Street Railway Journal

Vol. XX. NEW YORK AND CHICAGO, OCTOBER 4, 1902. No. 14.

DETROIT AS AN INTERURBAN ELECTRIC RAILWAY CENTER

DETROIT is now the terminus of about 400 miles of electric interurban railway, and has 187 miles of city street railway lines. The various interurban electric lines radiating from Detroit were originally built by different companies, and some of these roads were among the first electric interurbans built in the United States. At the present time the nearest to a purely interurban company operating cars into Detroit is the Detroit, Ypsilanti, Ann Arbor & Jackson Railway Company. In 1901 all the other interurban lines entering Detroit came under the control of the Detroit United Railway Company, which company also owns all the city lines. The interurban lines controlled by the Detroit United Railway are now designated as the various divisions of the Detroit United Railway, except the Rapid Railway system, which has a separate organization and operating officers. In the following list both the former name and the present division name are included: Detroit & Pontiac Railway (Pontiac Division), 36.52 miles; Detroit, Rochester, Romeo & Lake Orion Railway (Flint Division), 85.31 miles; Detroit & Northwestern Railway (Orchard Lake Division), 58.77 miles; Wyandotte & Detroit River Railway (Wyandotte Division), 10.78 miles, and Detroit & Port Huron Shore Line Railway (operated independently as the Rapid Railway System), 109.57 miles. The total interurban mileage therefore controlled by the Detroit United Railway Company amounts to 301.15 miles.

ON WOODWARD AVENUE AT INTERURBAN WAITING ROOM

Adding to this the 100 miles owned and operated by the Detroit, Ypsilanti, Ann Arbor & Jackson Railway Company gives a total of 401.15 miles of interurban road terminating in Detroit.

The interurban lines centering in Detroit are shown by the map accompanying this article. They reach out a distance of about 70 miles to the north and west, Jackson being 76 miles west, Flint 68 miles north, and Port Huron 73 miles northeast. Nothing gives a better general idea of the electric interurban service that is being maintained out of Detroit than the accompanying map in conjunction with the following list of towns reached by these interurban lines, in which is given the running time from Detroit, distance and rate of fare. The running time given includes that consumed in the city.

DISTANCES, ETC., FROM DETROIT TO TOWNS AND RESORTS REACHED BY ELECTRIC RAILWAYS

Towns.	Division	Distance from Detroit, Miles	Fare from Detroit One Way.	† Round Trip Rate from Detroit.	Running Time From Detroit
Anchorville	Rapid Ry....	35	$0.45	$0.85	1 hr. 46 min.
Algonac	Rapid Ry....	46	.55	1.00	2 hr. 14 min.
Ann Arbor.....	D Y.A.A. & J.	38	.50	....	2 hr. 15 min.
Atlas	Flint Div	58	.83	....	2 hr. 46 min.
Birmingham....	Pontiac Div..	18	.15	....	1 hr.
Canton.........	D.Y.A.A. & J.	22	.25	....	1 hr. 24 min.
Cass Lake......	Orc. Lk. Div.	29	.35	....	1 hr. 35 min.
Chelsea........	D.Y.A.A. & J.	53	.69	....	2 hr. 50 min.
Circle City......	Pontiac Div..	24	.20	....	1 hr. 10 min.
Clarenceville...	Orc. Lk. Div.	17	.25	....	55 min.
Dearborn	D.Y.A.A. & J.	10	.15	....	45 min.
Denton	D.Y.A.A. & J.	25	.30	....	1 hr. 31 min.
Ecorces	Wyandotte...	9	.10	....	35 min.
Eloise (Wayne Co. House)..	D.Y.A.A. & J.	15½	.20	....	1 hr. 3 min.
Fair Haven.....	Rapid Ry....	36	.45	.85	1 hr. 50 min.
Farmington	Orc. Lk. Div.	20	.25	....	1 hr. 5 min.
Farmington Jct.	Orc. Lk. Div.	19	.25	....	1 hr.
Flint..........	Flint Div	68	1.00	....	3 hr. 15 min.
Francisco	D.Y.A.A. & J.	60	.80	....	3 hr. 5 min.
Goodison	Flint Div.....	32	.40	....	1 hr. 35 min.
Goodrich	Flint Div	56	.80	....	2 hr. 39 min.
Grass Lake	D.Y.A.A. & J.	64½	.87	....	3 hr. 15 min.
Greenfield	Orc. Lk. Div..	9	.10	....	30 min.
Inkster.........	D.Y.A.A. & J.	13½	.15	....	1 hr.
Jackson........	D.Y.A.A. & J.	76	1.05	....	3 hr. 45 min.
Leoni..........	D.Y.A.A. & J.	67½	.92	....	3 hr. 22 min.
Lake Orion	Flint Div	37	.5·	....	1 hr. 51 min.
Lima Center ...	D.Y.A.A. & J.	49½	.65	....	2 hr. 41 min.
Marine City	Rapid Ry....	53	.65	1.20	2 hr. 29 min.
Marysville......	Rapid Ry....	67	.85	1.50	3 hr. 14 min.
Michigan Cen ..	D.Y.A.A. & J.	70½	.97	....	3 hr. 30 min.
Mt. Clemens....	Rapid Ry.... (Main Line)	21	.25	....	1 hr. 9 min.
Mt. Clemens....	Rapid Ry.... (Shore Line)	24	.30	....	1 hr. 30 min.
New Baltimore.	Rapid Ry....	32	.40	.75	1 hr. 42 min.
Northville	Orc. Lk. Div.	27	.35	....	1 hr. 30 min.
Orchard Lake..	Orc. Lk. Div.	28	.35	....	1 hr. 30 min.
Orion	Flint Div	37	.50	....	1 hr. 51 min.
Ortonville	Flint Div	51	.71	....	2 hr. 24 min.
Oxford	Flint Div	41	.55	...	2 hr.
Pearl Beach....	Rapid Ry....	42	.50	.90	2 hr. 5 min.
Plymouth	D. P. & N.Ry.	33	.40	....	1 hr. 53 min.
Pontiac	Pontiac Div..	26	.25	....	1 hr. 20 min.
Pontiac	Orc. Lk. Div.	34	.35	....	1 hr. 50 min.
Port Huron....	Rapid Ry....	73	.90	1.50	3 hr. 25 min.
River Rouge ...	Wyandotte...	7	.10	....	30 min.
Roberts Landi'g	Rapid Ry....	49	.60	1.10	2 hr. 19 min.
Rochester......	Flint Div .. .	28	.32	...	1 hr. 25 min.
Romeo	Flint Div	40	.50	....	2 hr.
Royal Oak	Pontiac Div..	14	.10	....	45 min.
Saline..........	D.Y.A.A. & J.	40	.50	....	2 hr. 15 min.
Sand Hill	Orc. Lk. Div	13	.15	...	45 min.
St. Clair	Rapid Ry....	61	.75	1.30	2 hr. 59 min.
Stony Creek ...	Flint Div	30	.35	....	1 hr. 35 min.
Sylvan Lake ...	Orc. Lk. Div	30	.35	....	1 hr. 40 min.
Trenton........	Wyandotte...	17	.20	.35	1 hr. 10 min.
Troy	Flint Div	22	.22	....	1 hr. 10 min.
Washington....	Flint Div	34	.41	....	1 hr. 45 min.
Wayne	D.Y.A.A. & J.	18	.20	....	1 hr. 9 min.
Wyandotte.....	Wyandotte...	12	.15	.25	53 min.
Ypsilanti.......	D.Y.A.A. & J.	30	.40	....	1 hr. 45 min.

† Round trip rates are given only where tickets are on sale.

The service to all points is hourly, except that to Mount Clemens, Trenton, Ann Arbor and intermediate points half-hourly service is given. It will be appreciated that the Detroit United Railway, in operating so many miles of interurban line, becomes much more than a local company, covering as it does the entire southeastern part of Michigan, and the management of this property is therefore materially different from that of a company operating city lines only.

The capitalization of interurban electric lines around Detroit will average in the neighborhood of $40,000 per mile of track, about one-half of which would be in most cases represented by bonds. The earnings per mile of track per year are in the neighborhood of $3,500. Of course, these figures are only approximate, and cannot be applied to the various particular cases. but the foregoing figures, together with the data on population, which is to follow, will give a good general idea of the interurban situation in the vicinity of Detroit.

The population of Detroit, according to the census of 1900, was 285,704. The population of the towns and villages served by the interurban roads terminating at Detroit, outside of the Detroit city limits, is 130,255. This, however, includes only the villages of sufficient size to be given independent of their townships in the census of 1900, with the addition of a few villages which have grown very rapidly in the last two years, and upon which a local estimate of the population has been made. The rural population on these interurban lines outside of the villages is an important factor, as is evident to any observing person patronizing these lines, and this was not included in the foregoing estimate. Assuming this rural population to be 20,000, so as to bring the total population served outside of Detroit up to about 150,000, the population per mile at interurban track terminating in Detroit would be 374, exclusive of Detroit's population.

Going into population figures more in detail, the Rapid Railway system has in towns and villages along its line 36,236, or an average population per mile of 329. This includes the mileage of the city lines in Port Huron.

The Detroit, Ypsilanti, Ann Arbor & Jackson Railway has a population in towns and villages along its line of 48,660, or 486 per mile of track. This includes a small city mileage in Ann Arbor.

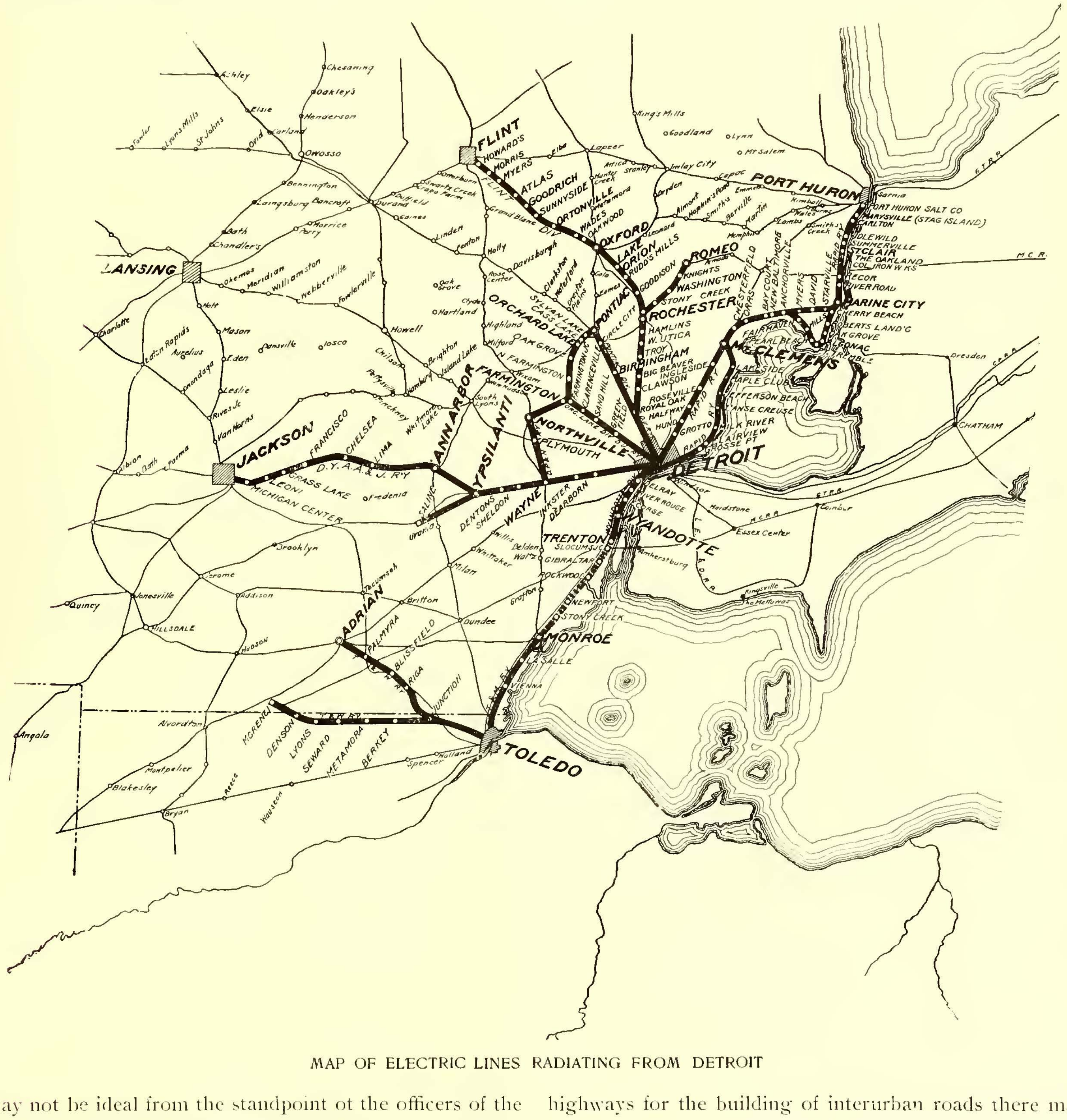
The Wyandotte Division of the Detroit United Railway serves towns and villages of a total population of 13,121, or 1193 per mile of track. This division runs along a thickly settled river bank which might almost be termed a continuation of the city of Detroit, although not within its limits.

