complicated, quite likely involving both the speed and the absolute length of the train. In the present state of knowledge of the subject, such a correction must be frankly empirical. The variation of the absolute term in Mr. Davis' several formulæ is also an empirical change for which it is less easy to find a rational explanation. None is needed, however, if the formulæ actually fit the facts. Great caution must be exercised in extrapolating from any formula, and we are glad to see that Mr. Davis gives the limitations of each case rather carefully. This is very desirable, and perhaps it would have been well to set the speed limits even rather more closely. We are inclined to think that "B" and "C" will give results considerably too high near the upper limits of speed ascribed to them.

This is not an uncommon fault in formulæ, in which the coefficient of V^2 is made to carry the burden of the unknown variables. Formulæ in V are likely to err in the opposite direction. For the sake of comparison we give the various results for train resistance as computed by the methods of Sinclair, Vauclain, Aspinall, Davis and Smith, the last named being promulgated at the last American Institute of Electrical Engineers' meeting in the excellent paper of Lyford and Smith. A five-car train is assumed, weighing 125 tons, and running at 60 m.p.h. R is in pounds per ton of 2000 lbs.:

R (Vauclain)	13.0
(Sinclair)	16.4
(Aspinall)	16.0
(Davis) B	24.8
(Smith)	20.2

Of these, the first two, in V only, give low results, the last two, in V and V^2, give large resistances, that of Davis' being much increased by his train factor. Aspinall's formula, involving $V^{\frac{5}{3}}$ only, gives a low result at this speed, but shows a rather sharp increase for higher speeds. The wide discrepancy between these results, making due allowance for differences in the character of the rolling stock assumed, shows clearly enough the need of further investigation. If Vauclain is correct, then a road equipped, by reference to Davis, would be overpowered by nearly 100 per cent; if Davis is right, then a road equipped by the former data, the standard, by the way, of the Baldwin Locomotive Works, would be in a very bad way indeed. As Mr. Davis very properly intimates, the former mistake is less serious than the latter, but the range in results is altogether too large to be pleasant, especially as all five of the formulæ are based on recent experiments, and are supposed to represent the latest phases in the investigation of the subject. In looking over these and similar results, the points which need clearing up seem to be as follows: First, the coefficient of V is very probably not a constant, as the speed varies. It is made up of resistances of rather miscellaneous character, which do not necessarily follow the same law of increase, and some of which may even decrease with the speed within certain limits. The results of experimental runs at very high speeds show, first, that the track resistances are sometimes unexpectedly low, and also that a point can be reached, as in the earlier Zossen tests, at which they increase sharply owing to instability of the roadbed. This point of abnormal increase must occur at different speeds on various tracks, and probably also with variations in the rolling stock. Second, the coefficient of V^2 may easily be taken too large, the Zossen values pointing to a figure not exceeding .0025 for trains with fairly smooth contour at the front. Third, the modification of the term in V^2 to take account of changes in the length of train is very uncertain indeed. In our judgment, the real variation probably involves both V and V^2, which gives justification for the use as a convenience of fractional powers of V, as shown by Blood and Aspinall. Fourth, in our modern practice it is pretty clear that a distinction must be made between motor cars and trail cars, and between the long trains of steam roads and the short trains or single cars of electric roads. There are some exceedingly good points about Mr. Davis' formulæ, but we think they will give too high figures near their respective limits of speed, particularly for trains. His scheme of a series of formulæ for different conditions appears desirable in the present state of our knowledge. Whether, however, these had better vary with respect to weight and speed of cars, or with respect to length of train, as in Aspinall's formulæ, remains to be seen. The whole subject still needs clearing up. The experimental data most to be desired are those which will separate train resistance and air resistance at speeds above 50 m.p.h., particularly for short trains. Most electric train data have been derived at considerably lower speed than this, and the Zossen results, invaluable for the purpose there in view, relate to single cars at speeds that give a greatly predominant importance to head air resistance.

High-Tension Trolley Construction

As indicated in the articles which have appeared in these columns during the past few months, the details of high-tension trolley construction for single-phase railways are being worked out by the two large manufacturing companies which are offering the single-phase systems on the market, and the solutions of the problem by these two companies are very similar. Both involve the use of a catenary; that is, a wire or a cable from which the trolley wire is supported at more or less frequent intervals. The construction is so novel, as far as practice in this country is concerned, that it is doubtful whether one out of every ten electric railway men who first heard the term catenary knew what it meant when applied to overhead construction. Nevertheless, it seems rather remarkable now that it should not have been adopted before, as there are some very strong arguments in its favor.

Possibly one of the arguments which is of most immediate practical bearing in favor of supporting the high-tension trolley wire from a catenary, is that the ordinary type of center-bearing high-tension insulator can be used to support the catenary, and there is therefore no need of designing any new high-tension trolley wire insulator, the performance of which in practical service must, of course, at this time be a matter of conjecture and experiment. Suspending the trolley wire from the catenary itself is such a flexible arrangement that most of the shocks and blows of passing trolley wheels or trolley bows are dissipated before they reach the insulator.

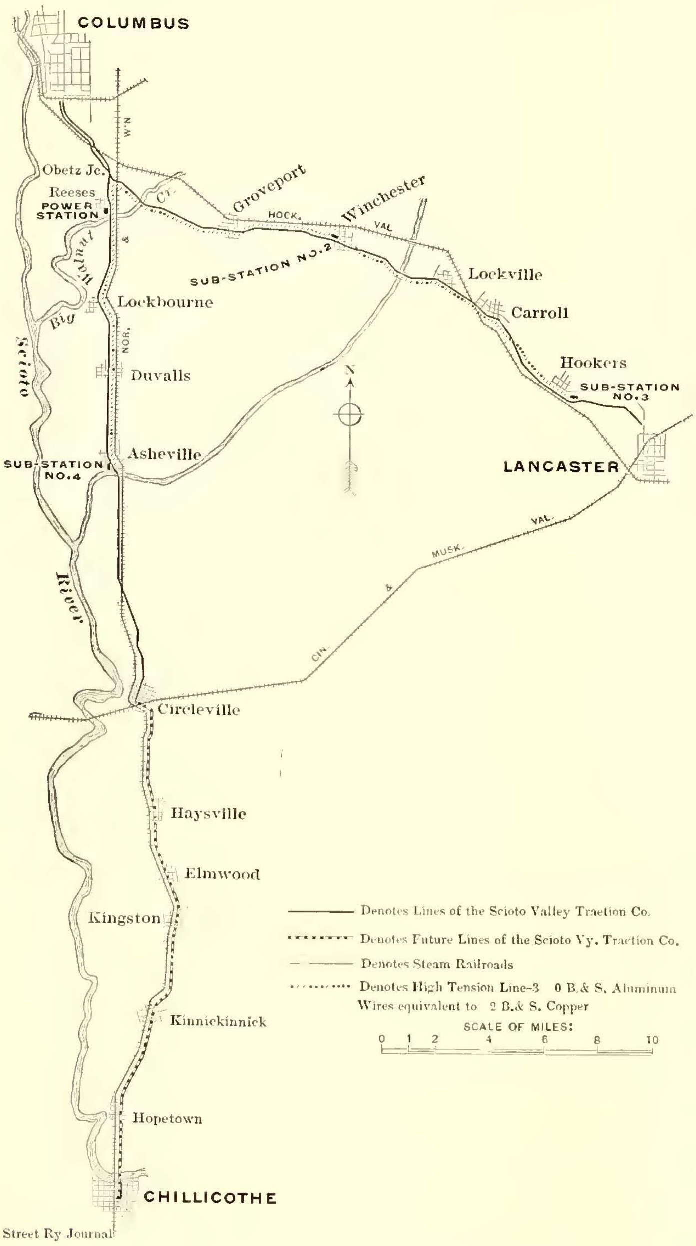
Another argument, which is a strong one if high-tension trolley wires are to be run through the streets of the smaller towns through which an interurban railway passes, is that a trolley wire supported at frequent intervals from a heavy catenary is less liable to fall down in the street than if the trolley wire is supported only at the poles.

The principal essential differences in the types of high-tension trolley wire construction with catenaries which have been experimented with so far are in the number of supports for the trolley wire and the position of the trolley wire. In the form called the tight catenary construction, both trolley wire and catenary are drawn tight and there are frequent supports for the trolley wire. In another form of construction the catenary is left looser, with a fewer number of supports for the trolley. The position of the trolley wire, whether over the center of the track or out on the side, will naturally depend on whether there is to be any hauling by steam locomotives over the same track. Placing the trolley wire in the center is certainly to be preferred, unless when locomotives are to pass over the track so frequently as to cause undue depreciation from smoke and steam.

THE SCIOTO VALLEY TRACTION COMPANY

Another and important addition to the already extensive network of electrical interurban roads in Ohio was completed during the past summer, and is now in successful operation. This consists of the lines of the Scioto Valley Traction Company which connect the city of Columbus with Lancaster to the southwest, and with Circleville to the south. An extension is also planned to connect Circleville with Chillicothe, further south. A special interest attaches to this system because it is the only line in Ohio which is operated by a third rail.

The country through which the Scioto Valley Railway is constructed is thickly settled with a population that is financially able to avail itself of the opportunities afforded by a first-class interurban road. The population tributary to this new road averages about 1100 per mile of route, exclusive of Columbus, which has a population of 135,000. A large part of these people are in the habit of doing business in Columbus. Throughout the year there are theater parties and sightseers, and during certain seasons the State Fair, horse races, baseball games and kindred attractions draw many people from the surrounding territory into the city of Columbus.

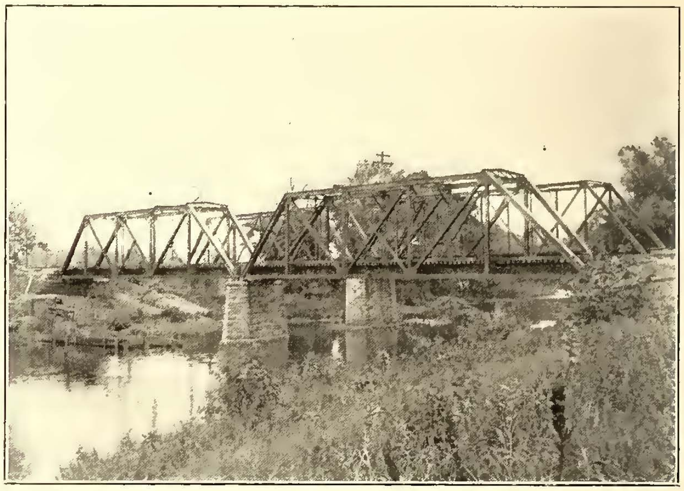


MAP OF THE LINES OF THE SCIOTO VALLEY TRACTION CO.

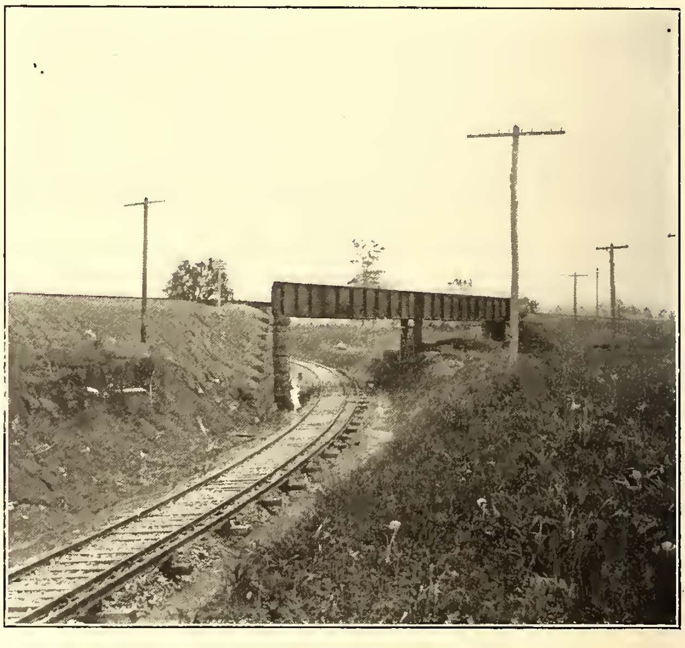
Lancaster is the county seat of Fairfield County, and has a population of over 9000. It has large glass factories and shoe factories, with well-paid employees, who will naturally avail themselves of the improved facilities for visiting Columbus. There are extensive stone quarries in the vicinity, and the town owns its own natural gas wells. Near Lancaster is the Boys' State Industrial Home and the camp meeting and assembly grounds of the Methodist Episcopal Church, where many Columbus people have erected summer cottages.

The town of Circleville has over 7000 inhabitants, and is the county seat of Pickaway County. Its interests are largely manufacturing, and it operates several paper mills, flouring mills, canning factories and a carriage factory.

The electric line from the city limits of Columbus to that of Lancaster is about 26.3 miles in length, and practically parallels for this distance the route of the Hocking Valley Railroad, while between Columbus and Circleville, the electric road follows the line of the Norfolk & Western Railroad. It is believed that much of the large traffic, which has hitherto been enjoyed by these steam roads, will naturally come to the more convenient and accessible electric road. The speed is substantially the same as that made by the steam roads, while the electric road has the advantage of entering the heart of the cities and affording much more frequent service.



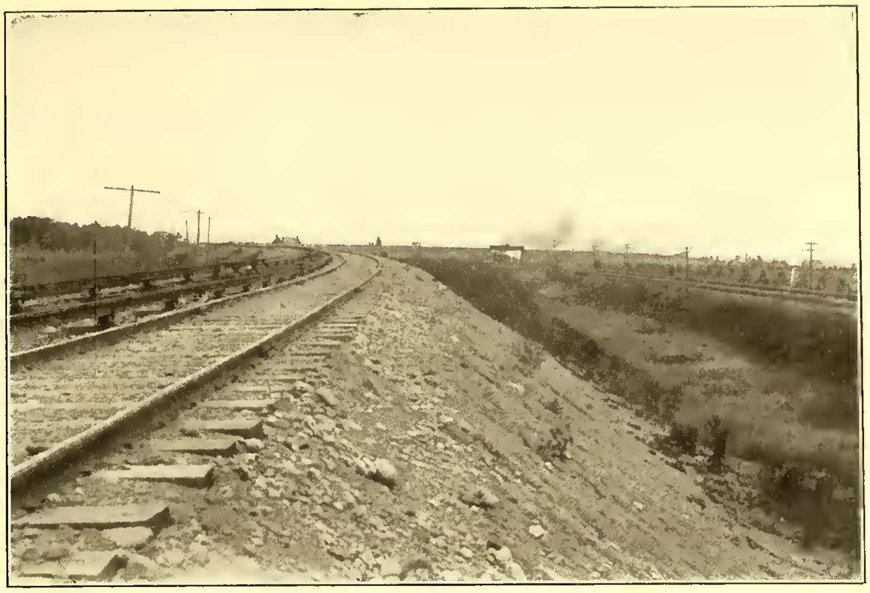
DOUBLE-SPAN TRUSS BRIDGE OVER BIG WALNUT CREEK—NORFOLK & WESTERN—SCIOTO VALLEY



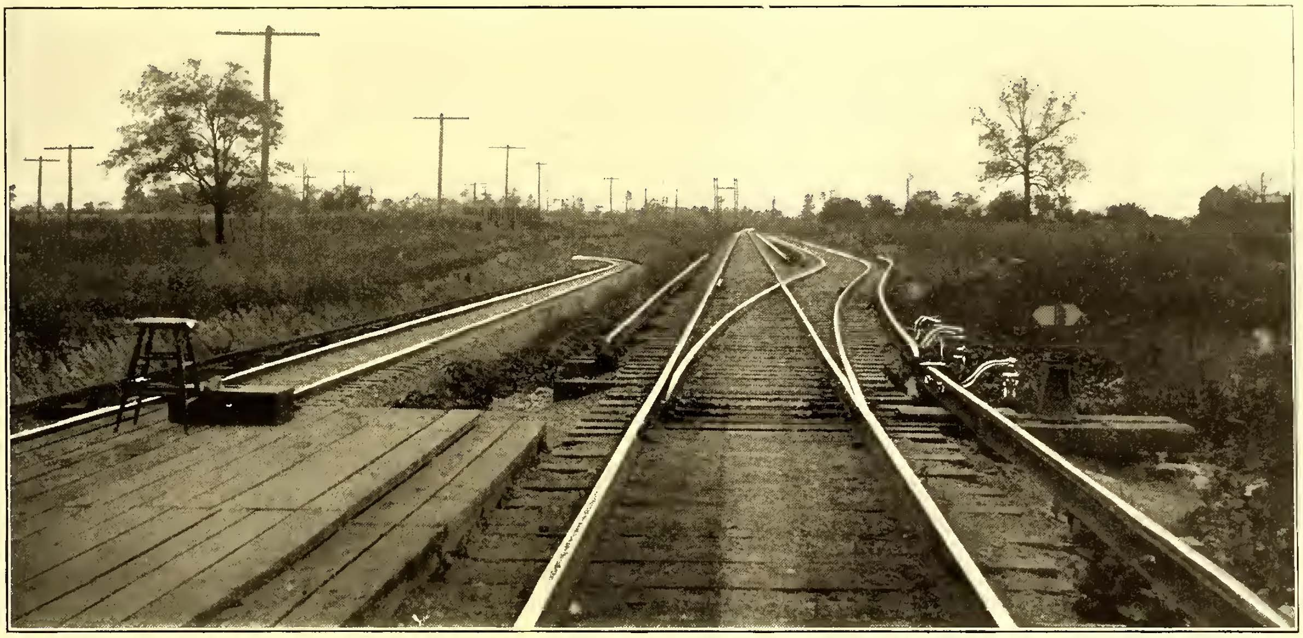
UNDERGRADE CROSSING—SCIOTO VALLEY AND NORFOLK & WESTERN RAILWAYS

In the city of Columbus the cars start from the Interurban Station on the loop of the Columbus, London & Springfield Railway, passing to the city limits over the tracks of the Central Market Street Railway, a distance of about 4 miles. From this point the road is double-tracked to Obetz Junction, a distance of about 3 miles. From the Junction, one single-track line runs in a southeasterly direction to Lancaster, and another single-track line southward to Circleville. The distance from Obetz Junction to Lancaster is about 23 miles, and from Obetz Junction to Circleville about 20 miles. The projected extension from Circleville to Chillicothe will add about 20 miles to the route.

Service is now established from the city limits of Columbus to Lancaster and to Circleville, and the trains make a schedule speed of 24.5 miles an hour, including intermediate stops. It is also proposed to inaugurate a limited service with few local stops, making a schedule speed of about 36 miles an hour. The present round-trip fare between terminals over either branch is $1, which is considerably less than the prevailing fare over the steam roads, previous to the inauguration of the electric service. Despatching is effected verbally over the company's private telephone wires, conductors being required to record their instructions in writing and repeat back to the despatcher's office at Obetz Junction for confirmation. There are two distinct telephone circuits, both carried by the high-tension poles. The despatching circuit connects the despatcher's office at Obetz Junction with each sub-station and with telephones located at each siding. Means are provided for connecting the telephone circuits with the public service of Columbus.



OVERHEAD CROSSING WITH HOCKING VALLEY RAILWAY—1½ PER CENT GRADE ON APPROACHES



ARRANGEMENT OF THIRD RAIL AT SIDING

OPERATING HEADQUARTERS OF COMPANY AT OBETZ JUNCTION

ROADBED

It has been the policy of the company to spare no reasonable expense in obtaining a roadbed of the highest class, and the construction throughout has followed steam road practice wherever possible. Steep grades and sharp curves have been eliminated wherever feasible, and in some few cases this has necessitated large cuts and fills. This is true especially on the Lancaster line, where the country is more hilly than on the Circleville line.

The ballasting along the road consists of a liberal foundation of high grade gravel for a depth of 8 ins. below the bottom of the ties and crowned up between the ties. The roadbed is drained at intervals by vitrified clay conduits extending under road and grade crossings, and by parallel side ditches extending the full length of the line.

All bridges are of substantial steel construction, resting on stone masonry abutments. To avoid the dangers and delays of steam road grade crossings, the company has constructed two under-crossings at its intersections with the Norfolk & Western Railroad, and one under and one over-crossing where it crosses the tracks of the Hocking Valley Railroad.

The ties are of oak and chestnut, 6 ins. x 8 ins. x 8 ft., spaced 2 ft. apart. Every fifth tie is 10 ft. in length and supports the third rail.

The track rails are 33 ft. long and 70-lb. A. S. C. E. section. They are bonded with two Mayer & Englund bonds, each of 204,000 circ. mils at each joint, and the track is cross-bonded every 1000 ft. with stranded No. 0000 copper bonds.

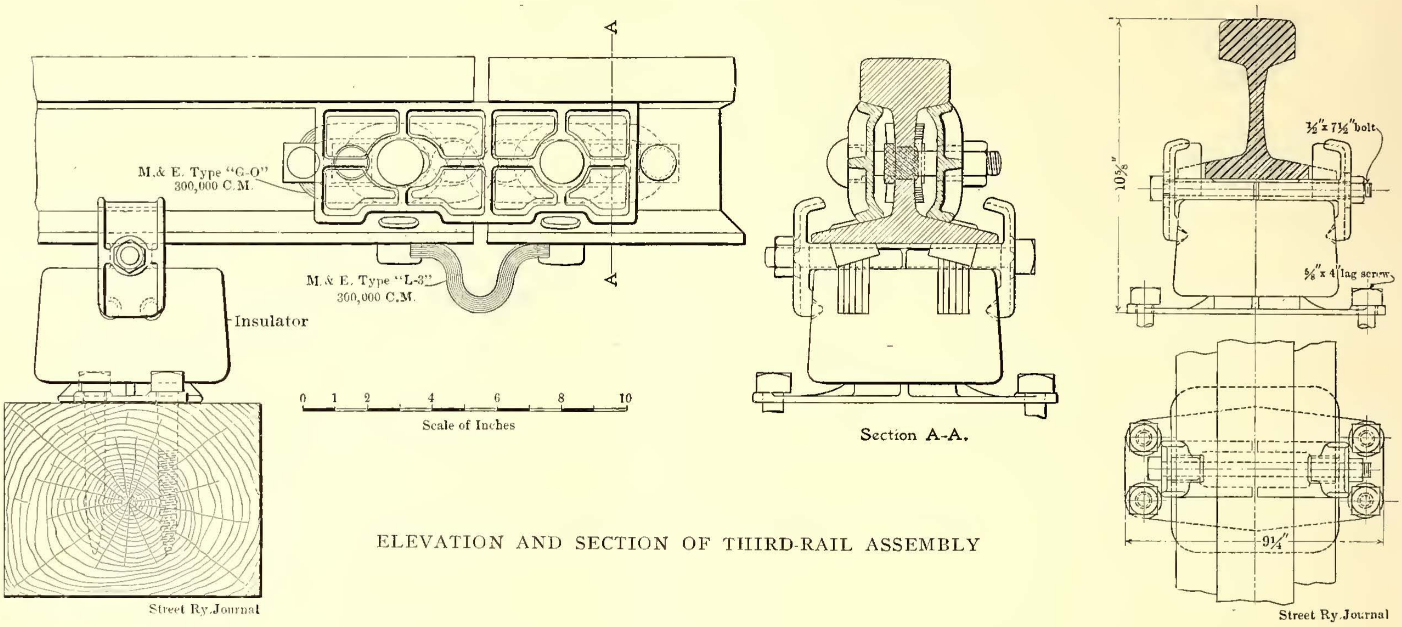
THIRD-RAIL CONSTRUCTION

The road is third rail throughout with the exception of 3500 ft. through Groveport and 7000 ft. through Circleville, where the track is located on the streets and necessitated the installation of a trolley wire. The third rail is of special steel, and weighs 100 lbs. to the yard, and is laid in lengths of 60 ft. It is elevated 6 ins. above the track rails, and the distance from the gage line of track rail to center line of third rail is 28 ins. It is mounted upon special vitrified clay insulators, with malleable iron bases and clips. The total cross-section of bonds at third-rail joints is equal to 1,500,000 circ. mils of copper.

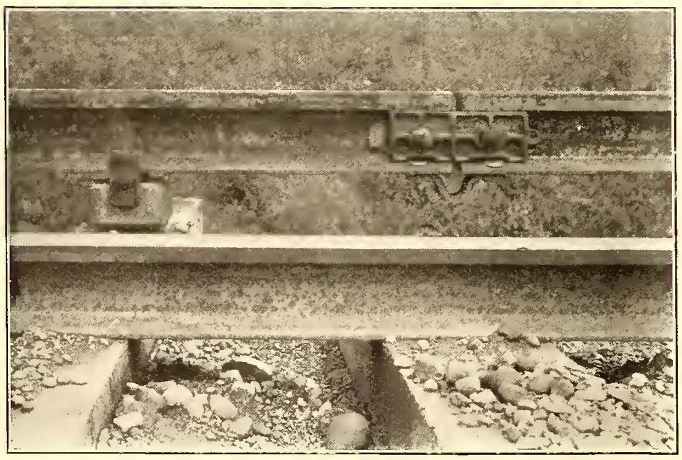
At highway crossings where it is necessary to leave out a section of the third rail, connections between ends of the rail are effected by means of lead-covered cable laid underground in vitrified clay conduits, the cable being connected to the rail by Keystone cable terminals. At sub-stations the feeders are connected to the third rail by the same method as at crossings.

ROLLING STOCK

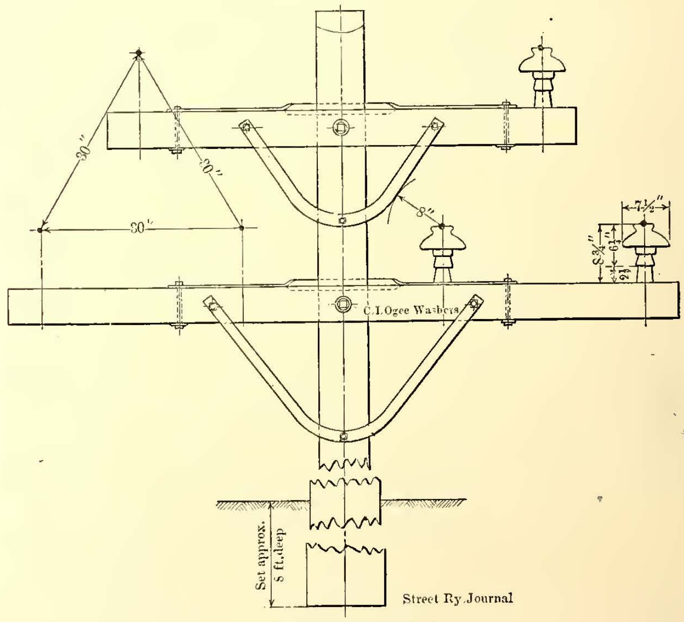
The company has eleven passengers cars and two baggage cars, which were supplied by the American Car & Foundry Company. The passenger cars measure 60 ft. over buffers, and are 8 ft. 6 ins. in width at the eaves, and the extreme height for clearance from top of rail with trolley pulled down is 14 ft. 4½ ins. When fully loaded and equipped, they weigh about 47 tons. The cars contain a smoking compartment and toilet room. The smoker will seat sixteen passengers, the total seating capacity being seventy-two. The cars are finished in oak and are furnished with rattan seats. The seats are of the Hale & Kilburn style No. 99-B. The trucks are of the Brill 27-E-2 type, upon which are mounted four GE 66 motors rated at 125-hp each. The motors are controlled by the type M multiple-unit system, which permits the operation of two or more cars in a train. Each car is provided with four third-rail shoes of the Potter type, and two trolley poles.



ELEVATION AND SECTION OF THIRD-RAIL ASSEMBLY

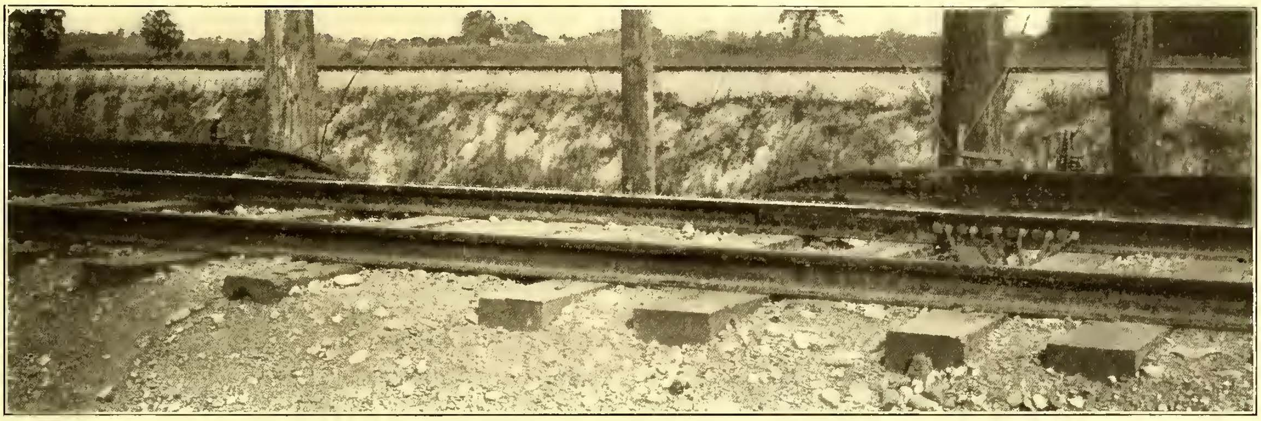


THIRD RAIL, SHOWING INSULATOR, JOINT AND BONDING—SCIOTO VALLEY TRACTION COMPANY



POLE ASSEMBLY

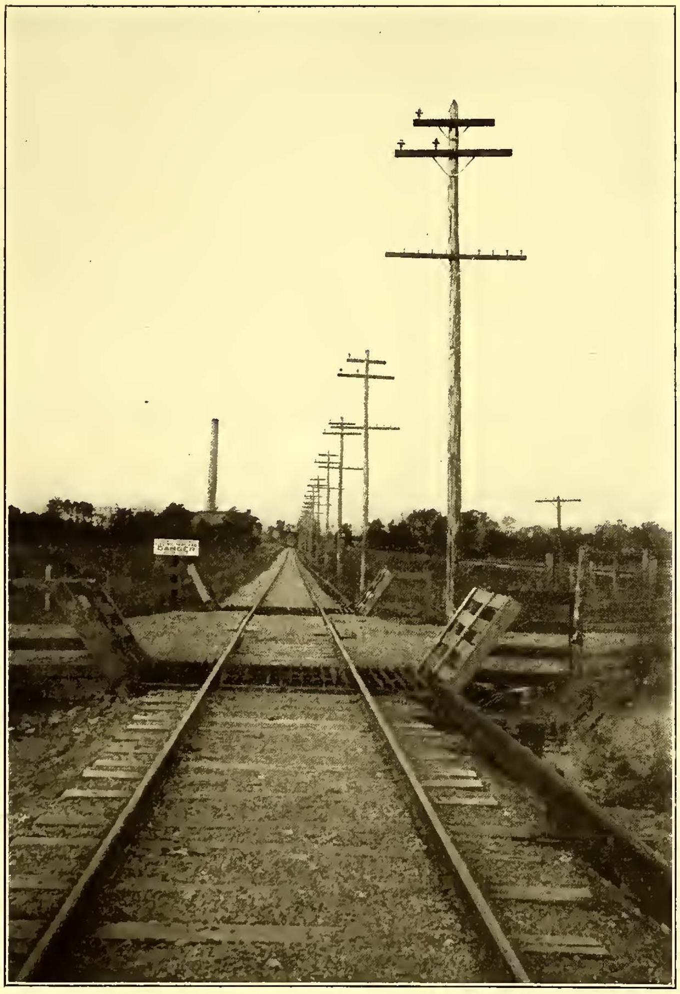
The cars are equipped with combined straight and automatic air brakes, supplied by the Westinghouse Traction Brake Company. The heaters were supplied by the Consolidated Car



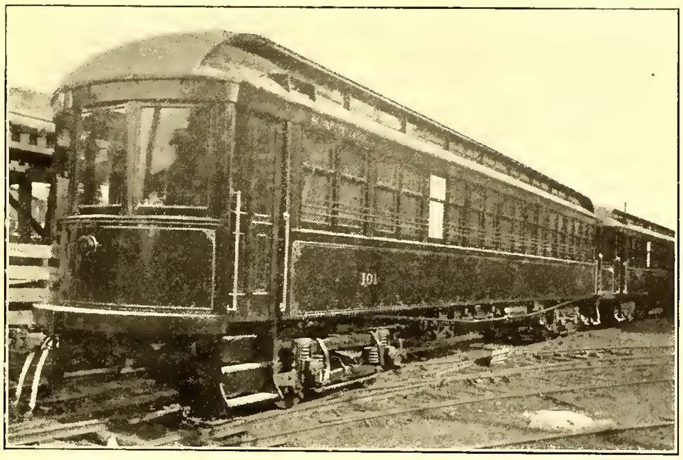
GROUND CONNECTION OF TRACK RAIL AT POWER HOUSE

Heating Company. Each car is fitted with whistle, gong, an unusual number of incandescent lights, and fire extinguishers.

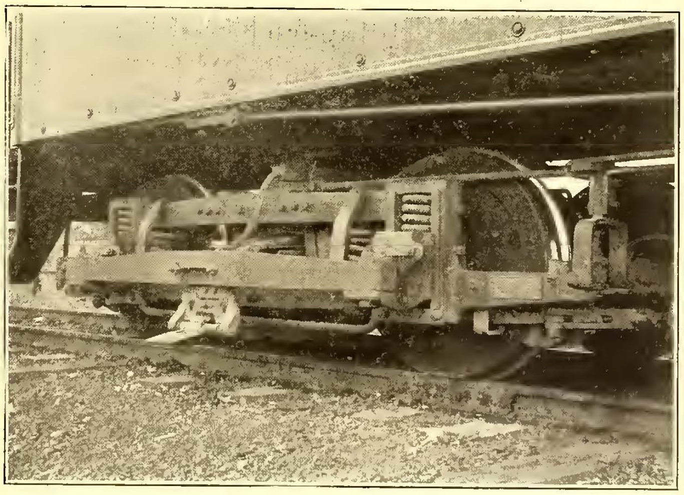
The baggage cars measure 44 ft. 3 ins. over buffers, 8 ft. 4 ins. over the eaves, and the extreme height for clearance



HIGH-TENSION LINE AND ROAD CROSSING



STANDARD PASSENGER COACH



TRUCK AND THIRD-RAIL SHOE

from top of rail with trolley pulled down is 13 ft. 7 ins. The electrical equipment is identical with that of the passenger cars.

TRANSMISSION SYSTEM

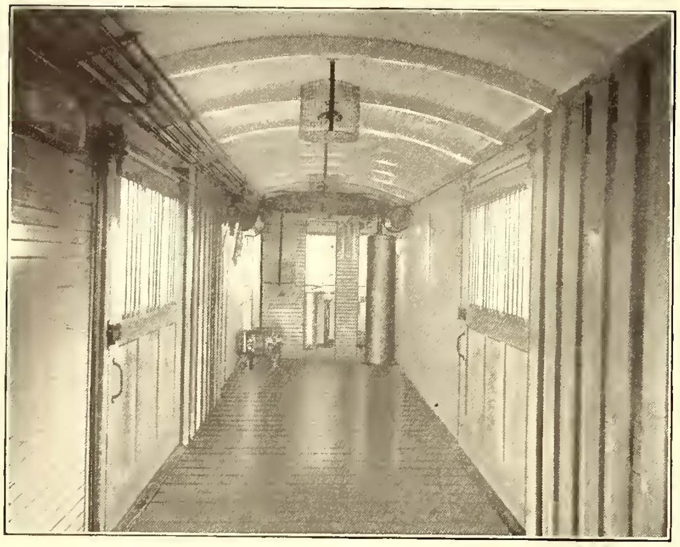
Power is generated in a central station, located at Reeses, near Obetz Junction, and is transmitted at 27,000 volts, three-phase, 25-cycle to sub-stations located at Canal Winchester, and Hookers on the Lancaster Division, and at Ashville on the Circleville Division.

The poles are set fifty-two to the mile, and are of well seasoned chestnut, 40 ft. long, except where the high-tension line crosses the steam railroad and telephone lines, or in passing through towns, where poles 50 ft. and even 60 ft. in length have been installed. The cross-arms are of yellow pine. This construction will accommodate two three-phase transmission lines, although at present only one is installed.

The high-tension conductor is of seven-strand aluminum, and the three cables, forming an equilateral triangle with 30-in. sides, are not transposed. The section of each conductor is 106,000 circ. mils, equivalent to 66,000 circ. mils of copper. The insulators are of brown porcelain, type "Locke No. 307," and are mounted on locust pins, supplied by the Ohio Brass Company.

POWER STATION

The main power station is located at Reeses, near the junc-



INTERIOR OF BAGGAGE CAR

tion of the two divisions. In the arrangement of the machinery an attempt has been made to carry out the "unit system" as far as advisable. This has been departed from in the case of the

BOILER ROOM, SHOWING FUEL-HANDLING OUTFIT AND STOKERS

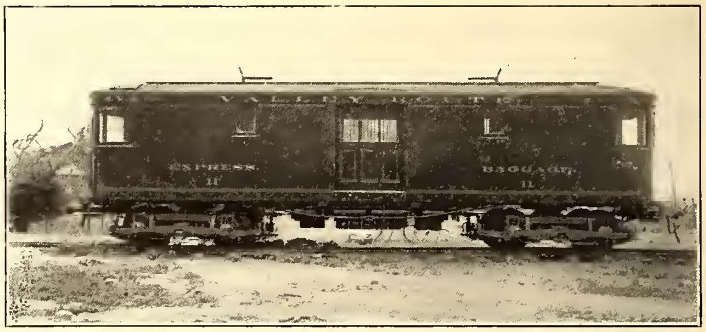
chimney, one only having been provided, also in the condensing apparatus, where the advantages of a central plant were recognized by the installation of a single apparatus to serve two units.

Each main unit consists of a battery of two boilers and an engine-generator set, two of which are now in operation. The building has sufficient capacity for four of these units without further extension.

In such a system a well-defined plan can be followed whereby each unit receives its coal at one side of the building and the generation and delivery of power take place across the station, while the longitudinal elements act in the nature of an equalizing system.

The general arrangement of the machinery may be briefly described as follows:

The four units are divided into two groups. Between these groups there is a space occupied in the boiler room by a coal supply pocket and the chimney; in the engine room, on the main floor, by the exciter sets; and the rotary converters and transformers forming one of the sub-stations of the system;



EXPRESS AND BAGGAGE CAR

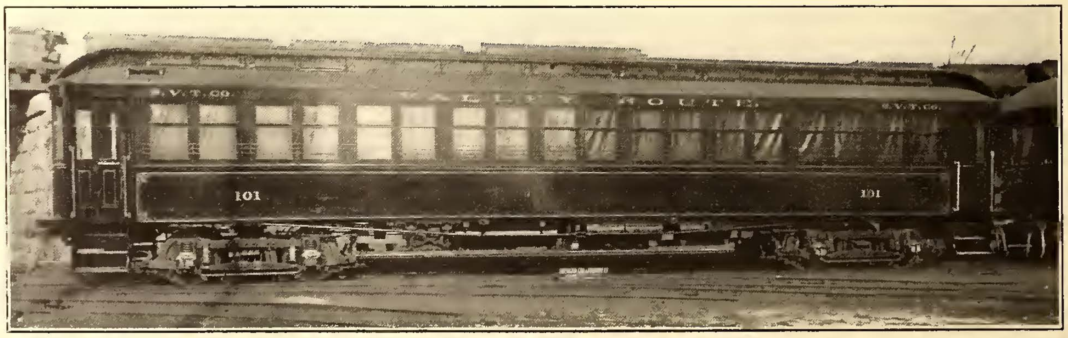
and in the basement by the boiler feed-pumps and heaters, the condensing pumps and the oil filters and pumps.

The building is of red brick and steel construction, with stone trimmings, and measures 186 ft. x 112 ft. The foundations are of concrete and the floors of concrete-steel construction. The monitor roof is of tar and gravel laid on porous book tile, and the main roof of Ludowici tile. A partition wall divides the building longitudinally into boiler room and engine room, 46 ft. and 64 ft. in width, respectively. A gallery, upon which is located the switchboard and the offices, extends the entire length of the engine room on the side opposite the division wall. Under the gallery, on the main floor, are the transformers and oil switches, and beneath, in the basement, is the bus-bar compartment.

BOILERS AND STACK

The boilers are of the water-tube type, built by the Franklin Boiler Works Company, and rated at 450-hp each. Each boiler has two drums, 48 ins. in diameter x 22 ft. 1½ ins. long, and there are 138 tubes, 3½ ins. in diameter x 18 ft. in length for each drum. The heating surface is 4884 sq. ft. They are designed for a working pressure of 200 lbs. per square inch, and are being operated at 160 lbs.

They are equipped with Roney mechanical stokers, each having 90 sq. ft. of grate surface. The stokers are driven by a 5-hp Westinghouse engine of the single-acting, double-cylinder enclosed type. The stack, built by the Alphons Custodis Chimney Construction Company, is



SIDE VIEW OF STANDARD PASSENGER CAR

200 ft. in height and 10 ft. internal diameter at the top. It has an octagonal base of red brick to a height of 4 ft. over the tops of the flue openings, surmounted by a radial brick column of circular section. Connection to the boilers is made by an overhead sheet-steel flue. There is one main damper at the flue opening into the stack, and individual dampers at each boiler.

COAL AND ASH-HANDLING MACHINERY

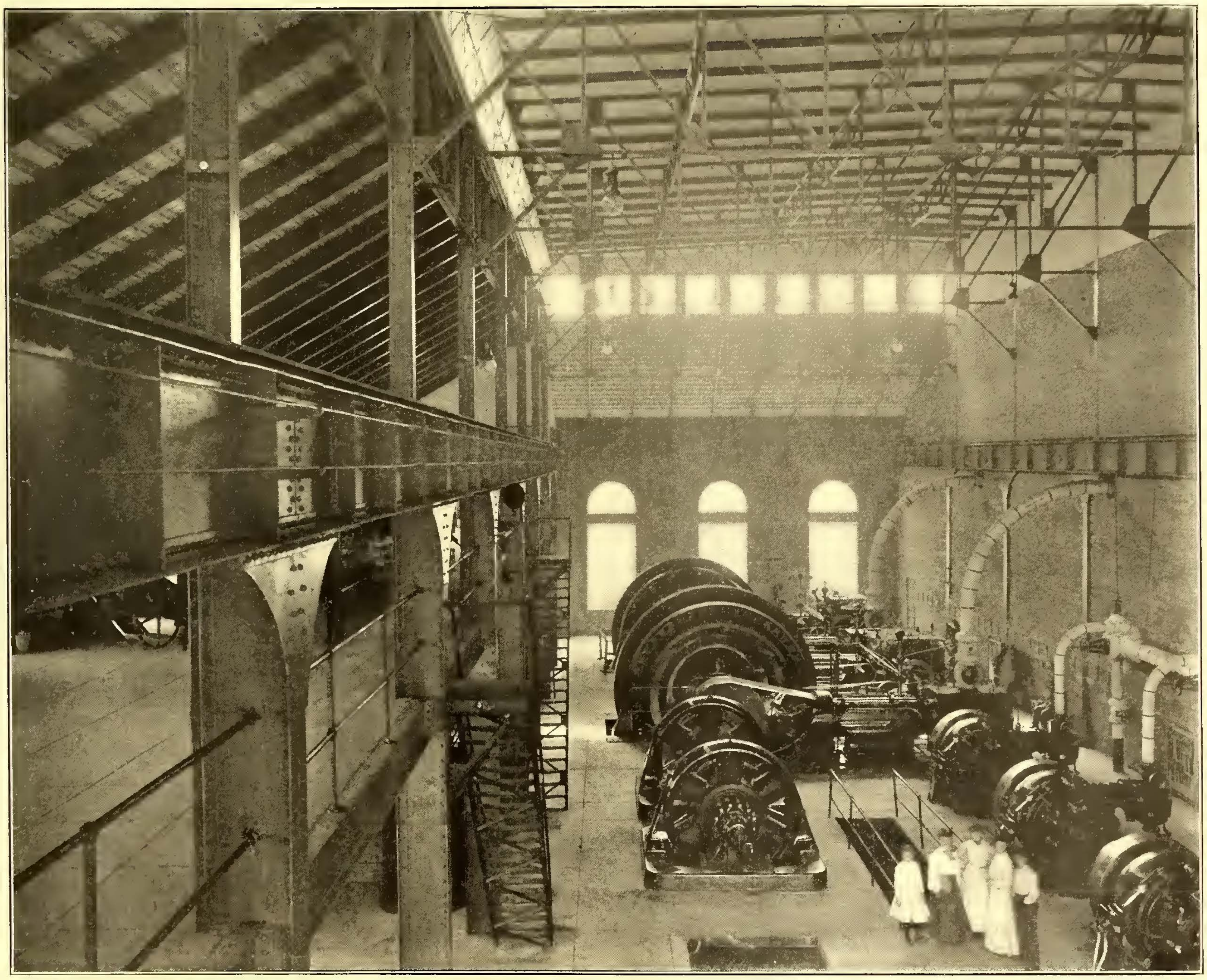
In selecting an apparatus for the handling of coal and ashes at this plant, a radical departure has been made from the method usually employed in a locality where a large percentage of the coal supply is delivered in gondola cars rather than in those of the bottom dumping type. The arrangement may be briefly described as follows:

Cars are set into the position indicated on the drawing on page 983, and, if of the dumping type, are emptied into the pocket under the track. Gondolas are unloaded with a grab bucket suspended from a trolley, traveling on an elevated runway. The coal can be delivered either to a storage pocket outside or to a supply pocket inside the building. Over the supply pocket a screen in the shape of an inverted pyramid receives the coal from the bucket, passing the small sizes and delivering the lumps to a crusher through an opening at its apex. A traveling hopper running in front of the boilers receives the coal from the supply pocket and delivers it to the stokers.

The grab bucket is of 1½ tons capacity, and is suspended by a steel cable from its hold and hoist mechanism on the trolley. A 20-hp motor operates the bucket, and the trolley is equipped with a 5-hp motor for traversing it on the runway. The apparatus is controlled by an operator from a cab on the trolley. A 25-hp motor operates the crusher, and the traveling hopper is provided with a 2-hp motor controlled from the boiler room floor.

The capacity of the unloading plant is 20 tons per hour; of the storage pocket, 1000 tons, and of the supply pocket, 60 tons, sufficient to carry the plant over night.