The Pontiac Division of the Detroit United Railway serves towns and villages outside of Detroit with a population of 11,407, or 317 per mile of track. Most of this road is double track.

The Flint Division of the Detroit United Railway serves towns and villages with a total population of 19,014, or 223 per mile of track. This, however, includes the population of Royal Oak (468), which is also served by the Pontiac Division.

The Orchard Lake Division of the Detroit United Railway reaches towns and villages with a total population of 12,054, or 204 per mile of track. However, the greater part of this is also reached by the Pontiac Division. Deducting the population of Pontiac, 9760, leaves only 2285 in villages along the line. The rural population however, is heavy along this road, and the travel from this source serves to keep cars fairly well filled.

Detroit being one of the oldest interurban centers in the United States, the results of operations there and the conclusions that have been reached have a value in connection with interurban work in other parts of the country. The great variety in track and line construction and rolling stock which is to be found on the various interurban lines and thickly settled community in the neighborhood of a large city. Much of the interurban mileage around Detroit was constructed before the days when the private right of way became popular with roads of this kind, and consequently much of it will be found along the highways. The construction has in most cases been carried on so as to interfere very little with the use of the highway for its original purposes, and for those who attempt the use of



MAP OF ELECTRIC LINES RADIATING FROM DETROIT

may not be ideal from the standpoint of the officers of the Detroit United Railway Company, who are earnestly at work getting interurban divisions of that system on as near a uniform basis of equipment and operation as practicable, but it does offer the outsider an opportunity to study a great many different kinds of construction and equipment and to note the results obtained with each and the constructions adopted as a result of experience.

The conditions which have favored the building of electric interurban lines around Detroit are practically the same as those which prevail around other cities where such work has been extensively carried on, namely, a fairly level highways for the building of interurban roads there may be found many suggestions in the construction around Detroit. It is notable, however, that around Detroit, as elsewhere, the tendency in building new lines is to buy a private right of way. The experience around Detroit has also demonstrated that there is sometimes danger that the eager promoter of interurban lines will consent to franchise terms which will cause a great deal of annoyance or great burden when it comes to operating the road. The private right of way, of course, does away with such inconveniences in so far as they relate to the portions of the line between towns.

Unlike many other interurban lines about the country, the Detroit companies have kept passenger and express business entirely independent. Passenger cars carry no express and express cars carry no passengers. Freight and express business has probably been developed to a greater extent around Detroit than in any other interurban center.

The general character of the service given on the various Detroit interurban lines is very similar. The schedule speeds from end to end of trip averages about 20 miles per hour, which the number of stops that must be made, both inside and outside the city, calls for car equipments that will make from 40 to 45 miles per hour maximum speed in the country with occasional bursts as high as 50 miles an hour. Four motors per car have been found more satisfactory than two, as elsewhere, and the latest interurban cars built, which embody the results of past experience, have four motors of 60 hp to 75 hp per car seating forty-nine to sixty people, being about 50 ft. over all and weighing 32 tons to 35 tons.

More detailed accounts of the various features which go to make up the Detroit interurban railway systems are to be found in various special articles in this issue.

The Merit System on the Detroit United Railway

BY ALBERT H. STANLEY, GENERAL SUPERINTENDENT

The idea of placing the merit system in effect on the Detroit United Railway originated with our president, Mr. Hutchins, who for three or four years previous to its adoption, the first of this year, had discussed with the executive officers of the company the advisability of instituting what is known as the Brown system of disciplining conductors and motormen. On Jan. 1, 1902, this system, as stated, was put in effect on all the properties of the Detroit United Railway. It affected some 1200 conductors and motormen; on both the city and interurban lines, operating on the regular schedule, 186 city cars and 24 suburban cars, and on the maximum schedule 400 city cars and 50 interurban cars.

A circular was issued on Dec. 23, 1901, addressed "To Conductors and Motormen," notifying them that: "Commencing Jan. 1, 1902, all punishment of conductors and motormen by suspension from duty with loss of time will be abandoned, and thereafter punishment for neglect of duty, violation of rules and bad conduct shall be by reprimand, demerit marks, or dismissal from the service.

"On that date, every conductor and motorman starts with a clear record, except that when subsequent records show that past offenses are being repeated, the persons concerned will be either dismissed from the service or double the demerit marks will be entered against them.

"It will be understood that disloyalty, intemperance, insubordination, wilful negligence, immorality, making false reports or statements, or concealing facts surrounding matters under investigation, will be considered as dischargeable offenses.

"A complete record of all conductors and motormen will be kept, and all discipline imposed will be shown thereon, and credit given for excellent conduct, deeds of heroism, loyalty, etc., and these records will be given full consideration in connection with the charges entered against any conductor or motorman. This record will be a private one, and no employee will be shown any record therein except his own.

"For every twelve (12) consecutive months (this has since been changed to every 3 months) of service free from demerit marks, or free from necessity for imposing a reprimand, ten marks (this has since been changed to 5) will be deducted from any that may have been previously entered against an employee's record. When sixty marks are entered against the record of any employee, his services will be dispensed with.

"On Jan. 1 of each succeeding year, the name of each conductor and motorman who has gone through the previous year with a perfect record will be posted at each of the car houses.

"In the promotion of employees, their previous records will be fully considered.

"Record Bulletins will be issued at least weekly and posted at all of the car houses on a special bulletin board. These bulletins will be educational, and will give a brief account of each case that has resulted in discipline, giving the number of demerit marks that have been inflicted, but will omit all reference that would identify the person at fault. A copy of the same will be sent to the person at fault.

"Each employee will be afforded an opportunity for appealing against any decision regarding the number of demerit marks imposed, but such appeal must be made to his division superintendent within ten days of receipt of notice.

"The objects to be obtained under this new system are:

"First—To avoid loss of wages by persons employed and consequent suffering to those who are dependent upon their earnings.

"Second—To stimulate and encourage all persons engaged in the company's service in the faithful and intelligent performance of their respective duties.

"This system is introduced with the belief that it will be directly beneficial and that it willl meet with the approval and cordial co-operation of all concerned."

Our records for the first six months of service under the merit system show as follows:

Two hundred and thirty-seven conductors and 341 motormen have no demerit marks.

Eighty-nine conductors and 124 motormen have between ten and twenty merit marks.

Three conductors and 16 motormen have over twenty merit marks.

Two hundred and sixty-seven conductors and 180 motormen have under thirty demerit marks.

Thirteen conductors and 22 motormen have over 30 demerit marks and under 60 demerit marks.

Discharged, 21 conductors and 16 motormen.

At first the general superintendent and division superintendents of the company met weekly to review all of the cases, which were pending, and to have a personal hearing with the employees at fault, and, if necessary, to give the employee an opportunity to explain his case.

The marks now given are the result of some six months' experiment. To-day we are satisfied that the marks as given for the different offenses are just, both to the employee and the company. No marks, either merit or demerit, are entered until the employee has been given a

VIEW LOOKING UP WOODWARD AVENUE FROM THE CAMPUS MARTIUS, DETROIT hearing and full opportunity afforded to explain his case. After the marks are entered he is immediately notified by letter, a copy of which is kept at the office, and the employee is required to receipt for this letter. The receipt is returned to the office and filed. The blank forms used for these letters and receipts are reproduced herewith. The reason for obtaining this receipt is to prevent the employee claiming he has never been advised that any demerit marks have been entered against him. The books are open at all

Detroit United Railway

OPERATING DEPARTMENT

Detroit, Mich................19..

Mr.......................................

........................Division.

Dear Sir:

You are hereby notified that Five Merit Marks have been entered to your credit for three months of continuous service without demerit marks or warning.

....

No.......... General Superintendent.

....

No..........

I hereby acknowledge receipt of letter No....

Detroit, Mich...............190..

....

NOTICE OF MERIT MARKS

times for inspection and a page is allowed for each conductor and each motorman, but nobody is permitted to see anybody's record but his own.

Now that we have practically decided on a schedule of marks, the division superintendent interviews the employee

Detroit United Railway

OPERATING DEPARTMENT

Detroit, Mich................19..

Mr.......................................

Conductor {
Motorman }

..........................Division.

Dear Sir:

Your are hereby notified that.................................
have been entered against you for.............................
....
....
....

....

No.......... Gen'l Supt.

....

No..........

I hereby acknowledge receipt of letter No....

Detroit, Mich...............19..

....

NOTICE OF DEMERIT MARKS

at fault, and sends to this office a report of the offense and the number of marks given, which, of course, is subject to revision at this office before the marks are entered against the employee.

The chief benefits of the merit system are:

First—That it thoroughly systematizes our system of discipline. Our property is divided into divisions; each division in charge of a division superintendent. We have seven division superintendents. Previous to putting into effect this system, each division superintendent was governed by his own idea in the infliction of punishments, as to the num-of days a man should be suspended for a certain offense. We now practically have a standard schedule of what the offense deserves in the way of demerit marks.

Second—It prevents any favoritism being shown on the part of any division superintendent toward certain conductors or motormen. It also does away with having to punish a good man the same as a poor man, both having committed the same offense. For example, under this system a good motorman and a poor motorman might each have a collision. Under this system they would both get the same number of demerit marks if neither had committed this offense previously; but the good man will wipe out his demerit marks through the accumulation of good marks, while the poor man will eventually be discharged through demerits inflicted for this and other offenses. If a man does his work faithfully and efficiently he is not suspended for any dereliction from duty; while a poor man will go on and discharge himself. All the operating officers have to do is to watch the men and see that the work is done right, and the proper number of marks given.

Third—It is not detrimental to the men. I have known more than one instance under the former method where an efficient man has been suspended a number of days for the offense. He has gone back on his car after that time very much deteriorated on account of his lay-off; perhaps merely from the loafing habit acquired by doing nothing, perhaps through getting in the habit of visiting drinking places during his suspension and becoming confirmed in the use of liquor. It has also resulted in his family losing the use of his pay for the time he was off duty. The family thus suffers. A man will often go back on his car with a feeling of revenge for what he thinks a too severe punishment. With this system he gets demerit marks, but has an opportunity of wiping them out by months of good service or the performance of meritorious acts.

We receive many reports from the public of particularly courteous or meritorious acts or acts of bravery. We always take cognizance of such reports, and if found correct after investigation accord a suitable reward. It greatly encourages men in the performance of their duties to have any deserving acts they perform brought to the attention of the officers of the company, and in that way get a word of praise or encouragement for it. Since this system was inaugurated it has been a very rare occurrence that our lines have been blockaded by broken trolleys. We give merit marks to the conductors and motormen who clean up trolley trouble, and it very rarely happens that cars are delayed longer than the time necessary for the crew of the first car which reaches the break, to pick up the line, using the trolley rope or bell cord. We have also escaped several very serious wrecks which might have occurred from washouts had not the crews been particularly alert because of their wish to obtain merit marks, and having heard of trouble from washouts, observed extra caution and discovered the danger in time to stop the car and avoid accident.

This system has received the approval of the great majority of the conductors and motormen; and has aroused among all of them a strong desire to avoid demerit marks and to take advantage of every circumstance to get merit marks; and those who have been given merit marks have been very much encouraged. The intelligent performance of the duties of conductors and motormen has very materially advanced.

Applications for employment with the Detroit United Railway are received every Wednesday and Friday morning at 11 o'clock. The applicant is required to appear in person and make application for a blank. If his appearance and recommendations are satisfactory he is given an application blank. After filling it out, he presents it at the office on the next application day. His application is then received and he is questioned closely on the application, and told if his services are required he will be notified by mail. If his appearance and endorsers are satisfactory,

Detroit United Railway

OPERATING DEPARTMENT

EDUCATIONAL BULLETIN.

No....... Detroit, Mich....................

Notice to Conductors and Motormen, all Divisions:

....

....

....

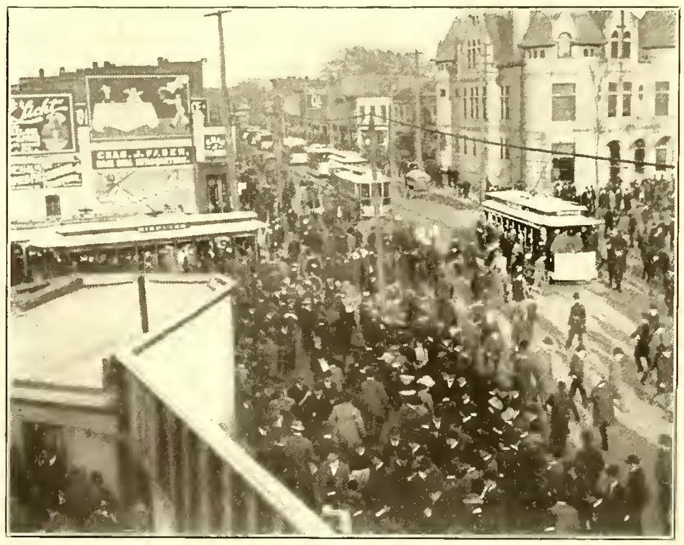
FORM OF BULLETIN POSTED

the latter are communicated with personally if they live in the city or nearby, otherwise by mail. If the reports from these persons are satisfactory and a vacancy occurs the prospective employee is requested to call, and is then sent to one of the car houses with a letter to the division superintendent in charge instructing him to put him on with a careful conductor or motorman (whichever position he applies for) to instruct him in the respective duties. If a motorman he is kept at practice every day for about two weeks; if a conductor, about seven days. He is then turned over to a night man and kept at night work for a week or three days longer. If the motorman or conductor in charge reports him competent to take charge of the car alone, the division superintendent rides with the man and closely watches him in the performance of his duties. If satisfactory to the division superintendent he is given a letter to the general superintendent. He is then supplied with an outfit, consisting of cap badge, riding badge, rule book and (if he is a conductor) with a punch. He is then placed at the bottom of the run board as "last extra" and does not lose his place on that board unless he is discharged from the company's service. He moves up only as those above him are moved. That portion of the merit system bulletin which relates to promotion refers only to promotions to positions in the car house or office, and does not relate to the change in position on the board. The man is then kept in service for a period of sixty days, after which he is sent to the company's physician for examination as to his eyesight, hearing and physical condition, which examination he must pass. The examination costs the applicant $2. There probably remain in our service after sixty days, about 40 percent of the total number of men employed. The reason for this sixty-day limit is that after that time the man is required to become a member of the union and is amenable to the conditions of an agreement between the company and the union. Previous to that the company can do what it pleases as to accepting the man.

It is the policy of the company to promote conductors and motormen to positions in the car houses and as division and assistant division superintendents. The division superintendents do not employ or discharge conductors or motormen. The employment is all done in the regular employment bureau, and in discharging a man the case comes before the general superintendent. A man has the right to appeal to the president of the company should he question the decision.

Detroit City Schedules and Rush Hour Traffic

One prominent characteristic in the operation of the city lines of the Detroit United Railway is the unusual provision made for carrying passengers during the morning and evening rush hours and also on all special occasions and all times when great crowds are to be taken away from certain points within a short period, as, for example, at the close of theaters and baseball games. There is probably no city in the United States where so great a proportion



HANDLING A BASE-BALL CROWD, DETROIT

of the passengers carried during the rush hours are given seats. The number of cars in operation during the evening rush hours is 125 per cent more than during the middle of the day in the winter, and 75 per cent more during the rush hours in the morning. In the summer the midday schedule is increased to accommodate the large number of out-of-town visitors who are always present in Detroit during the summer, since it is a favorite point for excursions and conventions from all over the country. The ordinary schedule in the summer during the day is 186 city cars and 24 interurban cars. The maximum schedule is 400 city cars and 50 interurban cars. The maximum interurban schedules, however, are put on only on holidays and Sundays.

One factor which goes to materially increase the number of cars required during the evening rush hours is that working men's tickets are sold eight for a quarter by the terms of the company's franchises, and these tickets are good from 5:30 to 7.00 in the morning, and from 5:15 to 6:15 in the evening. This has a tendency to crowd all the traffic of the evening rush hours into the hour between 5:15 and 6:15. In this respect the workingman's ticket has proved anything but a benefit to the people of Detroit, because it has tended to congest the service at the very time when every means should be taken to prevent congestion. However, the Detroit United Railway Company has to meet these conditions, since they have been established, and is giving an excellent service. The making of time schedules to meet all the requirements on the Detroit United Railway would drive to distraction any ordinary person who had not had long experience in this line, because of the necessity of providing work enough for the trippers to give them living wages, and because of the existence of an agreement with the local division of the Amalgamated Association of Street Railway Employees of America, by which every man must be able to perform his entire day's work within twelve and one-half consecutive hours. About one extra crew is kept for every two and one-half regular crews on the city lines. To illustrate the way the runs are divided, the Sherman line may be taken as an example. On this line there are thirty-seven regular and swing crews, having full paid runs of eight hours and over. Out of these thirty-seven men twenty-four are regular crews and thirteen swing crews. There are in addition thirteen crews on the tripper and extra list. These average about four and three-quarters hours' work per day, the minimum being a little over three hours. Those at the top of the tripper list may be able to get in as much as eight hours by supplying places of men absent higher up the list.

Motive Power and Rolling Stock of the Detroit United Railway

BY THOMAS FARMER, SUPERINTENDENT OF MOTIVE POWER.

The Detroit United Railway System is operated by power from six power houses and three storage battery stations, these different power houses being, of course, originally built to supply the various lines which have now been consolidated to form the Detroit United System. The two stations supplying the lines in the city of Detroit are designated as Stations A and B, those supplying interurban lines as D, E, F and G, and the storage battery stations as C and H. Reference to a map elsewhere in this issue in an article on power distribution will show the location of these various stations, as mentioned in the following paragraphs:

Station A was originally built by the Detroit Citizens' Street Railway Company, and Station B was built by the Detroit Railway Company, which latter, soon after the building of its power house, was acquired by stockholders of the Citizens' Company. These two power houses are situated near the river front at Riopelle Street, one being on the south side of Atwater Street, the other diagonally across the street from it. The switchboard for both stations is located in Station A. Station A has an engine room 65 x 243 ft., and boiler room 58 x 253 ft. The engine room is spanned by a 25-ton Brown traveling crane. This room now contains four Reynolds-Corliss tandem compound condensing engines, 28 and 52 x 48 ins., direct connected to 1000-kw Siemens & Halske outside armature generators. The boiler plant supplying these consists of Babcock & Wilcox boilers of 250 hp, each set in batteries of two. These boilers have Murphy automatic stokers. The stack of this station is 180 ft. high, with 11 ft. 6 ins. flue. The boilers are fed through Hoppes' live steam purifiers. For each of the four engines is a Worthington duplex jet condenser, 14 ins. x 22 ins. x 15 ins. For boiler feed there are two Worthington duplex compound pumps with outside packed plungers, 10 ins. x 16 ins. x 8½ ins. x 10 ins. A Worthington duplex pump 10 ins. x 5½ ins. x 10 ins. is kept for fire protection. Two pumps of the same type, 2 ins. x 3 ins. x 3 ins. do service on the oil distributing system, and there is also a Davidson, 3 ins. x 2¼ ins. x 4 ins. pump working on oil distribution. A Davidson pump, 6 ins. x 4 ins. x 7 ins., and a Gordon, 6 ins. x 4 ins. x 6 ins., are installed as pit pumps. A Worthington air pump supplies compressed air for cleaning armatures. A Hunt conveyor brings coal in and carries ashes out. This latter is run by a double 4-in. x 6-in. engine.

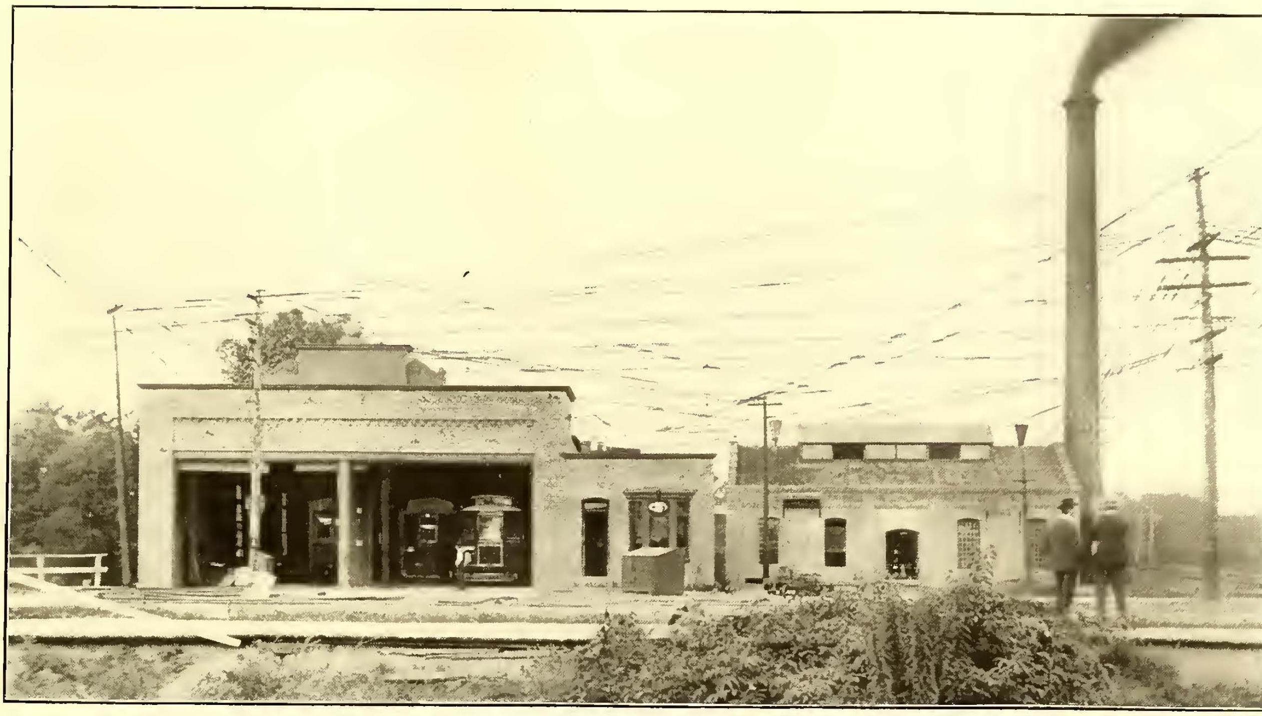
In both Stations A and B the gravity oiling system is used. All the piping of this oiling system is painted so as to easily distinguish supply and return pipes. The supply pipes are light yellow, the return pipes dark yellow, and the by-pass to the sewer dark red. This simplifies the manipulation of the system very much, because at best there is a multiplicity of pipes and valves. In case it were desirable to flood a bearing with water, the by-pass to the sewer would be open, and the return valve for this bearing would be closed. This would run to waste the oil used in that particular bearing, but would obviate filling up the whole oiling system with water and wasting all of the oil. However, it is a matter of record that water has not been used in a single bearing in over six years.