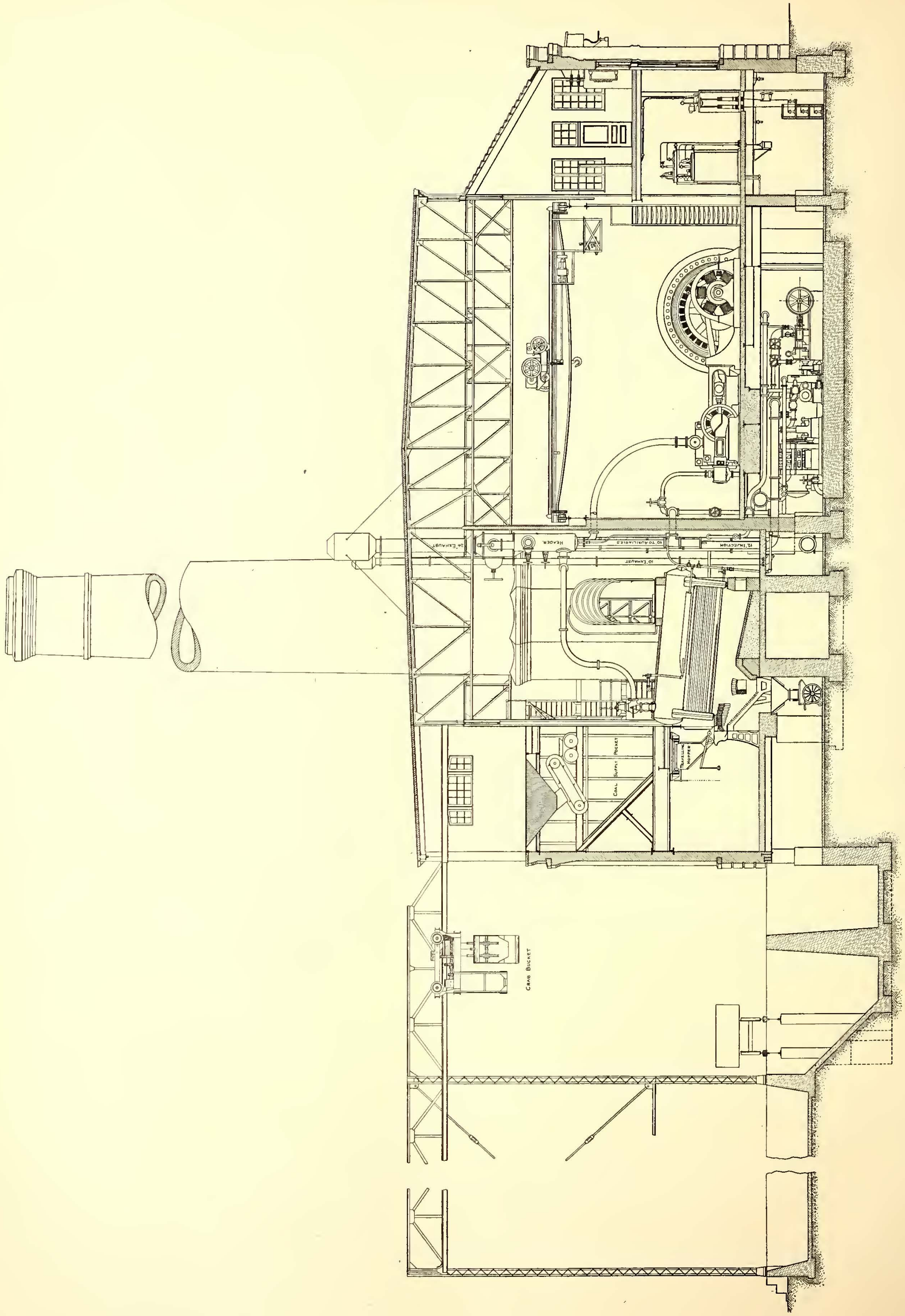
Ashes are removed in hand cars from the hoppers in the basement located under the boiler grates, dumped into a pit, and loaded by the grab bucket on cars for removal. Photographs and details of some of the interesting features are shown. The apparatus was installed by the Jeffrey Manufacturing Company.



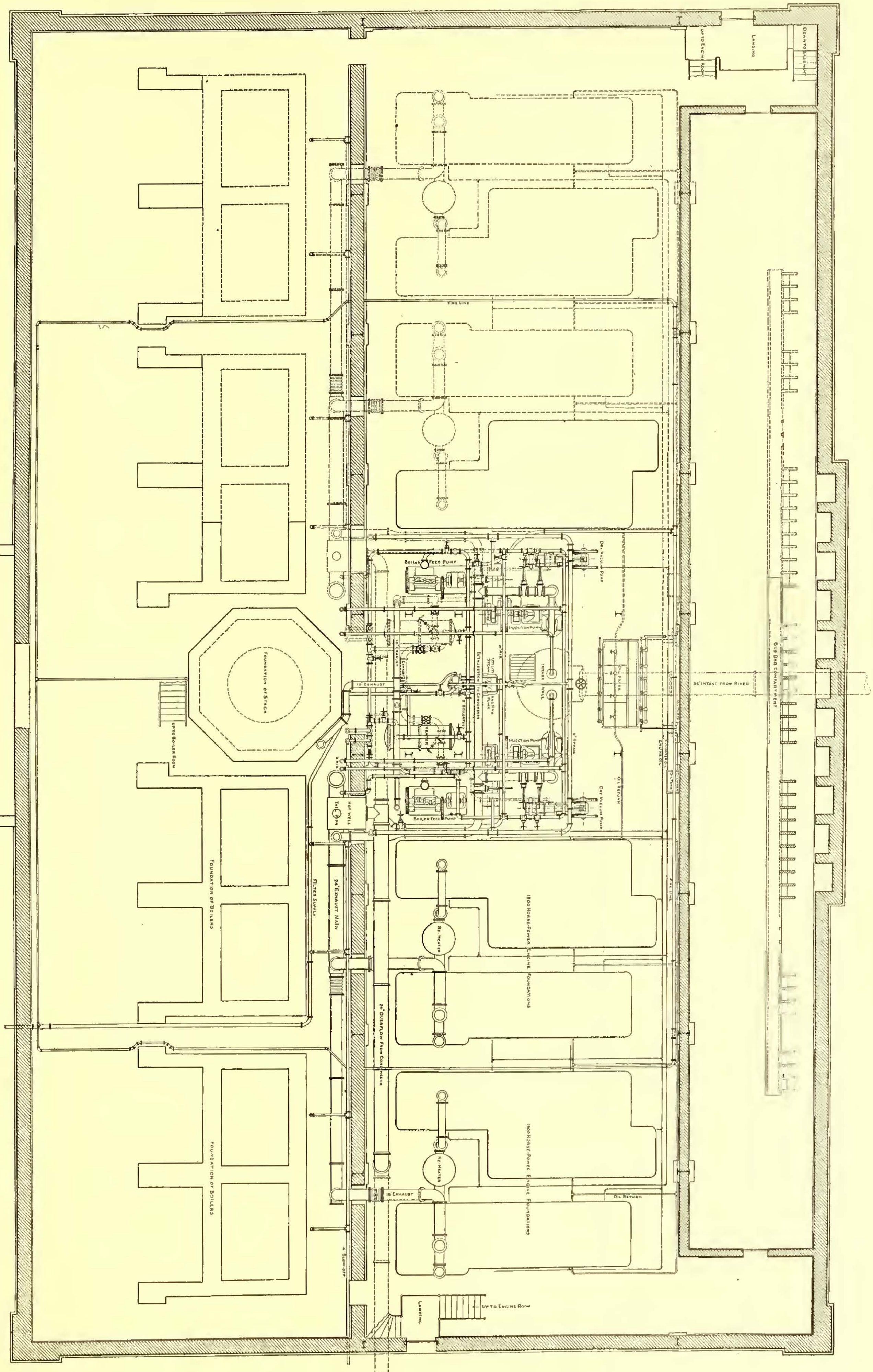
GENERAL INTERIOR VIEW OF ENGINE ROOM FROM CRANE

FEED-WATER AND PUMPS

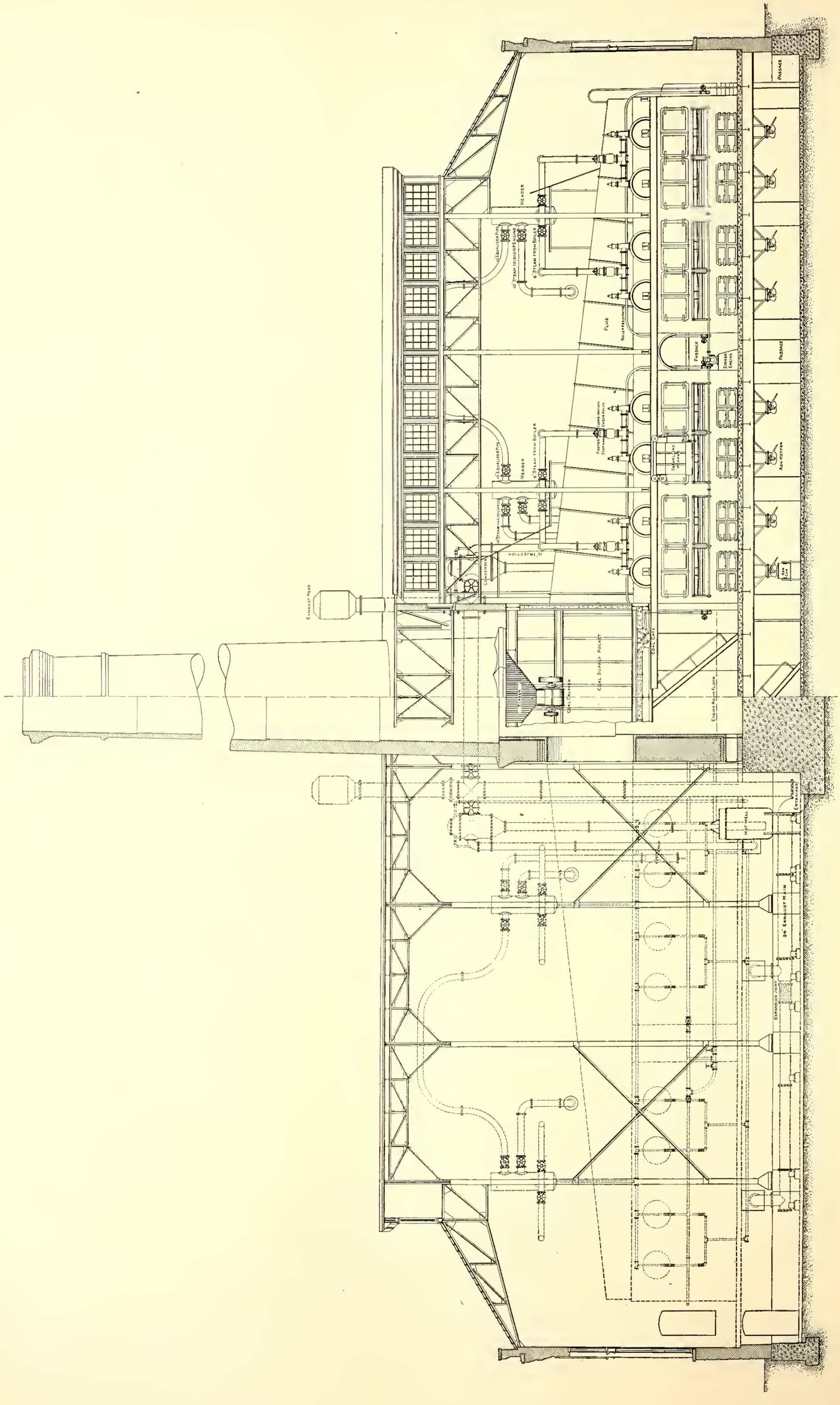
The water for the station is taken from Big Walnut Creek, and is brought through a 36-in. pipe into a well in the engine room basement. The entrance to the well is provided with screens and a cut-off valve, the river end of the pipe being protected by a crib work of timber and concrete. An analysis of the water of the creek showed its unfitness for use for boiler-feeding purposes, and a purifying plant was provided. This was installed by the New York Continental Jewell Filtration Company. The water is raised from the well by a steam-driven duplex pump, furnished by the Dean Brothers Steam Pump Works, and delivered to a tank, where it is treated with chemicals and allowed to settle. It then passes through a sand filter, after which it is stored in a "clear well." Two motor-driven triplex pumps, one being in reserve, furnished by the



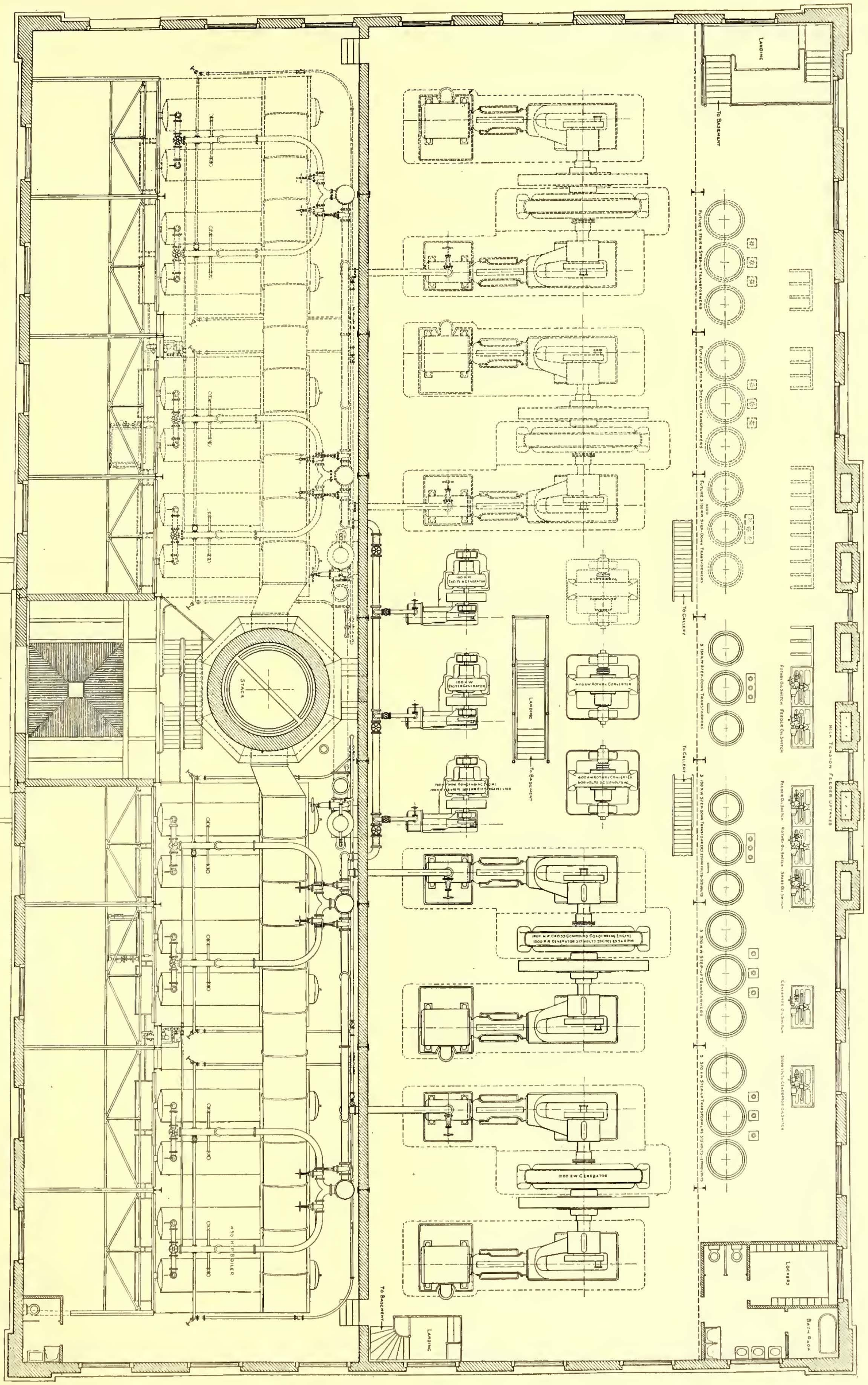
CROSS SECTION OF POWER STATION



PLAN OF BASEMENT OF POWER STATION, SHOWING PIPING



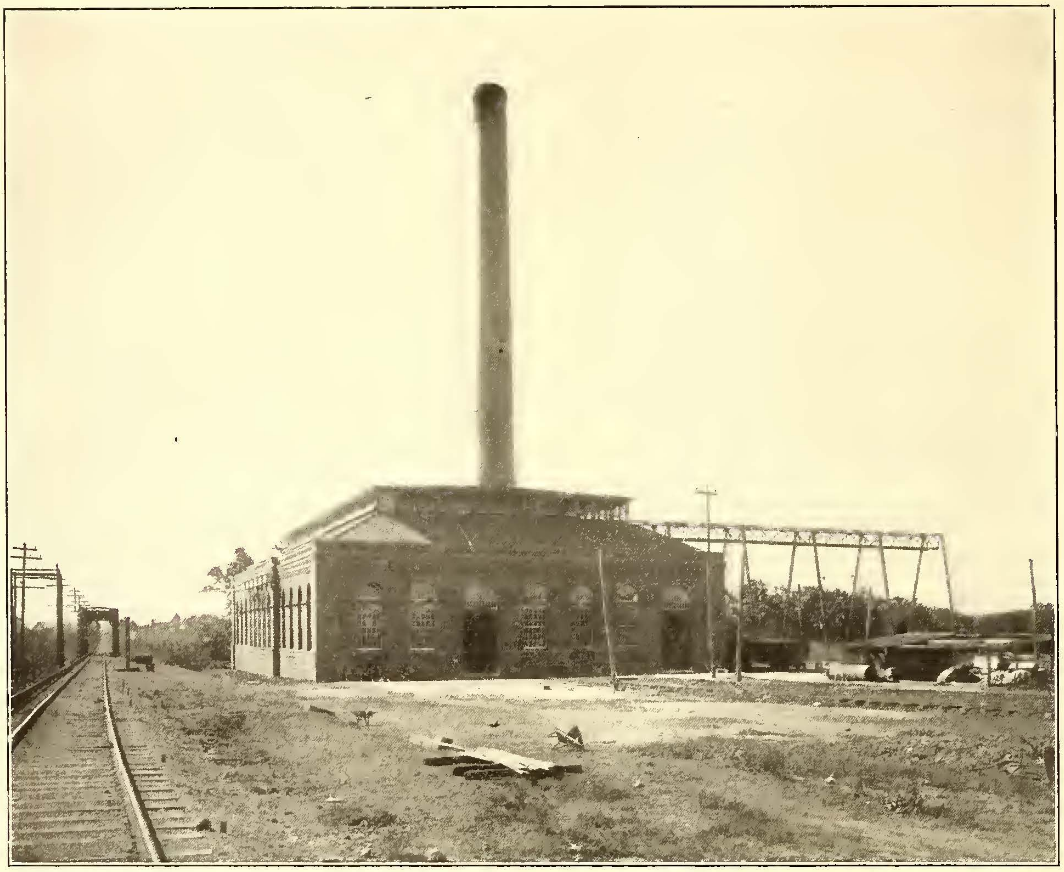
LONGITUDINAL SECTION OF POWER STATION THROUGH BOILER ROOM



PLAN OF POWER STATION, SHOWING ARRANGEMENT OF UNITS

Goulds Manufacturing Company, delivers the water from the clear well to the boilers through a Wainwright heater.

Arrangement has also been made whereby the steam pump may be used for this service in case of emergency, by-passing the water from the well around the filters, directly to the boilers. It also serves as a fire pump and for general utility purposes.



EXTERIOR OF POWER STATION

ENGINES AND CONDENSERS

The main engines are rated at 1500 hp. They are of the horizontal, cross-compound, condensing type, built by the Hoovens, Owens, Rentschler Company. The cylinders are 26 ins. and 52 ins. in diameter, with 48-in. stroke. The speed is 94 r. p. m.

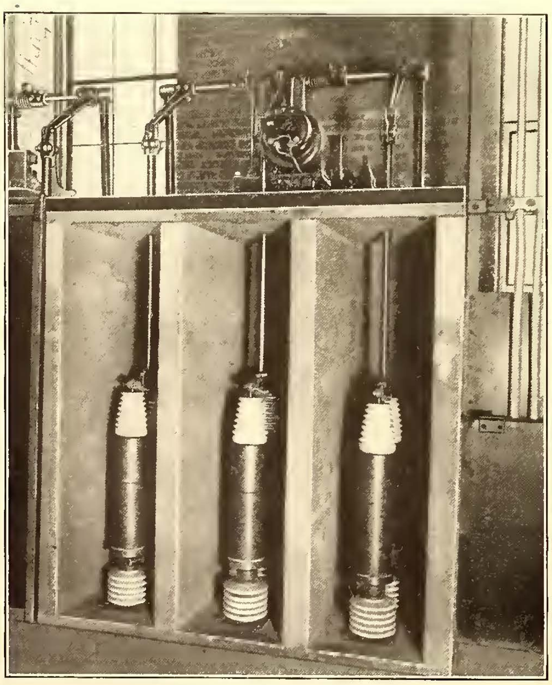
The Siegrist oiling system, by which the oil is delivered to the engines under pressure, is employed for lubricating. After use it is returned by gravity to a filter and pumped back to the engines.

The condensing apparatus was furnished by the Alberger Condenser Company. It consists of one barometric condenser serving two engine units, and of duplicate sets of water and dry vacuum pumps.

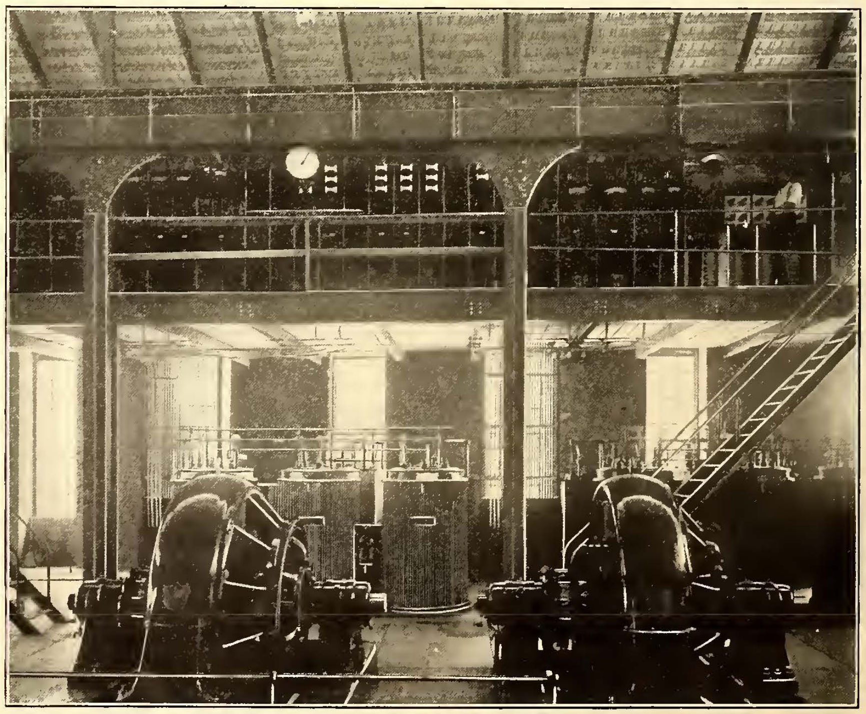
PUMPS

The condensing water pumps are of the centrifugal type, each having a capacity of about 3000 gals. per minute at 300 r. p. m. Each is direct connected to a simple, non-condensing, horizontal Harrisburg engine. These are fitted with throttling valve governors to act as a safety speed limiting device, but the actual speed of the engine, and hence the quantity of water delivered to the condensers, is controlled by a balanced Foster valve in the steam line, operated by a water regulator in the pump delivery.

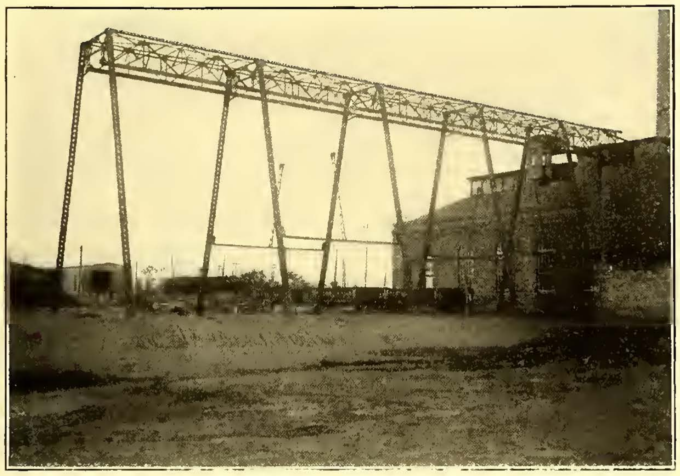
The dry vacuum pumps are of the horizontal, double-acting, fly-wheel type, with 8-in. x 16-in. steam and 12-in. x 16-in. air cylinders. In addition to their usual function of removing entrained air from the condenser, these pumps are cross-connected to the suction pipes of the centrifugal pumps. This serves to prime the latter, when necessary, as the suction lift varies considerably, being about 18 ft. under usual conditions,



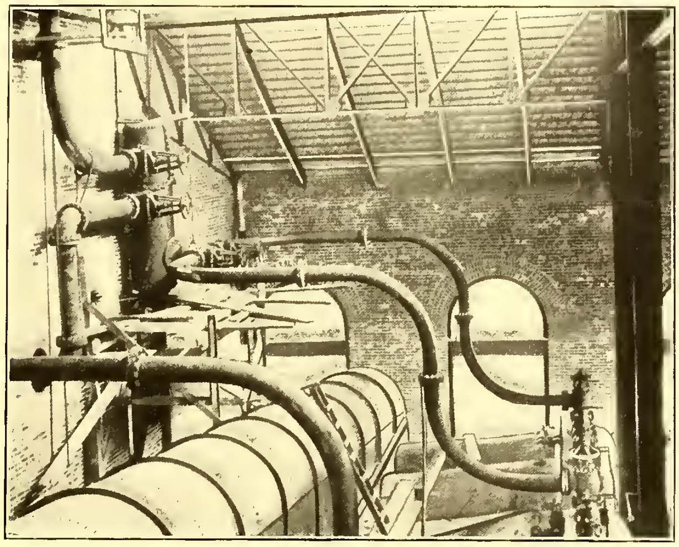
OIL SWITCHES IN SOLID CONCRETE COMPARTMENTS



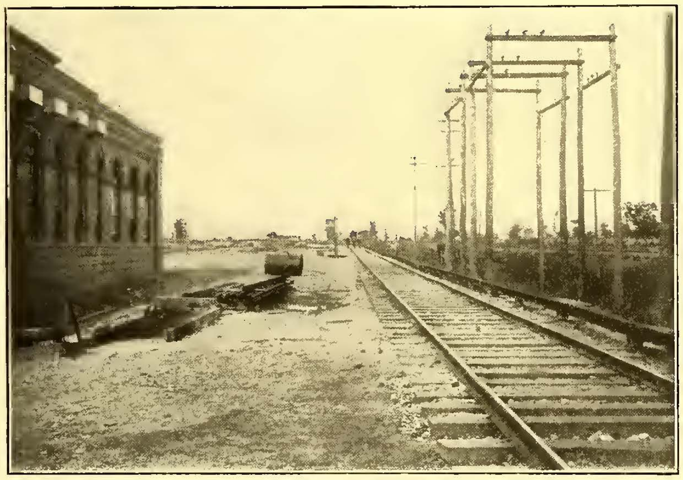
MAIN STATION, SHOWING SWITCHBOARD IN GALLERY but diminishing to a few feet during spring freshets. A safety or relief valve protects the system by opening the main engine exhaust to the atmosphere in case of trouble with the condensing apparatus.



RUNWAY FOR GRAB-BUCKET AND TROLLEY OVER STORAGE POCKET



VERTICAL STEAM HEADER IN POWER STATION



STRAIN TOWER AT POWER STATION

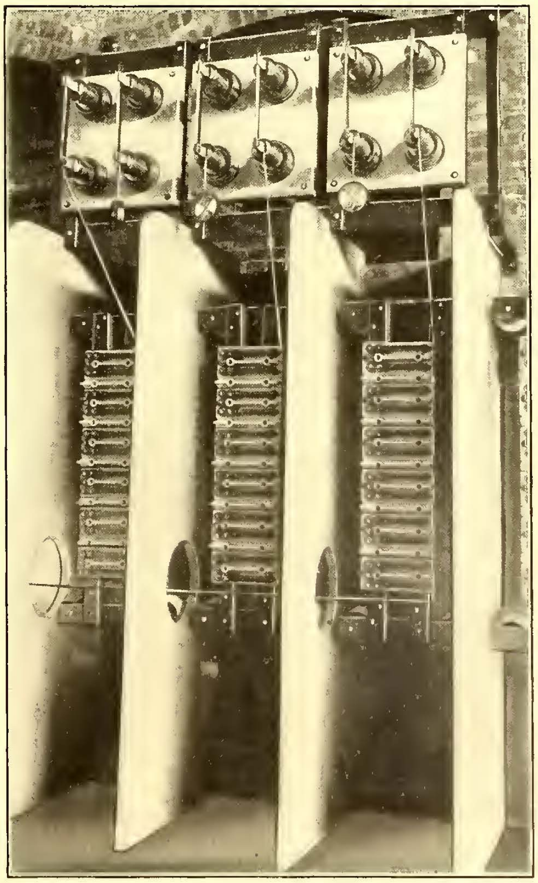
PIPING

There are several features in the design of the piping system which are believed to be novel, notably in the steam piping, where the departure from the usual practice has given excellent results. The arrangement may be briefly described as follows:

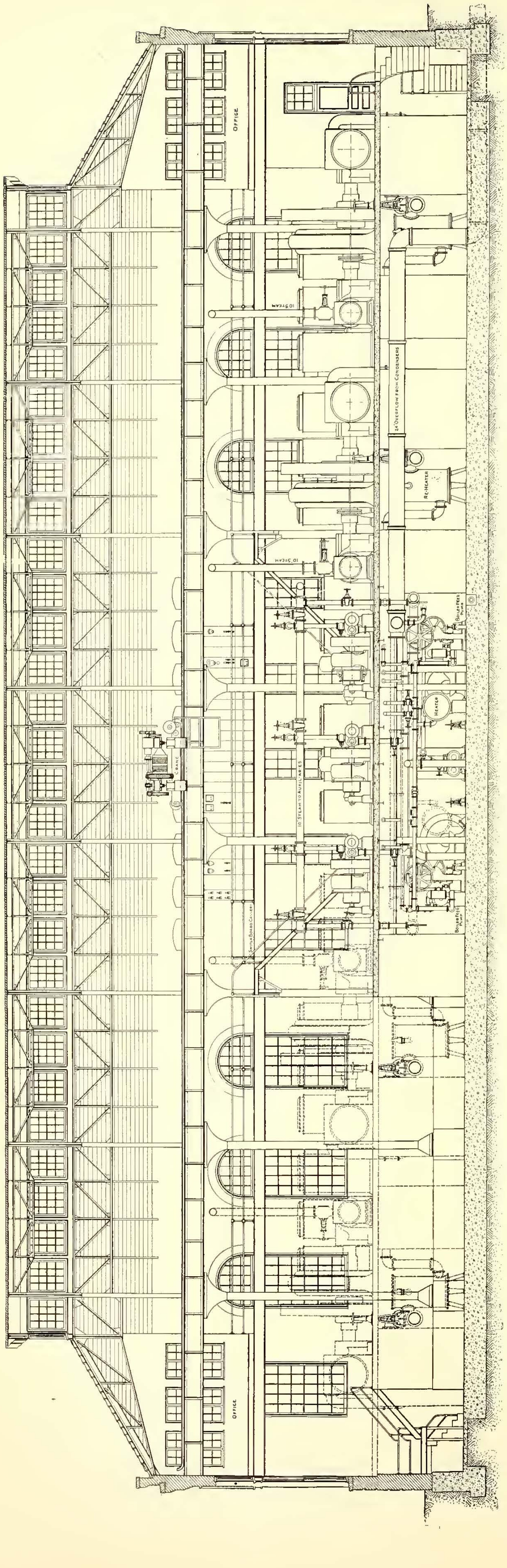
The steam is taken from the two boilers forming a battery, through long radius sweeps, to a vertical drum placed on the division wall back of the boilers. This drum acts as a separator, and is placed at sufficient height to return all condensation to the boiler by gravity. From the drum the steam passes through a long radius bend to the engine throttle. Each unit is provided with a drum, and pipes connect them in series. Between the first and second units this pipe acts as a pressure equalizer and a means through which one engine may be furnished steam from the boilers of another. Between the second and third, in addition to these functions, the pipe passes through the division wall into the engine room, forming a header for the purpose of furnishing steam for the auxiliaries. The exciter units take steam from this header, and a loop from it to the basement serves the pumping machinery.

The feed-water is delivered to the boilers through two mains carried along the division wall back of the boilers. From each main a lead is taken to one boiler of each battery. These

370-KW OIL-COOLED TRANSFORMERS IN MAIN POWER STATION



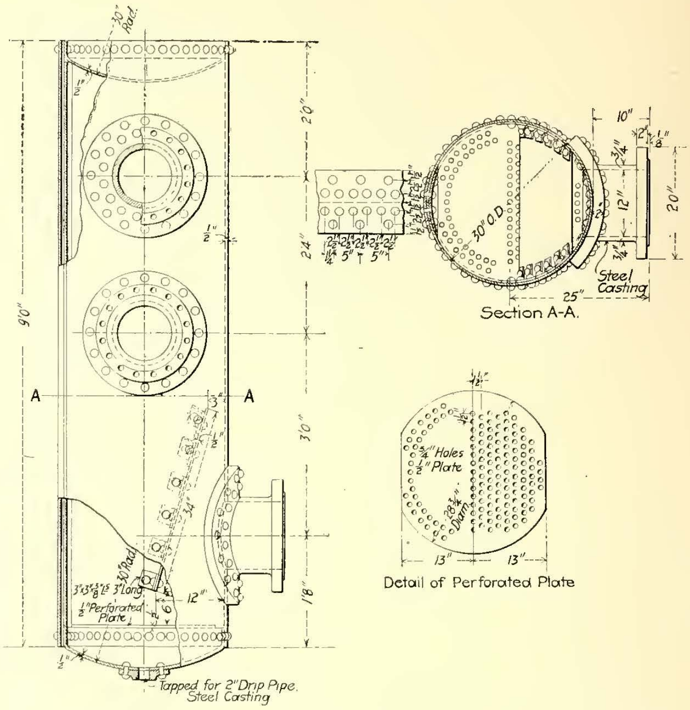
LIGHTNING ARRESTERS WITH DISCONNECTING SWITCHES AND TELLTALE DEVICES



LONGITUDINAL SECTION OF STATION THROUGH ENGINE ROOM

leads are connected, forming a loop. The mains are also cross-connected at the end, thus allowing any boiler to be fed from either main. Both mains are supplied from a ring in the pump room which the boiler feed-pumps supply.

Flanges for high-pressure work are of rolled steel for all sizes above 8 ins., and the joints are of the Van Stone type. Pipe

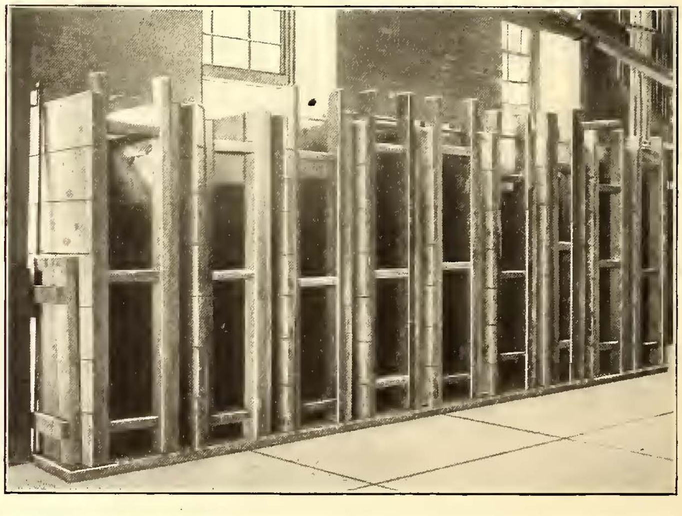


SECTIONS OF SIDE ELEVATION OF VERTICAL HEADER

of 8-in. and smaller have screwed joints and cast-iron flanges. All fittings are of the extra heavy pattern for high, and standard for low-pressure work. The piping was installed by M. W. Kellogg & Company; the high-pressure valves were furnished by Eaton, Cole & Burnham, and those for low-pressure by the Chapman Valve Company.

GENERATORS

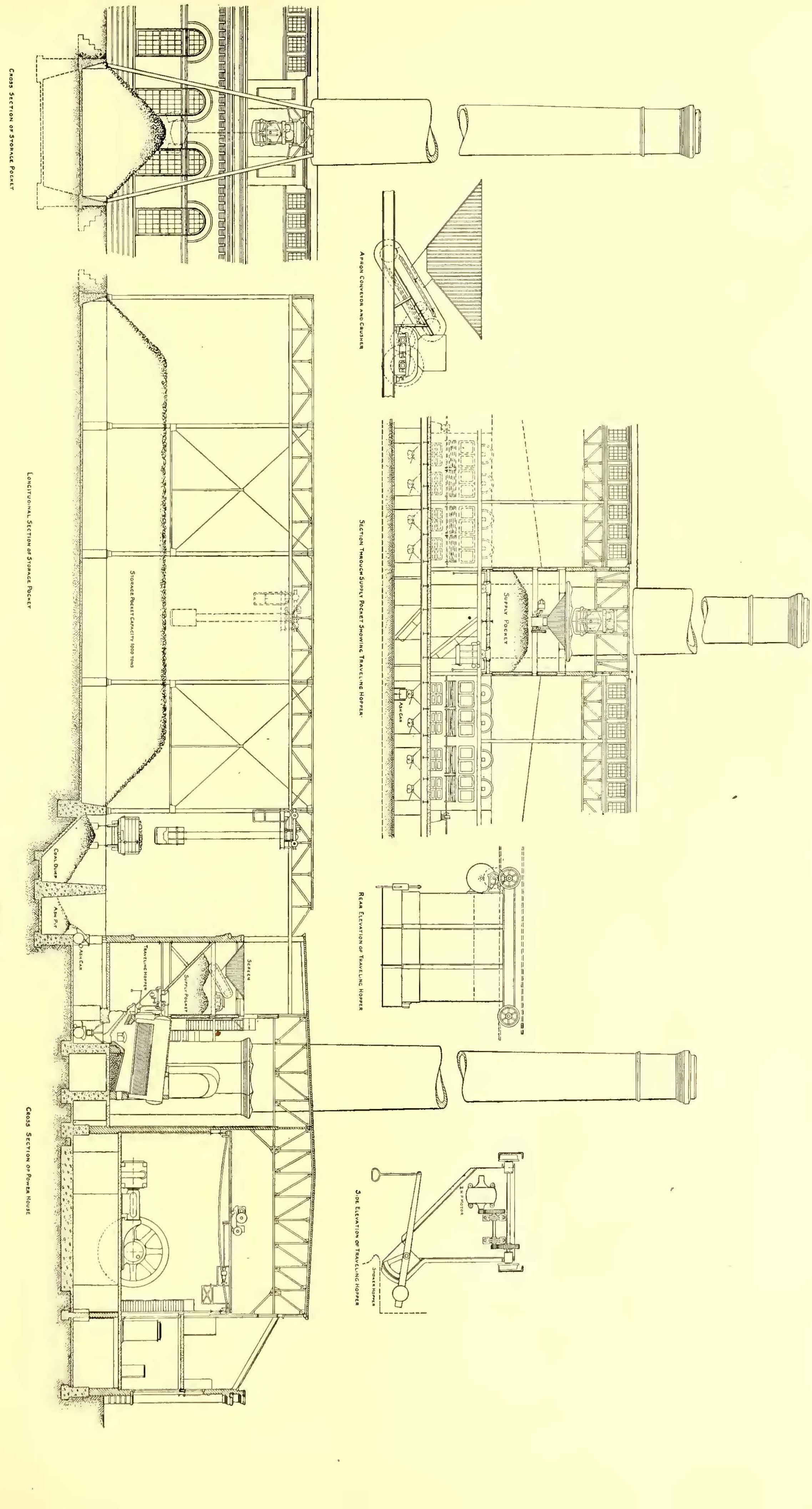
There are two main generators and three exciters, built by the Bullock Electric Manufacturing Company. The main gen-



METHOD OF MAKING CONCRETE CELLS FOR OIL SWITCHES

erators are of the engine-driven type, with rotating fields. They are rated at 1000-kw each, have thirty-two poles and run at 94 r. p. m., giving a frequency of 25 cycles per second. They generate three-phase alternating-current at 375 volts.

The exciters are of the engine-driven type, with rotating armature, and are rated at 100 kw, 125 volts, 250 r. p. m. One exciter is used for exciting the fields of the main generators,



COAL CONVEYOR AND STORAGE POCKET

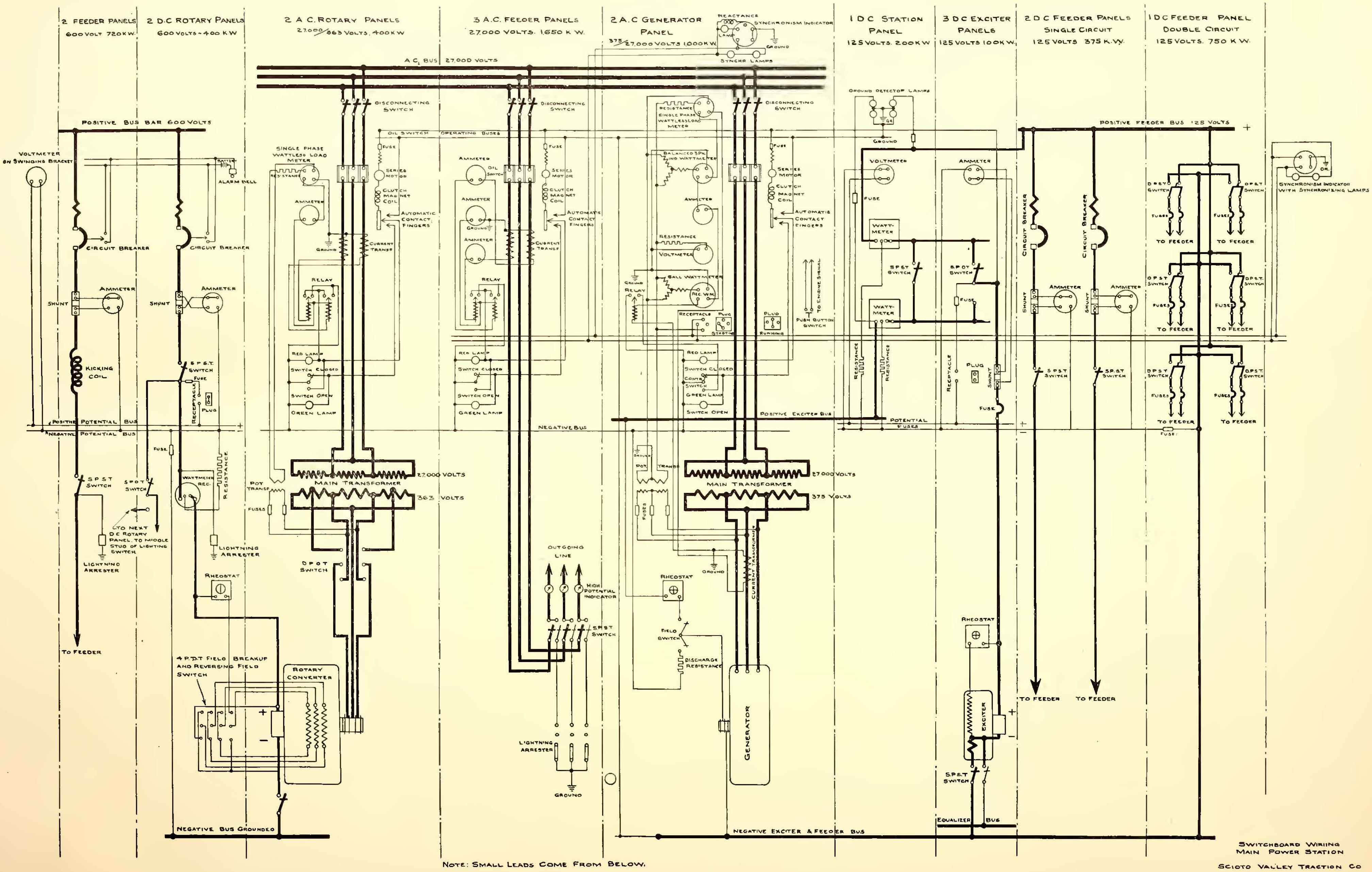


DIAGRAM OF MAIN SWITCHBOARD WIRING

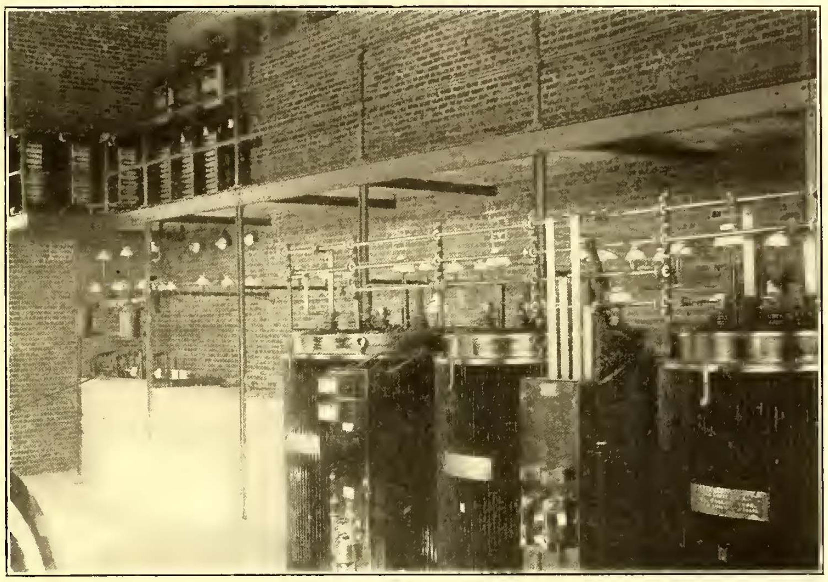
it being of sufficient capacity to handle all four generators; one is used for the auxiliary load, consisting of lighting, motor-driven machinery, etc., while the third is held as reserve. In addition, the station contains two 400-kw rotary converters, with space for a third.

From each generator the current is carried directly to a bank of three 370-kw transformers. These are of the oil-cooled type, built by the Wagner Electric Manufacturing Company. These transformers step up from 375 volts to 27,000 volts.

SWITCHBOARD

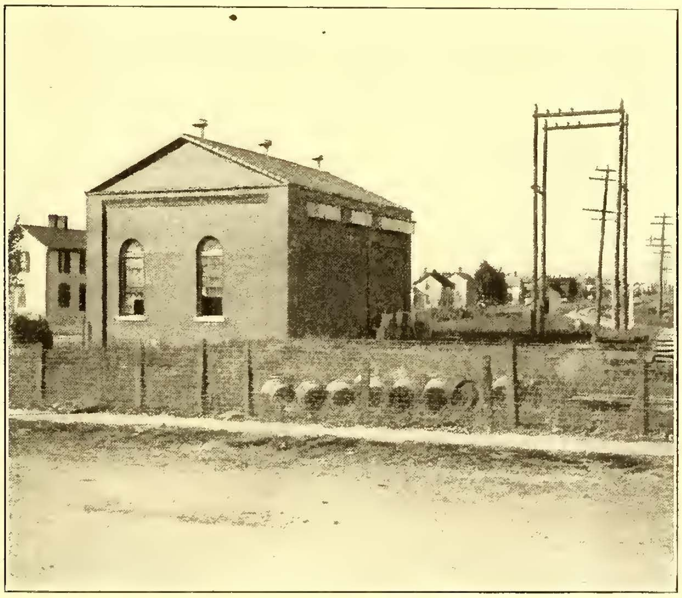
The switchboard was furnished and installed by the General Electric Company, and is of black enameled slate, 7 ft. 6 ins. high, 40 ft. 4 ins. long. It consists of twenty-four panels, and is of the usual standard construction, containing no radical departures. The indicating and recording instruments are connected through current and potential transformers, and no high-tension lines are connected to the switchboard.

At the south end of the board, mounted on a swinging bracket, is a 750-volt illuminated dial voltmeter, while at the other end, similarly mounted, is a dial synchronizer. A large synchronizer, having an 18-in. dial, is mounted below the crane girder, in front of the board, being visible from all parts of the engine room. Indicating wattmeters are mounted on the gage boards of the engines. All the high-tension current in the power house is

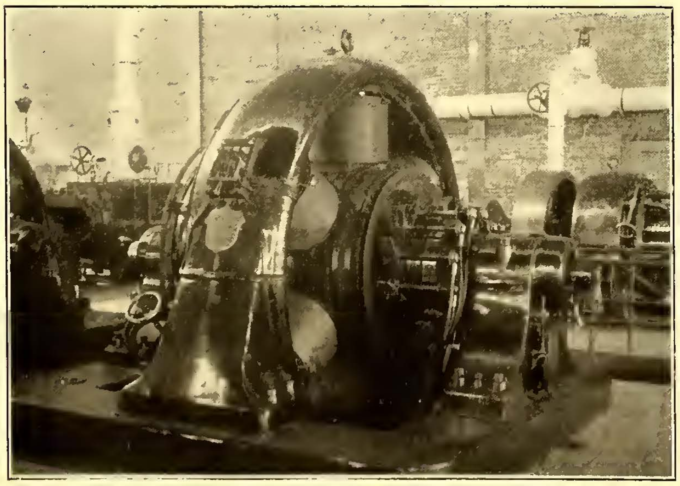


LIGHTNING ARRESTERS, OIL SWITCHES AND 150-KW TRANSFORMERS IN SUB-STATION

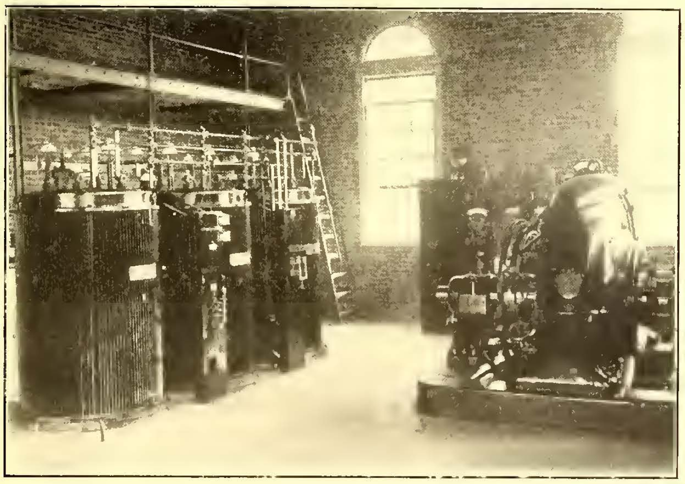
GENERAL INTERIOR VIEW, SHOWING EXCITER SETS



ASHEVILLE SUB-STATION



400-KW BULLOCK ROTARY IN MAIN STATION



INTERIOR ASHEVILLE SUB-STATION

controlled by Form-H motor-operated oil switches, built by the General Electric Company. The switch cells are of concrete, with walls 4 ins. thick. In addition to the oil switches, disconnecting knife switches are used between the oil switches and bus-bars, and between the bus-bars and outgoing lines.

The high-tension lightning arresters are of the 27,000-volt General Electric Company type. They are located on the wall just back of the switchboard and under the opening through which the high-tension feeders leave the building.

From the generators the current is conveyed by asbestos-covered cable, supported on racks beneath the engine room floor, direct to the 370-kw transformers, and thence by No. 00 bare copper cable through the oil and knife switches to the main bus-bars. These, three in number, are contained in a brick and concrete compartment located in the bus-bar chamber. This compartment is made up of three separate ducts, one above the other, separated by concrete slabs, so that all possibility of short-circuit between phases is eliminated.

The bus-bars are divided into sections by knife switches, thus allowing any section to be cut out without interfering with the operation of the plant.

From the bus-bars the circuit passes through oil and knife switches, either to the 150-kw step-down transformers and thence to the rotaries in the main power station, or to the sub-stations, the lines passing up the east wall through enclosed brick ducts and out through openings in the wall near the roof. These openings are protected by feeder hoods, built of Alberene stone, with concrete roofs. All instrument and auxiliary wiring is run in pipe conduit buried in the floor.

SUB-STATIONS

There are four sub-stations, one of which is located in the power house. The power house sub-station contains two 400-kw rotary converters, with provision for a third. The remaining three sub-stations at present contain one 400-kw rotary converter, with provision for a second. The three sub-station buildings are substantially alike, being built of red brick, with stone trimmings, and with roofs of Ludowici tile laid on angle purlins, supported by steel trusses which rest on the front and rear walls of the building. The foundations and floors are of concrete. Each building is 54 ft. x 31 ft. 6 ins., and 33 ft. high from the floors to the bridge of the roof. Along the rear wall is a gallery, giving access to the lightning arresters. Under this gallery are placed the oil switches. In front of these stand three 150-kw step-down transformers

The sub-stations are designed for two incoming and two outgoing high-tension transmission lines, only one of which is at present installed.

In the sub-station in the power house, the oil switches are electrically operated and controlled from the main switchboard, whereas in the other sub-stations they are operated by hand. The switching is done on the high-tension side of the transformers.

OFFICERS AND ENGINEERS

The officers of the Scioto Valley Traction Company are: President and general manager, F. A. Davis; treasurer, E. R. Sharp; general superintendent, L. C. Bradley.

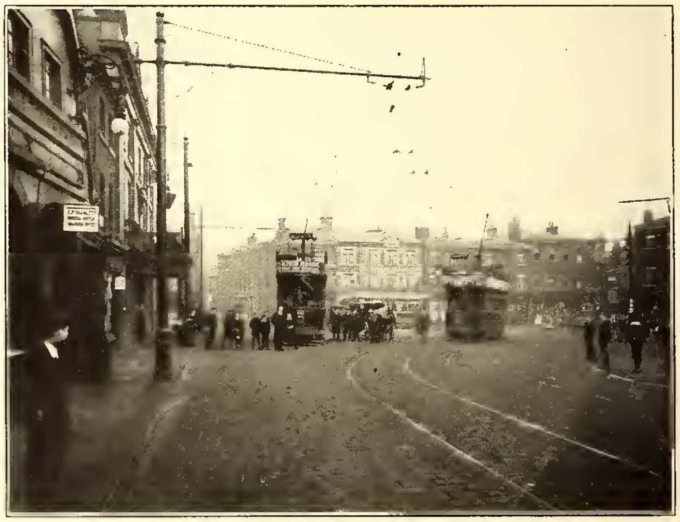
The power plant, transmission lines, third rail and cars were designed by W. E. Baker & Company, consulting engineers, New York, and the installation was under their supervision. This paper is indebted to them for the engineering facts contained in this article. The civil engineering was in charge of A. W. Jones, of Columbus, Ohio.

The Western Massachusetts Street Railway Company has asked for the approval by the Railroad Commission of locations in the towns of Westfield, Chester, Huntington, Becket and Lee. The company proposes to build a line 33 miles in length, extending from Westfield to Lee, forming the connecting link between the Springfield Street Railway on the east and the Berkshire Street Railway on the west.

THE LEEDS, WAKEFIELD AND WEST RIDING TRAMWAYS

An extensive electric system, owned by the Wakefield & District Light Railways Company of England, has been recently put in operation. Although there is a considerable mileage at the moment in operation, the scheme is only partially completed, and when the remaining sections and links are finished the system will embrace wide districts around Leeds and Wakefield, including Horbury, Ossett, Normanton, Castleford, Pontefract, Lofthouse and Rothwell. Eventually it will involve the operation of some 75 miles of single track, linking together, by a frequent service, some of the most populous districts in the West Riding of Yorkshire. A trunk line runs from Wakefield to Thwaite Gate, and there joins the Leeds Corporation Tramways System. Bearing in mind the recent and important discussions on the subject of joint running powers, it is interesting to note that it has been possible for the company to arrive at an arrangement with the Leeds Corporation under which cars can be run to the center of Leeds. Such an understanding must result in the greatest convenience, and should materially add to the efficiency of the District Company's system and prove to be a useful feeder to the Corporation tramways. The total mileage constructed up to date is roughly 32½ miles of single track.

The contract for the whole of the work was given to the firm of Dick, Kerr & Company, Limited, the consulting engineer for the scheme being B. D. V. Cooper.



VIEW IN BULL RING, WAKEFIELD

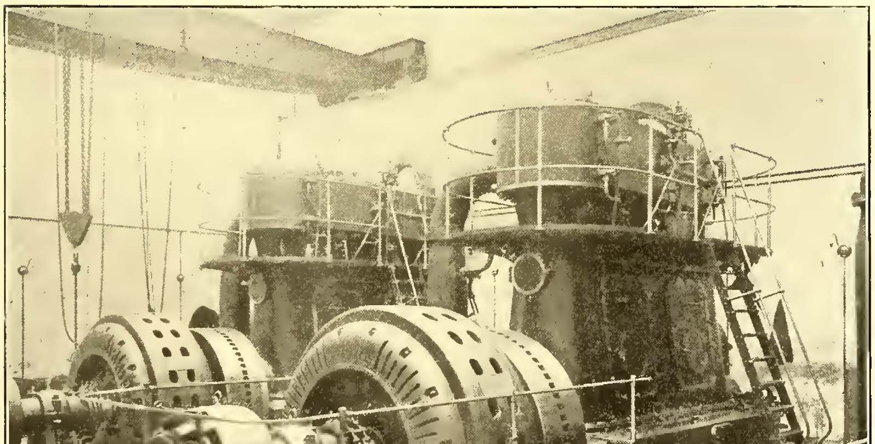
Such a system obviously calls for high-tension transmission, as it would be, of course, impossible to work all the routes embraced in the extended scheme from one central station. The main station is situated at Belle Isle, Wakefield, where alternating current is generated at high pressure and transformed at sub-stations to direct current of 500 volts. One sub-station is in use in Wakefield, about 1 mile from the power station, where three 200-kw rotary converters have been erected; another in Rothwell, with two 200-kw rotaries, and there will eventually be another at Castleford, which is about 10 miles from the power station, and ultimately a fourth at Ossett.

The total length of tramways now in operation is approximately 25 miles of single track, laid to standard gage. The usual British tramway construction has been employed on about 9 miles of single track. The roadway has been excavated to a uniform depth of 12½ ins. below the upper surface of the rails, to receive an 8-in. bed of concrete to carry the paving for a width of 8 ft. for single track and 17 ft. for double track. The roadway between the rails, and for an average space of 18 ins. on either side, both for single and double track, is paved with granite sets 5 ins. deep and 4 ins. wide. In the remaining portion, some 16 miles, the roadway between the rails is filled in with screened macadam. The rails are of the girder type, weighing 94 lbs. per yard, and are laid in 45-ft. lengths, with a proportion of shorter lengths to allow for closures. The rails are generally in accordance with standard tramway practice, 6½ ins. deep, with a groove of 1⅛ ins.; they are secured with six-holed angle-plates, 24 ins. in length, and are double bonded with No. 0000 Neptune copper pin bonds.

The construction of the overhead lines is for the most part carried out on the side-pole system with bracket arms, with flexible suspensions. The poles, which have an over-all length of 31 ft. and are made up in three sections of lap-welded mild steel, are erected about 40 yards apart on the straight, and closer in curves, in holes of a depth of 6 ft., and surrounded by from 6 ins. to 9 ins. of concrete. In towns and residental districts, the brackets are fitted with wrought-iron scroll work of a neat design. The trolley wires are of hard-drawn copper wire No. 00 S. W. G., having a diameter of .348 in., weighing 1935 lbs. per mile, and with a breaking strain equal to 24 tons per square inch. At certain points over the d. c. feeders, feeder switch pillars of the D. K. standard pattern are erected; each of these contain a white marble panel on which is mounted two 400-amp. Q. B. switches, these being connected through V. I. R. cables direct on to the trolley wire. At all other points the mains are looped into the pole section bases, described below.

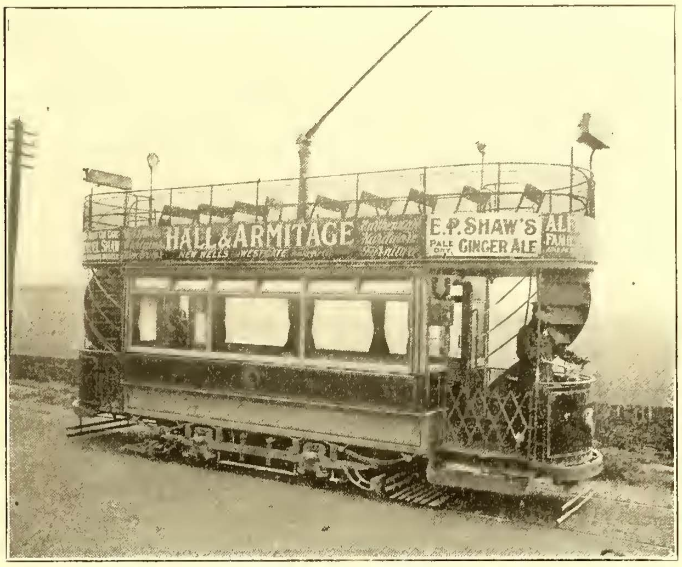
At every ½ mile along the route, small cast-iron boxes are fitted to the poles, each containing four 150-amp. "no arc" switch fuses. These boxes serve the purpose of dividing the trolley wire into half sections and cross connecting for the parallel running. The cable taken from these connecting boxes from the poles has the same section of copper as the trolley wire, and is insulated with vulcanized rubber.

Three car sheds have been constructed, the principal depot being situated at Wakefield, which has six tracks, and is capable of accommodating thirty-five cars; the other two car sheds have been built at Rothwell and Castleford.



TWO ALTERNATING SETS

The rolling stock eventually will consist of fifty-five electric motor cars, of the double-deck single-truck reversed staircase type, with a seating capacity of twenty-two inside and thirty-four outside. They were built by the Electric Railway & Carriage Works, Limited, of Preston. The floor frames are made entirely of oak and pitch pine, and are designed to combine the greatest strength and stiffness and minimum weight. Special care has been taken in designing the cars to insure the interchangeability of all the most important parts entering into the construction of the rolling stock; the length of car bodies over the platform is 26 ft., and they are about 6 ft. wide. Openings are arranged in the flooring over the motors to afford convenient access to the armature brushes and to all bearings requiring frequent inspection and oiling. The platforms are carried on four steel angles, the bearers being extended without interfering with the clearance of the trucks. The main floor is laid with ⅞-in. tongued and grooved boards 4 ins. wide, with strips of deal 2 ins. x 1½ ins. fixed longitudinally. To prevent the car from sagging, each side frame of the car is trussed by a ¾-in tension rod attached to the bottom sills. The side and end frames are of pitch pine and ash, and with white and corner pillars. The side frames each contain three large windows, with narrow pivoted ones above for ventilation. The roof frame is made of ash, the horizontal members being all in one piece without splices. The cars are fitted with life guards of the trigger pattern.

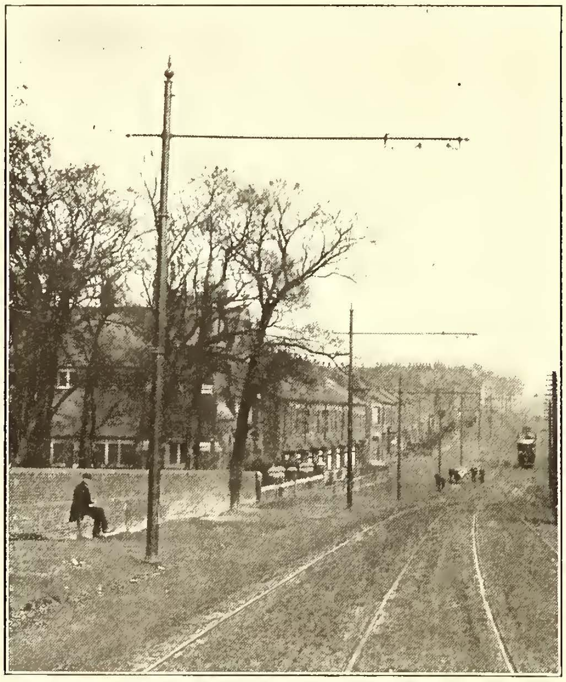


STANDARD CAR

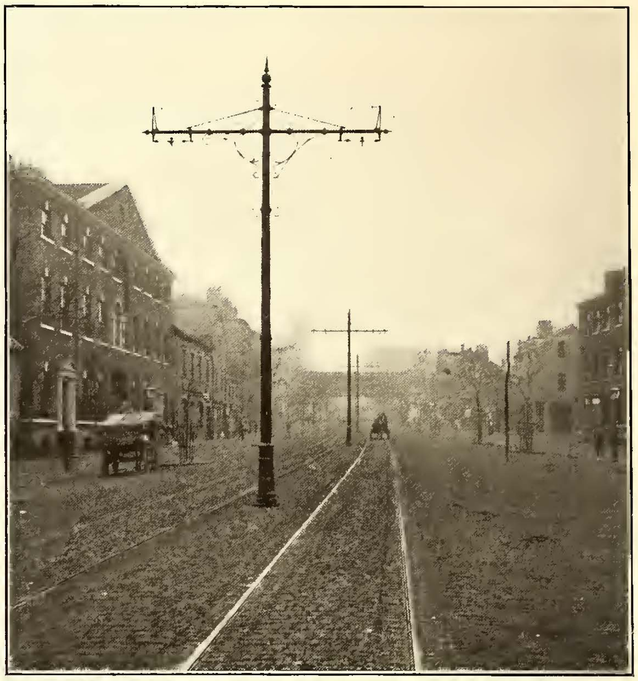
Each car is wired for fifteen incandescent lamps, which are run in series of five off the main circuit, the wires being run inside the walls of the car behind the ventilators, thus being efficiently protected and put completely out of sight and reach. Two 16-cp lamps are fitted as headlights, with reflectors. The cars are mounted on Brill trucks of 21-E type, suitably built to support the car bodies and to receive the motors and gearing. Two cross bars are provided to carry the motor at their centers, and they are cushioned on the side bar with draw and recoil springs. The axles are 3¾ ins. in diameter, and are made of Siemens-Martin steel, capable of standing a tensile strain of 60,000 lbs. The wheels are of chilled iron and are 30 ins. in diameter. Each car is fitted with a complete Dick-Kerr standard equipment, consisting of two standard 25a traction motors. The controllers are of the D. B. I. form C type, with metallic shield blow-out.

The power station is situated at Belle Isle, Wakefield. The steam plant consists of four Lancashire boilers, with the usual accessories, including "Lord" furnaces, hand-fired mechanical stokers, a Green's fuel economizer, a water storage tank with a capacity of 20,000 gals. of water, and two feed-pumps capable of delivering 24,000 lbs. of water per hour against a pressure of 150 lbs. The feed-water is drawn from the River Calder and town supply, the water for condensing purposes being wholly taken from the River Calder.

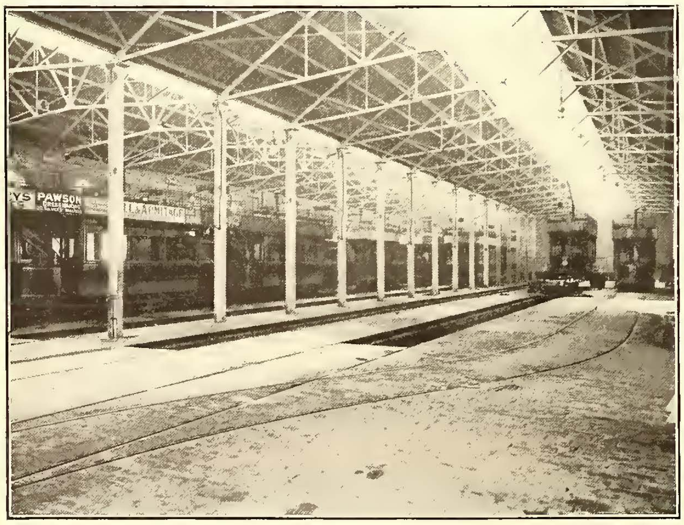
The power is supplied by three high-speed triple-expansion condensing engines of the well-known Howden type, manufactured by James Howden & Company, of Glasgow. These engines work at a steam pressure of 150 lbs., and at their standard speed of 375 r. p. m. are remarkably quiet-running. Each engine is directly connected to a Dick-Kerr alternator, which generates three-phase current at 6300 volts 25 cycles, each set being provided with direct-driven exciter. They are "star" connected, have an output of 400 kw continuously, and are designed to give an overload of 25 per cent for one hour with a moderate rise of temperature. All three machines are designed to run in parallel with each other, means being provided for raising their voltage up to 6600 to compensate for loss in the mains when running at a constant speed. The rotor spider is made of high quality cast iron, the hub being provided with flange for bolting to engine fly-wheel, and is pressed on to the shaft by hydraulic pressure and key seated.



SIDE-BRACKET CONSTRUCTION



CENTER-POLE CONSTRUCTION



MAIN CAR HOUSE

The pole-pieces are made of laminated steel and are held together between two cast-steel end plates. The upper part is T-shaped for holding the field coils in position; the lower part of the pole-pieces is dovetailed for fixing on the rim of the rotor, where it is held in position by means of keys. The removal of the field coils is effected by sliding the pole-piece from the dovetailed groove parallel to the shaft, without disturbing any other part of the machine. The design and shape of the pole-pieces give a distribution of lines of forces in the air gap to produce an approximately sinusoidal shaped wave of electromotive force. The exciter is mounted on the extension of the alternator shaft. The stator frame is built in two halves, bolted together by means of finished bolts.

The coils are former wound, and are embedded in rectangular slots, being held in position by wooden wedges, and are easily and quickly replaced; they are protected outside the laminations by means of a cast-iron shield, cast in sections, bolted to the frame, and easily removable. This shield is of a perforated design, and does not in any way interfere with the ventilation. The switchboard was built by Dick, Kerr & Company, and consists of seven enameled slate panels, each supported independently on an iron frame. The board consists of three generator panels, one power panel and three H. T. feeder panels.

The sub-stations are fed from the main station by duplicate three-core H. T. lead-covered cables. At the Wakefield sub-station there are three standard Dick-Kerr 200-kw compound-wound rotary converters, running at 750 r. p. m., generating direct current at 500-550 volts. Each rotary has its complement of single-phase, oil-cooled, step-down transformers. The rotaries are capable of dealing with an overload of 25 per cent for one hour. The Rothwell sub-station is similar to the one at Wakefield, but is equipped with two rotaries, with the necessary transformers and switch gear.

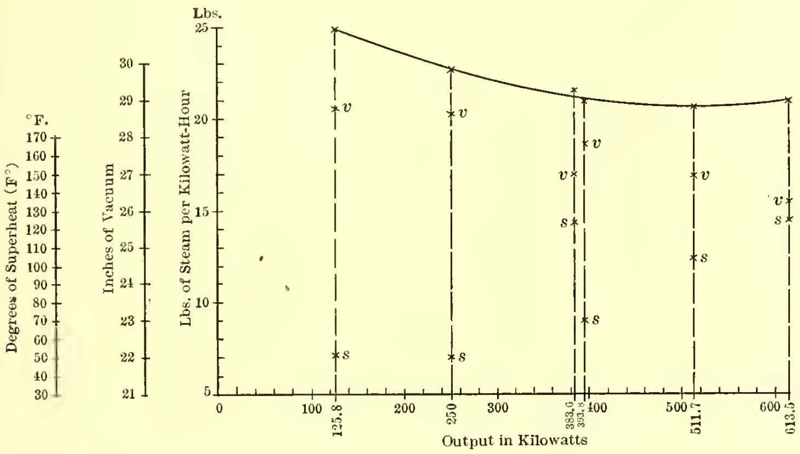
The run made Wednesday, Nov. 16, by H.A. Everett's private car, "Josephine," over the Lake Shore Electric, probably beats the world's record for long distance runs on electric railways. The car was coming back from Detroit, whither it was sent Tuesday with a party of railroad officials, and the actual running time between the Boody House, Toledo, and the Hollenden, Cleveland, was three hours and nine minutes. From this should be deducted twenty-three minutes time consumed in getting out of Toledo and forty-five minutes in getting into Cleveland, making the actual running time between the limits of the two cities only two hours and one minute for 111½ miles.

TEST OF 500-KW CURTIS TURBINE SET AT CORK

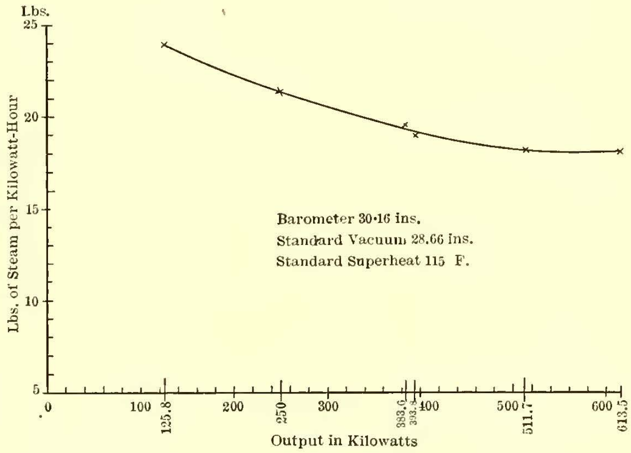
In view of the great attention being given by engineers to the performance of steam turbines, some particulars of a series of tests carried out on a 500-kw d. c. Curtis steam turbine set at the Cork Electric Tramway & Lighting Company's station, and which was supplied by the British Thomson-Houston Company, Limited, of Rugby, may be of interest.

These tests were conducted by Charles H. Merz, the consulting engineer to the company, through whose courtesy the results have been obtained for publication. The object of the tests was to ascertain the steam consumption at varying loads, and by commencing to fill the water tank, and three minutes after the start ammeter and voltmeter readings were taken. Six minutes after the first wattmeter reading, a second wattmeter reading was taken and the condensed steam was weighed. Six minutes after the first ammeter and voltmeter readings, second readings of these instruments were taken, and so on. Hence all readings were taken every six minutes, the ammeter and voltmeter readings midway between the wattmeter and condensed steam records.

A general summary of the results of the tests is given by the log-sheet herewith. Two steam consumption curves are also given, showing respectively the curve actually obtained, and that made out with correction to 28.66-in. vacuum and 115-deg. superheat.



STEAM-CONSUMPTION CURVE, PLOTTED FROM ACTUAL READINGS, BAROMETER 30.16 INS.



STEAM-CONSUMPTION CURVE, CORRECTED FOR VACUUM AND SUPERHEAT

LOG SHEET—TEST OF 500 KW CURTIS TURBINE

Particulars of Test		Ammeter Readings		Standard Voltmeter Readings	Average Load During Test in Kw		Total Units Used Throughout Test			Average Units	Total Water, Lbs.	Water per Kw Hour Lbs.	Vacuum, Ins.	Steam Pressure, Lbs.	Superheat, F.°	Speed Revs. per Min.
Load	Duration	Stnd.	Swb'd.		Stnd.	Swb'd.	Stnd.	Swb'd.	Wtmtr.							
¼	1½ hrs.	234	224.5	549	128.5	123.25	191.75	184.9	208.26	196	4,879	24.9	28.8	156	51	1,835
½	1½ "	460.7	453.65	547	252	248.12	378	372.2	not	375	8,400	22.64	28.6	155	50	1,820
¾	1½ "	718.5	717.8	548	393.7	393.9	590.5	590.8	con'ctd.	590.65	12,377	20.95	27.8	153	70	1,822
Full	1½ "	922 5	921.4	555	512	511.4	768	767	760	764	15,755	20.6	26.9	153	104	1,820
1¼	54 min.	1244	1235	495	615.8	611.3	554.2	550.17	544	552	11,530	21	26.2	151	124	1,800

and for this purpose five tests were made at one-quarter load, one-half load, three-quarter load, full load and 25 per cent overload, respectively. The tests were generally of one and one-half hours duration, although the last test at 25 per cent overload was slightly under one hour. Great care was taken in each case that before the test was commenced all conditions of load, etc., should be absolutely steady.

The weight of condensed steam was measured by a tank and weighbridge, which was tested before and after the test and found to be accurate. Vacuum gages were connected to the low-pressure chamber of the turbine and to the body of the condenser. These gages were in agreement. Under conditions of full load, however, the vacuum registered in the turbine exhaust chamber was 2 ins. lower than that registered in the condenser, showing that the pipe connection from the turbine to the condenser was not sufficiently large. The barometric pressure throughout the test was 30.16 ins.

The output of the machine was measured by two ammeters, a standard voltmeter and a recording wattmeter. The figures entered on the log-sheet attached are the mean figures of all readings at each load, readings being taken every six minutes. The readings given are the corrected readings after each instrument had been carefully recalibrated against a standard in the Newcastle-upon-Tyne Electric Supply Company's test house.

The tests were started by taking a reading of the wattmeter

The vacuum and superheat curves used in making the corrections were those published in "Engineering" on Feb. 5, 1904.

NEW ORLEANS POWER HOUSE CONTRACTS

Some interesting contracts were awarded last week for structural material, equipment, etc., for the new power house of the New Orleans Railways Company. Sanderson & Porter, of New York City, are the consulting engineers for the company, and the work of constructing and equipping the new station, which was described in the STREET RAILWAY JOURNAL, Aug. 6, will be done by the same firm as general contractors.

The American Bridge Company, branch of the United States Steel Corporation, has been allotted the contract for the steel to be used in the construction of the plant. Upward of 10,000 tons of material will be employed. While the ultimate capacity of the plant will be 60,000 hp, the equipment orders so far let are for about 7000 hp only.

The General Electric Company will build three turbo-alternators of 1500 kw each. The Babcock & Wilcox Company will manufacture eight boilers of 900 hp capacity each, or 7200 hp in all, and the Murphy Stoker Company, of Chicago, has taken the stoker contract.

THE WELLINGTON, N. Z., TRAMWAYS

Wellington, the Empire City of New Zealand, has made great strides during the past five years and now has a population of about 55,000. Its splendid harbor facilities give it the privilege of being the largest shipping port in New Zealand, with docks and other appliances that rank with the best in every respect. About twenty-two years ago Wellington was the happy possessor of a small steam tramway system. This was superseded by horse cars, which from about 1886 have been operated successfully up to the present time. The horse system was first owned and managed by the late Dr. Grace. The cars were supplied by the John Stephenson Company, of the United States, and it is worth noting that some of them are still giving good service in the outlying districts where they are now running.

In 1893 Messrs. Hall & Greenfield obtained a seven-year lease from Dr. Grace, and on its expiration the tramways were purchased by the Wellington City Council, the event being celebrated by giving free transportation to the public for one day. The Council effected many improvements and, as far as horse car service goes, little was left to be desired. Wellington is a growing, progressive city, however, and the capacity of the service was found to be inadequate for the requirements of the public, so to keep pace with the times the citizens desired the installation of an electric railway system. About two years ago construction bids were called for and the contract finally awarded to McCartney, McElroy & Company.

During the track construction period the interesting culvert work shown in the first four illustrations was carried out. They show the method adopted for lowering the crown of the culvert, which runs the full length of Kent Terrace, carrying storm water from Adelaide Road and Basin Reserve to the sea. When the new track was laid it was decided to wood pave the full width of Kent Terrace. Bringing the road to its proper level, left the arched top exposed about 6 ins. To overcome this difficulty and still retain the capacity of the culvert, a flat top was decided upon. The arch was taken off, the sides built up a little with concrete, and 41¼-lb. old rails were cut to the desired length, placed across and connected with old fish-plates, while running down the center underneath, full length rails were placed to give extra strength. The space between the rails was then filled in with concrete. The work was carried out very neatly, and it is likely that if measurements were taken they would show an increase in the carrying capacity of the culvert. Fig. 3 represents the open culvert, arch, the roadway in the center and the poles at the right with ornamental bases. The preparations for building up the sides and laying the top of the culvert are shown in Fig. 4. In Fig. 5 the rails are shown in position ready for the concrete. The appearance of the top of the culvert just after being filled in with concrete is reproduced in Fig. 6. It will be noticed that the top of the culvert stands higher than the concrete bed for blocks on either side. This allows for 5-in. blocks at the sides and 3 ins. on top of the culvert. This was done so as to give as much waterway as possible in the culvert.

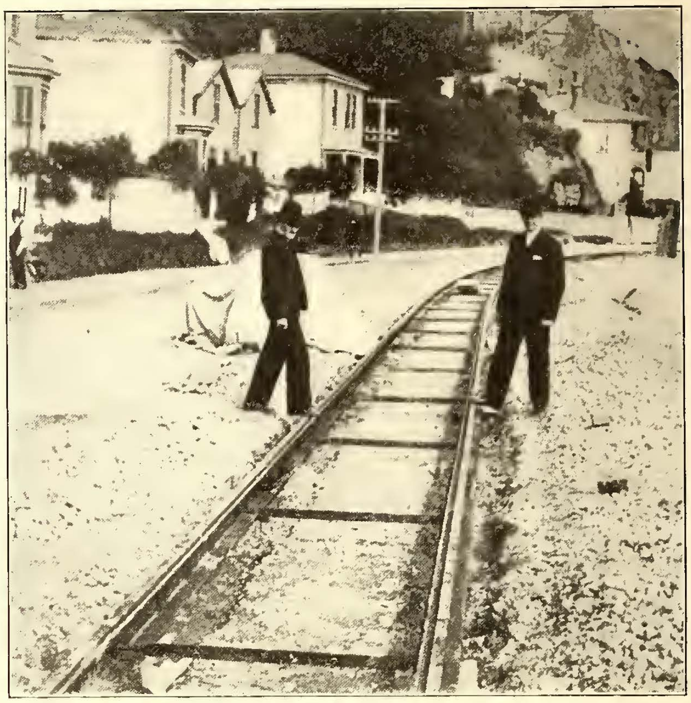


FIG. 1.—SINGLE TRACK AT ORIENTAL BAY

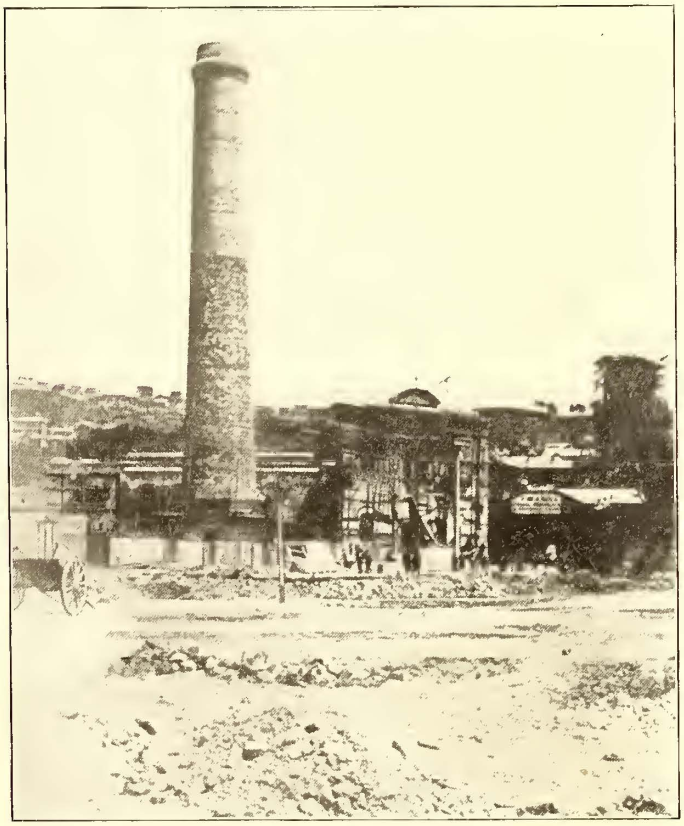


FIG. 2.—POWER HOUSE UNDER CONSTRUCTION

Grooved rails weighing 95 lbs. per yard are used, laid to 4-ft. gage. They are laid in a concrete bed covering the full width of the double track. All the city streets are being paved with concrete for their full width. In the outlying districts 4 ins. of tarred macadam is used for 18 ins. on each side of the tracks. Sets are used as protection for rails, with a top dressing of asphalt. Many sharp curves have been encountered, a notable one being on the Oriental Bay section. Around the Basin Reserve Recreation Ground the line takes four very sharp turns in ½ mile. These could have been avoided had the line been taken directly through the grounds, but the Council refused to permit it. The points and crossings are of manganese steel. Both side and center poles are used in the overhead construction. The poles are of steel, embedded in concrete, and are fitted with ornamental caps and bases, which present a very neat appearance.

The side of the hill has been hewn away where the car house stands and the material used in filling up the gulley at the northern end of the house. The bricks used in the construction of the car house were made on the spot by the contractor. The roof trusses, pillars and girders are of steel, and were designed to offer no obstruction to the interior lighting of the building. The total capacity of the car house is fifty cars, and of the pit room alone twenty-four cars. At the southern end are located

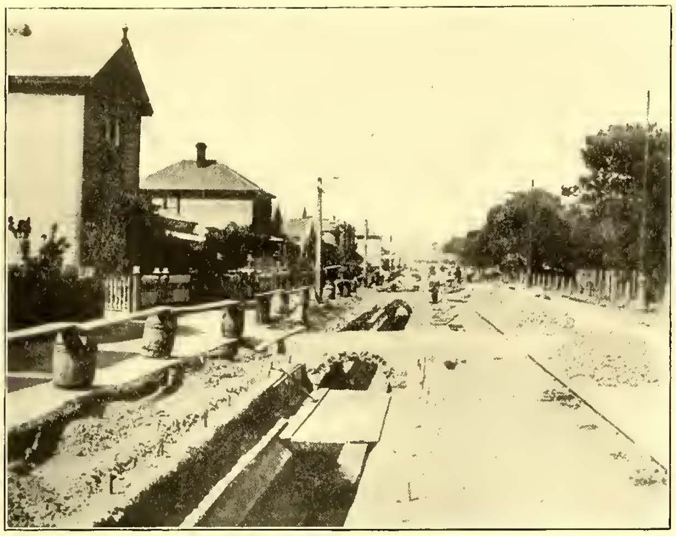


FIG. 3.—OPEN CULVERT ON KENT TERRACE

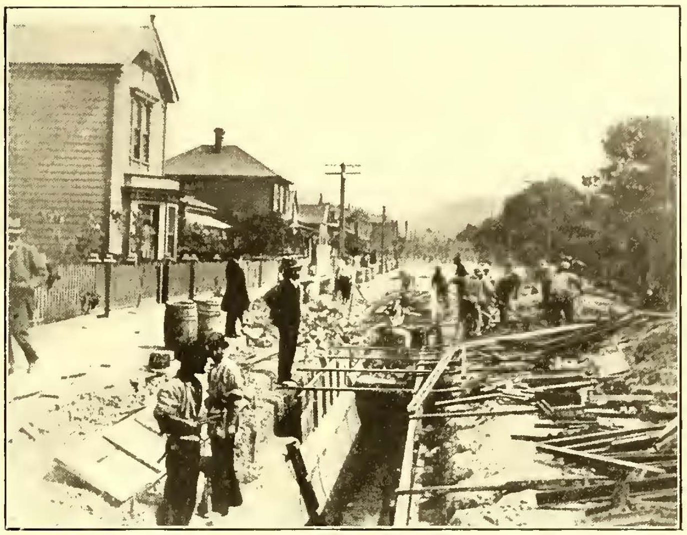


FIG. 4.—LAYING THE TOP OF THE KENT TERRACE CULVERT

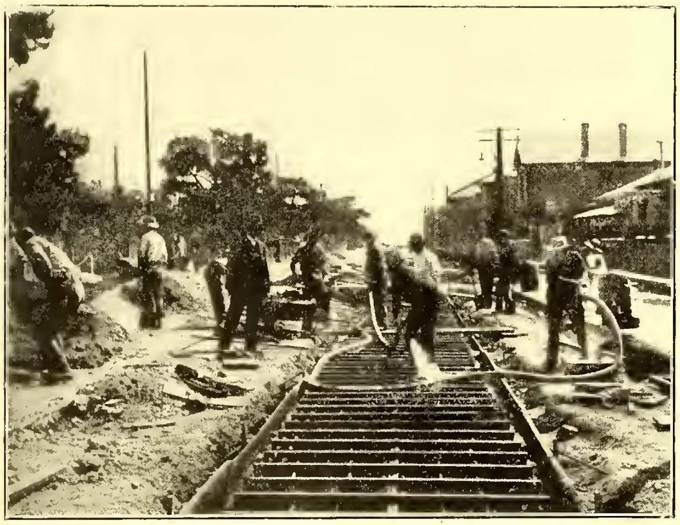


FIG. 5.—OLD RAILS USED FOR REINFORCED CONCRETE WORK

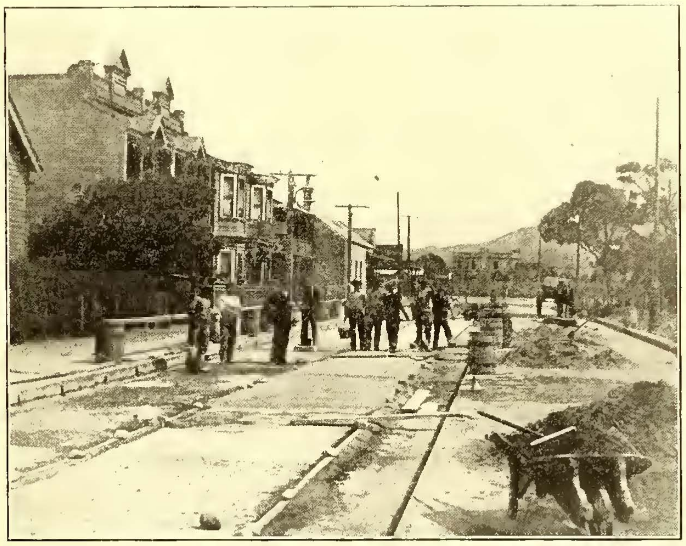


FIG. 6.—KENT TERRACE CULVERT AFTER CONCRETING

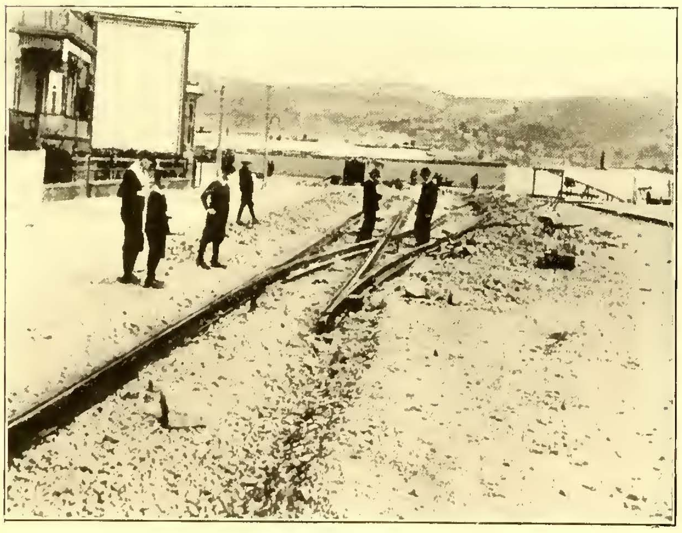


FIG. 7.—TRACK CONSTRUCTION AT ORIENTAL BAY

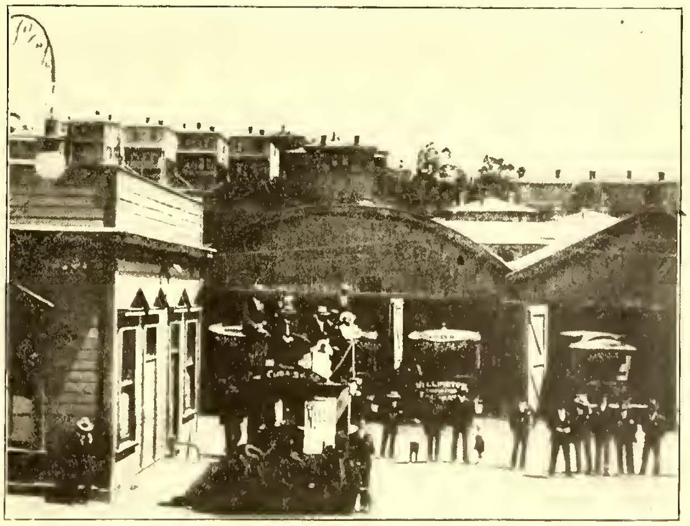


FIG. 8.—HORSE CAR SHEDS, WITH OFFICES AT LEFT

the repair shop, store room, electrical room and armature braking pit. A traversing table is situated in the southern end of the building, running the full width.

The cars, thirty-six in number, were built by the Manchester Car Construction Company, of England. They embrace twelve double-deck, twelve combination and twelve closed cars. The double-deck cars will seat fifty-six passengers, and are fitted with No. 21-E Brill trucks, C 18-B GE controllers, GE 57

FIG. 9.—A SHARP CURVE AT ORIENTAL BAY

motors, ratchet brake handles, illuminated destination signs overhead, and colored lights. Eureka maximum traction trucks are used for the combination cars. Electric conductor's bells are in use. Fares are paid according to the zone ticket system. A splendid telephone system has been installed, with a pillar box every ½ mile.

The power house is large enough for the present, but every provision has been made in the construction for extensions. The plant was supplied by an English company.

The first portion of the system, known as the "express route,"

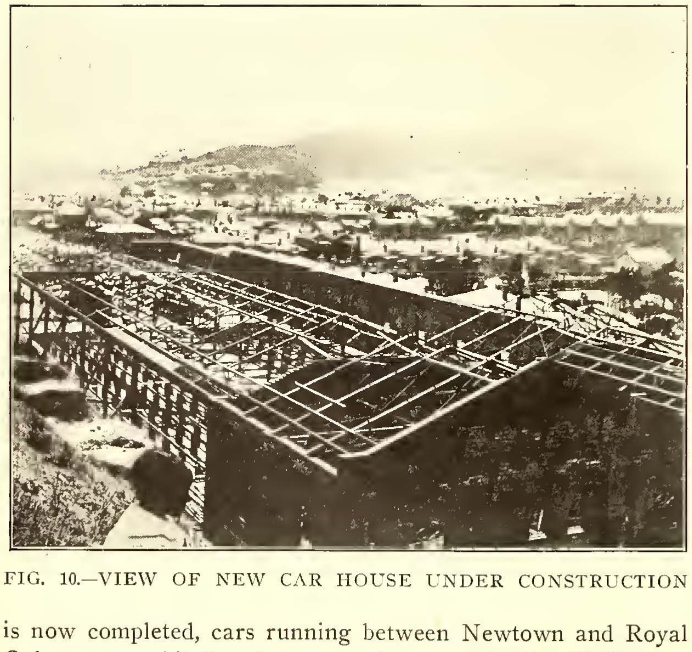


FIG. 10.—VIEW OF NEW CAR HOUSE UNDER CONSTRUCTION

is now completed, cars running between Newtown and Royal Oak corner. All the plans were drawn up by the Wellington Council's staff of engineers and carried out under their supervision. When completed the system will be one of which the citizens of Wellington may well be proud.

OWL CARS IN MILWAUKEE

General Manager John I. Beggs, of the Milwaukee Electric Railway & Light Company, Milwaukee, Wis., has announced that, in compliance with the city ordinance recently passed by the Council, owl cars will be run at one-hour intervals on all the main lines of the street railway system.

PROBLEMS OF HEAVY ELECTRIC TRACTION*

BY O. S. LYFORD, JR., AND W. N. SMITH

The Long Island Railroad system has at present two passenger terminals in the city of New York, one at Atlantic Avenue and Flatbush Avenue in the Borough of Brooklyn and one at the Thirty-Fourth Street Ferry in Long Island City, Borough of Queens. When the great tunnels of the Pennsylvania, New York and Long Island Railroad Company are completed there will be a third terminal for the Long Island Railroad passenger traffic in the Borough of Manhattan. From the present terminals there branches out an extensive system of through and suburban lines, over which is maintained a train service, both express and local, reaching all parts of the Island. In addition to the suburban service into these terminals, there is an interchange of traffic with the Brooklyn Rapid Transit Company at two points, and a connection is to be established between the subway system of the Long Island Railroad and the extension of the Rapid Transit Subway now being constructed between Brooklyn and the south end of Manhattan. The accompanying map shows the location of the western lines of the Long Island Railroad and the new connections which are to be made.