The method of lubricating low-pressure cylinders is original with these power houses. For this purpose a hole is drilled on both sides of the cylinder directly through its walls on its center line, these holes being connected by piping to a special double sight feed lubricator. The piston in passing these openings acts as a wiper, thus spreading the oil over the cylinder surface and giving most perfect lubrication. Not only has this scheme effected a great saving of oil during the seven years of its use, but has demonstrated its efficiency by giving such an excellent lubrication that but two of the sylinders have had to be rebored in that time. This is a rather unusual performance for tandem engines.

Station B, across the street from Station A, has an engine room 67 ft. x 227 ft., and a boiler room of the same size. Two of the units in this station are 20 ins. and 40 ins. x 48 ins. Reynolds cross compound Corliss condensing engines direct connected to 400-kw Walker generators. Two more units are 24 ins. x 48 ins. Reynolds cross compound condensing engines direct connected to 800-kw Walker generators. The last unit installed was a 32-in. and 64-in. x 60-in. Filer & Stowell cross compound condensing engine direct connected to a 1500-kw Westinghouse generator. A duplicate of this last unit is now going in. The boiler plant in this station consists of eight 300-hp Stirling boilers and eight 250-hp Stirling boilers. These have Murphy stokers and Green economizers. The stack for this station is 185 ft. high, with 10-ft. flue. There is one Blake vertical duplex compound jet condenser, 15 ins. x 24 ins. x 38 ins. x 21 ins. The other four units are served by Davidson jet condensers. Four Davidson pumps, 12 ins. x 8 ins. x 12 ins. are used for boiler feed. On the oil distribution, pumps 2 ins. x 2 ins. x 4 ins. are doing service. One Marsh 4-in. x 2-in. x 4-in. pump is connected to the bleeder. Two Davidson pumps are on the automatic feed and receiver.

For feeding on long lines this station has a double booster set, consisting of a Westinghouse motor direct connected to two 250-kw railway generators which are run with very weak field.

The switchboard, which has both the generator and feeder panels for both stations, is located in Station A, and has nine

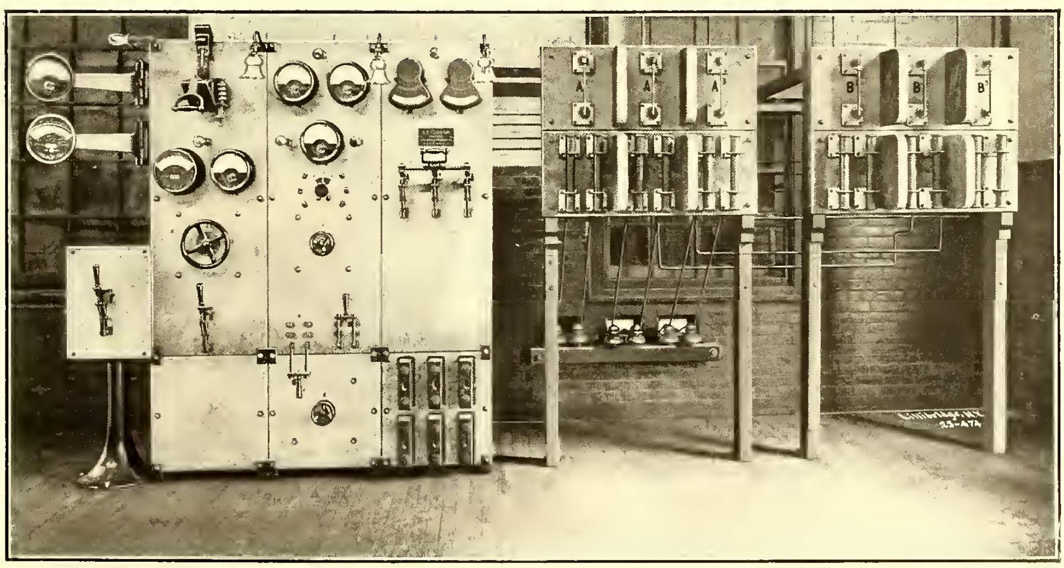


POWER HOUSE AND CAR HOUSE AT ROCHESTER, FOR FLINT DIVISION

generator panels, thirty-six feeder panels, two booster panels and two main instrument panels. This board has three sets of bus-bars, so that three different voltages can be supplied the feeders as explained in an article in this issue on electrical distribution. Part of the generators were built to maintain a high voltage for supplying outlying lines, and these generators are put on the higher bus-bars, leaving the nearer lines for the lower voltage machines. When desired, all bus-bars can be connected together and the night load carried by a generator in either station. A log sheet of Stations A and B for twenty-four hours is reproduced herewith, which illustrates our method of keeping records, and shows the storage battery charge and discharge.

The power houses just described were both built in 1895, and no additions have been made since then except the 1500-kw unit in Station B. The Filer & Stowell engine on this unit differs somewhat from that company's standard.

A duplicate of this is now being installed. The crank-shaft is 29 ins. in diameter at the wheel fit. The total length of the shaft is 26 ft. The bearings are 26 ins. x 48 ins. The shaft is Bethlehem hollow forged steel, with 10-in. hole. It weighs alone 41,574 lbs., and with crank discs, pins and hub 102,200 lbs. The fly-wheel is 160,000 lbs., 23 ft. in diameter. The cross-heads are fitted with an extension, so that the slippers are fastened by means of studs to the cross-head proper. The slippers will therefore be retained in case the adjusting screws break. No wrist plates are used in either the admission or exhaust. The valve gear is connected straight through. Both high and low pressure piston junk rings are babbitted. Both ends of the connecting rod are also babbitted. To give access to the low-pressure piston without removing the cylinder



SWITCHBOARD AT ROCHESTER STATION

head, a man-hole is provided in the head. This engine weighs, complete, without generator, 640,000 lbs.

Station D supplies what is known as the Orchard Lake Division, formerly the Detroit & Northwestern Railway, and is located at Farmington Junction, 18½ miles from the Detroit City Hall. The engine room of this power house is 52 x 120 ft., with boiler room of the same size. There are at present three Reynolds-Corliss engines, 26 ins. x 48 ins. direct connected to 400-kw Siemens & Halske outside field generators. There are eight Aultman & Taylor boilers of 250-hp each, with Murphy stokers. All the pumps are

SUB-STATION, WAITING ROOM AND FREIGHT DEPOT, AT OXFORD

Davidson. For use with unusual loads there are two General Electric 100-kw boosters, for operating distant portions of the road. In ordinary operation these are not used. An air compressor is located at this power house which compresses air for the Magann storage air brake system on the cars of this division, which stop at the power house to fill their air storage tanks each trip. The storage air pressure is 250 lbs. per square inch.

The Pontiac Division from Detroit to Pontiac is operated from Station E at Birmingham, $17\frac{1}{2}$ miles from Detroit City Hall. Here two Westinghouse compound condensing engines, 16 ins. and 30 ins. x 18 ins., are belted to Westinghouse 250-kw generators. There is one Babcock & Wilcox 250-hp water tube boiler with a Roney stocker and three 125-hp horizontal return flue boilers. Worthington pumps have been installed throughout at this plant. An air compressor, 7 ins. x 4 ins. x 12 ins. compresses air for the storage tank, from which the cars on this division obtain compressed air for operating air brakes by Magann storage air system. At this station the Wefugo system of water purifying and filtering has been installed for treating boiler and feed water.

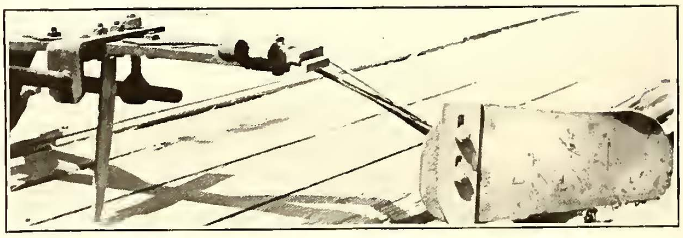
Station F is a small station situated at Pontiac, and is only used in an emergency. It was originally built to operate local lines in Pontiac. No men are regularly employed at this plant, but operators are transferred there from the shops when the plant is to be run.

Station G, operating the Flint division, is located at Rochester, 26 miles out. The building is at present 72 ft. x 104 ft. There are two Ball & Wood horizontal tandem compound condensing engines, $15\frac{1}{2}$ ins. and 128 ins. x 16 ins., each direct connected to Crocker-Wheeler 200-kw generators. There is also a large vertical unit consisting of a Ball & Wood compound condensing engine, $22\frac{1}{2}$ ins. and 45 ins. x 20 ins. direct connected to a 400-kw Crocker-Wheeler generator. For operating the alternating current transmission a 250-kw Stanley inverted rotary converter is at present used. Further particulars of this rotary and of this station are given in the article on electric power distribution of the Detroit United Railway. Adjoining the inverted rotary is a high-tension Stanley switchboard, illustrated herewith. There is also in the station a 60-kw booster and a 90-kw alternating current lighting generator for the town of Rochester. The boilers in this plant are four Aultman & Taylor water tube, 25 hp each. The pumps are all Deane, made at Holyoke, Mass. A compressor at this plant furnishes the storage air for braking the cars on this division.

ROLLING STOCK

There is considerable variety in the interurban rolling stock of the Detroit United system, although the differences are not as great as might be expected where a number of different companies have contributed to the consolidation. None of the interurban cars has been designed to carry on anything but a strictly passenger business, and all have smoking compartments in the front.

The heaviest interurban car owned by the company is the type belonging originally to the Detroit & Northwestern Railway. This car weighs about 33 tons loaded, is 51 ft. over all, with 40-ft. body. The width is 8 ft. 9 in. These cars seat nineteen in the smoking compartment, and thirty in the rear compartment, and have closet, hot water heater and drinking water tank in the left-hand rear corner. Most

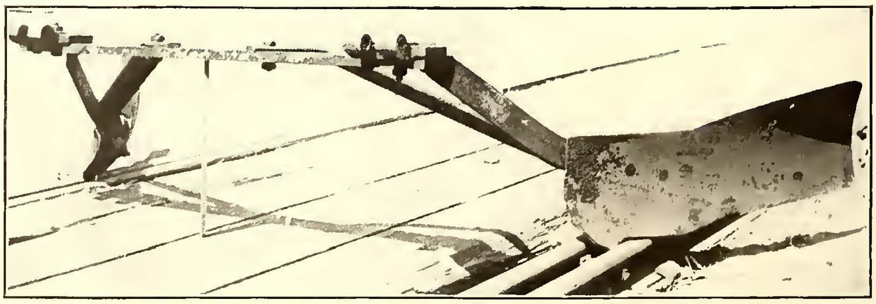


EARLY FORM OF RAIL GROOVE SCRAPER

of these cars are mounted on Dupont trucks with 33-in. wheels, 5-ft. 2-in. wheel base and $4\frac{1}{2}$-in. axles. A few have Brill No. 27 trucks. These cars were built by the G. C. Kuhlman Car Company.

All of the various types of cars used on the Detroit United system are illustrated in this issue, either in this article, or, in a few instances, in the article on interurban rolling stock.