Extensive plans for the electrification of the suburban service of this road have been under consideration for some years. These plans provide for the immediate adoption of electric traction on the lines emanating from Flatbush Avenue and for a progressive extension of electric traction over all of the strictly suburban routes, as rapidly as the conditions shall justify. On some of these routes the traffic is of a purely suburban nature. On other sections the important traffic is an excursion movement to and from New York's great playgrounds at the beaches. For the convenience of the suburban residents, a frequent service in comparatively short trains is to be provided, but for the excursion service comparatively long trains are necessary. As a result, the number of cars per train in this system will vary from one to eight or possibly ten. The initial service, limited to a maximum of six cars per train, results in fifty-two types of runs, varying in number of cars per train and distance between stops. On some sections the lines are fairly free from grades and curves, but on others the grades and curves are heavier than would be supposed from a general knowledge of the contour of Long Island. Some main points may be decided in this way:

(a) The number of cars per train varies from one to six, as stated. Eight or ten-car trains may be desirable at times. Such variations in train length cannot be provided for economically with electrical locomotives. Motor cars must, therefore, be used, and for all except trains of one or two cars, more than one motor car per train is necessary. The multiple-unit system of motor car operation is, therefore, best suited to this service.

(b) The greatest flexibility for make-up of trains is obtained by making all cars motor cars.

(c) On the other hand, the first cost of equipment and the cost of maintenance and inspection is least if the motor selected is of the largest size practicable, and the number of equipments required is thus made a minimum.

(d) For a miscellaneous service of the character contemplated, all trains, both local and express, should preferably be provided with equipment having the same speed characteristics, so that all motor cars are available for all classes of service. (Trains may operate as express in one direction and as local in the other.)

(e) For express runs of this suburban service, averaging not over 5 miles between stops, a moderately high speed, say 50 to 55 miles per hour, is found by experience in steam prac-

*Abstract of a paper presented at meeting of American Institute of Electrical Engineers, New York, Nov. 25, 1904.

tice to be most suitable. For these runs, therefore, it is essential that the electric trains shall be able to approximate these speeds.

(f) Future development of the service, such as increase in number of stops and decrease in running time, will mean heavier work for the motors. Therefore, reasonable reserve must be provided in the equipment, and consideration must be given to equipment which will make possible a convenient increase in number of motors per train.

SIZE OF MOTORS

The largest motor in general use for motor car trains is of 200 hp nominal rating, two of these being about the limit of motor capacity that can be placed on a track with 33-in. or 36-in. wheels and a reasonably short wheel base. On the basis of condition (c), this should be the motor adopted, provided the train combinations can be effected satisfactorily with motors of this size. Condition (f) is also complied with by selecting the largest motor practicable, as the number of motors per train in the initial service will then be a minimum.

GEAR RATIO

To meet condition (e), a gear ratio must be selected which permits the operation of trains at high speeds without damage to the equipment. On the other hand, the best starting conditions and least heating effect are obtained with high gear ratio. The gear ratio should, therefore, be as high as practicable and still permit of the maximum train speeds necessary for the express schedules. Provision must also be made for extra speeds which may occur on down grades. From observation of the existing service it was concluded that it is safe to assume 60 miles per hour as a maximum.

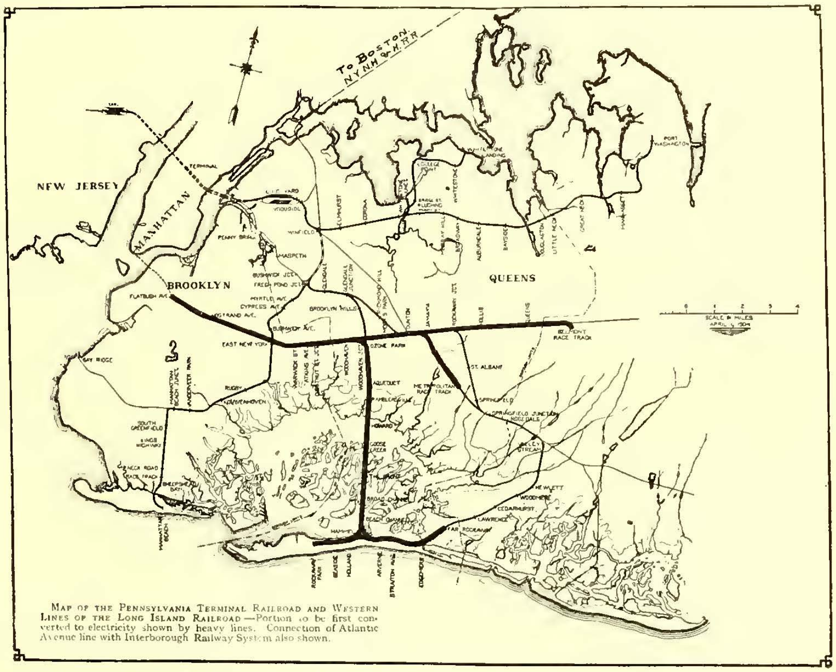
TRAIN WEIGHTS

The motor cars of the service are to be new steel cars, similar to those adopted for the Rapid Transit Subway. For the determination of motor characteristics, trailer cars were assumed to have the same size and weight of bodies. The weights assumed were as follows:

	Motor Car	Trailer
Seated load	81,000 lbs.	60,400 lbs.
Standing load	88,000 lbs.	66,000 lbs.

These assumed weights are in practical agreement with the actual weights of the subway equipment.

The 200-hp motor was found to be the proper size for the service of the subway; but the schedule conditions are so different that this in itself does not signify that the same motors are suitable for the Long Island Railroad conditions where the distance between stops for most of the local runs is greater than that of the express runs of the subway, and the express runs are longer in proportion. More or less of the usual calculating must, therefore, be done to reach a decision as to whether the characteristics of the standard motor of this size are suitable for this service or whether a smaller size could be used to advantage.



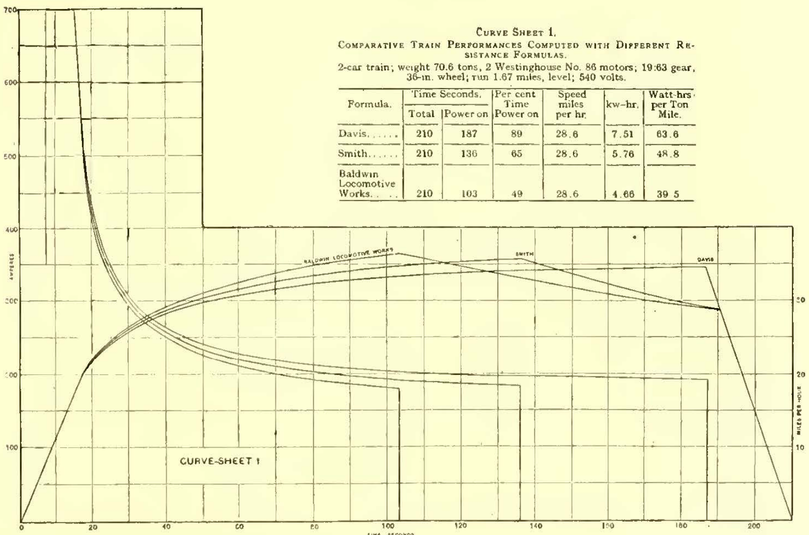
MAP OF THE PENNSYLVANIA TERMINAL RAILROAD AND WESTERN LINES OF THE LONG ISLAND RAILROAD—Portion to be first converted to electricity shown by heavy lines. Connection of Atlantic Avenue line with Interborough Railway System also shown.

THE TERRITORY TO BE SERVED BY THE ELECTRIFIED DIVISION OF THE LONG ISLAND RAILROAD

In Volume 19 of the transactions of the American Institute of Electrical Engineers and in the technical press of the last two or three years, there are a number of interesting papers giving theoretical and practical information regarding electric motors for railway service. Of these papers, that of Messrs. Arnold and Potter on "Acceleration Tests" gives some very interesting results of actual records of speed-time tests of steam and electric trains of different weights, illustrated by diagrams which admit of close comparison between theoretical and practical results. The scholarly and somewhat bewildering papers by Mr. Mailloux and by Dr. Hutchinson are of interest as representing the academic side of some of the problems involved; and Mr. Gotshall contributes some very interesting illustrations of theoretical speed-time curves derived for a specific case.

I. PLOTTED AND TEST RUNS COMPARED

The power required to overcome inertia and gravity may be calculated with exactness. Train resistance, however, made up of head resistance, mechanical friction and skin friction, may be estimated only by empirical formulæ, based on practical tests. Such formulæ have been derived and published by various engineers. Owing to differences in character of equipment and roadbed, nature of the train service, design of car bodies and trucks, methods of test, etc., there are material differences in the conclusions reached. For ordinary electric car service on urban and suburban lines, where the number of stops is frequent and the maximum speed is low, the train resistance is relatively unimportant as compared with the effect of inertia and grades, but as the speed increases the train resistance becomes a more important matter. The lack of agreement of these formulæ when applied to the conditions of the Long Island Railroad are illustrated in curve sheet 1 of the Davis and



CURVE SHEET 1.
COMPARATIVE TRAIN PERFORMANCES COMPUTED WITH DIFFERENT RESISTANCE FORMULAS.
2-car train; weight 70.6 tons, 2 Westinghouse No. 86 motors; 19:63 gear, 36-in. wheel; run 1.67 miles, level; 540 volts.

Formula.	Time Seconds.		Per cent Time Power on	Speed miles per hr.	kw-hr.	Watt-hrs per Ton Mile.
	Total	Power on				
Davis......	210	187	89	28.6	7.51	63.6
Smith......	210	136	65	28.6	5.76	48.8
Baldwin Locomotive Works......	210	103	49	28.6	4.66	39.5

the Baldwin Locomotive Works' formulæ are extremes; they therefore afford a sufficient illustration of the divergence of authorities on this subject. These formulæ are expressed as follows:

$$\text{Baldwin Locomotive Works, } R = 3 + \frac{V}{6}.$$

$$\text{W. J. Davis, } R = 4 + 0.13\,V + \frac{.004\,A\,V^2}{T}\,[1 + 0.1\,(n - 1)]$$

R = Train resistance in lb. per ton of 2000 lbs.
V = Velocity in miles per hour.
A = Cross sectional area of car in sq. ft.
T = Weight of train in tons of 2000 lbs.
n = Number of cars per train.

The formula marked "Smith" is one suggested by one of the authors, and has been found to give results close to actual practice, as will be explained in the following paragraphs. This formula has the following expression:

$$R = 3 + 1.67\,V + 0.0025\,\frac{A}{T}\,V^2.$$

The speed-time curves on this sheet are derived for a two-car train with cars of weight and dimensions similar to those of the Rapid Transit Railway in Manhattan. The length of run is an average for the total Long Island suburban service. It will be noted that the power consumption (watt-hours per ton-mile) varies from 39.5 to 63.6, the figure according to Davis' formula being 61 per cent greater than the Baldwin figure. Moreover, if the conditions were such that the average speed of 28.6 miles an hour between stations had to be maintained, the speed-time curve of Davis would be impracticable because of no allowance in coasting to provide for possible delays, etc. Therefore, whereas the Baldwin formula indicates a satisfactory equipment working with very low power consumption, the Davis formula for the same equipment shows relatively a very high power consumption and an impracticable equipment. The necessity of careful investigation of this matter in connection with our problem is apparent.

APPLICATION OF FORMULAS

The essential points which we wish to determine are the schedule speeds which can be obtained with given equipments, the power that will be required to obtain these speeds, and the heating effect on the motors. The value of train resistance is best determined at full speed, or while coasting; but except in the case of long runs, most of the power is consumed in accelerating. By comparing actual test runs with plotted runs from start to stop, we get some check on the train resistance formulæ, but, what is of more immediate importance, we get a verification of the accuracy of all the elements entering into our calculations.

To effect a comparison of theoretical results with actual tests, some special tests were made on the Grand Rapids, Grand Haven & Muskegon Railway, and on the Detroit, Ypsilanti, Ann Arbor & Jackson Railway in Michigan. These tests were necessarily confined to trains of one car each. The tests reported by Messrs. Arnold and Potter, made at Schenectady, were on trains of greater lengths. To supplement the single-car data of trains of identical composition and equipment, theoretical runs were plotted for comparison with some of these Schenectady tests. The various comparisons made are summarized in Table 1, which, therefore, shows the comparison of theoretical and actual results for trains of from one to eight cars per train.

TABLE I.

AVERAGE SPEED AND WATT-HOURS PER TON MILE

Comparison of Theoretical Results with Actual Tests

G. R. G. H. & M. RY.

(Schedule speed the same.)

2 No. 50-C Motors. Weight of train 29.5 tons.

Test No.	Davis		Smith		Test	
	Miles per Hour	Watt-Hrs. per Ton Mile	Miles per Hour	Watt-Hrs. per Ton Mile	Miles per Hour	Watt-Hrs. per Ton Mile
1	27.9	98.	27.9	79.2	27.9	88 2
2	32.7	99.2	32.7	81.6	32.7	81.
3	30.4	85.7	30.4	75.0	30.4	86.2
4	30.4	115.1	30.6	111.5	30.6	110.

D. Y. A. A. & J. RY.

(Schedule speed the same.)

4 No. 76 Motors. Weight of train 32 tons.

Test No.	Davis		Smith		Test	
	Miles per Hour	Watt-Hrs. per Ton Mile	Miles per Hour	Watt-Hrs. per Ton Mile	Miles per Hour	Watt-Hrs. per Ton Mile
5	28.3	99.	28.3	94.	28.3	99.
6	31.5	102.	31.5	96.	31.5	105.
7	33.4	95.	33.4	89.	33.4	97.

ARNOLD & POTTER TESTS

(Power cut off at same distance from start. Schedule speed not the same.)

8 GE-No. 55 Motors.

Test No.	Weight Train Tons	Davis		Smith		Test	
		Miles per Hour	Watt-Hrs. per Ton Mile	Miles per Hour	Watt-Hrs. per Ton Mile	Miles per Hour	Watt-Hrs. per Ton Mile
8	228.5	26.6	87.	27.6	72.	27.1	79 4
9	201.5	27.7	98.5	28 4	84.5	28.4	82.
10	175.5	29.2	102.	30.9	84.	29.9	86.9
11	148.5	29.6	111.	30.6	89 5	30.6	93.4

On the Grand Rapids, Grand Haven & Muskegon road the equipment consists of two 150-hp motors mounted on a heavy Baldwin truck with Gibbs suspension. The unequipped truck is also of the Baldwin make, and the entire equipment is of the highest standard. On the Detroit, Ypsilanti, Ann Arbor & Jackson road the equipment consists of four 75-hp motors mounted on rather light trucks.

For comparison with these actual results, theoretical runs were plotted in which the length of run was made the same, the average speed was made the same where possible, and the average rate of braking was assumed to be the same as in the actual experiments. The curves were corrected for pressure and grade so as to conform as closely as possible to the conditions prevailing during the test.

The acceleration curve from the Davis formula conforms more closely to the tests for the Detroit, Ypsilanti, Ann Arbor & Jackson car, but for the Grand Rapids, Grand Haven & Muskegon car and for the Arnold and Potter trains, it falls below the actual curve, in some cases to such an extent that the theoretical schedule speed is below the actual, even with coasting eliminated. The Smith formula gives accelerations practically coincident with the Grand Rapids, Grand Haven & Muskegon tests, and somewhat higher than the actual for the other tests, the difference in any case not being sufficient to be misleading in the results as to schedule speed. This difference may easily be accounted for by difference in pressure or inaccuracies in observation of instruments. In the case of the Detroit, Ypsilanti, Ann Arbor & Jackson car, the type of trucks and the drops in pressure may, either of them, have caused the reduced acceleration. In the case of the Arnold and Potter tests, the most decisive point in the comparison is the fact that, under the prescribed condition of cutting off power at the same distance from the start and making the same length of runs in the same time, to follow the Davis formula would not only necessitate the elimination of coasting, but would require braking at a practically impossible rate. In other words, if the Davis formula be correct, the trains could not have made the runs in the time that they actually did make. The conclusion, therefore, is that the Smith formula most nearly represents the actual train resistance for all of these tests.

It was found that, with reference to power required, the actual results appear to fall between the results obtained with either of the two formulæ. The calculations based on the Smith formula are closer to the actual results in most cases. For the Grand Rapids, Grand Haven & Muskegon car, where the acceleration curves agree, the watt-hours per ton-mile are also very close, and in the Arnold and Potter tests, even with a reduced schedule speed, the watt-hours per ton-mile are considerably greater for the Davis formula than for the observed tests. The conclusion reached is that the Smith formula affords a better basis for calculating the average speeds, and is sufficiently close for the determination of power required.

TEST OF EQUIPMENT SIMILAR TO THAT PROPOSED FOR THE LONG ISLAND RAILROAD

Through the courtesy of the Interborough Rapid Transit Company and Westinghouse Electric & Manufacturing Company, it is possible to present the record of a special test which has a direct bearing on this subject, because the type of motor equipment used in the test is the same electrically as that recommended for the Long Island Railroad project. The length of the test run was too short to permit the cars to reach maximum speed; as the value of train resistance is best determined at maximum speed, this test cannot by itself be considered an absolute check on calculated curves. The conclusions derived from this test are as follows:

(a) The motor control did not permit of the rapid application of power assumed in the calculations, time being lost in going from series to parallel. This, however, did not affect the results adversely.

(b) At the maximum speed when current was on, namely, 26 to 28 miles per hour, the theoretical curve shows practically the same energy consumption as the test. This indicates that the train resistance was practically as calculated. For corresponding speed on the motor curve, the power required according to theory is in both cases slightly higher than the power required according to test; this indicates that the Smith formula gives a train resistance which is slightly higher than the actual resistance for this equipment. The Davis formula, giving higher values than Smith would give, results still further from the actual conditions.

(c) The calculations f6r energy consumption and square root of mean square current give results slightly higher than the test.

(d) The theoretical methods, therefore, give values which are slightly on the safe side for short runs.

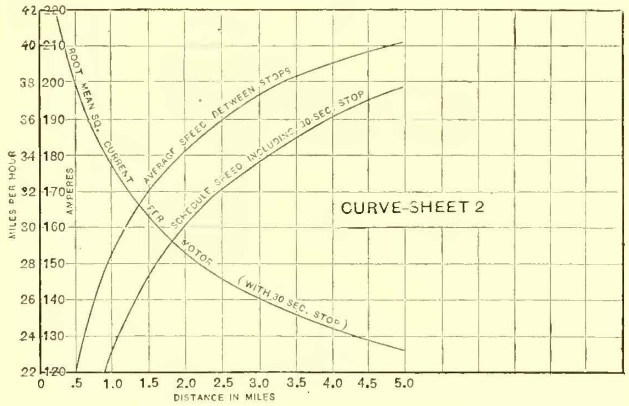
(e) The tests do not afford direct evidence of the accuracy of the theoretical methods when applied to longer runs with higher speeds, but the indications are that for such runs the theoretical values will also be on the safe side and close enough for all practical purposes.

II. USE OF TYPICAL RUN CURVES

As previously stated, the proposed electrical schedule for the Long Island Railroad provides for a large number of combinations of weights of trains and lengths of run. It is obvious that a tremendous amount of time would be consumed if an attempt were made to plot each of these runs and to make the determinations of schedule speed, power consumption and heating effect for the various types and sizes of motors which might be used. To avoid this expenditure of time it was necessary to adopt certain approximate methods, and one method which was used after verification by a practical comparison is what may be called the "Typical Run Curve."

Disregarding grades and curves, a single run for a distance equal to the average length between stops will represent the conditions pertaining to a through run; by plotting results for such average runs of different lengths, curves are obtained which will give exact results for the actual conditions assumed and approximate results for the varying distances between stops and on a succession of light grades and curves. Curve sheet 2 illustrates the character of the curves obtained in this way.

The principal question involved as to the propriety of such a typical run curve is whether the result so obtained (by considering the track straight and level and the distance between all stops the same) will agree closely enough with the average of results obtained from plotting the time-speed curves of an entire round trip, taking the grades and curves into account and placing the stops exactly. It would seem reasonable that the effects of grades in one direction should balance those in the opposite direction when calculating the general results of a run plotted for a round trip when the time of a single run is not greater than one hour, as in this case. If the results of train runs plotted complete be compared with typical run curve results, and if this comparison is generally favorable under varying conditions of grade and length of run, it is safe to assume that typical run curves can be used in place of plotted runs for purposes of general estimate and comparison of different types of equipment when operated under similar conditions. Comparisons, therefore, were made for a given equipment by making plotted runs in opposite directions over the same grades on certain routes of the Long Island Railroad, both on the comparatively level runs of the Manhattan Beach and Rockaway Beach divisions and on the more hilly runs from Long Island City to Port Washington.



CURVE SHEET 2.—GENERAL PERFORMANCE CURVE

Three-car train for Long Island Railroad; two 44-ton motor cars; one 33-ton trailer car; total weight, 121 tons; four No. 86 Westinghouse motors; 23:59 gear ratio; 36-in wheel; 540 volts; 1.5 miles per hour per second braking; no coasting.

These runs were calculated for the purpose of comparing the determination of square root of mean square current. It is possible to make similar comparisons for kw-hours per car-mile and watt-hours per ton-mile, but it is safe to assume that a check made on the comparative determinations for square root of mean square current will indicate the correctness of the assumptions for the determination of the other requirements.

In general, it will be noted that the differences between typical run results and the plotted runs, even in the case of the North Side division, on which conditions of grade are most severe, do not exceed 5 per cent for the square root of mean square current and about 4 per cent for speed. This would seem to be sufficiently close for practical purposes in making estimates for given equipment operated over runs of varying lengths where grades are so comparatively light, as in the case of the Long Island Railroad.

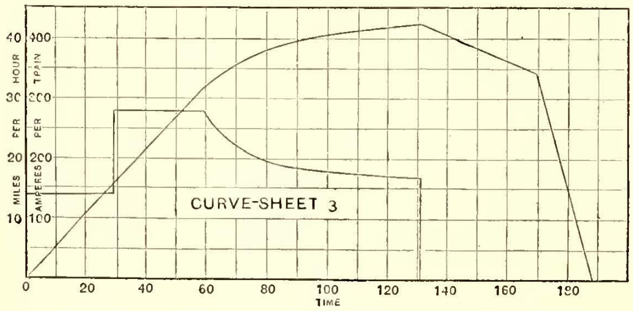
A verification of the accuracy of this method for power determinations in service on an interurban road of the normal amount of curvature in a comparatively level country is obtained by plotting an average run for the Grand Rapids, Grand Haven & Muskegon road. Curve sheet 3 shows a run plotted for the same distance, time, initial acceleration and percentage of time coasting and braking as averaged on a round trip service run of a single car of the Grand Rapids, Grand Haven & Muskegon Railway outside of terminal cities. The tabulated data on this sheet shows that the watt-hours per ton-mile were within 6 per cent of the same value for the theoretical average as for the observed average of an actual test.

The foregoing examples demonstrate that for preliminary determinations of motor characteristics, reasonably close results are obtained by this method, except possibly where very unusual conditions exist. No claim is made that the method is new; in fact, it is quite generally used. The data given simply show that under ordinary circumstances it is reasonable to use this short method and thus dispense with a vast amount of tedious calculating.

III. SCHEDULE SPEED REQUIREMENTS AND LIMITATIONS

The operating conditions of a large steam railroad introduce limitations which cut down the possible speed of the motive power equipment. Many of these are conditions over which the engine man has no control and which do not relate to the nature of the equipment; that is, curves, road crossings, junction points, yard limitations, meeting points on single-track lines, time to handle baggage and express matter, etc. There are delays at stations and delays during runs, some of which occur regularly, but many of which are intermittent. Because of the complicated service, these delays are greater on the suburban lines of a steam road than usually occur in interurban or elevated electric service. It is, therefore, evident that in the electrical operation of such suburban service the loading of the motors will differ materially from the loading in an ideal run which might be made with the conditions removed.

After considering various methods of providing for these conditions, it was decided to make a series of tests of the present steam equipment to determine the speed-time characteristics of the steam trains and the degree to which these characteristics are affected by the local conditions. To this end a test car was equipped with a speed-recording device and runs were made over various routes with this car attached to regular trains. Complete records were obtained of the movement of each train throughout a round trip, and observations made of local conditions which affect speed. These records were carefully analyzed and the results tabulated. In some instances



CURVE SHEET 3.—AVERAGE PERFORMANCE IN SERVICE OF GRAND RAPIDS, GRAND HAVEN & MUSKEGON RAILWAY CAR

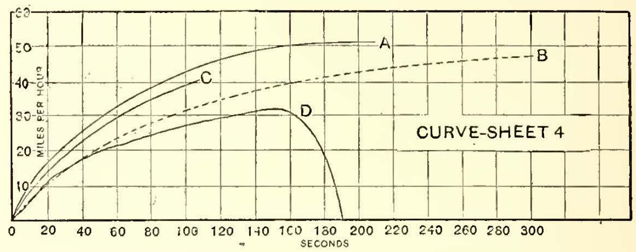
Two Westinghouse 50 C. motors; 20:51 gear ratio; 0.55 miles per hour per second initial acceleration; 525 volts; 140 amps. per motor starting current; weight, 29.5 tons; average grade, level.

Results	Theoretical	Observed Average G. R., G. H. & M. Ry.
Distance, miles	1.54	1.54
Time, seconds	188	188
Schedule speed miles per hour	29.5	29.5
Kilowatt-hours	3.84	3.65
Watt-hour per ton-mile	84.5	80.3
Root mean square current, amperes	95.6	

Smith formula.

in other cases they were not advised that a test was in progress.

In summarizing these test runs, comparisons were made between the average speed between stops as actually attained and the possible average speed if best acceleration had been made for each run. The character of record obtained is illustrated in Tables 2 and 3. It was found that the ratio of the actual speed to the possible speed without local limitations is from 71 per cent to 91.3 per cent. Even when the engineers were requested to do their best, they were able in only one or two instances to exceed 90 per cent of the speed which ap-



CURVE SHEET 4

Time-Speed Curve of Three-Car Steam Train.—(A) From best locomotive performance reduced to level. Weight of train, including locomotive No. 59, 171.9 tons, disregarding light live load. Weight of locomotive, including tender, 88.5 tons. Weight on drivers, 37.5 tons.

Time-Speed Curve of Five-Car Steam Train.—(B) From best locomotive performance reduced to level. Weight of train, including locomotive No. 64, 232.6 tons, disregarding light live load.

Time-Speed Curve of Three-Car Steam Train.—(C) From actual run made on a level. Weight of train, including locomotive No. 72, 175.1 tons, disregarding light live load.

Time-Speed Curve of Five-Car Steam Train.—(D) From actual run made on a level. Weight of train, including locomotive No. 64, 232.6 tons, disregarding light live load.

peared from the test to be possible. On runs 335 and 346 of the Whitestone division, in which locomotive No. 59 made the best single record, the average speed for the run was also nearest to the maximum limit.

From these records were selected the best four single accelerations. Curve sheet 4 shows the speed-time characteristics of these accelerations. Curve D illustrates the general character of record made by the instrument in these tests. This run, having been made on a level, conforms exactly with the record obtained. Curves A, B and C were obtained on grades, and the actual record has been corrected to illustrate the performance of these trains when reduced to a level. In each case the average acceleration over the run was less than the characteristic shows, but these curves illustrate the maximum that the steam equipment was able to do. The composition of trains and their estimated weights are indicated on the curve sheet.

TABLE 2

LONG ISLAND RAILROAD

Long Island City to Valley Stream via Far Rockaway. Eastbound
Length of Run, 22.97 miles

Train Number	1287	1303	1321	Average
Locomotive number	72	34	....	....
Locomotive weight	179,000	154,500	....	....
Number of cars	3	6	5	4
Total weight of train (tons)	175.1	186.55	....	....
Schedule time of run	56:00	55:00	58:00	56:00
Actual time of run	52:30	74:20	59:00	62:00
Schedule number of stops	9	10	12	10
Actual number of stops	10	11	12	11
Maximum acceleration	.6	.7	.65	.65
Grade on which made	—1.00	—0.08	—0.08	—0.38
Maximum retardation	1.6	1.8	1.9	1.76
Grade on which made	Level	Level	Level	Level
Average acceleration	.47	.46	.35	.426
Average retardation	1.04	1.06	1.22	1.11
Maximum speed	56.5	52.5	50	53.
Average length of run	2.08	1.91	1.77	1.92
Average time of run	4:03	4:48	4:10	4:20
Average maximum speed	39.9	34.8	33.5	36.1
Length of longest run	7.77	....	....	....
Time of longest run	11:20	....	....	....
Average time of stops	0:49	1:55	0:25	0:63
Average speed between stops	30.8	23.9	25.5	26.5
Possible average speed from curve	34.5	33.7	32.7	33.8
Ratio aver. to possible aver. speed	89.4%	71.%	76.%	78.5%

The live load on these runs was so light that it was disregarded. On curve sheet 5 will be found two curves (E and F) of actual runs on grades, compared with run A of the curve sheet 4. According to curve E, a five-car train on a down grade was accelerated at a rate far below the best performance, and even the three-car train with locomotive No. 35 (curve F) was not accelerated on a down grade with a rate any better than the best single performance on a level.

TABLE 3
LONG ISLAND RAILROAD
Whitestone Division. Westbound
Length of Run, 11.75 miles

Train Number	316	360	318	Average
Locomotive number	59	35	20	....
Locomotive weight	177,000	154,500	139,500	....
Number of cars	3	3	5	4
Weight of train (tons)	171.9	162.85	217.85	184.2
Schedule time of run	28:00	28:00	31:00	29:00
Actual time of run	28:34	27:34	35:15	30:27
Schedule number of stops	7	7	7	7
Actual number of stops	7	7	7	7
Maximum accelerrtion	.9	.95	.5	.78
Grade on which made	—0.65	—0.65	—0.75	—0.68
Maximum retardation	1.8	2.0	1.9	1.9
Grade on which made	1.07	0.69	1.28	1 01
Average acceleration	.44	.35	.29	.36
Average retardation	1.43	1.5	1.2	1.38
Maximum speed	52	50	44.5	48 8
Average length of run	1.47	1.47	1 47	1.47
Average time of run	3:08	3:14	3:55	3:26
Average maximum speed	41	38.3	33.5	37.6
Leneth longest run	....	....	1:63	....
Time longest run	....	....	3:47	....
Average time at stops	0:29	0:15	0:33	0:26
Average speed between stops	28.1	27.3	22.5	25.9
Possible average speed from curve	30.8	30.8	30 8	30.8
Ratio actual to possible av. speed	91.3%	88.6%	73 %	84.2%

It will be noted that the curve A was made by a locomotive whose weight was 51.5 per cent of the total weight of train. The officials of the railroad were of the opinion that service equivalent to that which could be performed by this locomotive, No. 59, with only three cars, would be sufficient for the electric equipment. The best performance of this locomotive was, therefore, taken as the criterion by which to work in determining the proper characteristics for the electric equipment. The condition laid down was that the electrical equipment, operating a train with standing load in the cars, should be able to make the same average speed between stops as this particular steam equipment.

Taking curve A as a basis, determinations were made of what may be termed the "speed limit" for steam trains. This is a curve indicating the average speed in miles per hour between stops with the rate of acceleration corresponding to curve A, without coasting; and with a braking rate of 1.5 miles per hour per second. On curve sheet 6 there will be found a characteristic speed-time curve of this steam train making runs of from 1 mile to 3 miles. From this curve the speed-limit curve No. 7 was plotted. Table No. 4 shows how this speed-limit of steam trains compares with the average speed between stops required to make various typical runs of the proposed suburban service. It will be noted that the average speed of the schedule runs is from 71.2 per cent to 92 per cent of the speed limit, with about 80 per cent as a mean figure.

SCHEDULE CONDITIONS OF PROPOSED ELECTRIC SERVICE

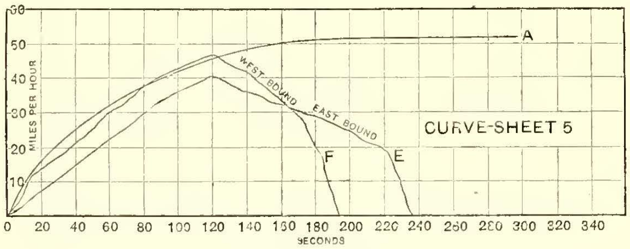
Obviously, to make the same time, the speed characteristics of the electric equipment selected for this service must be such that the schedule can be maintained with similar speed reserve, unless the limiting conditions are removed. Some of these conditions are being removed and others probably will be. Elimination of grade crossings at roads and junction points, handling of baggage and express matter by special trains, improvement of yard facilities, etc., will make it possible to operate trains at speeds closer to the limit of the equipment. On the other hand, as the population along the road increases, the tendency will be to increase the number of stops with as little increase as possible in the running time; therefore, it was decided not to make any material allowance for improved conditions in the initial service. The probability of such improvement, however, suggests another precaution to be taken in the selection of equipment—namely, the provision of a suitable reserve in capacity of motors to carry the greater loads which will result from running at speeds closer to the limit.

On curve sheet No. 6 are time-speed curves of a three-car electric train with two motor cars and one trailer, with standing load in the cars, which curves may be compared with the corresponding curve of the steam train on the same curve sheet. It will be noted that the electric equipment with the lower gear

TABLE 4
DATA FOR SUBURBAN RUNS. LONG ISLAND RAILROAD
Omitting Runs Where Number of Stops Is Same as Herein, but Time at Stops Is Less

Run	Distance Miles.	Time Minutes	Train Sheet Schedule Speed Entire Run	Intermediate No. of Stops per Trip	Time out for Stops	Average Length of Run Miles	Time of Average Run Minutes	*A* Average Speed Between Stops Miles pr. Hr.	*B.* Limit Av. Speed Best Steam Train Miles pr. Hr	Ratio of *A.*/*B* Steam	*C.* Limit Av. Speed Electric Train 23:59 Gear Ratio	Ratio *A*/*C* Electric
Long Island City	----	41.5	26.3	7	4.5	2.27	4.62	29 5	36.0	81.9	35.5	83 2
Port Washington	18.18	43.0	25.4	8	5.0	2.02	4 22	28 7	34.0	84.4	34 0	84 5
Long Island City	----	----	----	----	----	----	----	----	----	----	----	----
Whitestone Landing	11.75	31 0	22.8	7	3.05	1.47	3.44	25.6	30.8	83.2	31.8	80.5
	----	39.25	24.9	5	2.5	2 72	6.12	26.7	37.5	71.2	36.5	73.2
	----	39.0	25.1	6	2.75	2.33	5.18	27.0	36.0	75 0	35.5	76.1
	----	40.0	24.4	7	3.5	2 04	4.57	26.8	34 0	78.8	34 0	78.8
Long Island City	----	41.0	23.8	8	4.25	1.81	4.08	26 6	33.0	78.8	33.5	79.5
Rockaway Park	16.3	43 0	22 8	10	4.0	1.48	3.55	25.0	30.8	81 2	31.8	78.7
	----	43.75	22 3	11	4.5	1.36	3.27	25.0	30.0	83.3	31.0	80.7
	----	47.0	20.8	14	5.5	1.09	2.76	23.7	27.0	88.0	29.0	81.8
Long Island City	----	----	----	----	----	--	----	----	---	----	----	----
Valley Stream	22.97	59.5	23.1	11	7.5	1.91	4.33	26.4	33.7	78.4	33.7	78.3
	----	37.0	26.1	3	3.0	4.03	8.5	28.5	41.0	69.5	39 0	73 0
Long Island City	----	38.0	25.4	4	2.5	3.22	7.1	27.2	39.0	69.8	37.5	72.6
Manhattan Beach	16.1	40.0	24.2	5	3.75	2.68	5.87	27.4	37.5	73.2	36 5	75.0
	----	44.0	22.0	11	6.5	1.34	3.12	25.8	29.8	86.5	31.3	82.5
	----	39.5	24.5	7	4.0	1.98	4.56	26.0	34.0	76 5	34.0	76.5
	----	44.75	21.5	11	5.0	1.32	3.31	23.9	29.5	81.2	31.0	77 2
Flatbush	----	45.5	20.9	12	5.75	1.22	3.06	23.9	28.5	84.0	30.0	79.6
Rockaway Park	15.88	47.0	20.2	15	6.5	0.99	2 53	23.5	26.5	88.6	28.5	82.5
	----	48.0	19.8	16	6.75	0 93	2.43	23.0	26.0	88 5	18.0	82.2
Flatbush	----	19.0	30.4	1	1 0	4.81	9.0	32.0	42 5	75.3	40.0	80.0
Jamaica	9.63	23.0	25.1	5	3 0	1.61	3.33	29.0	31.5	92.1	32.5	89.2
Flatbush	----	----	----	----	----	----	----	----	----	----	----	----
Valley Stream	22.55	60.5	22.4	13	9.0	1.61	3.68	26.1	31 8	82.0	32.0	82.4

ratio has a maximum speed on straight level track of approximately 45 miles per hour, and with the higher gear ratio, 39 miles per hour; whereas the limit of the steam train on the level is 52 miles per hour. For a run of 1 mile or less between stops, however, the electric train with either gear ratio makes better time than the steam train. For a 1.5-mile run the electric train with higher gear ratio falls behind the steam train, and at



CURVE SHEET 5

Time-Speed Curve of Three-Car Steam Train.—(A) Taken from curve sheet No. 13.

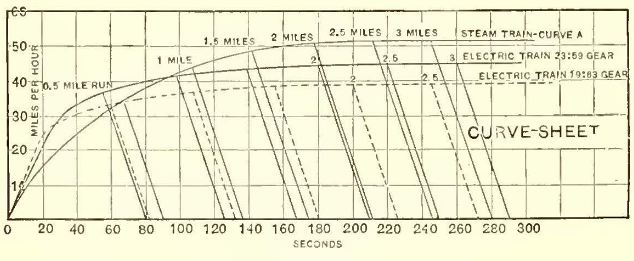
Time-Speed Curve of Five-Car Steam Train.—(E) From College Point to Whitestone, made by five-car steam train. Weight, including locomotive No. 18, 276.1 tons, disregarding small live load. Acceleration made on average grade of —0.78 per cent.

Time-Speed Curve of Three-Car Steam Train.—(F) From Whitestone to College Point, made by three-car steam train. Weight, including locomotive No. 35, 162.85 tons, disregarding small live load. Acceleration made on average grade of —0.74 per cent.

slightly over 2 miles the electric train with the lower gear ratio falls behind.

The comparative speeds of these trains are still better illustrated on the speed-limit curves of curve sheet No. 7. The general average length of run between stops for the suburban service is about 1⅔ miles. It is evident from the speed-limit curves on curve sheet 16 that a three-car electric train with two motor cars and gear ratio 23:59 will average slightly better as to speed than the three-car steam train, but that the same equipment with higher gear ratio falls considerably below the speed limit of the steam train. From this exhibit it is obvious that schedule requirements indicate that no gear ratio lower than 23:59 should be adopted.

It is also evident from these speed-limit curves that if 23:59 is the lowest gear ratio practicable as determined by the limitations, the three-car train unit will have to be made up of two motor cars and one trailer, in order that the requisite speeds



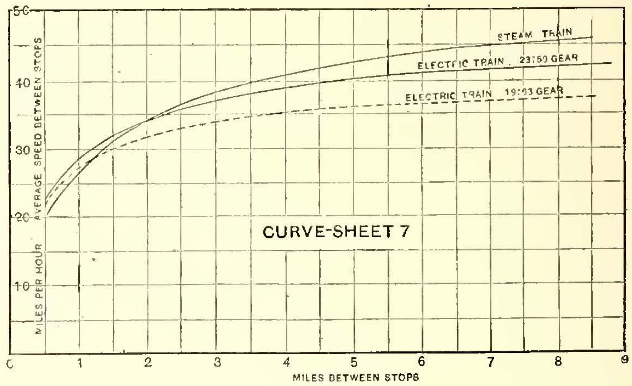
CURVE SHEET 6

Time-Speed Curve of Steam Train.—Curve A of sheet No. 4.

Time-Speed Curves of Proposed Electric Trains.—Best possible performance on level grade. Weight of train, 121 tons, without standing load. (All three-car trains.)

may be reached. The weight per motor for this equipment is 30.3 tons, which on this basis of speed requirements is obviously close to the limit. To determine what equipment will be necessary for a two-car train, the speed-limit curves of curve sheet 8 have been prepared. In this case the two-car train is made up of one motor car and one trailer. It will be noted that such an electric train, with standing load, falls below the speed limit of the steam train at slightly over 1 mile between stops. As regards speed requirements, therefore, the two-car train with motor car and trailer has not sufficient motor capacity, and except in cases where speed limitations are slight, two-car trains will have to be made up of two motor car in order to make the schedule. On this curve sheet, No. 8, the corresponding curve for train with seated load has been plotted to indicate the difference in schedule speed possible during the light traffic hours of the day, as compared with the hour of heavy load morning and evening. It will be noted that in the case of heavy equipment of this character, the changes in weight of live load do not materially affect the speed characteristics of the equipment.

Attention was called to the column of Table 4, which shows the ratio between the average speed of steam train between

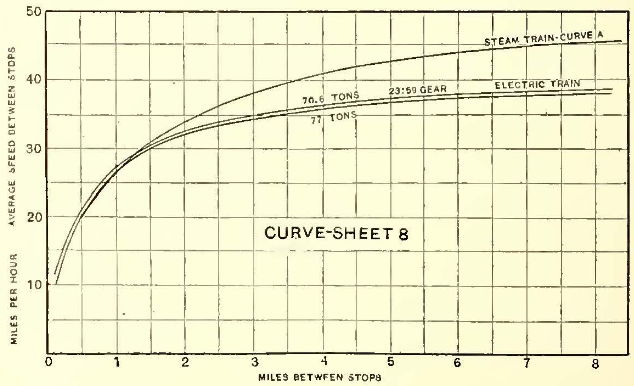


CURVE SHEET 7

Speed-Limit Curves for Three-Car Trains.—Showing best possible speed between stops over various lengths of run, without coasting. Steam train based on curve A for acceleration. Electric train with standing load weighs 121 tons.

stops on different runs according to schedule, and the speed limit possible with the best steam train in each case. Another column of this table gives the ratio of average speed to the speed limit of the three-car electric train for the same runs. It will be noted that the reserve speed in the electrical equipment corresponds closely with the reserve in the steam equipment throughout the list. It, therefore, seems evident that this three-car train unit fulfils the requirements laid down as to speed, and can be depended upon to make the required schedule with standing load in the cars, allowing for all the delays contemplated in the present schedule for steam equipment.

It is obvious that trains made up into combinations of motor



CURVE SHEET 8

Speed-Limit Curve for Motor Car and Trailer.—Compared with steam train. Electric train weighs 70.6 tons, seated load. Electric train weighs 77 tons, standing load. Steam train based on curve A for acceleration.

cars and trailers that give less weight per motor will be able to make better speeds than indicated for this three-car train. Furthermore, as the number of cars per train increases, the relative effect of head resistance decreases. For these longer trains it is, therefore, possible that a greater proportion of trailer cars may be used in some instances without reducing the speed limit to such an extent as to prevent the train from making schedule time.

It is not the purpose of this paper to follow out all the technical processes by which final conclusions were deduced as to size and characteristics of motor equipments for the project referred to. Sufficient illustrations have been given to show:

First, that a study of the operating conditions of even a complex project quickly narrows the selection of motors down to one or two sizes, and that these conditions also largely determine the speed characteristics of the equipment; secondly, theoretical methods are now developed to a point of sufficient accuracy to be considered reliable for purposes of selecting equipment; thirdly, short methods may be used with discrimination, at least for preliminary determinations.

With reference to the use of short methods, a remark may be made in closing regarding the advantage to be gained by deriving a set of general formulæ, applicable to all sizes of motors. On first consideration, such a problem as herein described makes such data seem almost indispensable. When we find that only one or two sizes of motor need be considered, however, the advantage of so general a method becomes less apparent. On the other hand, with a little ingenuity, graphical or mechanical methods may be devised for plotting characteristic curves, which make it possible to determine the values of speed, current, etc., throughout a complete run with surprising rapidity. At the present state of development, therefore, it appears that the most satisfactory results may be obtained by employing the characteristics of a specific equipment rather than by spending time in deriving a set of hypothetical characteristics in which many variables are neglected.

DISCUSSION

The discussion was opened by L. B. Stillwell, who said that the paper was one of especial importance in view of the fact that electric railway engineers were now leaving the field of tramway service for the broader one of heavy traction, about which so little is known. The train curves for the Manhattan Railway, given in the paper, but not reproduced in the accompanying abstract, did not represent the final Manhattan Railway equipment, as at that time the rheostats had not been properly adjusted. In taking up this problem on the Manhattan Elevated Railway, 13 lbs. per ton was assumed as train resistance; it was found that under 25 miles an hour the formula gave values too low for trains having half or all axles equipped with motors. The resistance given by several formulæ was 12 lbs. to 13 lbs. per ton for speeds of about 45 miles an hour. These tests suggested that it is possible to obtain an approximate curve without elaborate formulæ, at least for preliminary work. One of the other points brought out by Mr. Stillwell was that the adhesion of all of the wheels of a truck is never exactly the same, owing to the unequal distribution of the weight of the motors on the wheels.

Following Mr. Stillwell, C. O. Mailloux took up the discussion, and said that he was very pleased to note the close agreement of the theoretical curves with those obtained in practice. He did not agree with the authors of the paper that the making up of theoretical speed-time curves involved unnecessary and tedious labor, as their own results showed that the formulæ, provided their terms were properly changed to meet the prevailing conditions, were sufficiently close for practical purposes. He was pleased to find that his formula, as given on page 157 of Gotshall's "Electric Railway Economics," based on the experiments of Prof. Goss, had proved so close to results found by actual tests. Mr. Mailloux concluded his talk by referring to the extensive use of theoretical formulæ which he had noted during his recent trip to Europe.

Ward Leonard then took the floor and said that he deemed the occasion an appropriate one for discussing "heaviest electric traction." He had found that on an average, the steam trunk lines of the United States used about 125 hp per mile of line—that is, taking the total number of locomotive horsepower and dividing by the number of miles of line, would give that figure. However, in the case of the Pennsylvania Railroad, this was as high as 550 hp, and on the Pittsburg & Lake Erie and the Bessemer & Lake Erie, which carried a heavy freight service, he estimated that 1000 hp would represent the power per mile of line. Discussing the question of first cost of steam and electric locomotives, he saw no reason why, when the manufacture of electric locomotives had been standardized, they should not be cheaper than steam locomotives. The modern steam locomotive with tender costs about 5 cents per pound, but since the only useful weight is that upon the drivers the cost really figures out to 9 cents per pound of the weight on the drivers. He believed that wherever more than 250 hp is required per mile, the electric locomotive can replace the steam locomotive with a very decided economy. The cost of equipping a steam railway of that character complete with the necessary central station, transmission system and the locomotives, would not be far from about 15 per cent added to the existing capital investment, and the very great increase in starting torque and power upon grades and the reduction in the cost of fuel and maintenance would more than compensate for the additional outlay. In the most modern types of freight locomotives, the cost of maintenance per mile has been found to be as much as the cost of fuel per mile. This, he admitted, was a most startling statement, but he had found that $3,500 per annum represents the cost of each of these items on the so-called 2-10-2 type locomotive of the Santa Fe. He believed that electric locomotives of the Ward Leonard type—that is, using a motor-generator set on the train—would prove especially suitable for heavy freight work. It should be remembered, he said, that a steam locomotive is not capable of the great momentary overloads which can be secured with electric apparatus, therefore the latter should prove of great advantage wherever there are heavy grades. Again, when a long train of cars is turning a curve with a steam locomotive, most of the adhesion is at one end of the train, whereas with electric locomotives a number could be placed throughout the train and operated by multiple-unit control, thereby securing a more effective adhesion and taking the curves with greater ease. Mr. Leonard then gave a formula for calculating the power applied at the draw-bar, namely, multiply the miles per hour at which the train is moving by the pull in pounds at the draw-bar; doubling the product will give the number of watts. With regard to fuel economy, he said that it must be remembered that for every $100 which the railway company expends the fuel cost amounts to only $7 or $8, and the total cost of everything which can be added up for power, including shops, will not be greater than 20 per cent of the total. Given, a road where there is a heavy freight traffic, it will be evident that if twice the horse-power can be applied to a given length of line, double the receipts will be obtained from the same track, and if this can be done with an additional cost of, say, only 20 per cent, it is certainly a good business proposition.