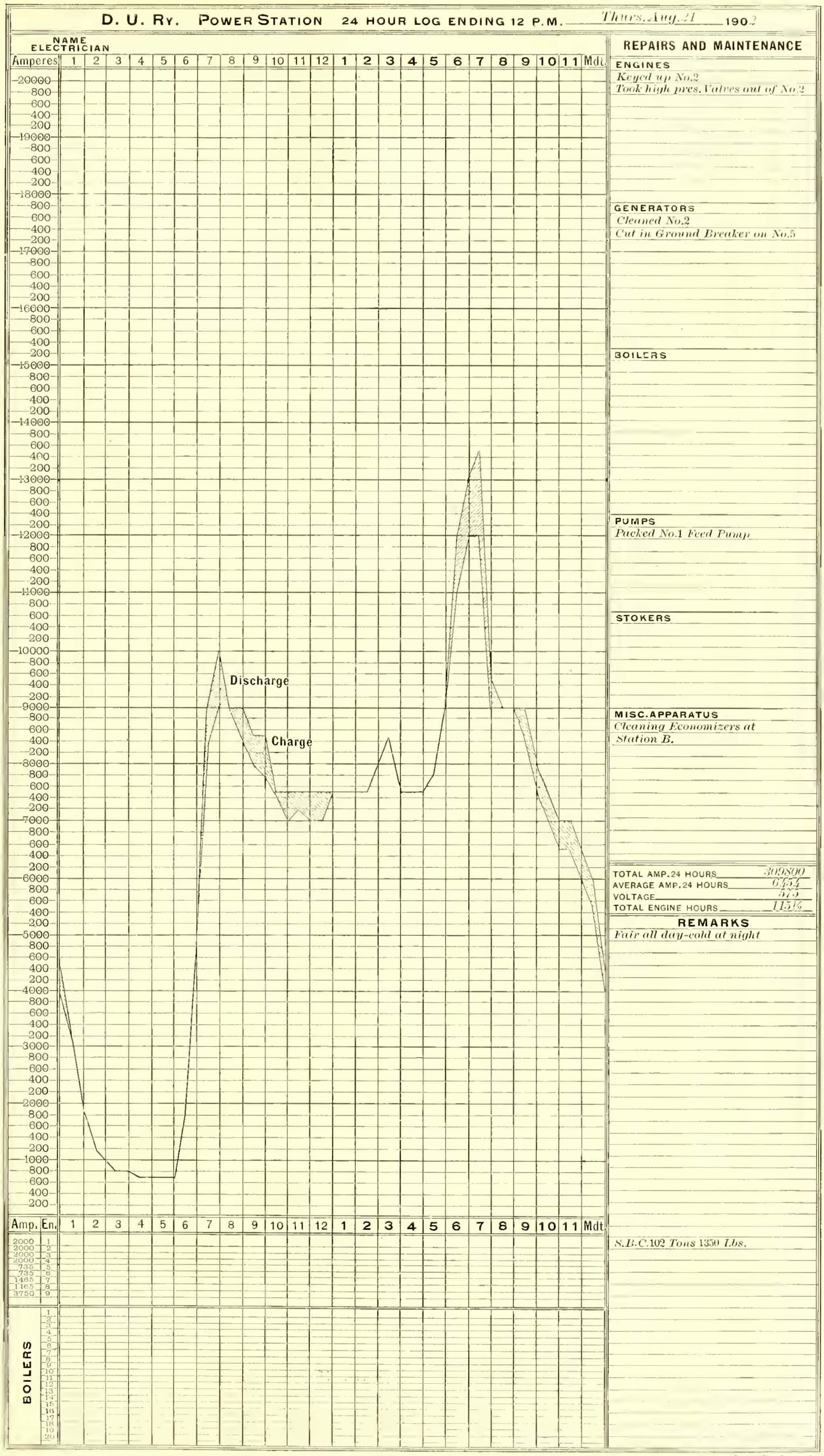
A parlor car built originally for interurban service on



LATEST FORM OF TRACK AND GROOVE SCRAPER

what is now the Flint division has a length over all of 45 ft. The length of the body is 37 ft. and the width 8 ft. 4 ins. They are on Peckham trucks, with 33-in. wheels and 5-in. axles. These cars were built with a parlor compartment in front, the idea being to charge an extra fare for the parlor car service, which idea, however, was never carried out.

On the Wyandotte division the closed car used is 44 ft. 5



POWER STATION LOG USED BY THE DETROIT UNITED RAILWAY ins. long over all, with 33-ft. 2-in. body, 8 ft. 6 ins. wide. These are on Dupont trucks, 33-in. wheels, 4-in. axles and 5-ft. wheel base. These cars were made in the company's own shops.

INTERURBAN PASSENGER CARS, DETROIT UNITED RAILWAY

A number of interurban cars will be found on the various divisions with side door and side aisle in place of the usual center aisle. Those built originally for use on the Flint division are 43 ft. 6 ins. over all, with 33-ft. 6-in. body, 8 ft. 4 ins. wide, on Peckham trucks, 33-in. wheels and $4\frac{1}{2}$-in. axle. There is also a side door car which is 45 ft. over all, with 34-ft. bodies, 8 ft. 6 ins. wide, on Brill No. 27 trucks, with 4-in. axles and 6 ft. wheel base. Both these side-entrance cars were built by the Kuhlman Car Company. A good idea of the general interior appearance of the forward ends of some of our interurban cars is given by the two views shown of the ends of the Rochester & Lake

Orion cars are given in this article. These cars were built by the Jewett Car Company. All interurban cars are heated by Peter Smith hot water heaters.

from the exit of the car, thus providing standing room for smokers in winter. This is the type of platform which originated in Detroit, and is commonly known all over the coun-

WORK CAR, SUPPLY CAR AND LINE CAR

In the city service the standard closed car is 35 ft. over all, with 22-ft. body, 8 ft. 3 ins. wide, built by the Detroit United Railway. The rear platform is 6 ft. in the clear, and has a railing which divides the rear part of the platform

try as the Detroit platform. These cars are mounted on single Dupont trucks with 8-ft. wheel base and 33-in. wheels. The heating is by hot air through a heater located in the motorman's vestibule.

The standard open car has a length over all of 34 ft. 6 ins. and 7 ft. 6 ins. wide with twelve cross seats. Dupont trucks are used with 8-ft. wheel base, 33-in. wheels and 4-in. axles. The seat supports are castings bolted firmly

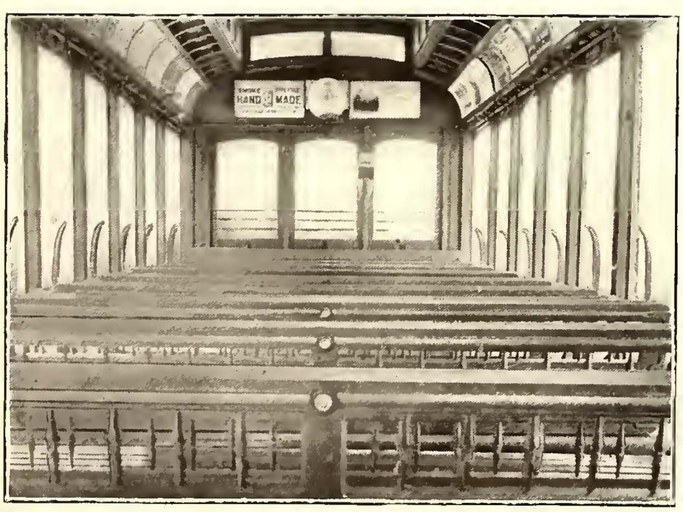
CAR SIGN

to the iron sill of the car, and these castings are of such a form as to give a long, firm socket for the upright posts. This construction was illustrated in the Street Railway Journal for July 6, 1901. All open cars have push buttons for the conductor's signal bell located in the middle of the back of each seat. Wires are run in both directions from the push button under a moulding, and connection is made through the metal fittings at the ends of the seats. Prac-

A SIDE AISLE AND SIDE ENTRANCE CAR

tically all cars on the Detroit United Railway system run single-ended, and have a controller on one end only.

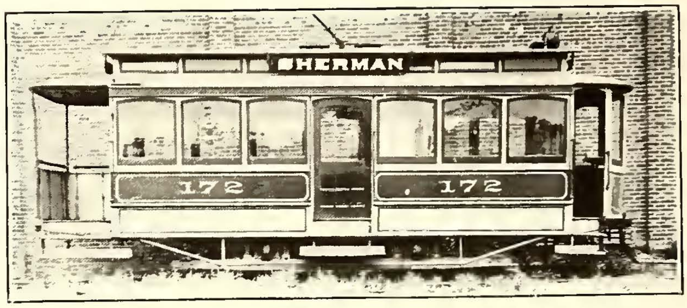
All cars on the system are equipped with the Wilson trolley catcher. This device is especially important on the



OPEN CAR SHOWING PUSH BUTTONS

interurban divisions where cars run at such high speed that the trolley coming off might do a great deal of damage if no means were provided for automatically catching it at once upon its leaving the wire. Both the standard open and closed cars for city use have been built in the company's own shops on Jefferson Avenue. An order of forty-five double-truck closed cars is now being filled by the Niles Car & Manufacturing Company. Twenty fourteen-bench open cars on double trucks have recently been purchased and used the past summer on the Wyandotte division, and for special service over the interurban lines.

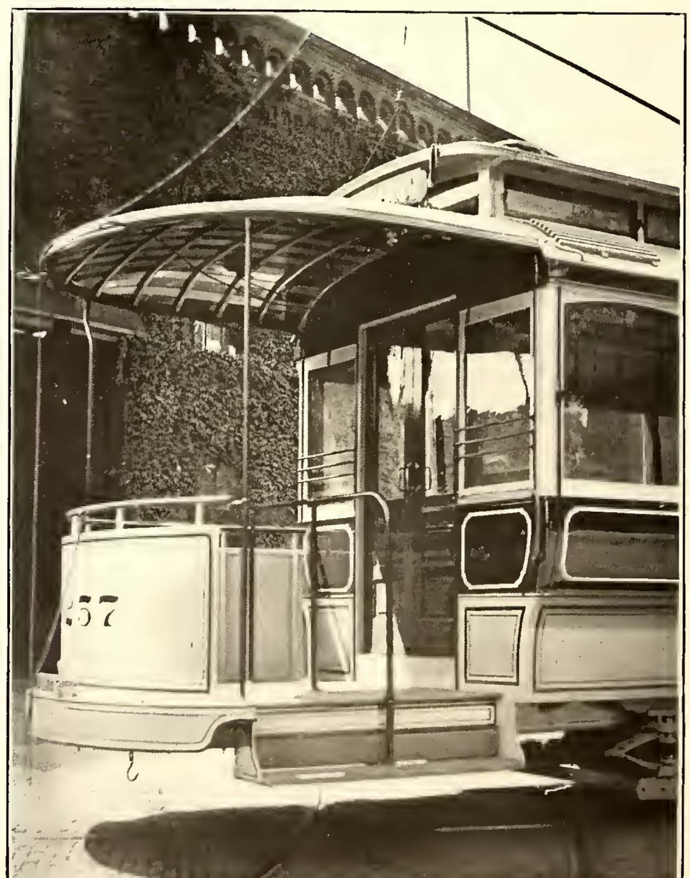
The old Detroit Railway System, popularly known as the 3-cent fare line, was equipped with closed cars having a side entrance in the middle as well as at the rear, and a side



SIDE ENTRANCE CITY CAR

aisle with cross seats. A large number of these cars are still in use.