A. H. Armstrong, upon taking the floor, criticised the methods adopted by the authors in making their curve sheets, especially in their use of the mean square root of mean square current. Cary T. Hutchinson followed Mr. Armstrong with a few remarks upon the fairly close resemblance between the theoretical and actual curves. Prof. W. S. Franklin, in discussing theoretical speed-time curves, said that an ultimate formula was impossible, owing to the great number of variables, but that a comprehensive study of train friction at different speeds should make it possible to keep these variables within certain limits.

W. N. Smith, who collaborated with O. S. Lyford, Jr., in the preparation of this paper, then took occasion to reply to some of the criticisms which had been made. With reference to Mr. Armstrong's remarks, he said that they had found the use of the square root of mean square current sufficiently close for all practical purposes, that they were obliged to look at the problem from a consulting engineer's standpoint, and therefore could not go into the same detail that a designer would. With reference to the discrepancies between some of the formulæ, these were due more or less to the fact that they had been copied or retraced several times from other sheets.

TRAIN RESISTANCE

BY W. J. DAVIS, JR.

In determining the motor capacity and possible schedule speeds of a car or train of cars, the investigator is confronted with the lack of reliable data on train resistance at high speeds as applied to the type of cars in common use on electrically operated railways. Results obtained from tests on the rolling stock of steam railways unfortunately cannot be generally applied to electric traction work. Not only are the electric cars lighter and trains shorter, but the prevalent use of a rounded or wedge-shaped vestibule in high-speed work considerably modifies the head or wind resistance. Many of the investigations made on steam railways have been carried through by means of a dynamometer car coupled to the engine and measuring the draw-bar pull of the train following. The results given, therefore, do not, as a rule, include the head wind resistance of the locomotive, and where an attempt is made to obtain such head resistance by indicator cards, the results are not applicable to electric traction on account of the difference in the shape of the steam locomotive and the electric car. Finally, the resistance of a single car is very different from that of a train of cars such as used in most of the published tests.

The first comprehensive tests to determine the resistance of electric cars at high speeds and the effect on the resistance of varying the number of cars in a train were made by the writer in March, 1900, on a section of the Buffalo & Lockport Railway. The coasting method was used in making the tests and the resistance for each set of conditions obtained from speed-time and speed-distance coasting curves as furnished by automatic recording instruments. Numerous repetitions of each test were made so as to obtain accurate average results. Since the publication of these tests and the formulæ derived from them in the Street Railway Journal of May 3, 1902, isolated tests have also been taken from time to time with electric cars operated under a wide range in conditions, and the resistance at various speeds obtained by ammeter and voltmeter readings. The constants so obtained form the basis of the data and curves given in this article.

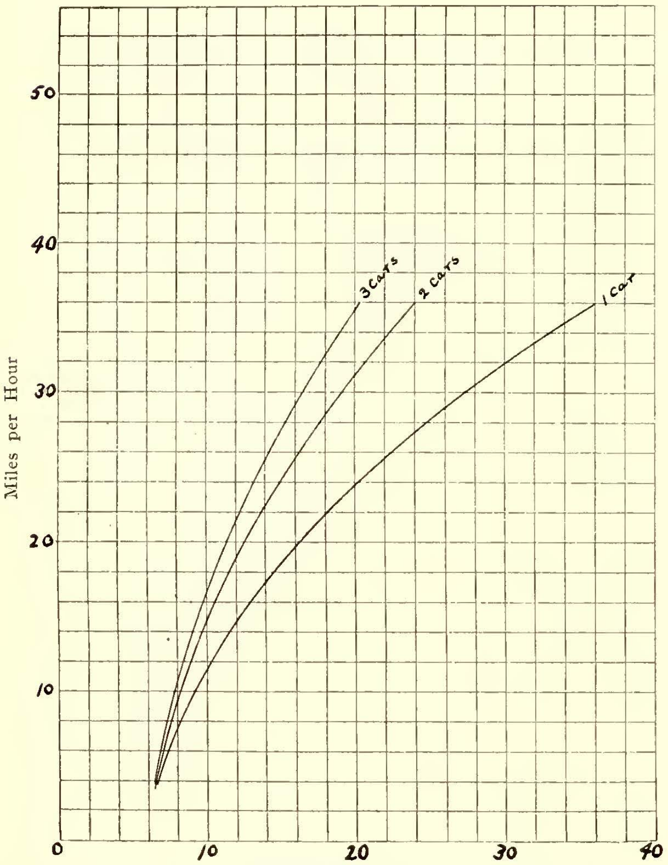


FIG. 1.—TRAIN RESISTANCE, 15-TON CARS
85 SQ. FT. EFFECTIVE CROSS SECTIONAL AREA

$$R = 6 + .11\,V + \frac{.3V^2}{T}\,[1 + .1\,(n-1)]$$

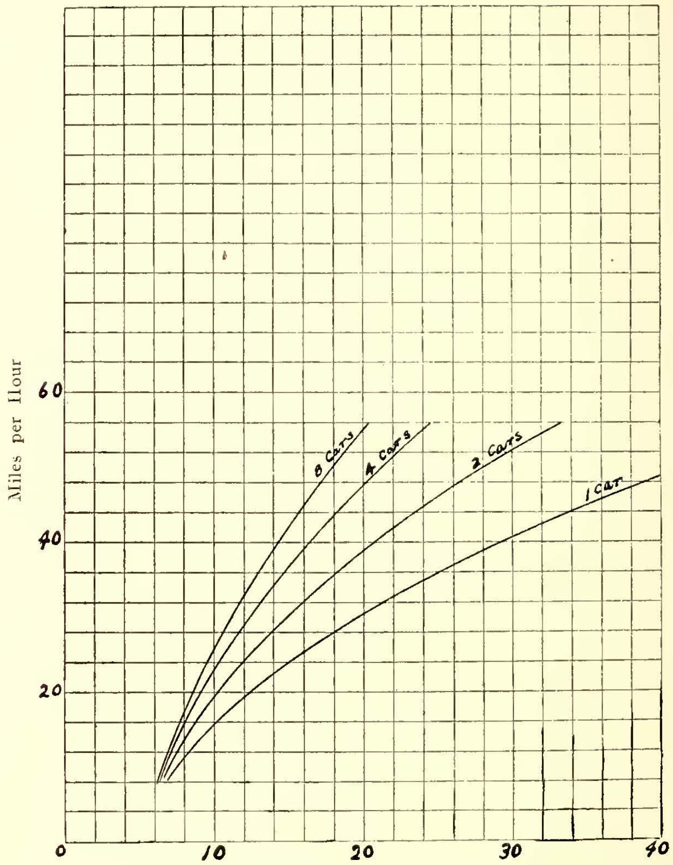


FIG. 2.—TRAIN RESISTANCE, 25-TON CARS
100 SQ. FT. EFFECTIVE CROSS SECTIONAL AREA

$$R = 5 + .13\,V + \frac{.3V^2}{T}\,[1 + .1\,(n-1)]$$

DEFINITION

Train resistance proper may be defined as the net tractive effort delivered at the driving wheels at constant speed on tangent level track, and comprises, therefore, the sum of all the forces opposing the motion of the train, exclusive of the internal losses of the motor or engine. In the case of an electrically propelled car, the internal losses of the motors consist of

(1) I^2R and frictional losses on commutator.
(2) I^2R losses in windings of armature and field.
(3) Armature iron losses.
(4) Gear and motor bearing frictional losses.

As these losses are primarily dependent upon motor design and capacity, it is the practice to properly include them in the characteristic curves of the motor, which curves show the net tractive effort delivered at the periphery of the wheels for any speed and power input. The investigator is therefore chiefly concerned with the losses due to the motion of the train, the principal components of which are journal friction, rolling friction and air resistance. These items vary considerably with varying conditions, such as general design of trucks, shape of car body and condition of roadbed. Moreover, there are other unusual conditions, such as side wind pressure producing flange friction, increase in rail losses due to insufficiently balanced or badly constructed roadbed, improperly lubricated journals, etc., which cannot properly be included in determining average results, so that at best the predetermination of train resistance is in the nature of an approximation.

JOURNAL FRICTION

The laws governing the friction of journal bearings have been made the subject of careful and scientifically accurate investigations by various engineers, and may now be considered well established. The first discovery of the true laws of friction was made by Prof. R. H. Thurston in 1876. The publication of these experiments was followed by exhaustive and elaborate investigations carried out by Beauchamp Tower, according to a method devised by him and published in the "London Engineering" of November, 1883. These investigations show that the coefficient of friction increases with the speed and decreases with the pressure on the bearings. Applying this law to railway rolling stock, it will appear that for a given speed the journal friction per ton of a light or empty car will be greater than that of a heavy or loaded one. Furthermore, for a coach of given design and weight, the bearing friction will increase as the velocity increases, and may approximately be expressed as a straight line function thereof.

It has also been found that the friction of bearings depends in a greater degree upon the lubrication than upon inherent characteristics of the metals themselves. In other words, the laws of journal friction follow those of liquids rather than of solids. This is illustrated by the high efficiency of oil compared with grease as a lubricant, and by the use on some roads of one kind of grease during summer and another kind during winter.

Journal friction may be expressed by an equation of the form $f = b + c'V$.

ROLLING FRICTION

Rolling friction is understood to include losses in trucks and springs due to oscillation of the car body, and between the wheel and rail due to roughness of the track or lack of rigidity in the roadbed. These items are directly proportional to the velocity, and on a heavily constructed and well ballasted road will at moderate speeds usually be found to be considerably less than the friction between journals and bearings. The laws governing the rolling friction have not been definitely determined, owing to difficulties encountered when attempting to segregate this quantity from bearing friction and head resistance. Theoretically, the tractive effort required to overcome rolling friction is proportional to the velocity, and may be written $f = c''V$.

AIR RESISTANCE

We now come to the consideration of atmospheric resistance. This includes head or wind pressure resistance, stern or suction resistance, both of which are proportional to the cross section of the train, and air resistance on the sides of the train which is proportional to the length. According to Prof. Goss, the head resistance is about 6.5 times the stern resistance. Experiments made on the Buffalo & Lockport Railway showed that the side resistance of a single car was equivalent to about one-tenth of the head and stern resistance. In practical work the head and stern resistances may be grouped together and taken as a function of the effective cross section. The side resistance may also be included as a fractional part of the head and stern resistances.

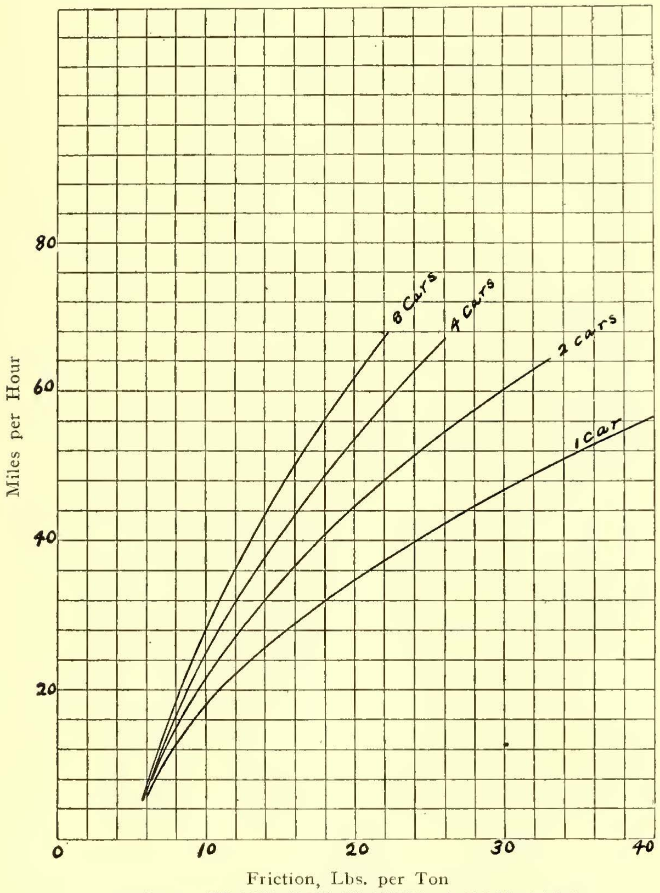


FIG. 3.—TRAIN RESISTANCE, 35-TON CARS
100 SQ. FT. EFFECTIVE CROSS SECTIONAL AREA

$$R = 5 + .13\,V + \frac{.3V^2}{T}\,[1 + .1\,(n-1)]$$

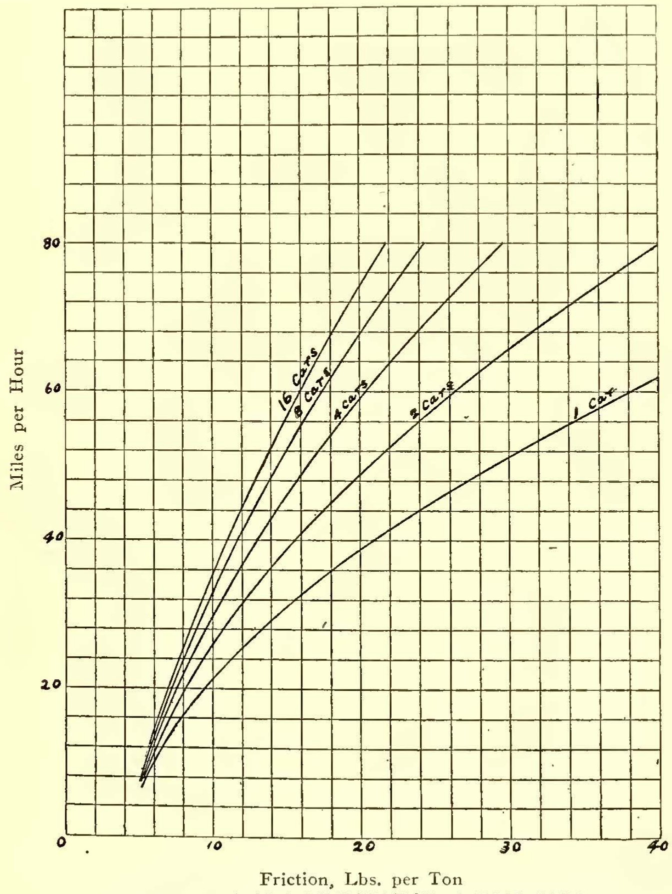


FIG. 4.—TRAIN RESISTANCE, 45-TON CARS
110 SQ. FT. EFFECTIVE CROSS SECTIONAL AREA

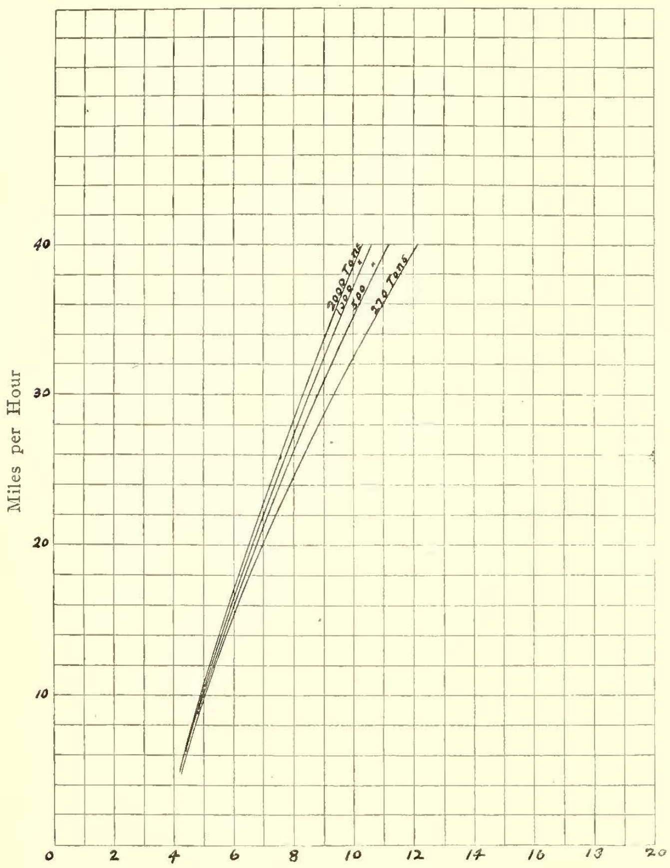
$$R = 4 + .13\,V + \frac{.33\,V^2}{T}\,[1 + .1\,(n-1)]$$

Authorities do not agree that the laws of atmospheric resistance have been as yet definitely determined. Tests on projectiles at high velocities made by Herr Krupp at Neppen, Germany, show great variation in functional values, the retarding force being proportional to the square of the velocity up to 790 ft. per second, to the cube from 790 ft. to 1370 ft. per second, and to the square again for higher velocities. At the velocities prevalent in railway work, tests made by Prof. Langley, Prof. Goss, Herr Reichel, the writer and others show the relation $p = dV^2$.

Where p = pressure in pounds per square foot.
v = velocity in m.p.h.
d = a constant.

The only disagreement in the results obtained has been in the value found for the coefficient d, which for flat surfaces has been given by various authorities as .003, .004 and .005. In the series of tests at Buffalo, referred to above, a coefficient of .004 was found for a wind shield mounted on the front of the locomotive and having an area of 50 sq. ft. This agrees closely with most of the data available. The standard type of high-speed electric car, however, is built with vestibule ends, which present a more or less sloping surface to the wind. It is known that the shape of the surface normal to the wind will greatly influence the wind pressure coefficient. In Herr Reichel's tests made at Berlin in 1901, a 10-ft. arm having a flat board attached to the end, with the surface at right angles to the direction of motion, was revolved at various speeds. An oblong body with ends parabolic in shape was then substituted for the flat board, and the tests repeated. The flat surface showed approximately $p = .004V^2$, and the parabolic surface $p = .001V^2$, while experiments with rotating arms have always shown $p \propto V^2$. The accuracy of the coefficient thus obtained is open to question, especially where the tests are made with short arms or at high velocities. Prof. Kernot's investigations ("Engineering Record," 1894) show the pressure upon an octagonal prism to be 60 per cent; upon a cylinder, 50 per cent, and upon a sphere, 36 per cent of that on a flat surface of equal projected area. This would give comparative coefficients of

.0040 for flat surface.
.0024 for octagonal prism.
.0020 for cylinder.
.0014 for sphere.



Friction, Lbs. per Ton

FIG. 5.—TRAIN RESISTANCE, FREIGHT CARS
110 SQ. FT. EFFECTIVE CROSS SECTIONAL AREA
WEIGHT OF CAR 45 TONS

$$R = 3.5 + .13\,V + \frac{.385\,V^2}{T}\,[1 + .1\,(n-1)]$$

Numerous isolated records of car and train resistance at speeds approaching 60 m.p.h. have shown the coefficient of wind pressure for head, stern and side resistance in actual practice to vary between .0025 and .0035, depending upon the type of car.

If A represents the cross section of car in square feet, T the weight in tons, V the velocity in miles per hour, we have for wind resistance in pounds per ton $f = \frac{dAV^2}{T}$

TOTAL RESISTANCE

Most of the formulæ proposed by various authorities are of a strictly empirical form and can only be applied with accuracy to cases in which the conditions agree closely with those existing during the tests from which the formulæ were derived. Moreover, these conditions are often so incompletely stated as to render the formulæ practically of no value to the general investigator. Again, if the investigator were to depend solely upon empirical formulæ, an unwieldy number would be required to properly cover all service conditions, such as cross section, shape and weight of car, number of cars forming the train, condition of roadbed, maximum speed, etc. It is therefore desirable to have a formula of such characteristics that change from one set of requirements to another totally different set may be made with a fair degree of accuracy by a simple change in the constants. Such a formula would have a separate term, with a single variable for each component of the resistance. As our present knowledge of train friction will not permit so complete a segregation, the nearest approach thereto would take the following form, combining the journal, rolling friction and air resistance above described:

$$R = b + cV + \frac{dV^2}{T}[A_1 + m\,(A_2 + A_3 + A_4 + \text{etc.})]$$

Where R = friction in pounds per ton.
V = velocity in miles per hour.
T = weight of train in tons of 2000 lbs.
A_1, A_2, etc., = cross section of cars in square feet, including trucks and motors.
c = combined journal and rolling friction coefficient.
d = wind pressure coefficient.
m = coefficient showing proportional section of trailing car considered as affecting total windage.

If all cars are of equal cross section, the formula becomes

$$R = b + cV + \frac{dAV^2}{T}\,[1 + m\,(n - 1)]$$

Where n = number of cars in train, including leading motor car.

The above formula was proposed by the writer in 1900, in a description of a series of tests taken on the Buffalo & Lockport Railway, in which a maximum speed of 60 m.p.h. was reached. Based upon these tests and other data available, the following values are offered for the various coefficients:

b = 3.5 for heavy loaded freight cars.
= 4 for standard passenger coaches or large electric interurban cars.
= 5 to 6 for light electric cars with grease lubrication.
c = 0.11 for heavy track construction.
= 0.13 for medium track construction.
d = 0.0035 for open platform cars.
= 0.0024 to 0.0030 for vestibuled electric cars.
m = 0.10.

The cross section of the car includes the space bounded by the wheels between the top of rails and body.

The coefficient of wind friction "d" is by all odds the most important one in the formula, and it should be accurately determined for all distinctive end shapes. In very high-speed work where the maximum running velocity exceeds 60 m.p.h. and comparatively light trains are used, the wind resistance not only seriously affects the motor capacity, but necessitates heavy additional outlay for power plant and distribution system, not to mention the effect upon the coal pile. It is therefore of the greatest importance to keep the wind resistance down as much as possible, and this may be secured by the use of sloping ends which will cut through the air much in the same manner as a ship cuts through the water. Future experiments should be conducted with reference to determining the comparative value of various end shapes, consideration also being given to the practicability of the design as applied to mounting of drawheads, proper housing of control apparatus, and to its efficient handling by the operator. Published results of the Zossen tests show a coefficient of .0022, based on effective cross section for pointed wedge, and .0024 for truncated wedge-shaped ends.

All data obtained by the writer on cars of the interurban electric type show that "d" lies between .0024 and .0030, and the latter value is recommended for ordinary practical use, as it insures the equipment having sufficient capacity to meet the requirements of the service.

For convenience in general reference, curves based on d = .003 have been constructed to meet various conditions as follows:

(A) For light open platform street cars, 8 tons to 20 tons; maximum speed, 30 m.p.h.; cross section, 85 sq. ft.

$$R = 6 + 0.11V + \frac{0.3V^2}{T} [1 + 0.1 (n - 1)]$$, see Fig. 1.

(B) For standard interurban electric cars, 25 tons to 40 tons; maximum speed, 60 m.p.h.; cross section, 100 sq. ft.

$$R = 5 + 0.13V + \frac{0.3V^2}{T} [1 + 0.1 (n - 1)]$$, see Figs. 2 and 3.

(C) For heavy interurban electric cars, or steam passenger coaches, 40 tons to 50 tons; maximum speed, 75 m.p.h.; cross section, 110 sq. ft.

$$R = 4 + 0.13V + \frac{0.33V^2}{T} [1 + 0.1 (n - 1)]$$, see Fig. 4.

(D) For heavy freight trains, cars weighing 45 tons loaded; maximum speed, 35 m.p.h.; average cross section, 110 sq. ft.

$$R = 3.5 + 0.13V + \frac{0.385V^2}{T} [1 + 0.1 (n - 1)]$$, see Fig. 5.

ANNUAL CONVENTION OF THE ASSOCIATION OF TRAMWAY AND LIGHT RAILWAY OFFICIALS

This is one of the three national street railway associations of Great Britain, the other two being the Municipal Tramways Association, whose last convention was held at Liverpool on Sept. 27-28, and was reported in the STREET RAILWAY JOURNAL for Oct. 29, and the Tramways and Light Railways Association, which holds monthly meetings in London.

The Association of Tramway and Light Railway Officials has been in existence for about five years, and held its annual meeting at Newcastle on Nov. 2 and 3. In his address, the president of the association, H. England, general manager of the Wakefield & District Tramway, referred to the advisability of consolidating with the other two associations so as to form one representative body, which he thought would be much more effective and would receive more official recognition than three individual associations. He referred to the suggestion made by Mr. Bellamy at the Liverpool convention of the Municipal Tramways Association in regard to the transportation of express and freight by electric railways. He also referred to the importance of the different companies uniting upon a standard gage, and to the desirability of a standard form of account.

The papers presented included one on car wheels, by A. N. Banister, of the Norwich Tramway Company, which is published in the following columns. Another paper was presented on methods of checking conductors, by F. Coutts, of the Ayr Tramways. Mr. Coutts stated that the British system of uniformed inspectors as spotters was not satisfactory, and recommended detectives in plain clothes. He believed that arrangements might be made with insurance agents, collectors and other individuals, whose employment compels them to travel frequently, by which for a small annual payment of $50 or so, reports could be secured. A second and perhaps a better plan, in his opinion, would be the establishment of a trained detective staff by the different companies, which would periodically visit all the tramways in the country.

In a paper on "Average Speed and Speed Allowance," submitted by A. R. Fearnley, of Sheffield, a table was given of the speeds permitted by the Board of Trade. Up to the early part of 1903, the maximum speed allowed appears to have been in a few cases 10 miles an hour, but in the majority of cases only 8 miles an hour. Reports from different cities show that there are now a number of companies with a maximum speed of 10 to 12 miles an hour, and three as high as 15 miles an hour.

The fourth paper was presented on "Automatic Regenerative Control," by J. S. Raworth. This system consists of using a compound-wound motor instead of a straight series motor. The shunt windings are employed under normal conditions of running for all variations in speed regulation, acceleration and braking. By varying the field excitation, the speed is either increased or decreased. When the speed required is less than that which can be secured with a maximum field, the speed of the car is controlled by a resistance in the armature circuit. The series winding can be used to assist the shunt field under certain conditions, but is usually employed only in cases of emergency, such as when descending a grade if the trolley comes off the wire; in this case, the series field is brought in operation and the car is braked by this means. Tests have been made with this controller in several cities, and considerable economy is claimed from its use, especially on lines having grades.

CAR WHEELS *

BY A. N. BANISTER

The life of the wheels and also of the rails is very largely dependent on the condition in which the permanent way is maintained. The topographical conditions of the system are also very important factors, and it is very frequently the case that wheels which give good results on one system will prove quite unsuitable for another. Until comparatively recently, the only possible wheel was the chilled cast iron. During the last few years, however, they have been run very close, and in many cases surpassed by steel-tired wheels, either with cast-steel or forged-iron centers. A few years ago, steel wheels cost from £20 to £22 ($100 to $110) per set, whereas better wheels can now be purchased at from £14 to £16 ($70 to $80) per set, and, at the same time, there has been a reduction in the price of cast-iron wheels, but not to a proportionate extent. These latter can now be bought at 28 shillings ($7).

With cast-iron wheels probably the most frequent cause of trouble is chipping of flanges, especially on a track which is uneven, incorrectly gaged, or has a narrow groove, or where the switches and crossings are not in good order. Flat spots is another trouble which is frequently experienced with chilled wheels. This, however, can be almost entirely eliminated by careful training and discipline of the motormen.

With steel tires the flanges do not chip, flats are almost unknown, and the cars run smoother and quieter, with, it is claimed by the makers, less wear on the rails. This latter point is, however, by no means established. On the other hand, trouble is often experienced through the flanges of steel tires wearing completely off, in which case the cost of re-turning must be added to the price; there is also a reduction in life owing to the amount turned off to produce new flanges. Another disadvantage of steel wheels is their varying size through their lifetime and consequent variation in the height of the car body from the rails, which introduces complications in the track

* Abstract of paper read at a meeting of the Association of Tramway and Light Railway Officials at Wakefield, Nov. 2.

brakes and life-guards, both of which have to be so arranged as to be adjustable to suit the varying height of the car; this variation in height amounts from 1¾ ins. to 2 ins. through the wear of the tires. There are, therefore, many factors which require consideration before deciding on the relative merits of steel and chilled-iron wheels.

I have here the records of two experimental sets of steel-tired wheels, bought July, 1902. These have cast-steel centers, and were bought on a basis of 1 shilling 8 pence (40 cents) per 1000 miles run; to this figure must be added for a set of four wheels the cost of

	£	s.	d.	$
Boring out and pressing on		11	0½	2.65
Turning down tires when worn out		1	6	36
Taking out of car and replacing		11	2½	2.69
Total	1	3	9	5.70
Less scrap value, 3s. per set of four		3	0	72
Total per set	1	0	9	4.98

The mileage obtained was 47,000. Hence the cost per 1000 miles per wheel for above work was 1 shilling 4 pence (32 cents), making the total cost per wheel, per 1000 miles, 21.4 pence (42.8 cents).

Cast-iron wheels at that date cost 30 shillings ($7.20), and ran 14,000 miles. Allowing for value of scrap, this works out at 24 pence (48 cents) per 1000 miles per wheel. Add to this, cost of boring, etc., 4 pence (8 cents), gives a total cost per 1000 miles of 28 pence (56 cents), or 6.6 pence (13.2 cents) more than with steel wheels. In addition to this, we have the cast-steel centers, and allowing 10 per cent per annum depreciation, these are worth 32 shillings ($7.68) per wheel.

With regard to maintenance, great care should be taken to have all wheels pressed on to their axles to the same gage. Our practice, in Norwich, is ⅛ in. narrower than the track gage, giving 1-16-in. clearance to each wheel. They should be pressed on at a steady pressure up to from 30 tons to 35 tons, and this pressure should increase steadily from zero to the total amount; that is, each inch of travel should require an equal increase of pressure. If the pressure is unequal, it indicates a bad fit, and there is danger of the wheel coming loose on the axle in service. They should also be carefully watched to prevent variation in size between the two wheels on one axle. Our wheels are calipered once a fortnight, and if the variation in diameter amounts to 1-16 in., the wheels are ground to size. At the same time the depth of the flanges is noted, and, if necessary, they are ground to the original depth, for if allowed to get too deep, they are liable to chip.

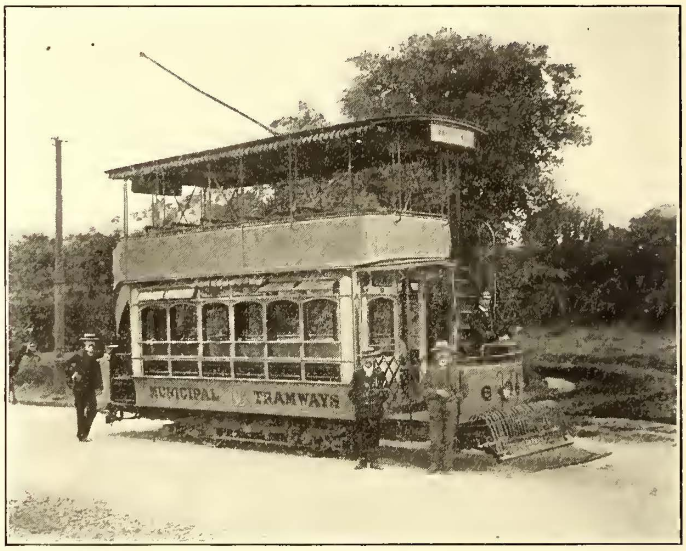
Flats are ground out immediately they are reported, and our practice is to punish any motorman who makes two flats in six months for which he can give no satisfactory explanation; he is also punished if he neglects to report a flat as soon as it is made. By this means we have reduced our trouble from two or three flats a week to about one a month or less. The time required for grinding all four wheels of one car averages two and one-half hours. This includes the time taken in moving the car from the running shed to the grinding machine and back again to the shed, ready for service. We find that carborundum wheels are best and cheapest in the end, though the first cost is more than twice as much as ordinary emery wheels. To insure wheels having equal wear on loop lines, cars should be occasionally turned. If there are no diagonal braces, the trucks are liable to get out of square; they should therefore be tested occasionally on that account.

The setting of the wheel brakes and the action of the brake gear should be carefully attended to, to see that the brakes do not grind away the wheel flanges. To remove any trouble from this source, we have recently had the pattern of our brake blocks altered, to do away with the lip on the flange side. By so doing, the weight and consequent cost of the brake blocks is considerably decreased, and any danger of wear on the flange of the wheels removed without, so far as I can see, any disadvantage.

The average mileage of chilled wheels obtained on the Norwich tramways from date of opening, July 30, 1900, to June 30, 1903, was 14,000; from July 30, 1900, to June 30, 1904, 15,000; and last year, June 30, 1903, to June 30, 1904, 19,000. This improved result I attribute entirely to extra care and attention to the wheels and rails. Nearly all our wheels having come from the same makers, it can hardly be attributed to improvement in quality; further, with this improvement comes also a reduction in price from 30 shillings to 28 shillings.

A GLIMPSE OF THE DURBAN, NATAL, TRAMWAYS

Although so far from the mother country, the transplanted Anglo-Saxon in Natal, Africa, does not lack many of the conveniences enjoyed by his Northern brethren, especially double-deck electric cars, as exemplified in the modern overhead trolley system operated by the municipality of Durban, the flourishing



STANDARD DOUBLE-DECK CAR USED ON THE DURBAN MUNICIPAL TRAMWAYS

capital of Natal. The accompanying illustration shows one of the standard single-truck cars, the lower part of which is furnished with rattan cross seats and the upper part with wooden ones. Among the notable features of the car equipment are the low windows, side ventilators, folding platform gates, Providence fender, electric bell for notifying the motorman, and awnings for the middle windows of the enclosed part of the car, in addition to the usual ones for the upper deck. The type of tubular iron side poles used may be observed at the left.

Beginning at the right, the gentlemen standing in front of the car are: E. C. Hawkins, cashier of the Durban Municipal Tramways; E. H. Corlett, traffic superintendent, and F. W. Chalsty, secretary.

During the twenty-nine days of its operation of the New York subway, the Interborough Rapid Transit Company has carried 5,838,235 passengers who have paid fare, in addition to a small number who traveled on passes and the larger number of policemen and firemen who travel free. The daily average of traffic, not counting the Lenox Avenue branch, which opened only a few days ago, was 201,318, showing daily average receipts of $10,065.90. Figures concerning the origin of traffic show that 428,318 took the cars at Fourteenth Street and 476,670 at the Grand Central station. Brooklyn Bridge station had, of course, the largest number of ticket purchasers, one-fifth, or 1,185,863.

MEETING OF THE OHIO INTERURBAN RAILWAY ASSOCIATION

The fourth meeting of the Ohio Interurban Railway Association, held at the Boody House, Nov. 17, was by far the best attended and perhaps the most interesting meeting the association has yet held. The efforts of the officers to interest those from outside of the State resulted in the attendance at the meeting of representatives from one Pennsylvania company, four Michigan companies, four Indiana companies and one Kentucky company, besides representatives of about thirty Ohio roads. The membership of the association now numbers 160.

In opening the meeting, President Harrie P. Clegg, of the association, said he wished to impress upon every one that the association was not a Dayton affair, nor even an Ohio affair, although the organization had its inception in Dayton and the majority of the officers were from that district, and he stated that at the next election the present officers would give way to men representing other districts. He outlined some of the problems which had caused the Dayton managers to get together, such as the demand for interchangeable transportation, the operation of through limited cars from one road to another, the checking of baggage over other roads, the shipping of through freight, etc., and he impressed upon those present the importance of all the roads in the Central West getting together and co-operating in these and other matters.

Secretary J. H. Merrill went over the work that had thus far been accomplished. He said that fifteen roads were now using the form of interchangeable transportation adopted by the association and that reports from these roads indicated that the books were meeting with a large sale. He urged the roads that had not yet signed this agreement to take up the matter at once. Several other topics brought up for discussion at previous meetings were outlined, and Mr. Merrill stated that on the matter of supplying transportation to newspapers in return for advertising, a standard form had been recommended and adopted by several of the roads. This contract is reproduced elsewhere. The matter of adopting a standard set of operating rules, he said, was one that should receive prompt attention. Several roads are now operating through service over the tracks of other roads, and nearly all lines are sending special cars over other roads. Some roads insist that where a foreign car enters their line, that they shall furnish not only a pilot but a conductor as well, owing to the rule requiring both the motorman and the conductor to participate in receiving the despatcher's orders. With uniform rules, the extra conductor, at least, could be dispensed with, and the conditions for operating through cars would be much improved. The set of operating rules adopted by several of the roads was recommended, and copies of these rules will be sent to all members, with the request that the rules be considered with a view to adopting them at the next meeting.

F. J. J. Sloat, who at a previous meeting had been delegated to prepare suggestions for a standard form of interline ticket, stated that a great many of the roads were selling through tickets over other roads, and showed a number of samples of such tickets, some of them carrying a passenger over five or six roads, among them tickets from Zanesville to Cincinnati, from Columbus to Indianapolis, from Lima to Cincinnati, etc. Thus far a road desiring to sell over another road designed its own tickets and arranged to have the other roads honor them, but there has been no uniformity of ideas, and there are plenty of opportunities for mistakes and crooked dealings. He said, in part:

"My findings have been partly taken from steam road tickets. Here, for instance, is a dummy ticket gotten out by the Columbus, Newark & Zanesville. That ticket is a dummy of what you would use from Zanesville to Cincinnati over the Columbus, Newark & Zanesville; Columbus, Buckeye Lake & Newark; Columbus, London & Springfield; Dayton, Springfield & Urbana, and the Cincinnati, Dayton & Toledo. It is possibly a little long, but by dividing it and slightly changing the contract, we could get up a ticket which would answer for every road in any State. The main points in connection with such a ticket would be (1) a proper contract covering the use of the ticket so that the passenger would understand what are his rights as well as the company; (2) taking care of baggage, which seems to be quite an essential feature nowadays in the transportation of passengers. The auditing stub and the form itself should have a limit stub or mark. My idea is that on the coupons arranged in this order, the ticket should have a limit, but for the cancellation to show that it is a limited ticket, each road should be numbered. For instance, the Cincinnati, Dayton & Toledo, No. 1; Dayton & Toledo, No. 2, etc., and in addition to this, after each number, should be the coupon ticket number. For instance, my road would be No. 1—1; 1—2; 1—3; and in the case of No. 2 it would be 2—1; 2—2; 2—3, etc., and when the No. 1 coupon is turned in by the passenger you will know that it is the sixth coupon ticket from some ticket, and can easily find out what road it represents.

"Class is another feature. You may desire to sell a standard ticket at less than the regular rate, or a second-class ticket. In that case the coupons should be punched second-class, or first-class, and in that way you could use the standard form of ticket to cover almost anything you would want in this particular line. I happen to know that great strides are being made in the manufacture of a machine to manufacture tickets within the machine; that is, you put in a roll and you can make any ticket you desire, and in addition to that form you would want this kind of a ticket in addition to the ticket over your own road. The machine, I presume, will be ready for the market within a very short time. It would be a very fine feature, and there is no doubt but that it would save money. The first tickets made embody three coupons, one for the conductor to take up, one for the passenger to retain, and a third retained within the machine, so that when the tickets come in they will all match, and you will have the complete transaction. Many of the roads, of course, put on relief conductors at certain intervals on the line, and now it is usual to mark the passenger by hat check or something of that kind, and there is very apt to be some dispute, but by these new tickets the passenger always has his stub, and he can always show his coupon and the time the ticket is sold, and it looks to me to be a very good thing.

"Now, as to the matter of form. This is a form of ticket I had manufactured from data for interline tickets. In the first place the ticket should be limited to thirty days from date of sale. Other essentials for such a ticket are as follows:

Each ticket should show rate, inserted to the left of where class is shown on right-hand edge of coupon.

Selling company should have its initials printed in "destination space."

Selling company should fill in initials of other roads, showing road or roads over which ticket is good.

A statement showing number of tickets sold, etc., should be rendered by each company not later than the tenth of the month.

Each company should furnish its own blank forms for making report of the sale of tickets, to be the same as now in use by the Cincinnati, Dayton & Toledo Traction Company.

Settlement to be made monthly not later than fifteenth of following month.

Selling company should stamp distinctly on back of each coupon, date of sale, also station from which sold.

Selling company's agent should define by punch marks on the right margin of each ticket the date of the expiration of the same.

Tickets taken up in error by the conductor, after the expiration of the same, should be accepted by the settling company at full value.

Through passenger rates effective at the date of this contract should become a part of this contract, subject to changes by giving ten days' written notice, accompanied by new passenger tariff.

The form of ticket to be agreed upon by the various roads entering into this contract.

Tickets should be printed on safety paper.

One general form of R. T. and S. T. full and half fare tickets should be used, the figure "½" to be shown on face of half-fare ticket in red.

One general color should be used on all forms of tickets, or, in other words, all roads will use the same color for the same class of ticket, namely, R. T.—S. T.—R. T. H-F—S. T. H-F.

Each road should have its distinguishing number printed on the face of each ticket and coupon, in large, plain type, and printed in red, to facilitate handling and auditing.

Unused portions of tickets to be redeemed by selling road when presented by purchaser for that purpose, and when tendered before the expiration of the thirty days.

Selling road to charge each other road interested in the ticket with its proportion of this. Said redemption to comply with the laws covering such matters.

Reports should be rolled and not folded, as this is more convenient for binding.

"The Cincinnati, Dayton & Toledo Company, in order to take care of this interline business, got out a simple form which is to be used in a loose leaf ledger. If we sold a ticket over the Dayton & Toledo, at the end of the month I expect to put in the date the ticket was sold, station to station, number of the ticket, which would designate it, and as the first half comes in we simply check it up. It is the intention to make up a standard form of reporting our tickets to the Dayton & Toledo, so that when the sheet comes in we take it and put it in the loose leaf ledger and give it a page number, say 6, and the Dayton & Toledo gives it a page number, say 7, consequently we now have a dozen different sheets for that month's business, numbering 6, 7, 8, 9, etc., that take care of that month's business. You will notice under that operation we are not called upon to hire any extra help."

Mr. Sloat was appointed chairman of a committee on interline tickets, and the committee was given power to act.

The question of checking baggage was brought up as going hand in hand with the sale of interline tickets. Owing to the lack of uniformity of ideas on this subject, Mr. Sloat requested that it be left to another committee, with the result that Edward Spring was appointed chairman of a committee to formulate standard rules for interline checking of trunks and baggage.

The subject announced for discussion at this meeting was "The Handling of Freight on Interurban Lines." A large number of forms adopted for handling freight were displayed, including a very extensive exhibit loaned through the courtesy of the Street Railway Accountants' Association. There were no prepared papers and the representatives of all the roads were asked to give their ideas and practices. It was developed early in the discussion that there was a wide range of ideas as to the best methods to be pursued and the rates to be charged in handling this business. Some held that the only profitable plan was to do an express business and get express rates, while others favored the handling of freight rates in direct competition with steam roads. Between these classes was another class which favored doing both freight and express, in short, doing business at any price so long as there was a margin of profit in it. Several speakers bemoaned the fact that the steam roads would not loan their cars to the electric lines, nor interchange business with them, although there were several indications that of late the steam roads were waiving this rule where it seemed to be to their advantage to do so. One radical speaker urged that the association attempt to force an interchange of business through legislation, but this view found little support. In fact, there was a general tone throughout the meeting that it was folly for electric lines under present conditions to attempt to combine to fight the steam roads on the freight proposition. It was stated that some of the roads were attempting to handle freight at less than the cost of operation, and that even if they had the cars, the large majority of lines were in no physical condition to handle trains of freight cars.

F. J. J. Sloat, of the Cincinnati, Dayton & Toledo, outlined the business of the Southern Ohio Express Company, which has been referred to in these columns on a number of occasions. The company now operates over the Cincinnati, Dayton & Toledo, the Dayton & Troy, the Western Ohio, and the Springfield, Troy & Piqua. On the Cincinnati, Dayton & Toledo, the rates vary from 25 cents to 35 cents per hundred for the 55 miles, with additional rates beyond. Last year the business on all the roads aggregated about $74,000. The operating expenses, however, have averaged nearly 90 per cent, due largely to the expense of making deliveries. By securing first-class terminal facilities in Cincinnati, something they have only recently accomplished, this can be reduced considerably, but the cartage will always remain an expensive item. Generally it is found that as soon as enough business is obtained for one car, the results are satisfactory, but as soon as a little more business comes in and another car is required, the operating expenses are doubled, while the receipts are not, so that it is the handling of the business with the least possible number of cars that counts. The southern end of this road was formerly an old steam road, and on this the company handles its own freight business, keeping it separate from the express business. Mr. Sloat stated that the Southern Ohio Express Company was endeavoring to make arrangements with other roads for handling their express business. By this plan four or five cars a day could run through to distant points, say from Cincinnati to Toledo, or from Columbus to Indianapolis. With the through runs there would be no necessity for changing cars at the end of 30 or 40-mile stretches, the various companies could do away with the organizations they now maintain and the business would be increased, because it would be in the hands of persons who would make a specialty of it. Business could be secured in bulk because it could be sent to a large number of different points without reshipping. The express company in its proposed contract would agree to pay the road a percentage on the mileage basis. If the express company sees fit, it will reserve the right to install its own motor and trail cars, but it will agree to buy such car bodies as the railway company may own. Mr. Sloat said that in the course of three or four years it would probably be necessary to run trains of two or three cars over the proposed routes, in which event the expenses would be still further reduced. He thought that at present rates and under present conditions, the roads had not been making money with straight freight, but under the plan proposed of routing through cars, the freight and express might be handled together to great advantage. Express would mean speedy shipment, with collection and delivery, while goods classed as freight would be shipped when most convenient within a reasonable time and with no delivery. For instance, a merchant buying a lot of shoes at Indianapolis might want some of them right away. These would go forward on the first car at express rates, while the balance would be shipped later at a 7 or 8 cents a hundred rate.

G. W. Parker, general freight agent of the Detroit United Railways, said that when the consolidation of the Detroit properties took place there were four companies doing an express business, each with different ideas. The four roads were brought together, but despite the economies resultant from consolidation, it was found that there was not enough express business in sight to carry on that business exclusively. The old-line express companies and the cheap water routes gave them strong competition, with the result that the railway companies have since devoted their energies principally along the line of package and light freight. Much of the business comes from the Cleveland, Detroit & Buffalo lake steamers. The company has no wagon service, but has an agreement with a teaming company, which makes its own charges. The company has a station which it shares with the Rapid Railway, the Detroit, Ypsilanti, Ann Arbor & Jackson, and the Detroit, Monroe &

Toledo. Expenses are divided on a tonnage basis. The company is handicapped considerably by a city ordinance which allows it to operate only one freight car in two hours. The total freight business aggregates about $150,000 a year, and the operating expenses are about 60 per cent. On some of its divisions the company handles freight in carload lots, but this is not brought into the city. Rates for this are competitive to the steam roads, and the company has an advantage in that goods are usually delivered the same day. Between Chesterfield and Marine City, the company operates freight trains by steam locomotive at night. The company has two locomotives and another coming, and owns a number of box cars. A train makes one round trip each night. Going up, the loaded cars are dropped in the various towns. They are unloaded immediately and loaded again with any goods that are outbound.