Up to within two years ago, sheet iron panels were used extensively in Detroit in place of wood panels. The use of these panels has been abandoned mainly because of the rusting around the screw heads which fastened them on. This

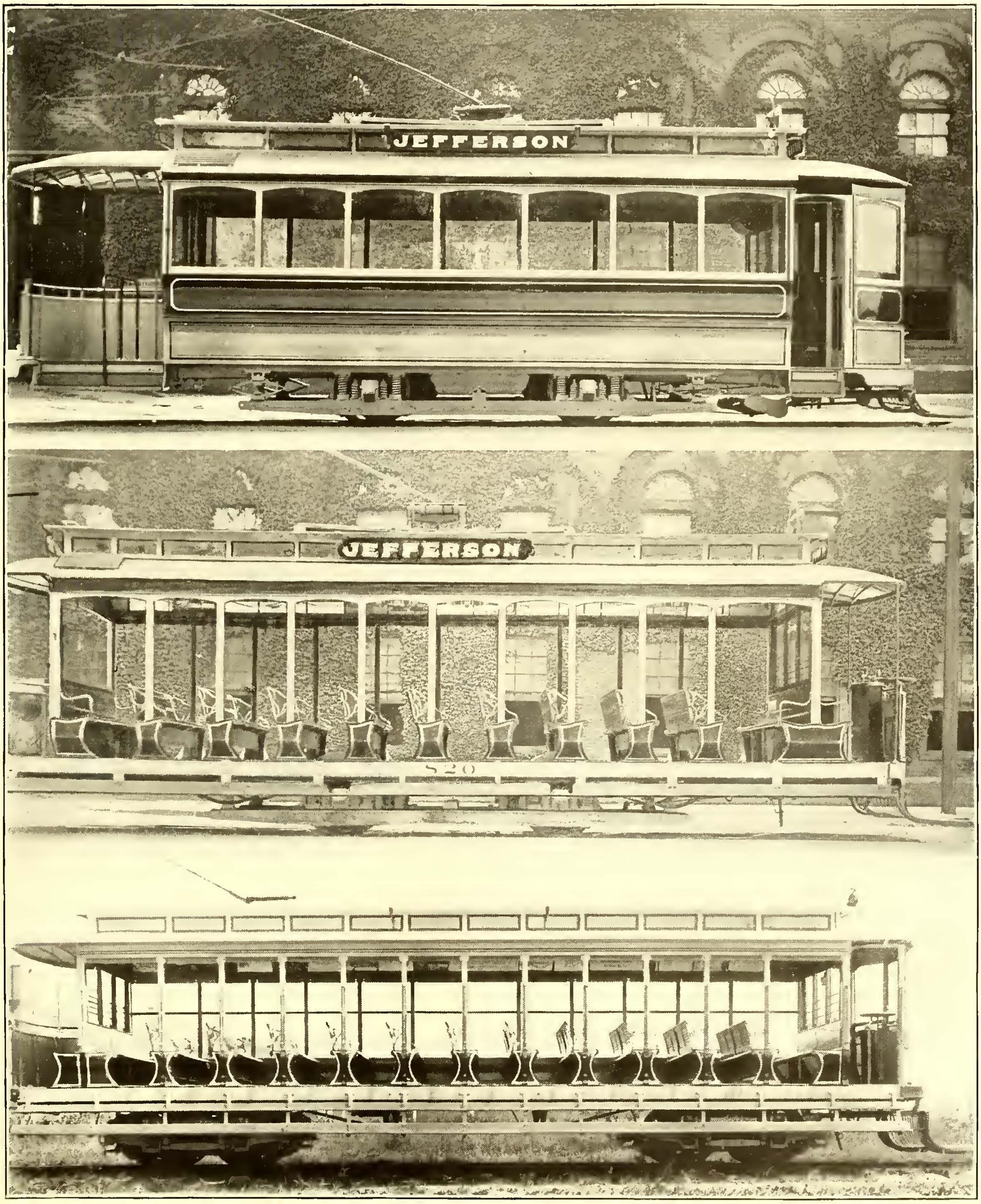


THE DETROIT PLATFORM

rusting, together with the working of the car body, resulted in loose car panels.

The destination signs on Detroit cars are somewhat similar to those used in a number of other cities, and an example is shown herewith. The letters are cut in the sign-board and a white celluloid back put behind the letters so that light from the car hood may shine through the sign at night. To assist in making the sign prominent the letters are emphasized by trimming of white paint around the edges of the carving.

The use of a narrow-grooved rail in Detroit as required by the city gives rise to considerable difficulty in keeping the grooves free of snow in the winter and dust in the summer. The grooved rail scraper employed at first is shown by an accompanying engraving, as is also a later form. Both forms have means of renewing the tongue which enters the groove and bears on top of the rail. In the earlier form the wearing part is fastened on by bolts. In the later form it is riveted.

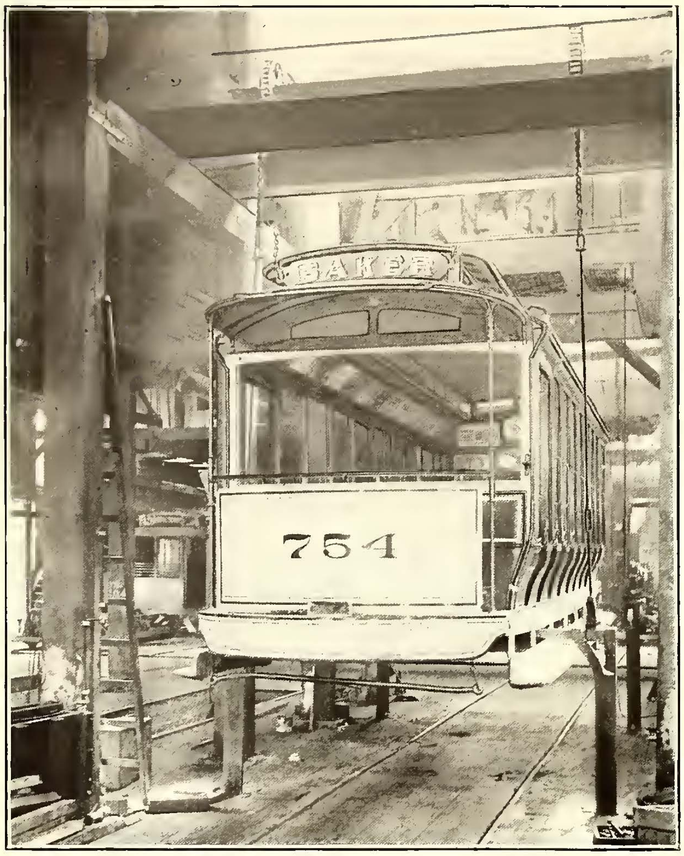


STANDARD OPEN AND CLOSED CITY CARS, DETROIT

The wheel flanges on both city and interurban cars are limited in depth and width by the groove rail required on all track inside the city limits. The flange adopted for Detroit United Railway cars is $\frac{5}{8}$ in. deep x $1\frac{1}{4}$ ins. wide at the throat, and the tread is $2\frac{3}{8}$ ins. wide. Wheels are pressed on between the limits of 25 tons and 40 tons.

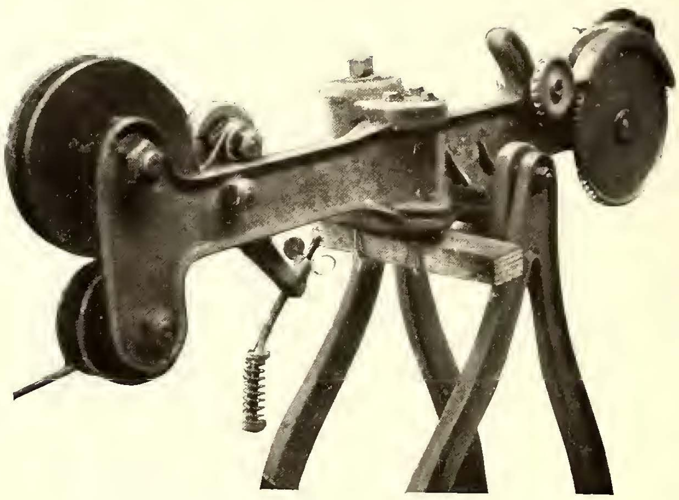
Kalamazoo trolley wheels are run on the interurban cars.

The latest form of trolley wheel we are using on the city cars is one made in our own shops. Drawings of the wheel and harp are shown herewith. No bushing whatever is used with this wheel. The bearing is directly on the brass. The pin on which the wheel runs is a piece of steel bicycle tubing with ends plugged up. A slot is cut in the tube lengthwise, and the space inside the tube is filled with wicking. The wicking is kept soaked with oil, of which enough escapes through the slot to lubricate the bearing. The bearing surface is large, both for wear and for electrical contact, and the bearing will remain in good condition until the wheel is discarded for flange wear. Longer bearing life than this is unnecessary. Trolley bases and springs are adjusted to give an upward pressure on the trolley wire of 20 lbs. to 25 lbs. for interurban work and 15 lbs. for city cars.

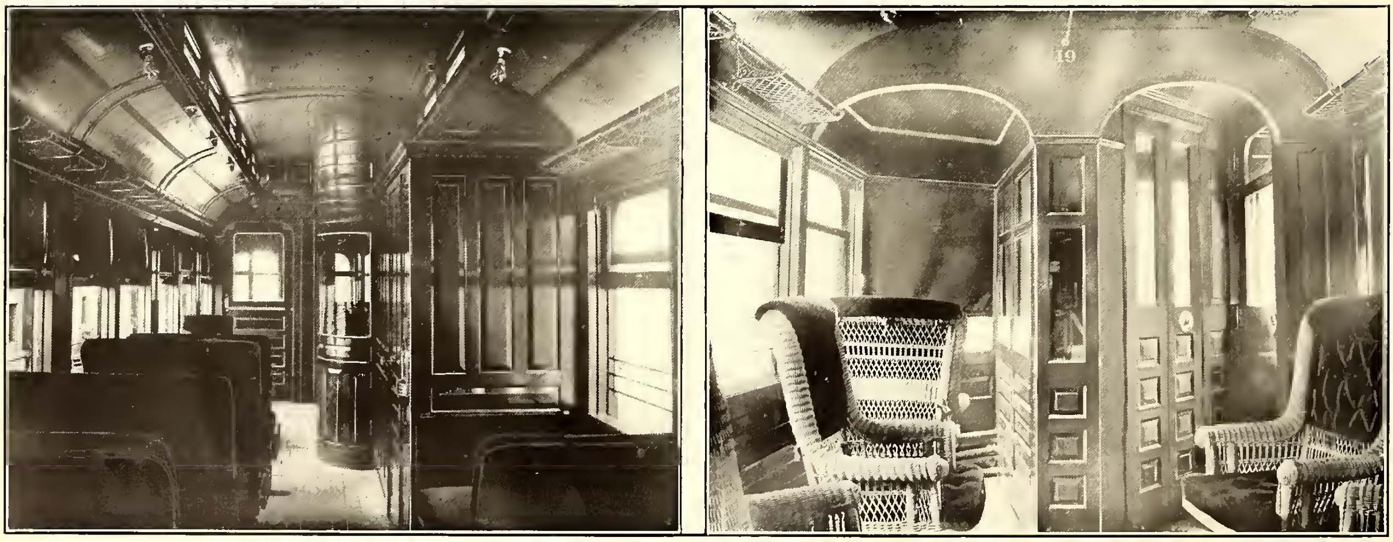


CAR HOIST

All extensive repairs for the Detroit United Railway system, and the car painting and varnishing for the Rapid Railway system are carried out in the Jefferson Avenue shops. Ordinary renewals of worn out or broken parts are made at the car houses. For distributing and collecting armatures, fields, brake-shoes, car wheels and other renewal parts to the four interurban division car houses a special supply car has been built which makes the rounds daily. This car is illustrated herewith. The closed part is fitted up comfortably for the men and for any officers who may wish to make use of this car on inspection tours over the road without the expense incident to a special car. The rear part is open and has a crane with a capacity of 2000 lbs. for loading and unloading heavy parts. It has also a windlass for pulling heavy machinery up an incline onto the car. Grooved tracks are laid into the floor of the car for car wheels. There are two tracks, so that the wheels can be staggered. The car has a four-motor equipment as speedy as any regular passenger car on the road, which is a more important point than would seem at first, because the dispatcher can allow this car to proceed ahead of regular passenger cars, where otherwise it would have to wait for them to pass. This enables the car and crew to cover more ground in a day than would otherwise be possible.

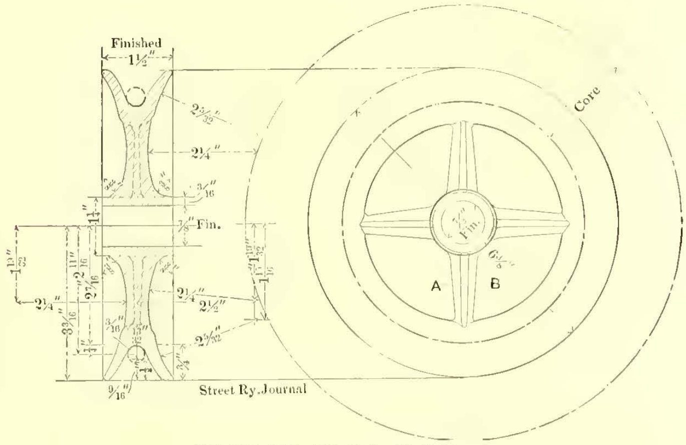


INSULATION SCRAPER AND TAPING MACHINE



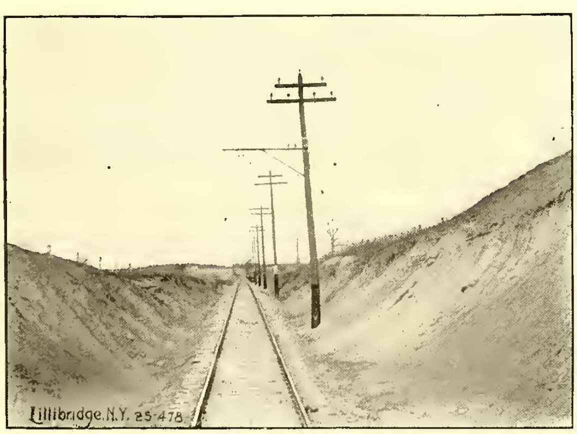
INTERIOR VIEW OF FRONT ENDS OF CARS ON ROCHESTER AND LAKE ORION RAILWAY

For the rapid removal of trucks from under single truck cars in the Jefferson Avenue shops two car hoists have been fitted up, part of one of which is shown in one of the engravings herewith. The first thing was to build a timber frame strong enough to allow a car to be suspended from it. On top of this frame is a winding drum with four ropes which pass over four different pulleys and down to the four hooks shown, which run in guides under the floor and are so placed as to come under the four corners of a car. The winding drum is geared to a motor, the controller of which is on the main floor close to the hoisting hooks. When a car is run in, the hooks are placed under the corners and the motor is started, hoisting the body clear of the truck in less time than it takes to tell of it. The truck is run off to the transfer table and a fresh truck run under the car. On some of our older cars all work is done from the pit by means of hydraulic jacks and the bodies are not lifted off the trucks.



STANDARD TROLLEY WHEEL

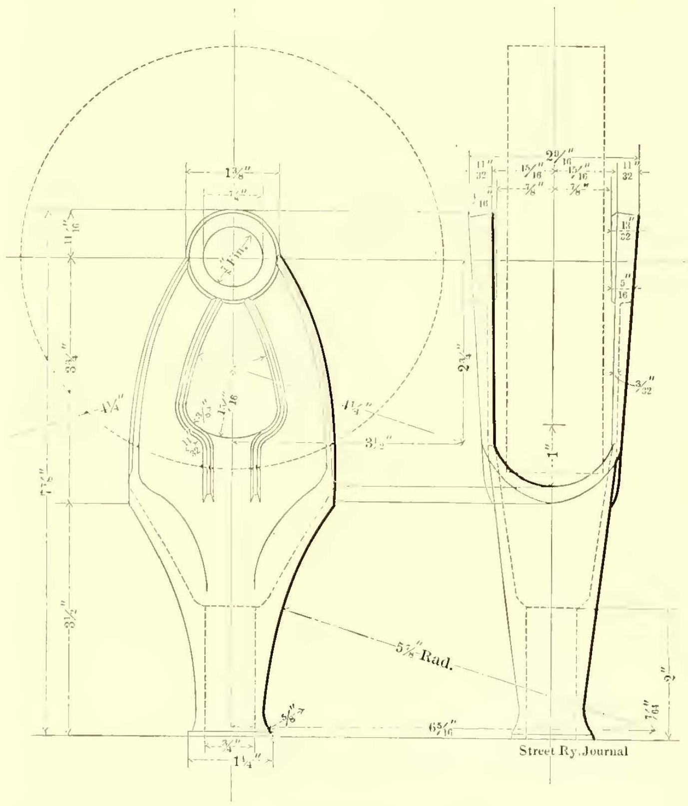
We wind all armature and field coils used in repair work and for armature coils use some of the Anderson formers and armature coil-taking machines, as used in the St. Louis Transit Company armature shops and described in the



VIEW ON THE ROCHESTER DIVISION

Street Railway Journal for July, 1901. Burned out field coils are used over again by running the wire through a machine of our own make, which takes off the burned insulation and winds on tape to recover the wire. But a single strip of tape is used, but it is so wound as to give two thicknesses over all of the wire. This tape covering is fully as good, if not better, than the original cotton covering. The machine passes the wire first quarter turn around a grooved pulley, consisting of an old trolley wheel, then once around a pulley with a corrugated tool steel face. The corrugations run lengthwise of the wire and are sharp enough to "chew up" the insulation as the wire passes around under tension. After passing a half turn around a second corrugated wheel the wire is drawn past scrapers which take off the insulations. Just as it passes out of the machine the tape is wound on by a revolving spool.

Before putting commutators in service on motors the



STANDARD TROLLEY HARP

"juice is cooked out" of the micaline used for rings and insulating segments, by heating the commutators near a forge fire and then applying pressure.

Gear cases are now planed off in a milling machine, which is much quicker than putting them in a shaper for this. A man can turn off eight cases a day with the milling machine, where two was a day's work with the shaper.

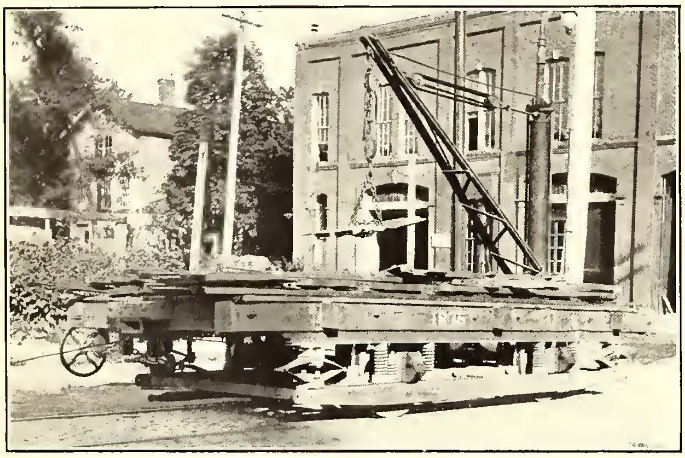
The rolling stock of the Detroit United Railway system is summarized as follows:

Single truck closed city passenger cars	457
Single truck open city passenger cars	308
Double truck interurban passengers cars	47
Double truck city or interurban open cars	20
Plow cars	16
Vestibuled front double truck flat work motor cars	4
Flat cars, all kinds	31
Dump cars	9
Construction box cars	4
Overhead line cars	5
Sprinkling cars	7
Freight motor cars	11
Freight trail cars	1

For interurban cars with 40-ft. bodies such as first described in our list of interurban cars, we have come to the conclusion that the motor equipment of four motors should be as large as No. 56 Westinghouse motors to give the best results in low repair bills. These cars make from 40 miles to 45 miles per hour on a level, with full voltage, and are scheduled for speeds of about 20 miles per hour, including all city and interurban stops for a trip.

Track Construction and Maintenance on the Detroit United Railway

The track department of the Detroit United Railway has under its care a great variety of construction, including not only 187.8 miles of city track laid according to various ideas, but 192 miles of interurban track laid alongside the



DERRICK CAR

highway and on private right of way. This department is under the charge of John Kerwin, a man of many resources in devising means for cutting down labor expenses by using machinery. With so many miles of interurban track to take care of it is imperative that the amount of hand

GRAVEL LOADER AND PIT

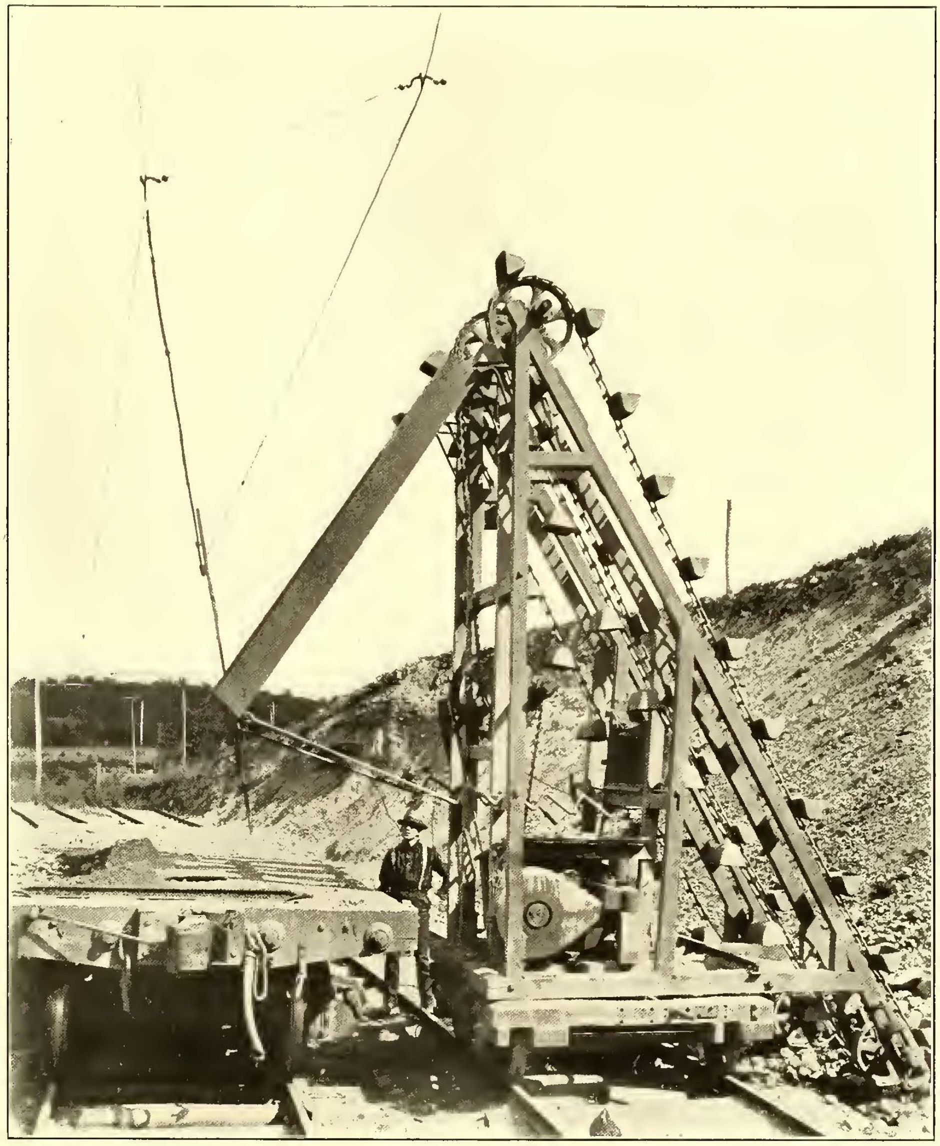
labor required be cut down to the very lowest point. The cost of track maintenance on the interurban lines runs about $12 per month per mile of interurban track in the winter months and $19 in the summer months, making the average per mile of track for the year about $15.50 per month. Of course, with this amount of track labor, which is about one-third that expended on some of the more important steam railroad trunk lines, it is impossible to keep the interurban roadbed in as good condition as such trunk lines, but it must be remembered that the traffic over these interurban lines is small in proportion to that on the steam

RAIL GROOVE SPREADER USED IN DETROIT

trunk lines spoken of. Everything considered, the condition of these interurban lines of road is as good in proportion to the traffic they have to withstand as the condition of steam trunk lines. They are in better shape than many steam road branch lines which carry an equal tonnage of rolling stock per day. These interurban lines are kept in good enough condition to operate over at speeds of from 40 to 50 miles per hour without danger or discomfort to passengers. On some of the divisions the surface and alignment are excellent and comparable with that on the best steam roads.