FORM 60-107 1-04-200

ADVERTISING CONTRACT.

This contract made and entered into this______day of____________190__,

by and between ____________________________

publishers of the____________________newspaper, party of the first part, and The Cincinnati, Dayton & Toledo Traction Company, a corporation under the laws of Ohio, party of the second part,

WITNESSETH: That the said party of the first part in consideration of the covenants and agreements hereinafter to be done and performed by the said party of the second part, hereby agrees to publish in each issue of its said newspaper the time-card of the said party of the second part, or any other advertising matter in relation to the business of said party of the second part, or the business of The Southern Ohio Express Company; said other advertising matter to occupy the same space in each issue of the newspaper as said time-card; said space not to be less than two inches by two inches and to cover a period from January 1, 1904, to December 31, 1904.

Said party of the first part further agrees in addition to the above that it will at the option of said second party publish any other advertising matter such as notices, etc. (except legal notices) which may become necessary during the period above mentioned, provided that said insertion will not take more than two inches by two inches of space and the said notice not to be inserted more than 24 times a year, or twice in each month or its equivalent, whether said notice be in reference to the business of the said The Cincinnati, Dayton & Toledo Traction Company or The Southern Ohio Express Company.

Said first party also agrees to send to the second party, at its office at Hamilton, Ohio, a copy of its daily issue, (if a weekly paper send weekly issue).

The said party of the second part hereby agrees in consideration of the covenants above stipulated, that it will issue to the said party of the first part, or to whom said party may elect, the following transportation good between the following stations to the value of__________

FROM STATION	TO STATION	RATE	VALUE

IN WITNESS WHEREOF the said party of the first part by____________ __________ its____________ and the said party of the second part by____________ ____________, its General Manager, have hereunto caused the corporate name of said parties to be signed hereto in triplicate the day and year first above written.

FORM OF NEWSPAPER ADVERTISING CONTRACT SUGGESTED FOR INTERURBAN ELECTRIC RAILWAYS

Toward morning the train makes the return trip and picks up the cars. The company has connection with the Grand Trunk, and it interchanges cars.

J. H. Huber, general freight agent of the Canton-Akron Railway Company, stated that his company did an exclusive express business. It has an arrangement with the Electric Package Company, of Cleveland, on goods going to or coming from the territory of that company, but it operates its own express car. Goods leave Cleveland at 9:15 p. m. and reach Canton by midnight, and are delivered the next morning. Rates are based on a tariff, which is 15 per cent to 20 per cent less than the old-line express rates.

Theodore Stebbins, of the Appleyard system, reported that his companies make two deliveries a day over 150 miles of road. About 90 per cent of the business may be classed as freight business, although the bulk of this is the better class of freight. There is one town on the system that has no direct connection with a steam road, and to this point the company handles from nine to fifteen cars a month. The neighboring steam road gives them the business—that is, it delivers the cars to the electric road and it gets a 10-mile haul, for which it charges the consignee $7 to $12 per car as switching charges, the consignee assuming the demurrage charges where there are any. Their business comes largely from wholesale merchants. They believe that possibly they could increase their gross earnings somewhat by charging express rates and making deliveries, but they find that the delivering is the heavy end of the operating expense. It is figured that deliveries cost about 60 per cent outside of the running of the car, but without the wagon delivery the expenses run about 30 per cent. They believe that the greatest limitation to their earnings is the lack of adequate terminal facilities.

W. B. Tarkington, general superintendent of the Detroit, Monroe & Toledo Shore Line, said his company handled freight exclusively. Formerly they made two trips a day, starting the car from Monroe, running it into Toledo for a load, repeating the operation the second trip, and then back to Monroe at night, making practically 85 miles for each load, for which they received the regular steam freight rate. Now they start the car out of Toledo and make one round trip to Detroit. They take the better class of business and let it go at that. Expatiating on how impossible it was for an electric line to compete with a steam road on heavy freight, he said that he was recently offered a contract to handle a large quantity of brick from Monroe. The contractor was laying 60,000 brick every eight hours. He figured out that it would take thirty gondolas every day to fill the contract, and as he did not have the gondolas nor the power to handle them, he did not take the contract.

G. S. Shinnick, of the Columbus, Buckeye Lake & Newark Traction Company, said that his company formerly did an express business and charged 5 cents lower than the old-line companies. Deliveries were made in Newark by a teamster to whom they paid 5 cents on each 25-cent package. This practice was discontinued, and lately they have handled freight both in carload lots and otherwise. On carload stuff they charge $15 per car from the outskirts of Columbus to Newark, 37 miles. On package freight their rate is 4 cents higher than steam rates for all classes. In connection with the Appleyard lines, they make through shipments to Springfield and Dayton, charging 25 cents and 27 cents, respectively, for first-class goods. The competing steam road has a local car for Newark, but goods for this car have to be delivered at night, whereas the electric line receives them in the morning and delivers before noon. He thought all roads in the district should get together on some kind of uniformity of prices so that one road could know in advance what it would cost to ship over another road. As it is now, they have different rates, and before a figure can be quoted it is necessary to call up the various roads and secure their rates, which takes time and costs money.

J. S. Young, of the Toledo, Bowling Green & Southern Traction Company, said that his company had just started handling freight. The road passes through an oil country, and it is handling a large amount of oil well supplies, tools, drills, etc. They get 20 cents for first-class freight to Findlay, while the steam rate is 12 cents. They are handicapped through the fact that they cannot get into the center of Toledo, but despite this, the business amounts to about $40 per day. After the first of the year the company will have its own line into Toledo, and will then operate cars to the Toledo freight station. It will also do a carload business with standard freight cars, turning these cars over to the Terminal Belt Railway (steam), with which it has an arrangement for switching cars at $3 each.

F. J. J. Sloat, of the Cincinnati, Dayton & Toledo, said that the old steam section of his road was a member of the per diem association and exchanged cars with steam roads, yet when his company wanted to transfer coal cars on the northern division of the road the steam roads declined for a long time to accommodate him. Coal is hauled on the old steam section a distance of 6 miles at 30 cents a ton. On account of the heavy grades on this division, the profits are small. They make a charge of $1 per day demurrage where cars are kept longer than forty-eight hours.

F. J. Green, general manager of the Springfield, Troy & Piqua, said that he had lost a great amount of sleep trying to solve the freight problem on other roads with which he had been identified, and when he opened this new line, he turned the whole business, freight and express, over to the Southern Ohio Express Company. They are handling considerable carload business and have practically a monopoly of the business at the towns they touch, as there are no steam roads. In two of the towns there have recently been erected saw mills, planing mills and grain elevators, and they expect this winter to ship grain to the seaboard. They will get cars from the connecting steam road and will charge the consignor a shipping charge for the service.

THE OHIO INTERURBAN RAILWAY ASSOCIATION

MONTHLY STATEMENT OF INTERCHANGEABLE COUPONS

..................190...

.... Railway Company, Dr.

To ....

For O. I. R. A. Interchangeable Coupons accepted during the month of 190

and enclosed herewith: .... Coupons, at 5 cents, face value, $..........

Less Discount, 16.66 per cent ....

Net value, ...

We have {added / deducted} on account of error on your Statement of .... 190 ..

per authority of ....

Balance due, $..........

Make check payable to ....

MONTHLY STATEMENT OF INTERCHANGEABLE COUPONS

F. D. Carpenter, of the Western Ohio Railway, said that his line, like the majority of roads, had not been constructed with a view to handling carload freight. The greater number of roads were absolutely unfitted for such service. Curves would have to be straightened out and lines built around towns before they could hope to meet the steam roads on their own grounds. The business on his road is handled by the Southern Ohio Express Company and the results are satisfactory. Goods are frequently shipped to Cincinnati, a distance of 140 miles.

Walter H. Abbott, of the Roberts-Abbott Company, Cleveland engineers, stated that his company had frequently been called upon to report on propositions designed to take carload freight business, and that up to very recently they had discouraged such attempts. He said that the present form of electrical equipment for interurban roads of moderate lengths was not designed for hauling trains of freight cars. The majority of such stations have equipment ranging from 600 hp to 1000 hp, and are designed for handling from five to fifteen passenger cars, but when a number of heavy freight cars are put on for a short interval the strain on the electrical equipment is such that it is likely to be ruined, while to install equipment to handle such loads at all times was almost prohibitive. He thought that the advent of the a. c. motor might help the situation somewhat, but he thought the better plan for handling such business was to install steam locomotives and use them at night if necessary. He referred to the Albany & Hudson Railway and the Cincinnati, Georgetown & Portsmouth Railway, which employ this plan, the former earning $26,000 and the latter $41,000 from freight alone, in addition to which these roads handle express in electric express cars. Referring to the Interstate Commerce reports, he said that the earnings of the smaller steam roads ranged from 2.3 to 5.4 cents per ton-mile, while some of the largest trunk lines handled carload freight at from 1 to 2 cents per ton-mile. The Albany & Hudson with its steam equipment earned 8.3 cents per ton-mile. He said that the future of electrically operated freight roads depended upon the straightening of curves, the reduction of grades and the building of private rights of way around towns.

A manager from the southern part of Ohio told of a proposition made him by a steam road to handle 2000 cars of freight a year to a point on his line not touched by a steam line. The haul was 4 miles, and he was to receive 25 cents a ton for coal and building material and 50 cents a ton for miscellaneous material. But he found that in order to handle it he would have to spend $15,000 in reducing a 5 per cent grade. He wanted the business, but he could not afford to spend that amount. The railroad was so anxious for the connection that it offered to pay part of cost of the grading, also to pay him for returning empty cars, with the result that he has about decided to accept the proposition.

W. K. Morley, general manager of the Grand Rapids, Grand Haven & Muskegon Railway, told of the freight business which his company carries on in connection with the lake steamers from Grand Haven to Chicago. They operate two through cars and two local cars each way daily. The average rate on goods is 20 cents a hundred from Grand Rapids to Chicago, and they divide with the steamer company. Goods are shipped from Grand Rapids in the afternoon and delivered in Chicago next morning. The road has a maximum grade of 1 per cent, and their cars have a capacity of 20 tons. The business is satisfactory and is increasing.

Edward C. Spring, of the Dayton, Covington & Piqua Traction Company, a warm advocate of the freight proposition, said that he was hauling freight in carload lots, and that while he appreciated that he was getting only a low price for it, yet he felt satisfied and would be glad to handle all that was offered to him. He handles garden produce, grain, live stock, in fact, almost anything that will go into a car. As an example, he said, he recently shipped three cars of hogs into Dayton. It took him three and one-half hours for each trip and he received $10 per car, which he considered good business.

H. C. Lang, of the Mandelbaum syndicate, Cleveland, was asked to sum up the situation. He said that the majority of electric roads had invested more money per track-mile than the steam roads. Thus far, comparatively speaking, they have attacked the steam roads on their least profitable side, that of handling passengers. Admitting for the sake of the argument, that the electric roads are not at present in position to handle heavy freight, he said that ten years ago the interurbans were looked upon as a joke by the steam roads, yet to-day wherever the interurbans have been developed, they have not only taken from the steam roads a great portion of the short-haul passenger business, but they have built up a business of their own that did not exist ten years ago. Then the interurban line was a cheaply constructed affair, built on the highway, laid out with no regard for grades and curves, and operated with cars that would not be fit for city service to-day. Within the past three or four years remarkable changes have taken place. The highway road is out of date and lines have been built which are equal to the best steam roads in nearly every particular. But there are improvements still to be made, and it is not to be expected that the electric roads can jump into the freight business at the same point that they have reached in the passenger business. Obviously, this business must be built up a little at a time, as has been done with the other branch. And to accomplish this the older roads and some of the newer ones will have to spend large sums in strengthening bridges, reducing grades, straightening curves and adding to power facilities. This work will not only improve the possibilities for freight service, but will aid the passenger business and make it possible to co-operate with other roads for long distance business. In the mean time, while these changes are going on, why not turn the freight and express side of the business over to a company like the Southern Ohio Express Company, of Cincinnati, or the Electric Package Company, of Cleveland, and let them devote their energies to developing it. These companies already have offices and wagons in the large centers, and with their organizations they can build up the business at a much less expense than each individual company working by itself. It will only be a matter of a short time before the network of lines is complete in this district, and by taking large contracts and routing to distant points, the business is bound to be developed much faster than under the scheme now being worked out by many of the roads. Two or three-car trains, operated through the larger cities at night if necessary, would mean decreased operating expenses and increased profits for all concerned, and this development would go on until gradually the electric roads would be brought up to a physical condition that would enable them to meet the steam roads on equal terms for the heavy freight as well as the express business.

The meeting adjourned at 4:30 p. m., and no attempt was made to take steps toward standardizing the methods of handling this business, as it was obvious that the range of ideas is still far too wide to attempt anything of the kind at this time.

Immediately after the meeting, about thirty-five of the members took advantage of an invitation from the officers of the Detroit, Monroe & Toledo Short Line to inspect this magnificent property, which has just been completed into Detroit, forming the connecting link in the systems of Ohio and Michigan. The party boarded a special car at the Toledo terminal station at 5 o'clock and reached Detroit at 8 o'clock. General Superintendent Tarkington, who accompanied the party, listened to many pleasing comments about his property, as the track, roadbed, overhead work and bridges on this line are unquestionably among the finest to be found on an interurban road in this country. At the Russell House the party was received by President Matthew Slush, of the company, and were entertained with a bountiful repast. Many of the party had planned to leave Toledo shortly after 11 o'clock, and not a few faces showed expressions of annoyance when up to a few minutes before 9 o'clock there were no indications of the party breaking up. Mr. Tarkington blandly assured them that he would reach Toledo in ample time, and he was as good as his word. Evidently the motorman had instructions to show what the road could do, for he covered the 59 miles from center to center in considerably less than two hours. At the supper table, a meeting was called to order and Messrs. Slush and Tarkington were unanimously elected to membership in the Ohio Interurban Railway Association.

"What do you do about carrying dogs?" was a question that was heard many times on the trip back from Detroit. The hunting season is on at present and many of the roads are at a loss to know what to do with dirty, odoriferous canines, without which no hunter's outfit is complete. Another subject gruesomely in line with hunting was, "What do you charge for carrying a corpse?" The beautiful new cars of the Short Line suggested still another subject, "Does it pay to carry advertising cards in cars?" A compilation of the answers to these questions makes interesting reading and demonstrates the wide diversity of ideas on these minor features of the business. Here are some of them:

Cincinnati, Dayton & Toledo Traction Company.—Dogs carried in hunting season in the smoking compartment only on payment of full fare. At other times, permit is required and full fare collected. Corpse handled by Southern Ohio Express Company. Advertising signs carried in cars.

Dayton, Covington & Piqua Traction Company.—Dogs carried in smoker or baggage compartment any time and any distance for 15 cents. Corpse carried only in express car, on charge of $1. Advertising in cars.

Columbus, Buckeye Lake & Newark Traction Company.—Full fare charged for dogs; carried only in smoker or baggage compartment. Hunter must take his gun apart before entering car. Corpse charged for at $2.50 to $5, according to size; carried in baggage compartment. No advertising in interurban cars.

Western Ohio Railway.—Dogs carried free in smoker during hunting season. Charge of 25 cents at other times. Corpse carried at regular adult fare in baggage compartment. Advertising cards in cars.

Detroit, Monroe & Toledo Short Line.—Dogs carried at regular passenger fare up to 25 cents. Full fare for corpse. No advertising in cars.

Indianapolis & Eastern Railway.—Dogs carried at a minimum charge of 25 cents; regular fare above that. Corpse carried in combination car at a minimum of 50 cents and double regular passenger fare. No advertising in cars.

Dayton & Troy Electric Railway.—Dogs carried free in hunting season; other times 25 cents. Corpse carried only on special car. The company receives $276 for advertising cards in cars.

Stark Electric Railway.—Charge of 25 cents for dogs at any time. Corpse carried for $2.50. Advertising cards in cars; company receives $144 per year.

Toledo, Bowling Green & Southern Traction Company.—Dogs charged 25 cents, carried in smoker or baggage. Double regular fare charged for corpse. Advertising cards in cars; company receives $175 per year.

Toledo & Indiana Railway.—Dogs carried in regular cars only during hunting season, on payment of 25 cents. Carried in express cars at other times. Regular fare for corpse in combination car. Advertising cards in cars; $160 per year.

Form OIRA-100

Daily Record of Interchangeable Coupons Received During Month of ______ 190__

DATE	BOOK NO.	Selling Road	Marginal Values Open	Marginal Values Closing	*No. of Coupons	‡VALUE	RECAPITULATION OF *COUPONS OR ‡VALUE DUE FROM OTHER COMPANIES 1	2	3	4	5	6	7	8	9	10	11	CORRECTIONS Add	CORRECTIONS Deduct

DAILY RECORD OF INTERCHANGEABLE COUPONS RECEIVED DURING MONTH

Maumee Valley Railway & Light Company.—Dogs carried free on permit secured from office and good for one month.

Pittsburg, McKeesport & Connellsville Railway.—Dogs charged regular fare; carried only on front platform.

Cleveland & Southwestern Traction Company.—Dogs carried in smoker on payment of 25 cents for any distance.

New members who have recently joined the association are as follows:

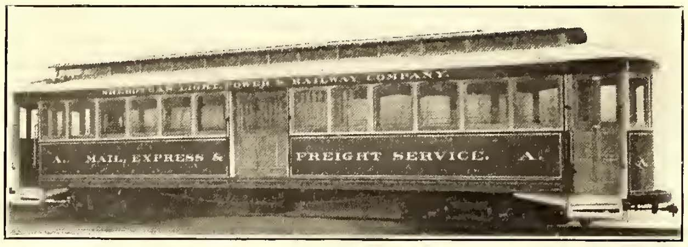
John A. Wright, Cleveland Varnish Company.
J. W. Brown, Pittsburg, McKeesport & Connellsville.
J. G. Kipp, Electric Railway Equipment Company.
Robert Dittenhaver, Toledo & Indiana Railway Company.
W. H. Fledderjohann, Fort Wayne & Springfield Railway Company.
H. E. Blemker, Cincinnati Metal Company.
C. C. Collins, C., L. & S., D., S. & U., C., G., C. & S. W.
G. S. Shinnick, Columbus, Buckeye Lake & Newark Traction Company.
C. P. Wright, Standard Brake Shoe Company.
R. R. Streblan, Lake Shore Electric Railway Company.
C. O. Scranton, Stark Electric Railway Company.
H. A. Austin, American Brake Shoe & Foundry Company.
R. S. Belknap, Pennsylvania Steel Company.
D. H. Lavenberg, Toledo & Indiana Railway Company.
S. P. Douglas, Lake Erie & Southern Traction Company.
Matthew Slush, Detroit, Monroe & Toledo Short Line.
W. B. Tarkington, Detroit, Monroe & Toledo Short Line.
Jas. W. Selvage, Holland Palace Car Company.
Haywood G. Brown, Dayton & Troy Electric Railway Co.
John J. White, Dayton, Covington & Piqua Traction Company.
T. B. Tarsney, Detroit, Flint & Saginaw Railway Company.
Henry W. Staats, Traction Mutual Insurance Company.
J. A. Hanna, Peckham Manufacturing Company.
R. W. Palmer, General Electric Company.
C. E. Prior, Columbus, Urbana & Western Railway Company.
Walter G. Jayne, Columbus, Urbana & Western Railway Co.

Some interesting figures relative to freight and express business on Ohio interurban roads have been compiled from reports of earnings filed with the Auditor of State for the year ending April 30, 1904. Twenty-six roads reported earnings from freight of $309,041. Nine roads reported, exclusive of express business, of $191,356. Fourteen roads reported freight and express business combined of $75,011. Three out of forty-eight roads reported that they did not handle either freight or express. The total for the forty-five Ohio roads engaged in some branch of this business was $575,408.

A NOVEL PASSENGER, FREIGHT AND EXPRESS CAR FOR SHEBOYGAN, WIS.

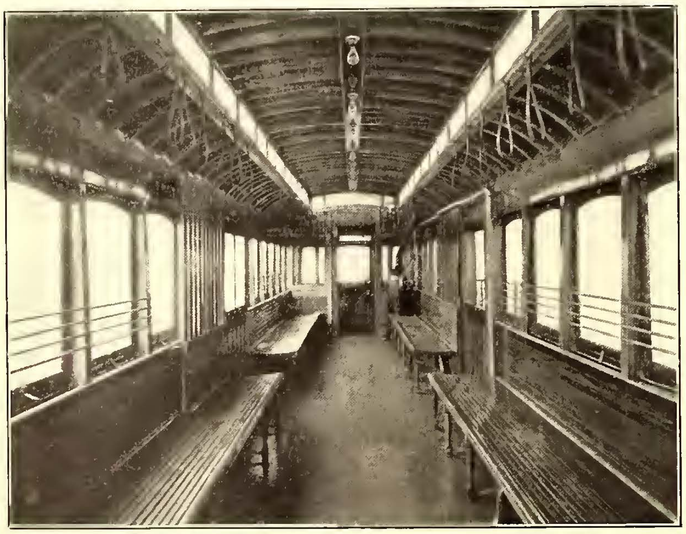
A car lately supplied to the Sheboygan (Wis.) Light, Power & Railway Company by the American Car Company, of St. Louis, is arranged to serve as a passenger car as well as for handling freight. It is used morning and night as a workmen's car from a factory district in the suburbs to the center of the city, passengers being carried at reduced fares.

Sheboygan is situated on Lake Michigan, and does a large grain export business, besides having important manufacturing interests, and being the commercial center of a considerable district.



MAIL, EXPRESS AND FREIGHT SERVICE CAR OF THE SHEBOYGAN LIGHT, POWER & RAILWAY COMPANY

The car is substantially constructed for carrying heavy freight, and includes in the bottom framing deep under trusses, and, in short, inside trusses centered over the bolsters. Sill plates 8 ins. x 5/8 in. are on the outside of 4½-in. x 7¾-in. side sills, and the end sills are 5½ ins. x 7¾ ins. The thickness of the corner posts is 3¾ ins., and of the side posts, 2¾ ins.; from center to center of side posts, 29½ ins.; length of the body, 37 ft., and length over the vestibules, 45 ft. The platforms are 4 ft. long; width over sills, including sill plates, 8 ft.



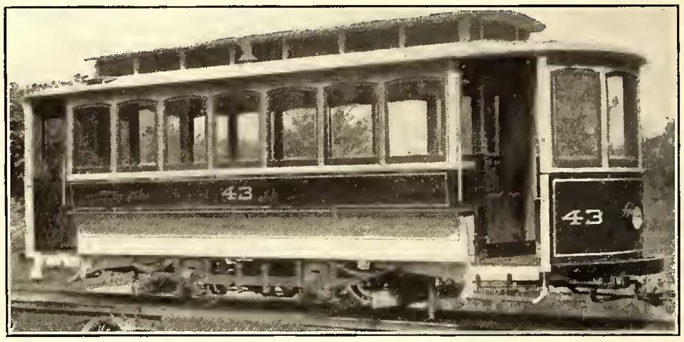
INTERIOR OF SHEBOYGAN COMBINATION CAR

The interior is finished in ash, with carline finished ceilings. The seats are arranged to fold up when not in use. The car is mounted on Brill 27-G trucks, and is equipped with a number of specialties of the same make, including platform and conductors' gongs, sand boxes and angle-iron bumpers.

NEW EQUIPMENT FOR ERIE, PA.

The G. C. Kuhlman Car Company has delivered recently eight cars like the one shown in the engraving to the Erie Electric Motor Company, of Erie, Pa. The railway company has 35 miles of lines and operates about one hundred cars. The Erie City Passenger Railway and the Erie, Reed Park & Lakeside Street Railway are controlled by this company. The city of Erie is in the northwestern part of Pennsylvania on Lake Erie, and is important as an iron manufacturing center and as a port of entry for shipping from various cities on the Great Lakes. Besides being a railroad center, it is connected by electric lines with all the towns in the vicinity.

The new cars measure 20 ft. over the end panels, and 29 ft. 5 ins. over the vestibules. The width over the sills is 6 ft. 3 ins., and over the posts at the belt, 7 ft. 6 ins. The sweep of the posts is 7 ins. The side sills are of long leaf yellow pine, 4¾ ins. x 7½ ins. The end sills of white oak are 5¾ ins. x 7½ ins. The sill plates, 7 ins. x 5/8 in., are on the outside of the side sills. The thickness of the corner posts is 3¾ ins., and side posts, 2¼ ins. The interiors are finished in cherry, with bird's-eye maple ceilings. The windows are glazed with heavy beveled polished plate. The car illustrated is mounted on a Brill No. 21-E truck, and among other specialties of the same manufacture with which the cars are furnished are folding gates, sand boxes, draw-bars, brake handles, angle-iron bumpers and platform gongs.



SINGLE-TRUCK CAR FOR ERIE, PA.

SEATING ARRANGEMENT OF ERIE CAR

President Hood, of the United Railways Company, of Baltimore, Md., states that within the past two years the company has expended over $1,000,000 in new cars and over $800,000 in track reconstruction. This, in addition to the extraordinary expenditures due to the February fire and the cost of new machinery, has made the aggregate of expenditure for the United Railways about $2,950,000. Of this amount, $1,150,000 was expended on the Pratt Street power plant and other points.

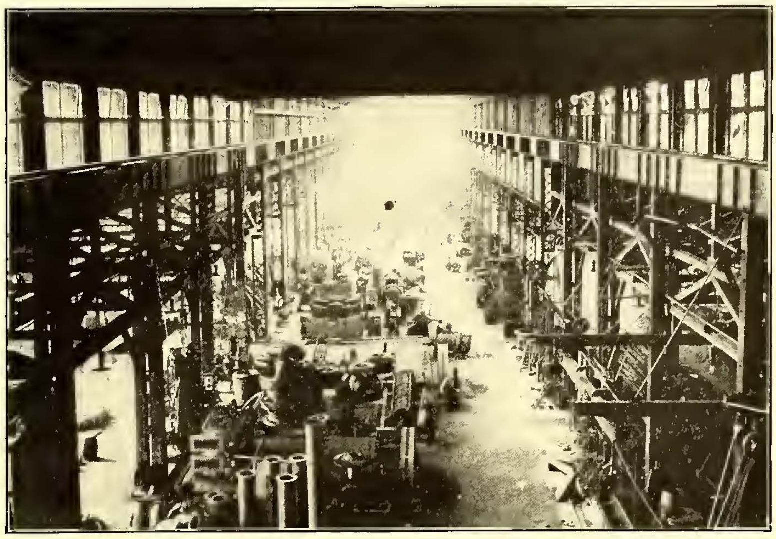
GAS ENGINES IN THE WORKS OF THE POWER & MINING MACHINERY COMPANY

The growing interest manifested in gas engines warrants the publication of a description of an important installation of this type of machine with the producer apparatus in the works of the Power & Mining Machinery Company, of Cudahy, Wis. The plant consists of products of the company itself, namely: Loomis-Pettibone gas producers, furnishing a supply of gas for operating American Crossley gas engines. Cudahy is a station on the Chicago & Northwestern Railway, about 8 miles south of the business section of Milwaukee and ½ mile from Lake Michigan. The Racine line of the Milwaukee electric railway system passes within a block of the plant, giving half-hour service to the city during the day, and more frequently in the morning and evening.

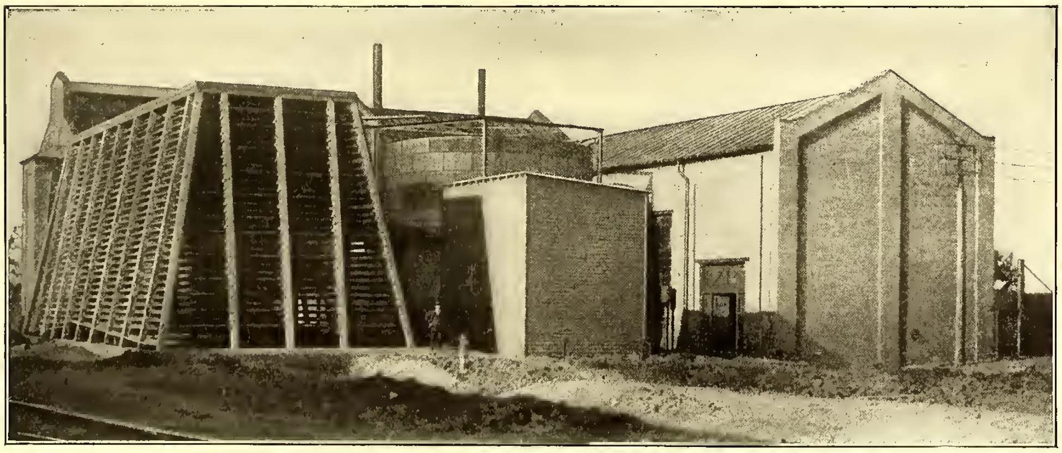
The power plant is located in an L-shaped brick building in the extreme northwest corner of the company's property. The extension on the south contains the Loomis-Pettibone gas producers, from which either producer or water gas can be generated; boilers, controlling mechanism, etc. A portion of this gas is piped direct to the engines in the generator room, and pipes are also laid to the furnaces of the forge and boiler shops and to the testing floor in the machine shop. Four producers, having a total capacity of 2000 hp, are provided, and are divided into two generating sets. The producers operate in connection with one boiler and form a set. Each producer measures 9 ft. x 15 ft., and is connected near the base through a 30-in. valve provided with hydraulic control to the boiler operating with it. The boilers, which measure 5 ft. x 23 ft., are set vertically, and are designed much after the pattern of an ordinary fire-tube boiler, the hot gases from the producer passing through the tubes. Leading from each boiler are two gas mains, that for the producer gas being 24 ins., while the other for water gas is 20 ins. in diameter. The mains from each of the boilers lead to the bottom of one of the two wet scrubbers located in the corner room. A main leads from the top of the producer gas scrubber through the engine-driven exhauster. The discharge from the exhauster is 20 ins., and, according to the position of the controlling valve, leads either to a purge stack exhausting into the atmosphere, or to the dry scrubber located outside the building. A by-pass, which may be used as occasion may require, is provided around this scrubber. A short length of 20-in. main connects the dry scrubber to the producer gas holder, which is of 10,000 cu. ft. capacity. From the top of the water gas scrubber a 16-in. main goes direct to the water gas holder of the same capacity as that for producer gas.

The gas from the producers in passing through the boiler on its way to the scrubbers, generates steam which is used for several purposes. In making water gas, it is introduced direct into the bottom of one of the producers. A limited quantity is also supplied above the fires of the producer when produced gas is being generated. A 2-in. steam pipe leads to the engine operating the exhauster. The boiler feed-pump working in connection with the feed-water heater, as well as the pump supplying pressure for the hydraulic valves, are also operated by steam.

Water is lead through a 4-in. pipe to the top of the two scrubbers into which it is thrown in the form of a spray. After having fallen down over the layers of coke in the scrubber, it flows out of the bottom of the scrubbers to the western end of the cooling basin, and after its temperature it reduced, it is again forced by an electrically-driven pump through the circuit. A similar pump, also motor-driven and placed near the scrubber pump, circulates water through the jackets of the engines. A 6-in. discharge from the pump runs the full length of the engine room, taps leading to the water jackets of the engine being taken off at frequent intervals. The discharge pipe continues through the engine room and to the testing floor in the machine shop. The returns from the jackets pass to the eastern end of the cooling basin. The two portions of the basin are divided by a solid partition to prevent the mixing of the water of the two circulating systems.

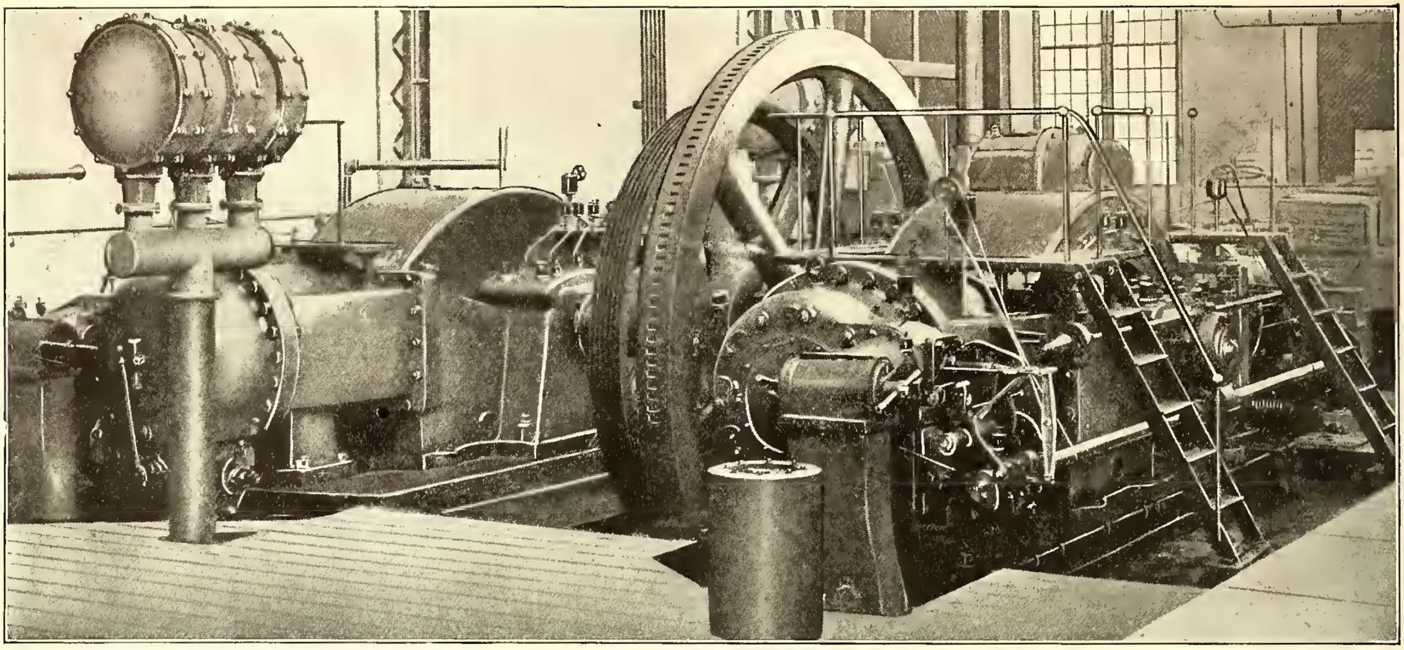


THE CENTRAL BAY IN THE MACHINE SHOP



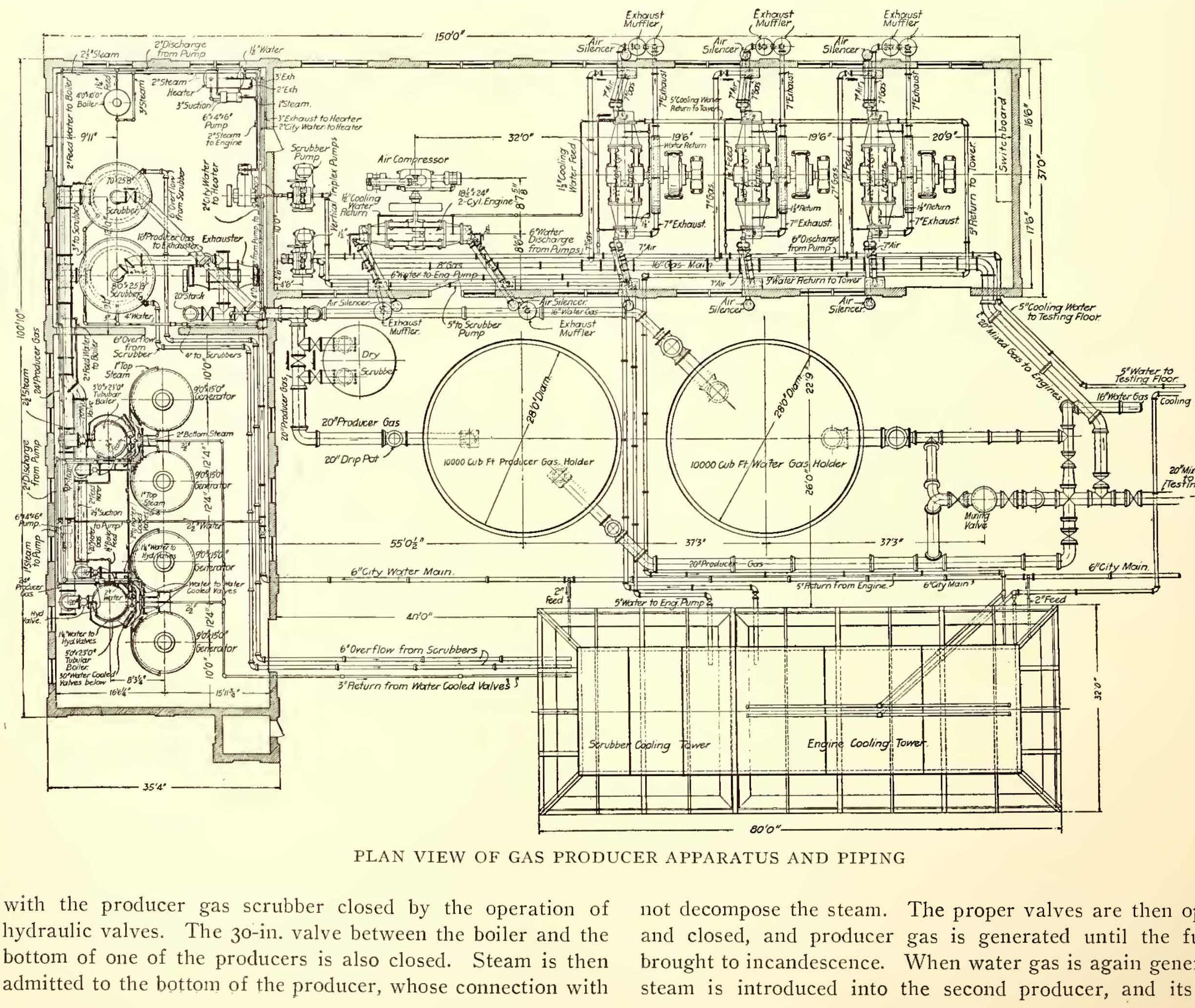
GENERAL VIEW OF POWER PLANT, SHOWING COOLING TOWER AND GAS TANKS

To start the plant when cold, the producers are filled with coal to a depth of about 5 ft. This is lighted at the top. The exhauster is then started, steam from the engine being obtained from the auxiliary boiler. The down draft produced by the exhauster soon ignites the mass of coal. More fuel is then added until the bed is about 8 ft. thick. While the fire is getting under way, the gas being of an inferior quality, is allowed to pass off into the atmosphere through the purge stack previously mentioned. After the fires have assumed the proper heat, the purge stack is closed, a limited quantity of steam is admitted above the fires and the producer gas generated is exhausted into the holder. If desired, producer gas may be made continuously, but usually the requirements of the furnaces and forges are such that the generation of producer and water gases is alternated at periods of from ten to twenty minutes. To make water gas, a few changes are necessary. The charging doors of the producers are screwed down tightly. The water gas scrubber is connected with the boiler and the connection with the producer gas scrubber closed by the operation of hydraulic valves. The 30-in. valve between the boiler and the bottom of one of the producers is also closed. Steam is then admitted to the bottom of the producer, whose connection with the boiler has been closed. The pressure forces it up through the fire of the producer, through a pipe connecting the two producers at the top, and down through the live coals of the other producer. It then passes as gas through the boiler and scrubber to the gas holder.

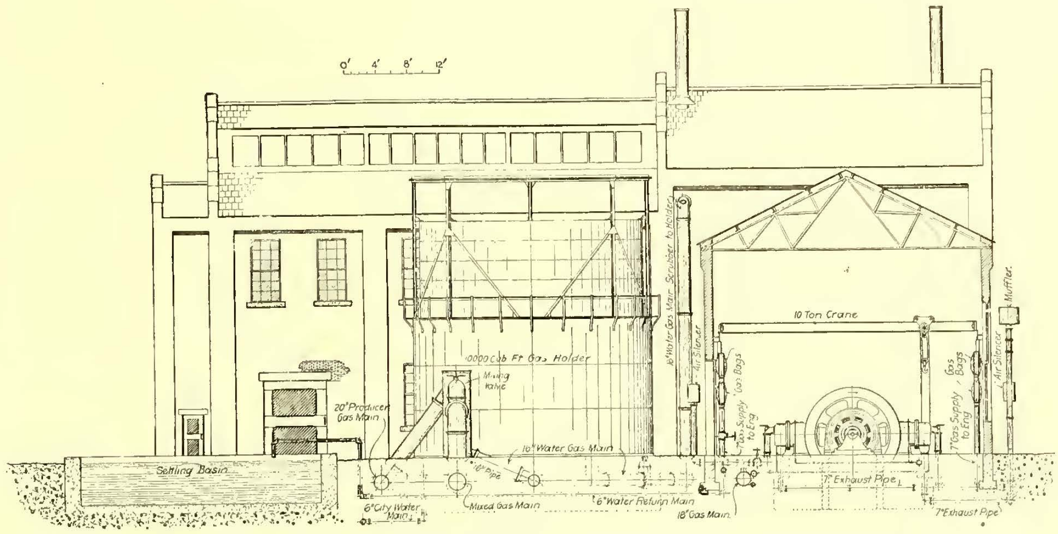


1400-HP GAS ENGINE FOR THE ELMIRA WATER, LIGHT & RAILWAY COMPANY

The steam soon cools the fires to a point at which they do not decompose the steam. The proper valves are then opened and closed, and producer gas is generated until the fuel is brought to incandescence. When water gas is again generated, steam is introduced into the second producer, and its path



PLAN VIEW OF GAS PRODUCER APPARATUS AND PIPING through the two producers is thereby reversed. This enables the raw steam to come in contact with the fire least cooled by the previous operation. As stated before, two producer sets are installed. One is run until the ash or clinker in the producer limits its capacity. The other set is then fired, the scrubber connection to the old set being closed. By means of the cleaning doors at the grate level, the old producers are then emptied and cleaned, when they are again filled and are ready to be fired. About 80 tons of bituminous coal can be consumed before cleaning is necessary.

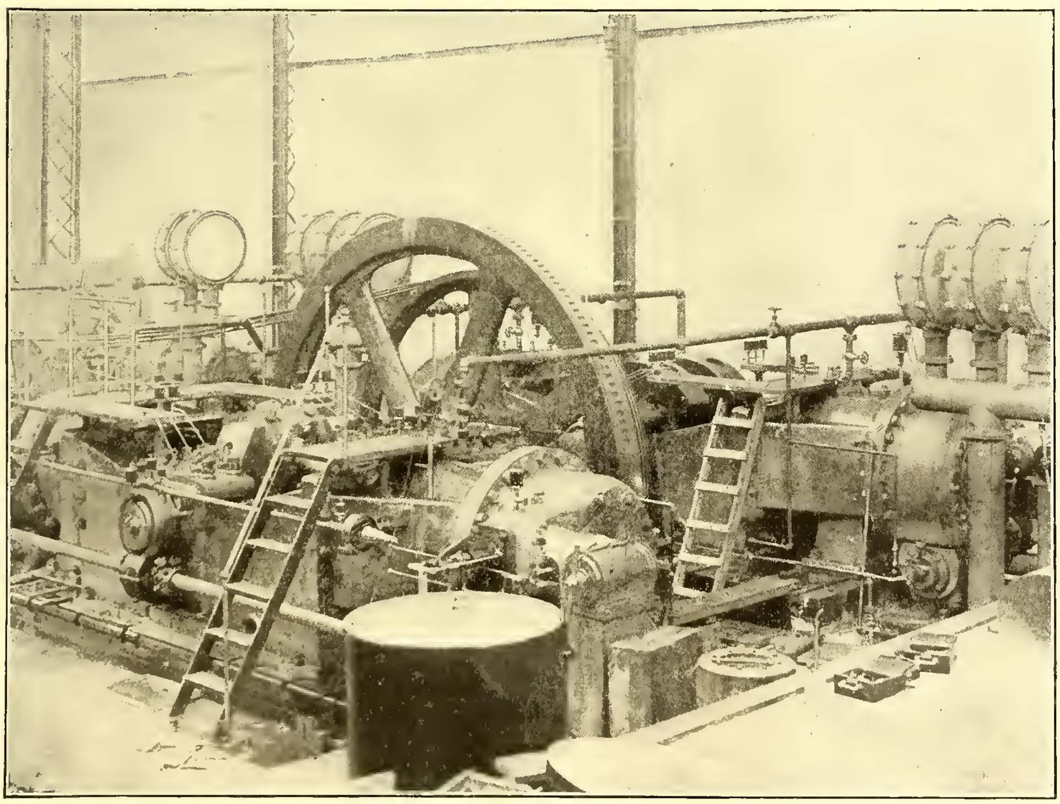


SIDE ELEVATION OF PRODUCER GAS-ELECTRIC POWER STATION

The engine room contains three 22-in. x 30-in. two-cylinder American Crossley gas engines, each direct connected to a 150-kw, 250-volt, direct-current generator. A smaller engine of the same general design operates an air compressor supplying air to the surrounding shops. Gas for the engines is supplied through a 20-in. main. The connections are such that either all-water gas, all-producer gas or any desirable mixture of the two may be supplied to the engines. The arrangement of the pipes may be seen by reference to the plan.

The American Crossley gas engines, manufactured by the company, are made with single cylinders up to 150 hp. Two-cylinder engines range in power from 180 hp to 645 hp, while those of four cylinders are rated at from 360 hp to 1400 hp and larger.

After assembling, each engine is given a thorough test under load. After the engines have been assembled on the testing blocks, the bearings are worn down by a run without load of from one to four days duration, depending on the size of the engine. The supply of water to the jacket of one of the cylinders is then shut off, the jacket being filled with water, and another run is made. The engine is kept running until the heat expands the piston so that it rubs on the cylinder walls. The piston is then removed and the spots where the rubbing has taken place are scraped down. This process is repeated until the engine runs freely with water boiling in the cylinder jacket. The other pistons are then fitted in a similar manner. Next, the cams are given their final finish. When cut, an allowance of 1/3 in. is left on these so that variations in keying them on the shaft may be corrected. The corrections necessary are found originally by studying indicator cards of the engine. Afterward, it is sufficient to note the position of the piston. After the corrections required are found, the cams are filed down to proper shape while on the shaft. The final tests are made by separate runs under one-quarter, one-half and full load, each run being of two hours duration. Occasional readings are taken of the heat value of the gas, these being obtained by the use of a Junker calorimeter. This enables the thermal efficiency to be computed.


1400-HP GAS ENGINE FOR THE ELMIRA WATER, LIGHT & RAILWAY COMPANY

In one of the views a four-cylinder engine is shown on the test blocks. This was built for the Elmira Water, Light & Railway Company, of Elmira, N. Y., and will be direct connected to the generator. The engine is rated at 1400 hp, and has a 36-in. stroke, the cylinder diameter being 32 ins. A fly-wheel 13 ft. in diameter is provided. A notable feature of the engine is the method of constructing the water jacket. The inner metal surrounding the combustion chamber is cast separate from the outer. Lugs are cast on the outer and inner walls of the two shells. These are drilled and tapped and binding stays inserted, which tie the shells together. This method of construction is used in order that casting strains, blow holes and other defects may be avoided.

Each cylinder is fitted with a weighted fly-ball governor, which varies the mixture in the cylinder according to the load carried. A safety gear prevents the engine starting in the wrong direction. Ignition is accomplished by a double-ignition tube, arranged so one tube may be renewed while the engine is operating.

The entire oiling system drains to the crank pit. The engine is built under a guarantee of speed variation not to exceed 2 per cent from the mean.

Another of the products of the plant is the 100-hp Crossley suction gas producer. The producer proper consists of a cylindrical shell lined with fire brick and fitted with a revolving grate. The gas, after passing to the top of the producer, enters an evaporation, where heat is transferred from the gas to water-forming steam which enters the bottom of the producer. A hydraulic box through which the gas next passes, prevents the gas backing up into the producer. It then flows through a coke scrubber, where it is cooled and cleaned, and then through one of sawdust, to remove any fine ash or other solid matter which may have been drawn through from the producer.

SECURITY REGISTERS ON THE INTRAMURAL RAILWAY AT THE ST. LOUIS WORLD'S FAIR

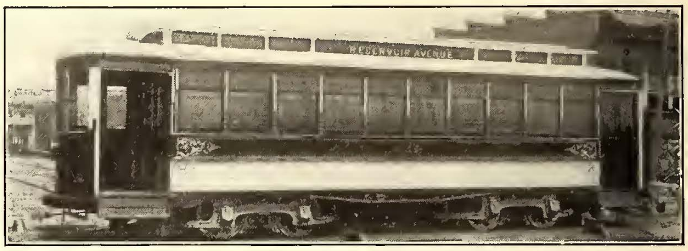
At the opening of the World's Fair in the early spring, the Security Register Company, of St. Louis, Mo., was favored with an order from the Intramural Railway Company for fifty-five fare registers. These registers were of the company's numeral type, and have been in operation constantly since Opening Day, ringing up daily an average of 700,000 fares. At the time the order was given, six extra registers were furnished, to be used as substitutes in emergency cases if any of those in daily operation should get out of order. It is worthy of note that at the closing of the Fair, not a single one of the registers furnished for emergency service had been taken out of the cases in which they were delivered. Every one of those installed on the intramural cars is as good to-day as when placed in the cars, and not a single part of the mechanism has been replaced during a summer of as severe service as can possibly be given to a register.

These registers were not manufactured especially, or in any sense picked out, for this particular service, but were simply taken out of the common stock from which all orders are filled. This excellent showing is therefore all the more creditable, and is evidence of good material and excellent workmanship.

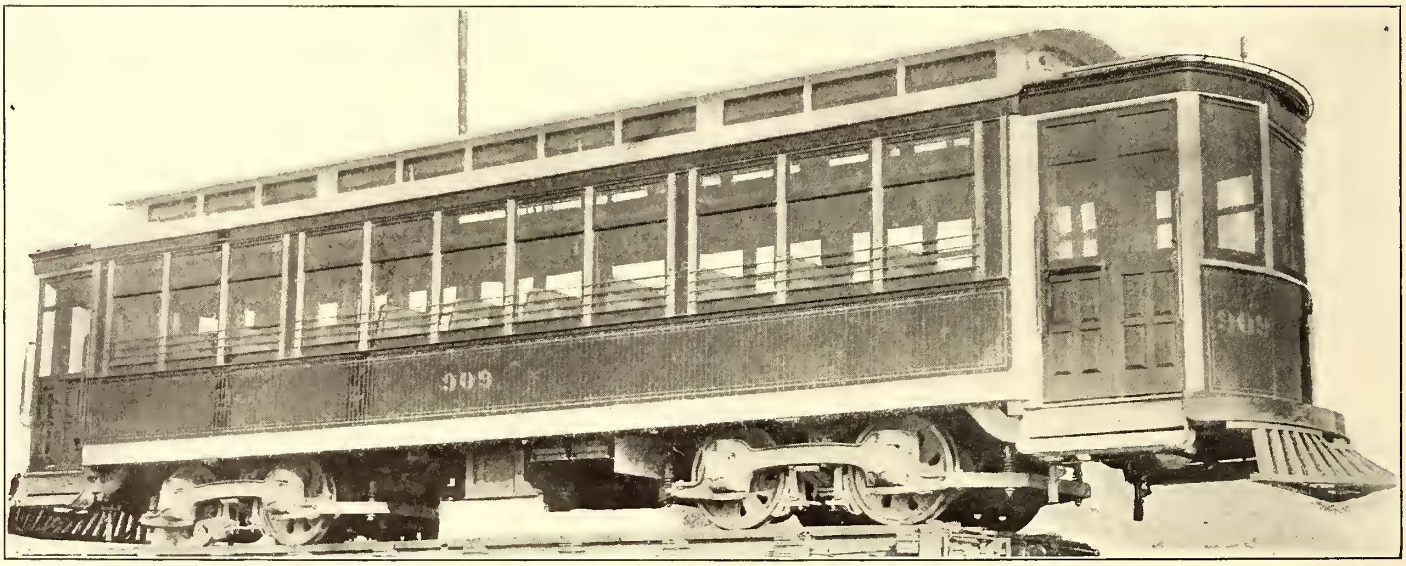
NEW CARS FOR LOUISVILLE

The St. Louis Car Company recently built three different types of cars for the Louisville Railway Company which are illustrated herewith. One of these is a standard double-truck city car, another is an interurban passenger car, and a third an interurban baggage and express car.

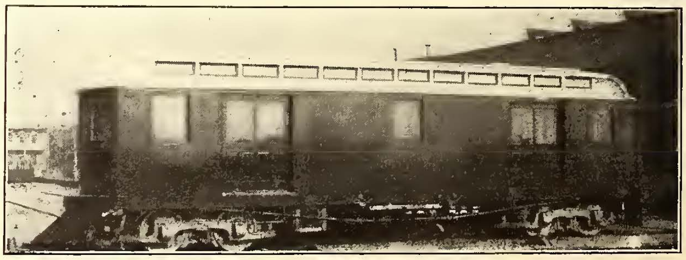
The city car has a 28-ft. body, is 8 ft. 3 ins. wide, and the length over all is 39 ft. 4 ins. The seats are of the company's reversible cross seat type, and number twenty, making the seating capacity forty passengers. The concave and convex panel construction has been retained in the construction of this car. There are three drop sash in each vestibule. The cars are intended to run as single tenders, and have a longer platform on the rear than on the front. There are vestibule doors on one side of the platform. Over the center window of each vestibule is an illuminated sign. The car is mounted, as shown, on St. Louis No. 47 trucks and is equipped with St. Louis sand boxes.



STANDARD DOUBLE-TRUCK CAR FOR LOUISVILLE



INTERURBAN PASSENGER CAR FOR THE LOUISVILLE RAILWAY COMPANY

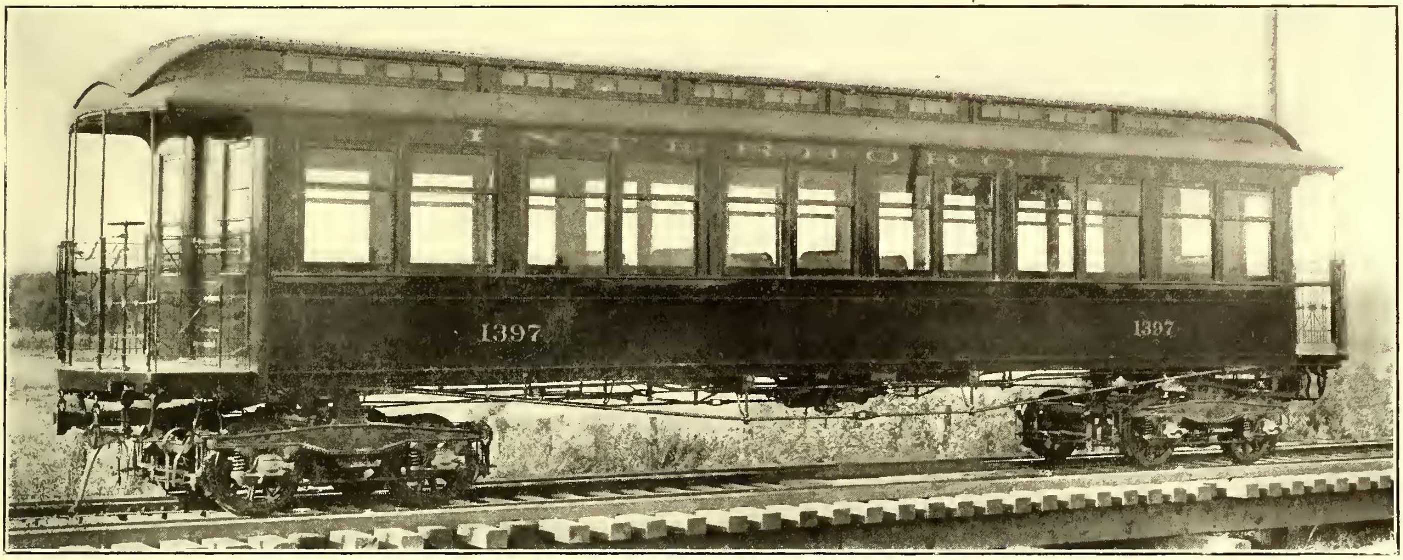


INTERURBAN BAGGAGE AND EXPRESS CAR

The interurban passenger car is slightly longer than the city car and of heavier construction. It has a 32-ft. body, is 8 ft. 3 ins. wide, and is 43 ft. 4 ins. over all. It has the St. Louis steel channel bottom, with the strength in the side sills and with pockets in the sides, into which windows are lowered, making a semi-convertible car. The seating capacity is forty-four. The seats are high backed and reversible, are covered with rattan, and have head rolls at the back. The vestibules have three drop sash in the ends and folding doors on each side. There is an illuminated sign in each vestibule over the center window. These cars are also mounted on No. 47 trucks and are equipped with the company's arc headlights and sand boxes.

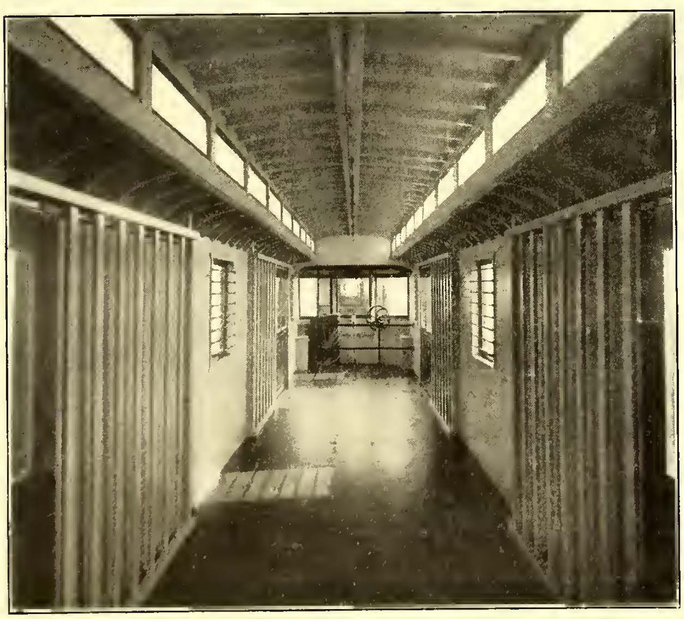
NEW MANHATTAN ELEVATED CARS

Fifty new cars are now being equipped for service by the Interborough Rapid Transit Company, of New York, for its Manhattan elevated lines. The car presents no radical changes from the regular elevated cars of the company. It is intended for use as a trail car. The length over all is 47 ft. 1 in.; the width over all, 8 ft. 9½ ins.; height from under side of sill to top of roof, 9 ft. 6 ins.; and seating capacity, forty-eight passengers. There are four cross seats on each side of the aisle in the center of the car, with longitudinal seats at both ends of the car. Cars are of the double-side construction, with steel anti-telescoping device. Single sliding doors have been adopted. The lower window sash raises as in an ordinary steam coach, and the upper sash is stationary. The finish is mahogany. Van Dorn automatic couplers are used, as on the other cars of this elevated system. The trucks are known as Hedley No. 33 trailer trucks. Both cars and trucks were made by the St. Louis Car Company.



ONE OF FIFTY NEW TRAIL CARS FOR THE ELEVATED DIVISION OF THE INTERBOROUGH RAPID TRANSIT COMPANY

The baggage and express car, interior and exterior views of which are shown, is 42 ft. over all and is without platforms. There are two doors on each side of the car, so that loading and unloading is facilitated, and it is not necessary to keep a passage clear the whole length of the car. There is also ample window space, the windows being protected from the inside by iron guards. At each end of the car is a partition rail of iron pipe to protect the motorman from the baggage. The equipment of this car as regards trucks, sand boxes and headlights is the same as the interurban passenger car.

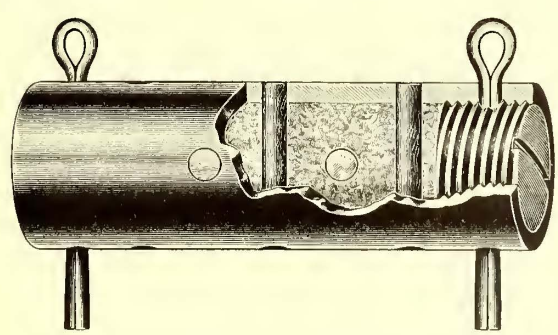


AN INTERIOR VIEW OF THE BAGGAGE AND EXPRESS CAR

At the height of the rush hour crush on the morning of Nov. 29, traffic on the Brooklyn Bridge was tied up by an accident. The trouble occurred near the Brooklyn side, where a cable train broke down with a shattered axle. The stalled train caused the trains behind to be stopped, and in a few moments the tie-up was general on the entire cable service.

SELF-LUBRICATING TROLLEY AXLE

The self-lubricating trolley axle, which is made by Swazey & Smith (Inc.), Boston, Mass., is a combination of trolley axle, bushing and oil receptacle. Its use prevents the arcing and roughening that wear out bushings and cause the wheel to wobble and leave the wire. The apparatus is constructed to furnish just enough oil so that none will leak on to the harp, pole, rope or other material on the top of the car. It lubricates only when the wheel is revolving, friction drawing oil through the wooden plug as a lamp draws oil through a wick. Where this axle is used, bushings are not required on new wheels, and they may also be removed from old ones.

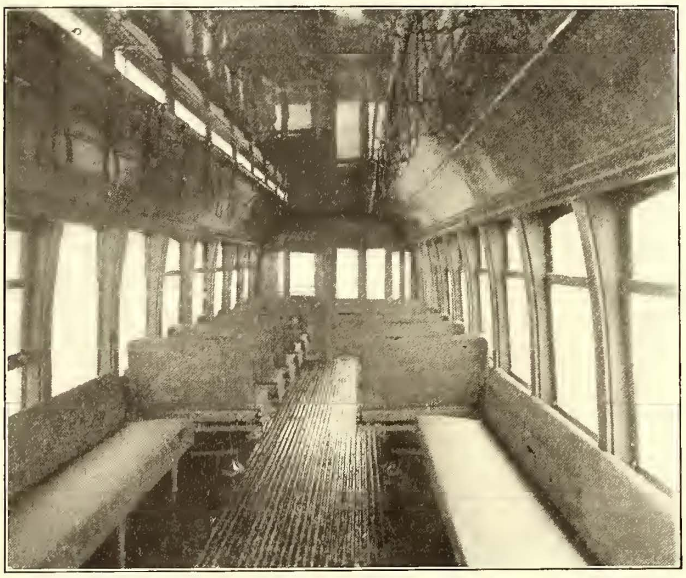


SELF-LUBRICATING TROLLEY AXLE

The only machine work needed in changing the harp to use this axle is to remove the axle from the harp and redrill the ½-in. holes to ⅞ in., which will serve to take the place of the ordinary axle and bushing. The manufacturers recommend the refilling of the axle with oil as often as every 5000-mile run.

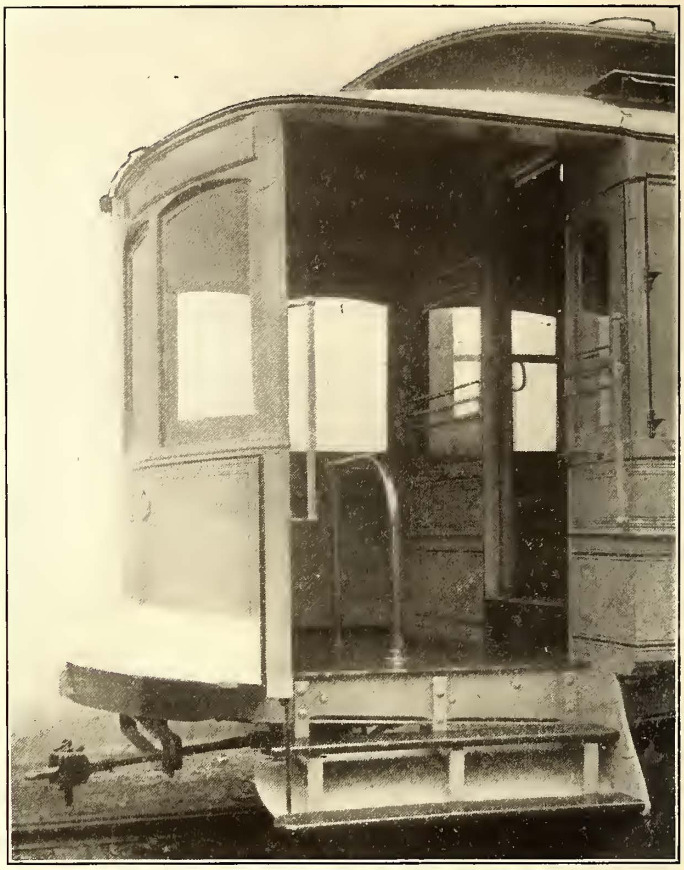
INTERESTING SEMI-CONVERTIBLE CARS FOR MONTREAL

Several cars just completed by the J. G. Brill Company for the Montreal Street Railways have a number of especially interesting features. The cars are of the semi-convertible type, with the pockets in the side roofs for the window sashes. The lines in Montreal are planned to have the cars run in one direction; therefore, the entrances are at one side and the seating plan arranged accordingly. At the forward right hand corner



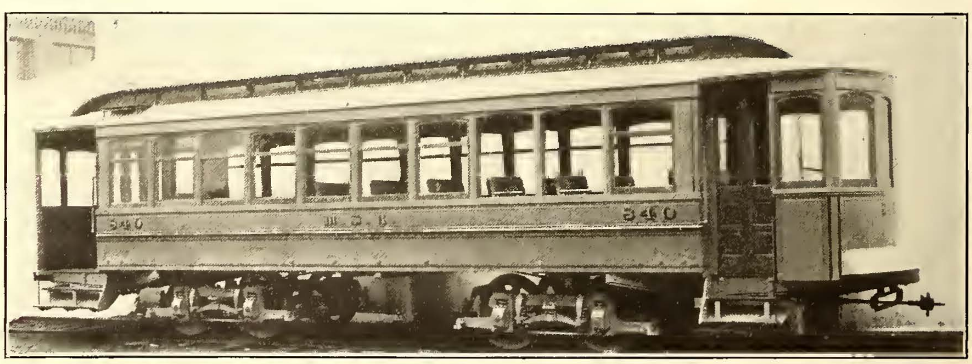
INTERIOR OF THE MONTREAL SEMI-CONVERTIBLE CAR

a double seat is placed longitudinally, at the rear end are longitudinal seats with a capacity of seven passengers each, and between are transversely placed seats 35 ins. long, leaving the aisle 22 ins. wide, and the hand poles extend the full length of the car, with hand straps only over the longitudinal seats. Arm rests are bracketed to the window sills at the sides of the transverse seats. These are necessary because of the low window sills, the height from top to floor being 24⅝ ins. Semi-accelerator doors are in the car ends, which, being at the sides near the entrances, facilitate the movement of passengers in and out, and is particularly applicable to the platform arrangement of these cars. The rear platform, as illustrated, is provided with a bronze pipe railing which starts at a point 18 ins. from the step line and 26 ins. from the car body, and is bent around to join the car body 20 ins. from the vestibule sheathing. This arrangement gives a large amount of standing space on the platform and prevents standing passengers from obstructing the passage way into the car. It also provides a convenient place for the conductor to stand on the platform—that is, between the door posts and the railing, where it is bent around. The spaces are wide enough for two passengers to enter or leave at the same time, and as the cars are mounted on pivotal trucks, which carry them too high for a single step which could be safely used in city service, double steps are used, the lower being 15 ins. from the rail head and the outer edge of the lower step being within the width of the car. Platforms at either end are 5 ft. 4 ins. long, and that at the forward end has a railing which is placed transversely to the platform and separates the space occupied by the motorman from the rest of the platform, which may be used by standing passengers. This vesti-



REAR PLATFORM OF MONTREAL SEMI-CONVERTIBLE CAR

bule is furnished with a door which folds against the vestibule posts. The windows of the vestibules at either end are arranged to drop in pockets in the wainscoting. Sheet metal is attached to the outer sheathing of the vestibules and brought over the bumpers to prevent persons from standing on them. The interior of the cars is furnished in ash of natural color, and presents a bright and pleasing appearance. The roof is of an



EXTERIOR VIEW OF MONTREAL STREET RAILWAY'S NEW CAR

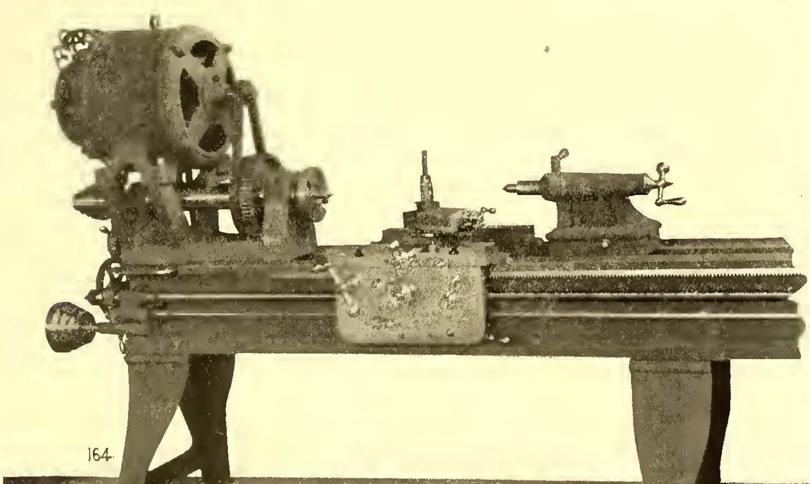
odd construction, as will be seen in the illustrations, the intention being to make it light and strong. As is well known, the steam car type of roof is more waterproof than the monitor type with transoms exposed to the weather, but the weight on long platforms is excessive, therefore the arrangement as shown was adopted, which, besides reducing the weight, gives a pleasing appearance.

The cars are 28 ft. over the end panels, and 38 ft. 8 ins. over crown pieces; width over sills, 7 ft. 8½ ins., and over posts at belt, 8 ft.; sweep of posts, 1¾ ins. The side sills are 4 ins. x 7¾ ins., with 12-in x ⅜-in. sill plates on the inside, to which the bases of the posts are attached. The end sills are 5¼ ins. x 6⅞ ins. The thickness of the corners is 3¾ ins. x 3¼ ins. The car is furnished with "Dumpit" sand boxes, "Dedenda" gongs, retriever conductors' bells, ratchet brake handles, radial draw-bars, angle-iron bumpers, etc. The weight of the car body is 15,310 lbs.

THE MORSE SILENT CHAIN FOR MACHINERY DRIVING

With the growth of importance of the machine shop question in street railway repair shop practice, the associated problems of machine tool selection and operation, as well as the other important factors of management, etc., are assuming places in the mechanical departments of electric railway systems which closely rival those to be met on steam roads and under factory operating conditions. As has been the very general experience elsewhere, the question of the arrangement of tools and, subsequently, that of driving them, have been found among the most difficult.

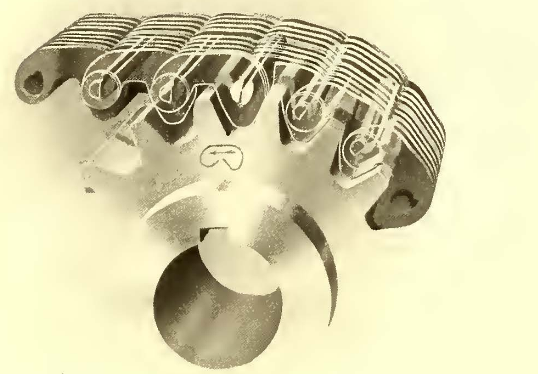
The driving of machine tools, and in fact of any class of machinery, is one of the most important factors bearing upon successful operation. The plan of driving machines individually by electric motors has been shown in modern shop practice to be the most conducive toward increased production and efficiency of operation, but the limitations of the belt and gearing methods of driving, formerly available and in use, did much to restrain the more general adoption of motor driving. The introduction of the silent chain drive has, however, created a new field for motor driving—the silent chain has all the advantages of flexibility and smoothness of drive that is inherent in the belt drive, and to this is added the positiveness of drive which belongs to gearing.



A TYPICAL APPLICATION OF THE MORSE CHAIN FOR DRIVING A LATHE

The Morse Chain Company, of Trumansburg, N. Y., has made a special study of the application of silent chain driving to severe and limiting conditions, which have given trouble with any other method of driving. As a result of thorough and exhaustive investigation, it has perfected a chain for machinery driving which is adaptable to any class of service whatever; it is not affected by high speed, very hot or dry atmosphere, or moisture, and will run satisfactorily with but little lubrication. It is found in practice not to wear rapidly even when subjected to the most severe extremes of dust, dirt and grit imaginable. The important feature is that its efficiency in transmission of power is very high, being by actual test from 98½ per cent to 99 per cent.

The construction of the Morse silent chain is clearly shown in an accompanying illustration. As may be noted, the joint consists of two pieces of hardened tool steel, so shaped and arranged that, as the joint works while passing on and off the sprockets, one piece rocks or rolls on the other. The two rocking parts of the joint are fixed in opposite ends of the links, and as there is only a pure rolling friction on hardened tool steel surfaces with ample contact area to withstand the pressure, there is no tendency for the joint to wear and cause the chain to lengthen. To prevent undue vibration under high speeds and the consequent wear, the rocker pins of the high-speed silent-running chain are so shaped that the areas of contact surface are greatly increased when the chain is drawn straight between sprockets, in which position a broad bearing is given. The two-part pin used in the Morse rocker joint permits of an unbroken contact the whole width of the chain, less the outside links, which results in nearly doubling the length of the bearing surface over a chain with a single-pin joint.

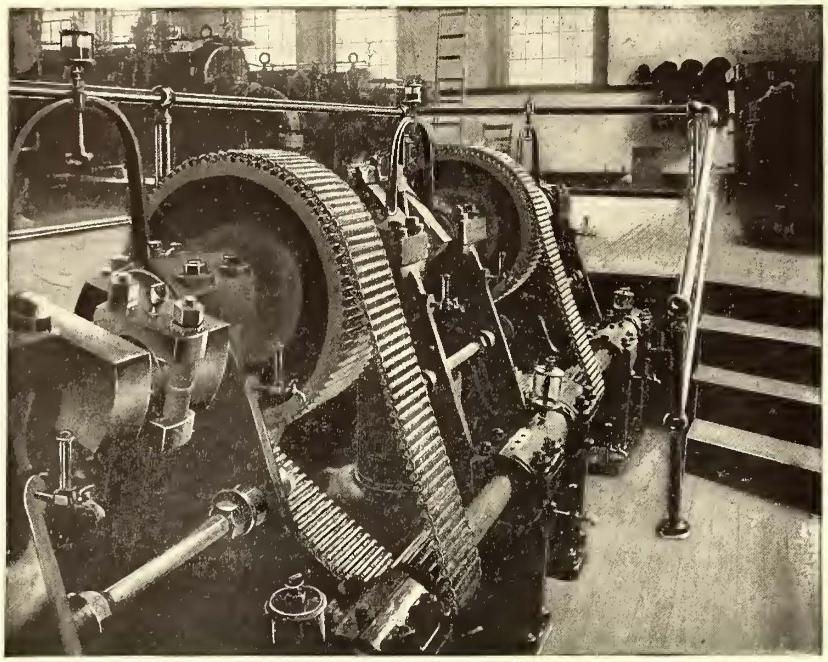


CONSTRUCTION OF MORSE SILENT CHAIN

As the rocker joint is subjected only to rolling friction, it does not require lubrication, and the speed limit is therefore not fixed by the point at which the centrifugal force will throw off the lubricant. A paste grease, sufficiently heavy so that it will not be thrown off at high speeds, affords proper lubrication for the chain in its contact with the sprocket teeth and between the plates of the chain itself. As the pressure between the chain and the sprocket teeth is inversely proportional to the number of teeth in contact with the chain, and as this number is large, the pressure is small, and very little wear will take place.

The life of a silent chain is inversely proportional to the number of teeth in the large sprocket, and since the lengthening of the Morse chain is very slight, it is possible to use very large sprockets and make large speed reductions. The relation of the size of the wheel to the life of the chain (this being the principal feature that makes it silent) comes from the fact that the chain climbs higher on the tooth as it lengthens and does not become inoperative until the top of the tooth is reached. The height of the tooth for a given pitch is practically the same for all sized wheels, and it follows that in a unit length of chain, equal to the circumference of any wheel, the total lengthening that may take place before the top of the tooth is reached is the circumference of a circle whose radius is the height of the tooth. The amount of stretch, therefore, that can take place per link in this length of chain is inversely proportional to the number of teeth in the wheel, which equals the number of links in the chain. It is for this reason that with a chain having the less lengthening due to joint wear the greater the number of teeth that can be satisfactorily used in the large wheel, with a consequent larger speed ratio.

The sprocket wheels are made of high-grade cast iron, accurately cut, and in use are found to show little or no wear. For exceptionally hard service or when there is little metal around



TWO SILENT CHAINS DRIVING CONDENSING PUMPS

the shaft, hardened steel sprockets are used. To properly guide the chain, special guiding links are used, projecting below the balance of the chain into grooves turned in the sprockets. The holes in the opposite ends of the links are punched to conform in shape to and securely hold, in the large end of the link, the rocker pin, and in the small end the seat pin, there being no motion between either part of the joint pin and link. The outside links are bent laterally so that the large end comes under the small end of the adjoining link to permit of the proper engagement with both seat and rocker pin. The joint pins are made of the best grade of tool steel carefully hardened, the shouldered ends of the seat pins being softened to permit of being riveted in the outside links, or in washers in the larger pitches, to securely hold the chain together.

With the increasing use of machine tools in street railway shops, a study of this important branch of the subject will be profitable. Under such shop conditions, where the question of motor driving is simplified by the presence of the 500-volt direct-current power circuit, the silent chain is particularly applicable for machine driving. Some interesting applications of the chain may thus be here shown to advantage.

The accompanying illustrations show the application of the drive to a lathe, and two chain drives, operating from a motor-driven shaft to drive condensing pumps. These latter were introduced here to replace the gears formerly used, and which were abandoned on account of their noisy action; the maximum pull on the chain is 10,000 lbs., which alternates to 300 lbs. negative pull at each stroke, due to the intermittent action of the pumps, but over two years' service has shown no depreciation.

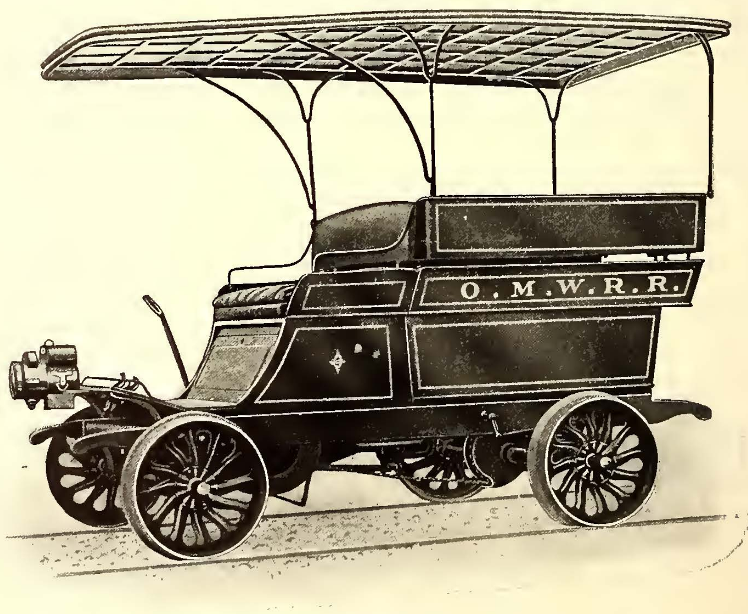
With the driving of a couple of silver spikes on Nov. 21, President Mellen, of the New Haven Railroad, completed at Muddy River, 10 miles north of New Haven, the last link in the chain of trolley lines between New York and Boston.

RAILROAD INSPECTION CAR

A new type of the Oldsmobile railroad inspection car, known as the model No. 2 tonneau car, is shown in the accompanying cut. This car is similar in general construction to the No. 1 car, with the exception of having a tonneau added, which gives it a capacity of from six to eight persons. It is designed so that the tonneau can be removed and a platform added, which will carry the necessary men, tools and material for ordinary railroad repair work. The No. 2 tonneau car is operated by a 7-hp gasoline motor, and has a speed of from 30 to 35 miles per hour, which is variable and under perfect control. The engine and gearing are the same as used in the regular Oldsmobile runabout, and the motor is started by cranking the same while the car is standing, in the same manner as the ordinary automobile.

The car is built for standard gage, has a 62-in. wheel base, oak sills, 20-in. pressed steel wheel, M. C. B. pattern, cold-rolled steel axles, Hyatt roller bearings and powerful brakes of the expanding clutch type. These cars have ample capacity for water and gasoline to run the car 100 miles or more, and the cost of operating is very slight, as a gallon of gasoline is sufficient to drive it from 20 to 25 miles.

One of these cars has run something over 3000 miles on a large railroad where there are grades as high as 3 per cent, and has demonstrated its capacity for running at a satisfactory speed up these grades with a full load. From a full stop on a maximum grade, the car quickly develops a speed of 20 miles per hour. In operating the car in backward motion it is geared to run at about one-half the forward speed.



RAILROAD INSPECTION CAR

The Railway Appliances Company, of Chicago, is the sole selling agent for these cars in the United States.

The Cincinnati, Georgetown & Portsmouth Railway Company expects to complete its extension to Russellville by Christmas. The extension is 8 miles long and necessitated the erection of three steel bridges from 260 ft. to 312 ft. long, and three very heavy fills. The Bethel & Felicity Railway Company has placed a contract for constructing a 6-mile road from Bethel to Felicity as a feeder for the Cincinnati, Georgetown & Portsmouth Railway Company.

THE CHICAGO & MILWAUKEE ELECTRIC RAILWAY'S NEW CARS

The accompanying illustration shows the new cars which the Jewett Car Company has recently shipped to the Chicago & Milwaukee Electric Railway. These cars embody some new features in interurban car construction, among which are the steel platforms, the Edwards sash balance and the Edwards trap door for the platform. The total length of these cars is 46 ft. 9 ins., while the body is 36 ft. long. The floor framing consists of channels and I-beams with wood fillers. The platform framing is made detachable from the body floor framing and is entirely of steel. The vestibule has a folding partition, so as to form a separate space for the motorman, as shown in Fig. 1. Each car has a smoking room about 12 ft. long.

The car throughout is finished in mahogany, inlaid with neat marqueterie. The ceiling is of the semi-Empire type, and is painted cream color, with gold decorations. The seats are of the Walkover type, with high roll-top backs, and are finished in rattan. They were manufactured by Hale & Kilburn. The gothics and decks are glazed with green opalescent glass. All trimmings are of solid bronze. The curtains are of pantasote of the Forsyth type. The cars are lighted by incandescent lamps, so placed that they form arches across the ceiling.

Four of the cars are mounted on Brill trucks and two on Curtis trucks. The motor equipment consists of four GE 76 65-hp motors, operated by the type M control system. The cars are heated by hot-water heaters and are equipped with

FIG. 3.—SEATING ARRANGEMENT OF CHICAGO & MILWAUKEE ELECTRIC RAILWAY COMPANY'S NEW CARS

hand brakes, as well as Christensen straight air brakes, made by the National Electric Company. The air brakes are arranged so these cars can run in trains. Van Dorn draw-bars are used, and the cars are also equipped with the DeFrance pneumatic air sanders.

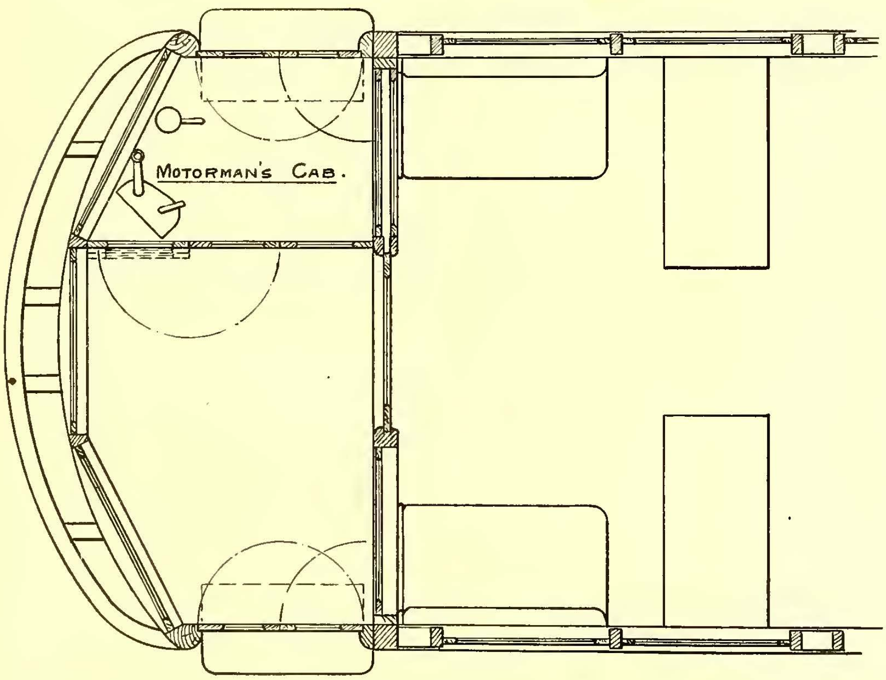


FIG. 1.—PLAN OF VESTIBULE, WITH FOLDING PARTITION FOR MOTORMAN'S SPACE

Thomas W. Childs, a well-known electric railway promoter, will run for the office of mayor of Akron, Ohio, at the next election. Mr. Childs has been trying for a long time to secure an entrance to Akron for his proposed line to Massillon. He was granted a franchise, but it was repealed at the next meeting of the Council. He was backed by prominent business men, and at the recent election he succeeded in defeating three of the councilmen who had opposed his road. Now he hopes to become mayor and will have a traction plank in his platform.

The Mansfield (Ohio) Railway, Light & Power Company has leased quarters on Main Street which will be fitted up for the general offices of the company and for ticket office and waiting room for the two interurban lines entering the city.

FIG. 2.—ONE OF THE NEW STEEL PLATFORM CARS FOR THE CHICAGO & MILWAUKEE ELECTRIC RAILROAD

A TROLLEY CONTROLLER

A novel type of trolley retriever, or trolley controller, as it is termed by the manufacturers, has recently been placed on the market by the International Trolley Controller Company, of Buffalo. The device is the invention of P. D. Milloy, whose roller-bearing trolley base is in extensive use, and depends for its operation on compressed air. The controller, a section and side elevation of which are published in Fig. 1, is mounted on top of the car at the base of the trolley pole, as shown in the second engraving. A small wire cable is attached to the middle of the trolley pole and is carried around a pulley on the top of the car and then around a 6-in. sheave at the end of the pneumatic piston at the end of the controller, then around the drum at the base of the controller. The apparatus in its normal position is shown in Fig. 1. If, however, the pole should leave the wire, the drum revolves the fraction of a turn, opening the air cock shown in the section. This admits the full air pressure from the brake reservoir into the air cylinder, and the air piston, which carries at its outer extremity the 6-in. sheave, is pushed out a distance of 18 ins., taking up 3 ft. of the wire cable and drawing down the trolley pole a proportionately larger amount, say about 7 ft., depending upon the point on the pole at which the wire cable is attached. The pole is returned to the wire by the conductor by means of the regular trolley cord. Pulling this down releases the tension on the drum, closing the air valve and exhausting the air in the cylinder. The operation is so simple that the conductor can replace the trolley on the wire without delay or stopping. The device not only acts as a retriever, as described, but it is found that the wire cable guides the trolley pole on curves, junctions, etc., and prevents its leaving the wire. It also steadies the trolley and prevents arcing between the wheel and wire when the car is running at high speed.

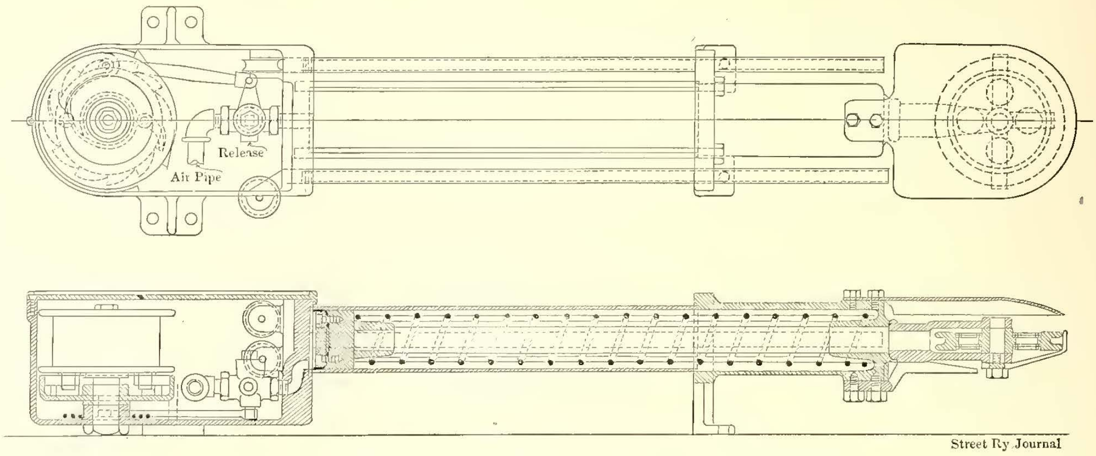


FIG. 1.—SECTION AND PLAN OF TROLLEY CONTROLLER

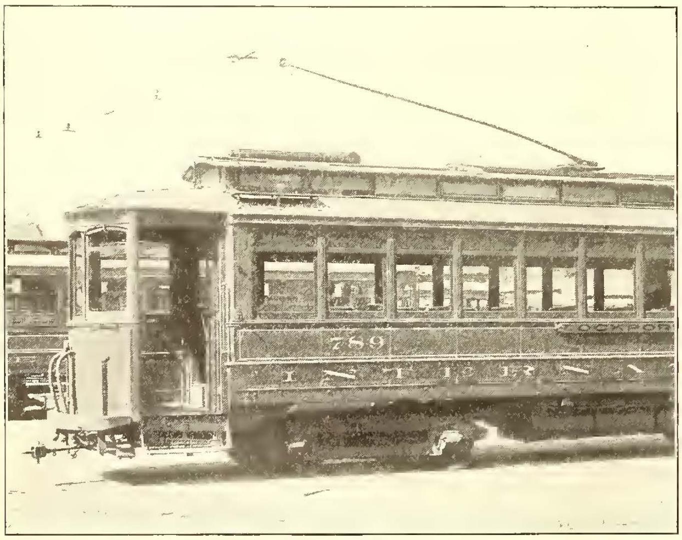


FIG. 2.—CAR EQUIPPED WITH TROLLEY CONTROLLER

Mr. Milloy has also recently invented a new type of rear-end signal lamp, which is also in use by the International Traction Company. This lamp normally burns white, but when the brakes are applied a red disk, which is connected pneumatically with the braking system, is interposed between the lamp and the lens. In this way the motorman of the following car can tell instantly whether the brakes on the car in front of him are being applied, and hence whether the distance between the two cars is being shortened.

The International Trolley Controller Company has recently opened an office at 26 Cortlandt Street, New York City, in charge of A. J. Wilson, formerly master mechanic of the Brooklyn Rapid Transit Company. In addition to trolley controllers, trolley bases and the signal lamp mentioned, the company has made arrangements by which it is in a position to furnish electric railway supplies of all kinds, especially trolley poles, armature and axle bearings of all kinds, assembled commutators, armature coils, gear cases, both wooden and malleable iron, brush holders and controller parts. This company has also secured the agency for the Security register, and has recently placed on the market a trolley trough to be used over the trolley wire at railroad crossings, to catch the trolley wire and conduct the current to it in case it should leave the wire. The company has also secured the agency, and will place on the market a new type of electric railway truck with steel side frames, which is being manufactured under the Bettendorf patents.

INTERURBAN RAILWAY TO PROSECUTE PRACTICAL JOKERS

Three youths of Grandview, Iowa, recently attempted a practical joke on the interurban line which came near having a serious ending. The boys made a dummy man out of old clothes, straw and excelsior and placed it on the interurban track at the bottom of the high hill south of Grandview Park. Car No. 100 was speeding down this hill when the motorman in charge saw the figure of a man on the track. He turned off the power and applied the air brakes, and the car came to a stop a short distance beyond where the figure was lying. The motorman rushed into the car saying he had run over a man. The conductor and others hurried out of the car and soon discovered that the car had run over a dummy. The joke came near having a serious ending, as it was a miracle that the car did not jump the track and roll over a steep embankment when the brakes were applied so suddenly. The interurban officials have had the boys arrested and intend to have them punished on the charge of placing obstructions on the track.

This is the second time this offense has been committed within the past two months. The first time the dummy was discovered in time for the motorman to bring his car gradually to a stop, and there was no danger either for himself or passengers. But the last time the motorman actually believed he had run over a man, and suffered greatly from the shock, and the car came near leaving the track, which would have resulted in injuries to passengers and possibly death to some of them.

LONDON LETTER

(From Our Regular Correspondent.)

An account of the technical features of the eighth general meeting of the Association of Tramway & Light Railway Officials, held at Wakefield on Nov. 2 and 3, is published elsewhere, and some particulars will be given here of the highly successful social side of the convention. The members were duly welcomed on the first day of the meeting by the Mayor of Wakefield and the directors of the Wakefield & District Light Railway Company. The same evening members and friends were invited to a dinner by the directors of the Wakefield & District Light Railway Company, the small banqueting hall of the Town Hall having been kindly placed at their disposal. On the second day the papers of Messrs. Coutts and Raworth were presented. In the afternoon the delegates and visitors were taken to see the electricity works of the corporation, and also the new power house of the Wakefield & District Light Railway. It had been specially arranged by President England to have the opening ceremony of the Wakefield & District Light Railway on that day, and a large gathering, not only of the delegates to the convention, but of many of the Town Councillors and their friends belonging to the various local authorities through which the system runs, were present. The opening ceremony took place at 4.30 at the power house, where elaborate refreshments were offered by the company. The whole of the work of the Wakefield & District Light Railways has been done by Messrs. Dick, Kerr & Company, of London, and a full description of the system will be found in another column. It is a source of great satisfaction to be able to report that this system, which is operated by a company, has entered into a very amicable arrangement with the Leeds Corporation Tramway, by which cars belonging to the company will be able to run into the center of Leeds, and the Corporation cars will be able to run over the company's system when required. All arrangements for this inter-communication of traffic between the company and the Corporation of Leeds are not yet completed, but, as was stated at the Association dinner the outline of the plan has been drafted out by Mr. J. B. Hamilton for the Leeds tramways, and Mr. H. England for the company's tramways, and has been practically agreed to. Thus we have one more example in England of a municipality and a company working together on a friendly basis which must result in mutual benefit.

What can reasonably be termed a record in electric railway operation recently took place on that portion of the line of the North Eastern Railway, near Newcastle, which has been electrically equipped by the British Thomson-Houston Company, Ltd. Owing to the festivities occasioned by the visit of the Channel Squadron to Newcastle the passenger traffic on the electrified line was enormously increased, necessitating on the first day the continuous running of eighty-six out of the possible eighty-nine available cars, and on the following day the full complement of cars (eighty-nine between the hours of 5 p.m. and 11 p.m.). Although the equipment was subjected to exceedingly heavy and unusual demands, not a single breakdown or interruption to service was experienced. The successful operation of this line, one of the first and largest surface electric railways in the United Kingdom, and its ability to successfully meet sudden and heavy demands certainly augurs well for the future of heavy electric traction.

Mr. John Young, who recently resigned his position as general manager of the Glasgow Corporation Tramways to take up the position of general assistant to the chairman of the Underground Electric Railways Company, of London, and general manager of the Metropolitan District Railway Company, was recently entertained at dinner on the occasion of his leaving Glasgow. About 180 gentlemen were present, Sir John Ure Primrose, Lord Provost of Glasgow, occupying the chair. A large number of the gentlemen present consisted of those connected with the Corporation in various capacities and others well known for their interest in civic work. The Lord Provost proposed the toast of "the guest of the evening, Mr. John Young," and congratulated Mr. Young upon the apparent manner in which he has received the acknowledgment of the good will of his fellows, and also in that material signification of approval which should be the accompaniment of capable service. He did not wish to give the history of the tramways, but stated that in every aspect of the evolution of tramways the dominating note of the man who was given an absolutely free hand, and an absolute personal control, had justified the act of the Town Council in placing Mr. Young in charge. He also stated that the president of the British Association of Electrical Engineers who had recently returned from seeing every tramway system in America and on the Continent had stated that in every detail as to equipment, cheapness of fares, and cleanliness of tramway systems, Glasgow was the finest in the world. The Lord Provost wound up his remarks by stating that the citizens who had admired his work could congratulate themselves on the parting evening in saying to him "God speed you, John Young." Mr. Young in replying stated that he had a very plesant memory of the kindness which had been extended to him in Glasgow. He felt that it was a very high compliment to him to be asked to go to London. As his department was no longer in a state of transition, but thoroughly organized and equipped, the new field was a great inducement to him, and he had accordingly accepted the work which would open up many new problems. A toast was then proposed to the health of the new manager, Mr. James Dalrymple, who, in acknowledgement, stated that nobody knew better than he did what Mr. Young had done for the tramways department, and to what a high state of efficiency that department had been brought.

A presentation to Mr. John Young took place in the offices in Renfield Street previous to his leaving for London. In asking Mr. Young to accept the crown Derby dinner and dessert services, with silver tray and rose bowls, which had been subscribed for by the employees of the department, Mr. James Dalrymple said that as long as the cars ran in Glasgow they would be associated with his name. Mr. Young returned thanks for the presentation, and remarked that he did not think anyone could have desired a better staff. He looked back upon his connection with them with the greatest pleasure, and he was sure they would prove equally loyal to Mr. Dalrymple, his successor.

The tramways department of the Glasgow Corporation has now secured for itself a fitting home. For years back the department has not had such convenient or suitable headquarters as was necessary, and some time ago it was determined to vacate the present premises while they were being altered and to occupy temporary premises. Accordingly the building which had been occupied for years was given into the hands of the builders who have now remodelled the whole building into one of a much more imposing aspect and of greatly increased convience. The old entrance, situated in Renfield Street has been closed, and the address of the department will now be 46 Bath Street, where a new entrance has been built. The extensive basement is occupied by stationary stores, while the ground floor is entirely devoted to the tramway department, telephone exchange and inquiry office. The general manager's room, with the accounting staff and the purchasing and correspondence staffs, is situated on the first floor, while the cashier, pay clerk, etc., are on the second floor. The engineering staff occupies the entire third floor, and the female staff occupies the fourth and a part of the fifth floor.

Hastings and District Electric Tramways Company, Limited, was registered Nov. 9. Capital, £500,000 in £5 shares (50,000 preference). Object, to adopt agreements (1) with M. S. Myers and C. Mendel, (2) with the Hastings Tramways Company, and (3) with Dick, Kerr & Company, Limited; to construct, purchase, lease or otherwise acquire light or other railways and tramways in Hastings and Bexhill or elsewhere; to obtain any orders or Acts of Parliament in connection with the same, and to carry on the business of tramway and railway proprietors and workers, electricians, mechanical engineers, contractors for public and other works, etc.

Speaking recently at an election meeting, Alderman M'Cabe (a member of the tramways committee) said in a very short time Manchester would soon be making its own cars. It would have one of the best arranged and well equipped workshops in England for the purpose of repairing and making cars, and he believed it would be the first municipal workshop of its kind in England. This would to some extent solve the unemployed problem, because it would be bringing into Manchester employment that was not there before. It will be remembered that Glasgow has had municipal car workshops for several years.

The electric tram system, inaugurated by the Swindon Corporation, has been inspected by Colonel Von Donop, R. E., and C. L. Trotter, Electrical Adviser to the Board of Trade, and the formal opening has taken place. The overhead system has been adopted, and the route extends to 3½ miles. An additional route has been sanctioned, but not laid. The total cost is estimated at present at £37,000. Only seven cars have been obtained; but this number is certain to be increased very shortly. The whole of the work on this system was carried out by J. G. White Company, of London.

The Tramways Committee of the Birmingham City Council, at its last meeting, formally approved of the draft of the proposed Parliamentary bill embodying the committee's tramway scheme for the city. The draft was ordered to be printed for the information of the Council, and the committee also approved a short report explaining certain points. This report has now been issued, and it is stated that the draft bill will follow in a few days. The cost of the construction of the new tramways, including street widening, reconstruction of existing tramways, overhead electrical work, car sheds, rolling stock, etc., is estimated at £1,018,350. It is intended to apportion the cost of the street widenings between the public works and tramways committees.

having regard to the extent to which such widenings are required as street improvements or for tramway purposes.

The Stockport Corporation has decided to recommend the Council to purchase the Stockport and Hazel Grove Tramways undertaking at a cost of £24,000. The negotiations between the company and the Corporation have extended over a long period, and the Corporation committee have at length accepted the company's terms. It is estimated that in the event of purchase the Corporation will take over realizable assets to the amount of £5,000, and together with the purchase money and electrification the total cost to the Corporation of the route will be £72,000. On this sum a profit of £4,500 a year, or 6¼ per cent, will have to be made to pay interest and sinking fund. The company's lease had still seven years to run, and at the end of the period the Corporation could have acquired the lines compulsorily at a price fixed by arbitration. The purchase price of £24,000 is equal to 28s. per share.

The Birmingham City Council has authorized the tramway committee to proceed with a Parliamentary bill for power to extend and electrify the city tramways, the existing portions of which have already been acquired. The cost of the scheme will be over a million sterling. One important suburb, Harborne, is left out of the scheme in consequence of opposition by the inhabitants to the proposal.

The proposal to construct tramway lines over the bridges and along the Embankment has now a better chance of becoming an established fact. The open hostility hitherto displayed on the subject between the City Corporation and the London County Council is becoming less marked, and this is considered to herald an early decision to proceed with the scheme. When the question was earlier discussed, the County Council named as possible tramway routes several streets in which it was impossible to place tram lines; but as far as the Embankment was concerned there ought not to be the slightest objection. If the proposal were heartily backed up by the Corporation and the County Council, the House of Commons would not be likely to stand out against it.

A farewell dinner was recently given to F. D. Huntington, who returned to America some weeks ago. Mr. Huntington has been in London for some years in the construction department of the British Westinghouse Company, and has chiefly been known here as the resident engineer in charge of the erection of the Neasden power house for the Metropolitan Railway Company's electrification scheme. Mr. Huntington's record here for a young man has been a brilliant one, and he had endeared himself to a large circle of friends and acquaintances who wished him God speed in his return to his native land. A. C. S.

PARIS LETTER

(From Our Regular Correspondent.)

During the first ten days following the opening of line No. 3 of the Paris-Metropolitan Railway, a line, it will be remembered, adding 25 per cent to the length of lines already in service, the average daily number of passengers increased nearly 40 per cent. This result, although notable, is overshadowed by the results of the second period of ten days following the opening. From Nov. 1 to Nov. 10 the average number of passengers exceeded 418,000 daily, with receipts amounting to f. 72,500. The lines thus far have carried over 11,000,000 passengers more than during the same period of 1903.

This paper has from time to time pointed out the very poor state of several of the tramway companies operating their lines, or a part of them, on the various surface-contact systems. The Est Parisien rolling stock is quite a disgrace to the city, the impecunious state of the operating company preventing urgent repairs being carried out to the cars. This month has just been declared bankrupt another of the "Lignes de Penetration," serving the southwest of Paris and environs, known as the Vanves-Malakoff and extensions. This line is operated largely on the Diatto contact system.

The tramway situation in general in France is rather quiet, owing to the completion of most of the principal lines in the larger towns and cities. The smaller seaport towns are arranging for electric tramways, and also some of the mountain resorts, especially those where water-power is available. Thus Treport-en-Mer, by no means a large town, has just approved plans for electric traction, and in the Vosges Mountains, Epinal, a very secondary place, has also been able to arrange for electric traction. There is, however, a very fair opening for interurban light railways in France, and a field will be opened for the conversion of existing steam light railways, of which France has more than most European countries.

In connection with the General Electric omnibus, a description of which appeared in the STREET RAILWAY JOURNAL for Oct. 29, it is of interest to note that the Krieger Automobile Company, well known for its accumulator cars, has had in regular production for some months a line of automobiles equipped with electric petrol combination. The company speaks highly of the results obtained, and claims a better efficiency for its machines than is given by the usual chain and geared transmission.

Maisons Laffitte and St. Germain, two of the best-known suburbs of Paris, both within a few miles of the metropolis, have hitherto had no direct means of communication with each other. The Seine and Oise District Council has now approved a project for an interurban tramway between these two favorite resorts. The length will be about 8 miles. Maisons Laffitte is a well-known racing center.

Uniting the Rhone Valley with the Swiss capital has been the subject of several projects which have been under consideration by the Swiss Government of late years. The engineers appointed to report on the schemes presented have finally proposed to the Swiss Government the Beyeler project for an electric railway between Berne and Brig, as offering the most advantages. The line has a length of 116 km, and includes two tunnels of 6250 meters and 13,500 meters, respectively. Double track would be provided for, and the estimated cost is $16,000,000. The annual receipts are expected to yield $1,132,000, and the operation costs to absorb about half this sum, leaving an interest of 3 per cent to 3½ per cent on the capital expended.

The Prussian government has had under tests for a year or two on the Berlin-Altona and other lines certain train lighting equipments. It has now adopted a system which gives entire satisfaction. The lighting group includes a 20-hp DeLaval turbine coupled to a series dynamo, mounted on the locomotive. This dynamo gives current during the time the train is running, and at the same time charges a battery of accumulators, which is capable of supplying current for three hours while the train is at rest. The pressure employed is 65 volts to 85 volts. Twenty-c. p. lamps are used in first-class cars, and 16-c. p. incandescent in second-class wagons.

In Italy great activity is shown at present in obtaining and working concessions for harnessing various rivers and mountain streams. One of the most important has been commenced in the building of the great dam across the river Serchio at Barbellino. This dam (40 meters high) will retain 10,000,000 m^3 of water, and from two falls of 300 meters and 500 meters some 16,000 hp will be obtained for distribution to various traction and industrial establishments in the vicinity.

EXHIBITION OF RAILWAY SUPPLIES IN WASHINGTON

The announcement has already been made in this paper of the International Electrical Congress which will be held in Washington next May, and a list of the papers relating to electric railway work which will be presented has been published. In connection with the Congress, it is proposed to hold an exhibition of American railway appliances in the interest of the extension of American trade to foreign markets. The site selected for the exhibition is north of the Washington Monument, and is 10 acres in extent. An application has already been made to the War Department for the use of this ground. The exhibition will be held under the auspices of a committee which has secured headquarters at 160 Broadway, New-York, and which is composed of the following persons:

Chairman, George A. Post, New York; treasurer, Charles A. Moore, New York; secretary and director of Exhibits, J. Alexander Brown; H. P. Bope, vice-president Carnegie Steel Company; L. F. Braine, general manager Continuous Rail Joint Company; A. E. Brown, vice-president Brown Hoisting Machinery Company; J. A. Brill, vice-president, J. G. Brill Company; J. B. Brady, vice-president Standard Steel Car Company; O. H. Cutler, president American Brake Shoe & Foundry Company; C. A. Coffin, president General Electric Company; F. H. Eaton, president American Car & Foundry Company; H. Elliott, Jr., vice-president Elliott Frog & Switch Company; William Goldie, Sr., William Goldie, Jr., & Company; F. N. Hoffstot, president Pressed Steel Car Company; H. S. Hawley, president Railroad Supply Company; A. B. Jenkins, Jenkins Bros.; Alba B. Johnson Baldwin Locomotive Works; B. F. Jones, Jones & Laughlin Steel Company; A. M. Kittredge, vice-president Barney & Smith Car Company; W. V. Kelly, president Simplex Railway Appliance Company; E. B. Leigh, vice-president Chicago Railway Equipment Company; William Lodge, president Lodge & Shipley Machine Tool Company; Gen. Charles Miller, president Galena Signal Oil Company; Charles A. Moore, Manning, Maxwell & Moore; Governor Franklin Murphy, president Murphy Varnish Company; D. C. Noble, president Pittsburg Spring & Steel Company; Hon. H. Kirke Porter, H. K. Porter Company; A. J. Pitkin, president American Locomotive Company; Alfred A. Pope, president National Malleable Castings Company; H. S. Paul, president Verona Tool Works; George A. Post, president Standard Coupler Company; C. W. Sherburne, president Star Brass Manufacturing Company; C. A. Starbuck, president New York Air Brake Company; W. W. Salmon, president General Railway Signal Company; H. A. Sherwin, president Sherwin-Williams Company; Albert Waycott, president Damascus Brake Beam Company; H. H. Westinghouse, vice-president Westinghouse Air Brake Company; W. W. Willits, vice-president Adams & Westlake Company.

THE CLEVELAND, PAINESVILLE & ASHTABULA SETTLEMENT

A. B. Cleveland, of Unionville, Ohio, formerly general manager of the Cleveland, Painesville & Ashtabula Railway Company, takes exceptions to certain statements made in these columns recently, relating to matters which lead up to his appointment as receiver for the company, and his later discharge from the receivership. The statements mentioned were not our opinions, but were a condensation of court documents and the opinions of others. The appointment of Mr. Cleveland as receiver was brought about by an application made by J. G. Mitchell, of Toledo, who claimed, among other things, that the company was insolvent. A representative of the company informed us that a petition had been prepared asking to have the receivership vacated and entering a general denial of the charges made by Mr. Mitchell. He stated, furthermore, that the trouble had been caused by certain differences of policy between the company and Mr. Cleveland chiefly over the location of a new car house.

Mr. Cleveland states that the location of the car house at Unionville was the result of a unanimous vote of the directors; that he does not own any property adjoining the site of the proposed car house, and that the acceptance of him by the court indicated his eligibility to act as receiver. Mr. Cleveland claims that the entire controversy between Messrs. Mitchell and Cleveland and the officers of the company was settled by an agreement in which the latter contracted to purchase from Messrs. Mitchell and Cleveland certain stocks and bonds of the company owned by these gentlemen.

EXTENSION TO MANILA TRACTION SYSTEM

The Manila electric traction system is to be extended about 5 miles in the suburbs of that Philippine city. J. G. White & Company, who have the contract for the initial system—40 miles—now being hastened to completion, have ordered the T-rails for the construction of the additional line from the United States Steel Corporation. Six more Belgian cars have also been ordered from La Metallurgica, of Brussels, which secured the initial fifty, having secured the contract. These cars will be built of teak wood in order to withstand the ravages of the white ant, which insect is very much in evidence in the Philippines.

NEW YORK MEETING AT NIAGARA FALLS IN SEPTEMBER

At a special meeting of officers and members of the executive committee of the New York State Street Railway Association, held in the Butterfield House, Utica, on Nov. 26, it was decided to hold the next convention of the association at Niagara Falls on the second Tuesday and Wednesday in September. The meeting was called by C. Loomis Allen, general manager of the Utica & Mohawk Valley Railway Company. The question of selecting the place for the next annual gathering was the only one definitely decided upon, but in connection with the meeting preliminary plans for the programme were discussed. At the last State convention, held in Utica, A. V. Colvin, of the Hudson Velley Railway Company, invited the association to meet in Glens Falls, and the matter was placed in the hands of the executive committee. Mr. Colvin was not present at the special meeting, and the invitation from Niagara Falls was accepted. President Allen states that another special meeting will be held in two or three months.

Those present at the meeting were: President Allen, Secretary and Treasurer W. W. Cole, of Elmira; First Vice-President J. H. Pardee, of Canandaigua; E. G. Connette, general manager of the Syracuse Rapid Transit Company; R. E. Danforth, of the Rochester Company; E. F. Peck, of the Schenectady Railway Company, and B. B. Nostrand, Jr., of the Peekskill Railway & Lighting Company.

IMPORTANT PLANS FOR ELEVATED SERVICE IN NEW YORK —SUBWAY SCHEDULE

Extensive plans for the improvement of the elevated railroad lines in New York, especially on the east side, so that rapid transit facilities for the Bronx may be an early possibility, are under consideration by the Interborough Rapid Transit Company and by the Rapid Transit Commission. Within the next fortnight the commission expects to make public a report prepared by one of its subcommittees, and the entire subject then will be thrashed out in public.

Chief among the suggestions now receiving the attention of the company's officials and the commissioners is one for complete express train service over the Second and Third Avenue Elevated structures, so that expresses may be run from City Hall to the Harlem River over the Second Avenue line without stop between Chatham Square and One Hundred and Twenty-Seventh Street. This, it is believed, would give an effective service for Bronx residents, and would leave the Third Avenue express track clear for express business below the Harlem River.

To carry out this plan it would be necessary to put in two new tracks on Second Avenue between the present local service tracks, making the Second Avenue line a four-track line from the Harlem River to Chatham Square. From Chatham Square, according to the plan, the local Second Avenue trains would be run to South Ferry as now, while the new express tracks would be run on a new structure to the City Hall and Brooklyn Bridge station of the Third Avenue line. To do this the present elevated structure in Park Row, from Chatham Square to the Bridge, would be turned into a double-decker affair, so that the express trains could be rushed right out from the City Hall station without any interference with the present traffic over the Third Avenue line.

Then the expresses, by being run without stop to One Hundred and Twenty-Seventh or One Hundred and Twenty-Ninth Street, could be run as locals for the Bronx points as far north as Pelham Avenue and Two Hundredth Street, the present terminal of the Third Avenue line, over the tracks of which all Second Avenue trains have to run beyond One Hundred and Twenty-Ninth Street.

A new subway schedule which will nearly double the number of subway trains during rush hours is as follows:

EXPRESS TRAIN SCHEDULE

Between Ninety-Sixth Street and Brooklyn Bridge

6.24 A. M. to 7.06 A. M.	Every 3 minutes
7.06 A. M. to 9.16 A. M.	Every 2½ minutes
9.16 A. M. to 9.28 A. M.	Every 3 minutes
9.28 A. M. to 10.00 A. M.	Every 4 minutes
10.00 A. M. to 3.00 P. M.	Every 5 minutes
3.00 P. M. to 3.24 P. M.	Every 4 minutes
3.24 P. M. to 3.54 P. M.	Every 3 minutes
3.54 P. M. to 6.04 P. M.	Every 2½ minutes
6.04 P. M. to 6.28 P. M.	Every 3 minutes
6.28 P. M. to 6.42 P. M.	Every 3½ minutes
6.42 P. M. to 7.06 P. M.	Every 4 minutes
7.06 P. M. to 11.36 P. M.	Every 5 minutes

LOCAL TRAIN SCHEDULE

Leave Ninety-Sixth Street, Southbound, Between

12.00 M. N. to 5.00 A. M.	Every 7½ minutes
5.00 A. M. to 5.30 A. M.	Every 5 minutes
5.30 A. M. to 6.00 A. M.	Every 4 minutes
6.00 A. M. to 7.00 A. M.	Every 3 minutes
7.00 A. M. to 7.30 A. M.	Every 2½ minutes
7.30 A. M. to 8.30 A. M.	Every 2 minutes
8.30 A. M. to 4.15 P. M.	Every 2½ minutes
4.15 P. M. to 5.15 P. M.	Every 2 minutes
5.15 P. M. to 8.00 P. M.	Every 2½ minutes
8.00 P. M. to 11.00 P M.	Every 3 minutes
11.00 P. M. to 11.40 P. M.	Every 4 minutes
11.40 P. M. to 12.00 M. N.	Every 5 minutes

Note.—North of Ninety-sixth street express and local trains alternate, one-half to east division and the other half to the west division.

E. P. Bryan, vice-president of the Interborough Rapid Transit, in answer to the charge of poor service on the elevated lines, has given out the following comparative statement as to the number of trains run and passengers carried during the first twelve days in November, 1903. The increase in car mileage is due, not to the increase in number of trains, but to the fact that more cars have been added to the trains already running.

The figures given below were taken at a time when many of the elevated patrons were using the subway because of its novelty. The statement, which is for the first twelve days of November, is as follows:

Passengers carried, November, 1903	10,332,793
Passengers carried, November, 1904	10,201,245
Decrease in 1904 for first 12 working days	131,548

CAR MILES RUN

First 12 working days, November, 1903	2,093,793
First 12 working days, November, 1904	2,119,165
Additional car mileage run for the aforesaid 12 days in 1904, as compared with 1903, shows increase for 1904 of	25,372

The above shows that passengers per car mile carried during the first twelve workings days of November, 1903, equals 4.93 passengers per car mile, and for the same days during 1904 equals 4.81 passengers per car mile.

ELECTRIC TRACTION FOR ROSARIO

The construction of an extensive electric traction system in and around Rosario, one of the leading cities in the Argentine Republic, is mooted. At present there is no electric road in that part of the world, mule tramways being the principal method of transport. The chief mule systems, which in all are about 30 miles long, are operated by the City of Rosario Tramways, Rosario de Santa, of which Jose Gil is general manager, and the Tramway Rosario del Norte, of which Manuel Gilveti is president.

M. Henlizitka, representing the Cia Aleniana Transatlantic de Electricidad, which generates the current for electrically lighting the city and its suburbs, has approached the municipal authorities regarding the matter of electric transit. Santiago Keenan is also negotiating for a seventy-year concession to build and operate upwards of 50 miles of road, and everything points, according to advices just to hand from South America, to the conversion of the existing mule lines and the construction of additional track before many months are past.

THE WORCESTER & PROVIDENCE STREET RAILWAY

Announcement is made by F. C. Hinds of some of the details of the proposed street railway between Worcester, Mass., and Providence, R. I. The company has secured practically all the necessary locations in the Massachusetts towns through which it is to pass, and will soon ask for their approval by the Railroad Commission. The route selected is 36 miles in length and the running time will be less than two hours. The fare will be about 50 cents. The present steam railroad fare between the two cities is $1 and the running time about an hour and a half. An agreement has been entered into with the Worcester Consolidated Street Railway Company for bringing the cars into Worcester over that company's lines, and a similar arrangement will probably be made with the Union Traction Company, of Providence. The road will be of double-track boulevard construction, similar to the Boston & Worcester Street Railway, so that cars may be operated over it at high speed with safety. It will traverse much territory in which there is no present street railway accommodation.

CHICAGO FREIGHT TUNNELS CHANGE HANDS

The Chicago Subway Company was incorporated in New Jersey Nov. 21, with a capitalization of $50,000,000, to take over immediately the property of the Illinois Tunnel Company, which owns the extension system of single-track freight tunnels under the business streets of Chicago. President Albert G. Wheeler, of the Illinois Tunnel Company, gave out the following statement:

The tunnels finished under the streets, to prove of great benefit to the community, must have the traffic diverted from the streets and transported through the tunnels. While no question was ever in any one's mind that this would ultimately be accomplished, yet to have the community reap the benefit of the removal of such congestion at once it became necessary that the parties controlling the steam railroads, with terminals in Chicago, should be interested in the tunnels, and immediately use them for the transfer of the freight from the railroad terminals to the basements of the business houses.

To produce this result and get the tunnels in full operation at the earliest date, the holders of two-thirds of the stock of the Illinois Tunnel Company sold their stock to a corporation called the Chicago Subway Company, this corporation being controlled by the owners of all the steam railroads that terminate in Chicago, and represented by E. H. Harriman and James Stillman, of the National City Bank of New York City, Kuhn, Loeb & Company, through Jacob Schiff, and P. A. Valentine, of Chicago, the local representative of the railroad interests.

The operation of these tunnels, now under the control of the representatives of the railroad interests terminating in Chicago, will prove beneficial to all merchants handling freight in and out of their buildings, and to the general public in having the streets relieved of congestion. The broad scope of the development of these tunnels, through this representative railroad interest, cannot but help be a great commercial advantage to the future growth of the city.

This Chicago Subway Company has no connection with nor are any parties interested in it connected with the street railways of Chicago.

The franchise of the tunnel company does not give it the right to carry passengers, so that this tunnel system is not a factor in the passenger transportation problem in Chicago.

No regular freight delivery service has been inaugurated in these tunnels as yet, but daily about 2000 tons of dirt from new buildings under construction are being hauled to the lake front to fill in the new park.

The company has purchased several electric mining locomotives of various types, and a number of cars of Bettendorf make, but apparently has been waiting for the consummation of the present deal before going ahead on a comprehensive scale with the equipment of the system.

AN ASSOCIATION OF INDIANA INTERESTS

A movement has been started among Indiana traction interests to organize an association or body that shall admit to membership all street and interurban companies whose officers think that concerted action is advantageous. Meetings have already been held of those interested in launching the project, and there is evidence that the thing will be successfully organized. In general, the new organization will be fashioned after the Ohio Interurban Association. Besides the feature of that association which provides for interchange of traffic, the Indiana Association will probably be organized on lines similar to those governing the State association in New York. Regular meetings will probably be provided for at stated periods when there can be free exchange of ideas. Provision will also be made for settling any special questions of interest to the members at large at such time as they may come up. P. H. White, of the Indianapolis & Martinsville Company, is interested.

ANNUAL MEETING OF WESTINGHOUSE AGENTS

Several years ago Frank H. Taylor, vice-president of the Westinghouse Electric & Manufacturing Company, in the able co-operative methods that have so characterized his work, instituted the annual meetings of the district office managers and the heads of the various works and departments of the company. The men come from all parts of the United States, where different sets of conditions prevail, and each gives the result of his experience during the past year for the benefit of all. A careful analysis of the reports is made by the management, and these results play an important part in the policy of the company and in the guidance of the further efforts of its representatives. During the week ending Nov. 19 the district managers of the Westinghouse Electric & Manufacturing Company held their latest meeting of this kind at the works at East Pittsburg and discussed plans and methods for the coming year.

Those attending the convention were Calvert Townley, general agent, New York; G. Pantaleoni, general Southwestern manager, St. Louis, Mo.; R. L. Warner, New England agent, Boston, Mass.; E. W. T. Gray, New York; D. E. Manson, Boston, Mass.; W. S. Heger, San Francisco, Cal.; F. B. H. Paine, manager export office, New York; C. W. Underwood, Buffalo, N. Y.; C. F. Medbury, Detroit, Mich.; G. B. Dusinberre, Cleveland, Ohio; W. F. Fowler, Baltimore, Md.; C. A. Bragg, Philadelphia, Pa.; M. P. Randolph, Seattle, Wash.; S. J. Keese, Los Angeles, Cal.; P. N. Jones, Pittsburg, Pa.; D. E. Webster, St. Louis, Mo.; T. P. Gaylord, Chicago, Ill.; L. M. Cargo, Salt Lake City, Utah; J. R. Gordon, Atlanta, Ga., and T. J. McGill, Minneapolis, Minn. On Wednesday evening the management gave a banquet to the visiting managers, at which all of the executive officers of the company were present.

A feeling of optimism was evidenced throughout the convention regarding the business situation and the prospects of continued prosperity throughout the country. W. S. Heger, of San Francisco, stated that the outlook on the Pacific Coast was never better, work being plentiful and money easy. "Mining projects in California are flourishing," he said, "and they appear to have plenty of money behind them. This insures large installations of Pittsburg electrical machinery." L. M. Cargo, of Salt Lake City, said that the election of Roosevelt had given a decided impetus to mining development in Utah, Arizona, Nevada and New Mexico, capital, which prior to that had been timid, being induced to pour money liberally into dormant investments. J. R. Gordon, of Atlanta, Ga., said: "The South will soon have the greatest boom of its history. For the past two years the cotton crop, the barometer of Southern prosperity, has been phenomenal. Business conditions reveal a greater stability and the increase of manufacturing in the South is extraordinary. Abundant water-power easily available will prove an enormous boon and a producer of business for Pittsburg." F. H. B. Paine, manager of the export department, said: "The outlook for foreign business has never been more promising for American manufacturers, because never before were Europeans more alive to the superiority of American manufacturing methods." C. A. Bragg, of Philadelphia, said: "The outlook for general industrial activity was never brighter. While there has been planty of capital during the past year, timidity over unsettled political conditions prevented its investment. Lack of confidence has disappeared and hopeful buoyancy is observable everywhere." E. W. T. Gray, of New York, said: "New York suffered severely the past year because of building strikes, but these have subsided and business has been good there for six months. It is a foregone conclusion that it will be even better, as cheap money is abundant, and there is no lack of financial support for any legitimate enterprise."

TO BUILD ANOTHER PERUVIAN ROAD

Another electric traction system is to be built in Peru, and the entire equipment, etc., to be used in its construction will be purchased in the United States. About three-quarters of a million dollars will be expended.

The Ferrocarril Urbano de Lima, which operates about 20 miles of mule tramways, will convert its system into an electric line. Peruvian capital exclusively will be employed. The manager of the mule tramways is Senor Don Emilio Godoy. The line is to be laid with 60-lb. T and 70-lb. girder rails. Fifty cars will be ordered in the first instance. They will be open, eight and ten bench ones. The former will be equipped with double 25-hp. motors, while the others will have double equipment of 38-hp. each.

Power to operate the new system will be derived from the hydraulic plant of the Empresa Electrica de Santa Rosa, Limitada, located at Choosica, 35 miles distant from Lima. This plant furnishes energy to operate the Lima-Chorillos interurban road, as well as the Callao-Lima line, recently completed. General Electric equipment is used entirely on these two traction systems. On the Callao-Lima road, ten Brill cars, semi-convertible, 40 ft. each, and four Stephenson ones are in operation. The motor equipments are double G. E. 57, of 50 hp. each. Six more Stephenson cars are now on the way.

A sub-station of 1200 kw. capacity will be used for the projected Lima city road. When this system is completed it will be possible to travel by electric railway from Callao, the port of Lima, through Lima and on to the various watering places along the coast, a total distance of about 40 miles.

NEW PUBLICATIONS

Electric Lighting, Vol. I. The Generating Plant (sixth edition). By Francis B. Crocker. 482 pages. Illustrated. Published by D. Van Nostrand Company, New York. Price $3.

The best comment on the value of this book is that it has passed through five editions since it appeared in 1896. The author, Prof. Crocker, of Columbia, has in the sixth edition, just issued, practically rewritten the book, bringing the various branches up to date. Particular care has been exercised in eliminating the deadwood, consisting of antiquated illustrations and statements, which are too often left in revised editions of technical works.

Between the Ocean and the Lakes. The Story of the Erie; new edition. By Edward H. Mott. 550 pages. Illustrated. Published by John S. Collins, New York. Price $7.

The history of any railroad is interesting, but that of the Erie is especially so, because of the wide reputation, both good and bad, of those who have been prominent in its management, and of the many dramatic events connected with its history. With perhaps no other transportation system in the world has there been so much of tragedy and comedy blended, nor have so many leading lights in financial, political and railroad life been identified. During the past seventy-five years the road has had an exciting history, much of which has centered in Wall Street and Albany. These facts have been set forth by Mr. Mott in a most entertaining way, and no important detail of any branch of history of the road has been neglected. The present edition contains a portrait of F. D. Underwood, the present president, and brings the history of the road down to date. It also contains an index, which the earlier editions did not have.

PERSONAL MENTION

MR. W. H. BROWN has been appointed master mechanic of the Auburn & Syracuse Electric Railroad Company.

MR. J. W. MUMPER has resigned as superintendent of the Hanover Light Heat & Power Company and the Hanover & McSherrystown Street Railway Company, of Hanover, Pa.

DR. LOUIS DUNCAN has become associated with the staff of the Allis-Chalmers Company as an expert in electrical patent work in connection with its electrical department. Dr. Duncan will continue to make his headquarters in New York.

MR. N. B. RHOADS, superintendent of transportation of the Savannah Electric Company, was married to Miss Sarah Katherine Collins, of Savannah, on Oct. 25 last. Both of the contracting parties are well known in society. Mr. Rhoads previous to coming to Savannah was connected with the Richmond Traction Company, of Richmond, Va.

MR. R. McADOO, formerly president and general manager of the Mexican Traction Company, a Pittsburg capitalized concern which acquired concessions for the construction of a network of electric lines in and around Mexico City, now part of the property of the Ferrocarril del Distrito Federal, the Wernher-Beit system of which Mr. W. W. Wheatley is general manager, has been elected general manager of the Winnebago Traction Company, of Oshkosh, Wis., to succeed Mr. Downs, resigned.

MR. GEORGE R. SCRUGHAM has resigned as president and general manager of the Interurban Railway & Terminal Company, of Cincinnati, Ohio, and is succeeded by Mr. Charles H. Davis. Mr. Scrugham's retirement really marked a change in the control of the company. With him Mr. G. W. Mallon and Mr. Ellis G. Kincaid resigned from the board of directors. Mr. Scrugham was instrumental in organizing and carrying to successful completion the Cincinnati & Eastern Electric Railway, the Suburban Traction Company and the Interurban Terminal Company, which finally were merged as the Interurban Railway & Terminal Company.

MR. WILLIAM ARTHUR HEYWOOD, general manager of the Pennsylvania Iron Works Company, is dead. Mr. Heywood was born in Bolton, England, and came to this country in 1855. He was at one time division engineer of the Philadelphia Traction Company, and when the Baltimore Traction Company decided to install the cable system, Mr. Heywood became the company's engineer. He resigned from the Baltimore Company in 1893, and opened an office in Baltimore as a consulting engineer. Later Mr. Heywood returned to Philadelphia and associated himself with the Pennsylvania Iron Works Company, becoming its general manager.

MR. S. B. McLANEGAN has been appointed superintendent of the Belt line, the Angeleno Heights line and the Temple Street lines of the Pacific Electric Railway Company, of Los Angeles, Cal. Formerly these lines were managed by Superintendent F. Van Vranken, who, owing to the large expansion of the company's beach system, has been relieved of the city feeders. The last appointment really groups the Pacific Electric into three divisions—city division under Mr. McLanegan; southern division (including the beach lines and the lines to Whittier and Santa Ana) under Mr. Van Vranken; northern division (including the lines into the San Gabriel Valley and Pasadena) under Mr. J. B. Rowry. Speaking of the new arrangement, Mr. A. A. Joly, assistant to General Manager Schindler, says: "When the Pacific Electric Railway Company gained control of the Los Angeles Traction Company and the Los Angeles Interurban Railway Company was formed, the development of the beach lines was just beginning, but so extensive has been our progress in every direction during the past two years that reorganization was absolutely necessary. The maintenance of track of the Los Angeles Interurban Railway Company, formerly in charge of Superintendent McLanegan, has been transferred to Mr. M. Dozier, Jr., engineer of maintenance of way of the Pacific Electric Railway Company.

MR. A. W. McLIMONT has been appointed consulting engineer to W. R. Grace & Company, of New York, London, Lima, Valparaiso, etc., who represent the General Electric Company on the west coast of South America, where there is considerable important electric railway work pending. He will make his headquarters at the New York offices of the Grace Company. Mr. McLimont is an old Thomson-Houston employee. His first work was the overhead construction of the West End Street Railways in Boston, Mass. He next superintended the building of the overhead lines in Nashville, Tenn., and afterwards supervised the overhead construction of the Prospect Park & Coney Island Railroad, in Brooklyn. After completing this work he went West under the jurisdiction of the Chicago Thomson-Houston Company, and built a number of important systems. In the early part of 1892 he became consulting engineer to the late Mr. R. T. McDonald in the building of the New Orleans street railway system. In 1895 Mr. McLimont built a large part of the present Chicago North Shore Electric Railway system, and later in the same year was sent to Dubuque, Ia., for the General Electric Company, to rehabilitate and reconstruct the Dubuque Light & Traction Company's system. After completing that work Mr. McLimont entered the foreign field. In 1901 he constructed the high-tension transmission line from Mechanicsville to Albany, N. Y. He then left for Mexico, where he was engaged by the State government of Guanauato to reconstruct various power plants in that part of the republic. On completion of this work he was retained as consulting engineer for a proposed street railway in Monterey, Mexico. His last work was building the Lima & Chorillos Railway, which is a high-speed interurban railway operating between the capital of Peru and several of the sea coast towns. This system was described in the STREET RAILWAY JOURNAL, June 4.

TABLE OF OPERATING STATISTICS

Notice.—These statistics will be carefully revised from month to month, upon information received from the companies direct, or from official sources. The table should be used in connection with our Financial Supplement "American Street Railway Investments," which contains the annual operating reports to the ends of the various financial years. Similar statistics in regard to roads not reporting are solicited by the editors. * Including taxes. † Deficit.

Company	Period	Total Gross Earnings	Operating Expenses	Net Earnings	Deductions From Income	Net Income, Amount Available for Dividends
AKRON, O.	1 m., Oct. '04	78,013	42,839	35,174	22,467	12,707
Northern Ohio Tr. &	1 " " '03	75,272	41,314	33,958	22,447	11,511
Light Co	10 " " '04	747,727	406,522	341,205	226,125	115,080
	10 " " '03	741,574	403,264	338,310	222,112	116,198
AURORA, ILL.	1 m., Oct. '04	37,947	22,040	15,906	9,333	6,573
Elgin, Aurora & South-	1 " " '03	37,011	22,869	14,142	9,173	4,970
ern Tr. Co	4 " " '04	165,206	85,928	79,278	37,173	42,106
	4 " " '03	172,063	94,460	77,613	36,690	40,923
	1 m., Oct. '04	19,431	11,572	7,859	......	......
BINGHAMTON, N. Y.	1 " " '03	18,613	10,586	8,028	......	......
Binghamton Ry. Co	4 " " '04	94,248	48,763	49,483	......	......
	4 " " '03	92,120	44,584	47,537	......	......
	1 m., Oct. '04	354,811	194 034	160 777	139,851	20,926
BUFFALO, N. Y.	1 " " '03	336,978	198,711	138,267	134,613	3,654
International Tr. Co	4 " " '04	1,579,396	767,163	812,233	556,734	255,499
	4 " " '03	1,535,294	791,637	743,657	533,584	210,073
CHICAGO, ILL.						
Aurora, Elgin & Chi-	1 m., Oct. '04	42,713	21,202	21,511	......	......
cago Ry. Co	4 " " '04	201,570	97,330	104,239	......	......
	1 m., Oct. '04	55,625	17,812	37,813	......	......
Chicago & Milwaukee	1 " " '03	43,307	10,746	32,561	......	......
Elec. R. R. Co	10 " " '04	379,902	143,556	236,346	......	......
	10 " " '03	237,944	77,682	160,261	......	......
CINCINNATI, O.	1 m., Oct. '04	47,911	25,411	22,501	16,250	6,251
Cincinnati, Dayton &	1 " " '03	46,667	24,246	22,421	15,931	6,490
Toledo Tr. Co	5 " " '04	245,345	130,577	114,768	82,331	32,437
	5 " " '03	251,328	123,832	127,496	80,221	47,274
CLEVELAND, O.	1 m., Oct. '04	19,758	11,844	7,915	......	......
Cleveland, Painesville	1 " " '03	18,333	11,696	6,637	......	......
& Eastern, R. R. Co	10 " " '04	191,948	114,002	77,946	......	......
	10 " " '03	183,219	105,704	77,515	......	......
	1 m., Oct. '04	44,171	24,150	20,022	......	......
Cleveland & Southwest-	1 " " '03	43,656	24,875	18,782	....	......
ern Traction Co	10 " " '04	397,243	248,289	148,954	......	......
	10 " " '03	373,889	219,614	154,275	......	......
	1 m., Oct. '04	59,588	35,530	24,058	29,370	3,688
Lake Shore Electric Ry.	1 " 03	55 336	35,589	19,747	20,370	† 623
Co	10 " " '04	550,760	368,300	182,460	203,708	† 21,248
	10 " " '03	523,250	326,727	196,523	200,004	† 3,480
COLUMBUS, O.	1 m., Sept. '04	24,229	12,201	12,028	......	......
Columbus, Buckeye	1 " " '03	20,258	10 630	9,627	......	......
Lake & Newark Tr.	9 " " '04	171,834	96,131	75,703	......	......
Co	9 " " '03	148,632	80,368	68,264	......	......
	1 m., Oct. '04	401,837	*237,085	164,752	88,585	76,167
DETROIT, MICH.	1 " " '03	387,340	*234,239	153,101	85,119	67,982
Detroit United Ry	10 " " '04	3,819,289	*2311791	1,507,498	891,655	615,843
	10 " " '03	3,720,963	*2181717	1,539,246	828,882	710,364
	1 m., Oct. '04	51,642	26,077	25,565	16,514	9,051
DULUTH, MINN.	1 " " '03	53,632	29,010	24,622	15,838	8,784
Duluth St. Ry. Co	10 " " '04	513,536	272,377	241,159	164,984	76 175
	10 " " '03	518,893	286,051	232,842	154,923	77,919
EATON, IND.						
Muncie, Hartford &	1 m., Oct. '04	16,747	* 7,289	9,458	5,000	4,458
Ft. Wayne Ry. Co	10 " " '04	151,386	* 70,825	80,562	44,000	36,562
	1 m., Oct. '04	56,047	29,775	26,272	10,116	16,156
FORT WORTH, TEX.	1 " " '03	47,569	27,459	20,110	9,723	10,387
Northern Texas Trac-	10 " " 04	461,911	256,575	205,336	101,122	104,214
tion Co	10 " " 03	382,866	205,627	177,239	92,213	85 026

Company	Period	Total Gross Earnings	Operating Expenses	Net Earnings	Deductions From Income	Net Income, Amount Available for Dividends
HANCOCK, MICH.	1 m., Sept. '04	18,451	9,498	8,953	3,388	5,565
Houghton County St.	1 " " '03	16,479	9 376	7,103	3,852	3,251
Ry. Co	12 " " '04	192,079	131,530	60,548	37,874	22,674
	12 " " '03	185,001	121,144	63,857	35,097	28,760
	1 m., Oct. '04	13,646	8,780	4,866	2,386	2,481
LONDON, ONT.	1 " " '03	13,772	8,656	5,116	2,289	2,827
London St. Ry. Co	10 " " '04	150,755	102,618	48,137	24,296	23,841
	10 " " '03	146,289	92,412	53,877	22,161	31,716
MILWAUKEE, WIS.	1 m., Oct. '04	280,386	130,197	150,189	78,790	71,398
Milwaukee El. Ry. &	1 " " '03	264,513	137,890	126,623	73,949	52,674
Lt. Co	10 " " '04	2,656,481	1,323,307	1,333,174	756,734	576,440
	10 " " '03	2,509,950	1,266,371	1,243,579	723,504	520,074
	1 m., Oct. '04	38,727	17,155	21,572	17,670	3,902
Milwaukee Lt., Ht. &	1 " " '03	35,313	18,333	16,980	14,666	2,314
Tr. Co	10 " " '04	387,462	183,041	204,421	168,016	36,404
	10 " " '03	356,780	177,885	178,896	139,393	39,502
	1 m., Oct. '04	368 057	170,238	197,819	97,308	100.511
MINNEAPOLIS, MINN.	1 " " '03	348.646	161,451	187,195	78,444	108,751
Twin City Rapid Tran-	10 " " '04	3,576,229	1,680,406	1,895,823	914,441	981,382
sit Co	10 " " '03	3,369,489	1 560,338	1,809,151	784,074	1,025,077
MONTREAL, QUE.	1 m., Oct. '04	222,276	121,637	100,639	18,947	81,692
Moatreal St. Ry. Co	1 " " '03	206,601	110,709	95,892	18,922	76,970
	1 m., Sept, '04	9,492	5,080	4,412	2,631	1,781
OLEAN, N. Y.	1 " " '03	9,050	3,888	5,162	2,414	2,748
Olean St. Ry	3 " " '04	32,841	16,157	16,685	7,894	8,791
	3 " " '03	27,890	10,838	17,052	7,356	9,696
	1 m., Oct. '04	119,894	......	......	......	......
PHILADELPHIA, PA.	1 " " '03	116,763	......	......	......	......
American Rys. Co	4 " " '04	547,169	......	......	......	......
	4 " " '03	538,995	......	......	......	......
	1 m., Oct. '04	127,104	70 320	56,784	27,036	29,749
ROCHESTER, N. Y.	1 " " '03	108,426	57,049	51,378	25,933	25,445
Rochester Ry. Co	10 " " '04	1,235,081	678,972	556,109	......	......
	10 " " '03	1,055,212	538,488	516,725	......	......
SAN FRANCISCO, CAL.						
United Railroads of	1 m., Oct. '04	595,445	......	......	......	......
San Francisco	1 " " '03	568,690	......	......	......	......
	1 m., Sept. '04	46,843	26,099	20,744	10 613	10,131
SAVANNAH, GA.	1 " " '03	45,606	26,505	19,101	10,583	8,517
Savannah Electric Co.	12 " " '04	535,579	303,742	231,837	125,678	106,159
	12 " " '03	510,514	303,991	206,523	116,722	89,802
	1 m., Sept. '04	196,295	134,167	62,128	25,771	36,357
SEATTLE, WASH.	1 " " '03	175,678	122,200	53,479	22,917	30,562
Seattle Electric Co	12 " " '04	2,266,785	1,582,927	683,859	281,894	401,965
	12 " " '03	2,067,418	1,470,964	596,454	287,976	308 479
	1 m., Sept. '04	72,786	40 433	32,354	20,338	12,016
SYRACUSE, N. Y.	1 " " '03	72,079	39,966	32,113	20,329	11,784
Syracuse R. T. Co	3 " " '04	219,406	121,508	97,898	60,792	37,106
	3 " " '03	212,593	117,459	95,134	60,883	34,251
	1 m., Sept. '04	52,148	28,706	23,442	9,664	13,778
TERRE HAUTE, IND.	1 " " '03	46,712	25,309	21,403	8,522	12,881
Terre Haute Elec. Co.	12 " " '04	420,642	277,196	143,446	86,109	57,337
	12 " " '03	342,824	222,143	120,681	60 955	59,726
	1 m., Oct. '04	150,196	*76,183	74,013	41,251	32,762
TOLEDO, O.	1 " " '03	142,651	*74,805	67 846	41,245	26,601
Toledo Rys. & Lt. Co	10 " " '04	1,440,144	*768,325	671 809	416,555	255,254
	10 " " '03	1,368,580	*705,979	662,601	408,096	254,505
YOUNGSTOWN, O.						
Youngstown-Sharon	1 m., Oct. '04	39,109	*23,601	15,508	......	......
Ry. & Lt. Co	10 " " '04	379,208	*229,935	149,273	......	......