It is worthy of note that in spite of much that was said in engineering circles a few years ago as to the hammer-blow effect of electric motor cars on rail joints, that the joints on all the interurban lines around Detroit are in excellent condition, and what roughness there may be in the track is due to the inequalities of the roadbed and ballast and not to low joints. It is very difficult for even an experienced car to detect the passage of the wheels over the rail-joints, and there are very few steam roads about which the same can be said. Judging from the life of rail-joints on Detroit interurban lines, there is much encouragement for the belief that the joints will prove less troublesome on electric interurban lines than on the steam roads. Of course, the weight of rolling stock on steam roads is heavier in proportion to the weight of the rail. Practically all the rail in the neighborhood of Detroit is 60-lb. and 70-lb. standard T section. The amount of weight per wheel on an interurban car is not equal to that of even a light steam locomotive, but is in the neighborhood of that on light steam road freight and passenger cars. Taken altogether, there seems to be little ground for any fear that if the joints are looked after carefully there will be a sufficient joint depreciation on electric interurban railway lines to force the abandonment of a rail on account of joint wear before it is sufficiently reduced in cross section to make it advisable to replace it for other reasons. On the greater part of the Detroit United Railway interurban mileage ordinary angle-bar joints are used. On the Orchard Lake Division, however, the wedge joint made by the American Rail Joint Manufacturing Company has been extensively employed. Considerable 60-ft. rail has been laid in various places. While this has given freedom from the expense and maintenance of one-half the number of joints required by 30-ft. rail, it has also given more trouble from creeping and drawing apart on grades. Those divisions having 60-lb. rail are much more expensive and troublesome to maintain than those having 70-lb. rail. This is partly, however, because the heaviest grades are on divisions laid with a 60-lb. rail.

In handling gravel for construction and ballasting along interurban lines Mr. Kerwin found it very desirable to cut down the expense of a shoveling gang at the gravel pit, and accordingly devised a loader built on the automatic-conveyor principle and shown in the accompanying engravings. This loader has an old railway motor geared to a couple of endless chains. On these chains are mounted buckets which scoop up gravel from the bank and deposit it on flat cars in a manner which is made plain by the accompanying engravings, one of which shows the loader in detail and the other a general view of the loader and gravel pit. The loader is moved along on its track as occasion requires, and deposits gravel on flat cars standing on the track parallel with it. As the supply of gravel is exhausted in one place the loader is moved along so that it dips into the bank. The bank is kept broken down so that the loader always has loose gravel to work upon. This apparatus cost about $800, and when there is any new construction so that a large amount of gravel is required, the loader will replace the services of a gang of thirty men,



GRAVEL LOADER

who would otherwise be engaged in shoveling gravel on to the flat cars. Working steadily, it will load about one flat car every thirty minutes.

At the present writing it is saving the wages of six men who would otherwise be required to shovel sufficient gravel on the cars to keep ballasting crews busy. The motor, of course, secures current from the trolley and connection therewith is established by a hook and fishpole.

In order to save the expenses of using horses where plowing is necessary along interurban lines, as is frequently the case where they run alongside of a highway, a motor car is used to pull the plow, and thus considerable time and expense is saved.

During the past season washouts have been numerous on interurban lines around Detroit as well as upon steam roads in that vicinity. Some 60-ft. rails on false work have been used to span these washouts in some cases, and

TRACKS IN SOD IN SUBURBAN STREETS

they have thus saved what otherwise would have been a long delay in getting the road in operation.

Practically all the switches on the interurban lines have double-spring tongues and No. 9 spring frogs so as to leave an uninterrupted main line at sidings not frequently used, or in the case of turnouts at regular meeting points they are set so as to obviate the necessity of throwing the switch. In the latter case, of course, the switch is always set to send a car on the right-hand track. As common target signals when used on such spring switches are not very satisfactory, since they will not surely show the displacement of a switch point which may be sufficiently out of place to cause a wreck, Mr. Kerwin has invented a semaphore switch signal which will show clear only when the switch point is entirely closed. One of these signals now in use at Log Cabin Loop is shown in the accompanying engraving. The semaphore is worked by a bell crank lever connected to a rod fastened directly to the switch point. The signal falls to danger as soon as the switch point is moved a small fraction of an inch away from the main-line position. The rest of the movement of the switch point does not affect the semaphore, as a slot in the

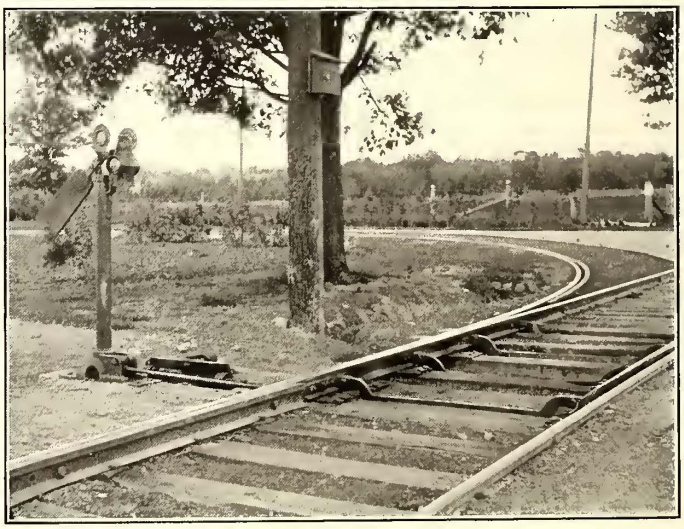
EMERY WHEEL TRACK GRINDER

signal switch-rod permits the switch to be moved the balance of the distance without moving the semaphore.

Switches when located in the traveled roadway along interurban lines, as for example at Royal Oak Junction, are covered with iron trap doors, and the switch handle is located between the tracks.

At the main line steam-road crossings, interlocking signals and derailing switches are used. Semaphore signals are located several hundred feet back from the crossings on the steam road, and these are interlocked with derailing switches on the electric road. The derailing switches are normally at danger, and can only be set for the passage of a car on the electric road when the semaphore signals of the steam road are at danger. The levers for working these are near the steam-road track, so that when the conductor goes to throw them he can see whether a train is approaching.

For unloading gravel in ballasting track, the dump-car with a sectional bottom has been used to some extent. This dump-car throws an even layer of gravel in the entire space between the tracks, thereby doing away with the second handling, which



NEW SWITCH SIGNAL.

would be necessary if the gravel were unloaded at one side of the track. The bottom of this car consists of slats 3 ins. wide. In the middle of the car, instead of a slat there is a boiler plate wide enough so that one slat can be slipped under it. When the car is to be dumped the first slat next to the boiler plate is slipped under the plate, thereby leaving an opening 3 ins. wide for the gravel to fall through. When the gravel has fallen through this opening as much as it will, the next slat is moved along, and so on for half the width of the car. The operation is repeated for the other half.

The rail required on city lines in Detroit is a narrow-groved rail, and in one instance on Michigan Street a section had been laid which was so narrow in the groove that it would not permit the passage of interurban cars.

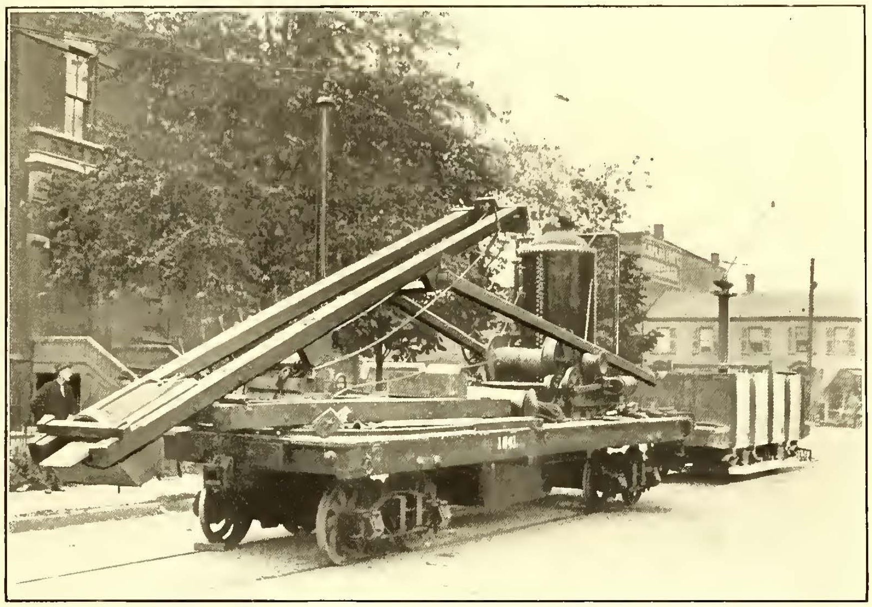
from the Detroit, Ypsilanti & Ann Arbor Railway. A device was made for spreading the groove of this rail, an engraving of which is shown herewith. It consists simply of a massive lever with a hard tool steel portion which fits down over the lip of the grooved rail. The lever is then raised by jack-screws, as shown in the accompanying engraving, until the lip of the rail has been bent outward enough to widen the groove. To keep the lip from springing back and to determine when the groove has been widened enough, a gage-bar is used with a tongue just large enough to go into the widened groove.

One excellent feature of track construction in Detroit now being laid by Mr. Kerwin is that there are no combination angle-bar joints joining different sections of rail. At special work, at crossings and at all other places where transition is made from one section of rail to another, cast-welded joints are put in so that angle-bars are used only between rails of the same cross section. Special work all has a short piece of the standard grooved section of rail cast welded to each rail for connection with the regular grooved rail.

Grooved rails which are worn out on city lines so that the flanges of the wheels ride in the rail grooves are taken out and laid on suburban and interurban track with the grooves on the outside.

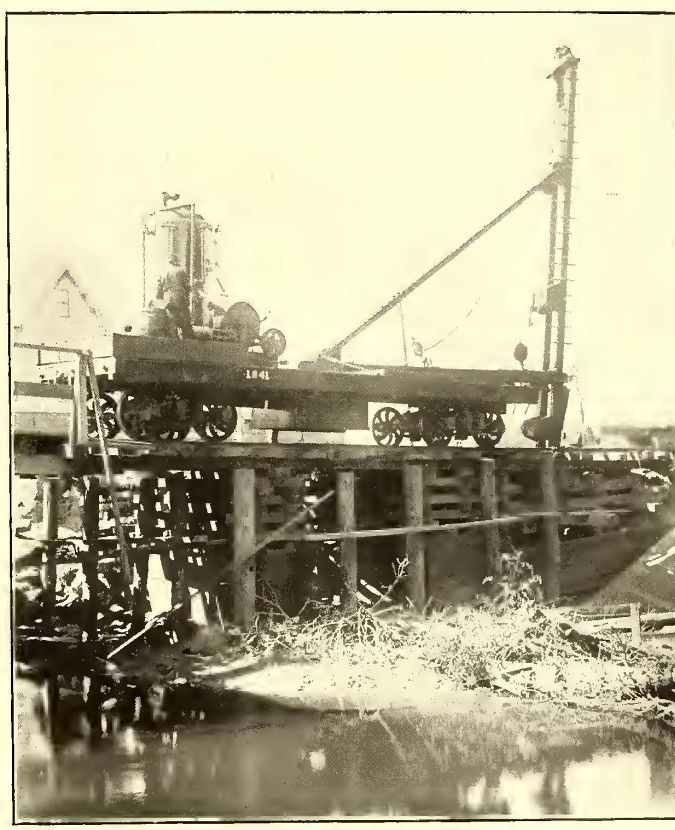
On Woodward Avenue, in the business part of the city, just north of Campus Martius, there is some 77-lb. grooved rail which has been down thirteen years, carrying the heaviest traffic of any track in the city, cars averaging about one per minute over it. This rail has now almost reached the limit of its usefulness, having been worn down in cross section until the flanges of the car wheels begin to touch the bottom of the groove.

It will be remembered by some that the first track construction to be laid without ties on concrete stringers was that in Detroit. This was in 1894 and 1895. Two kinds of construction were employed. The Detroit Citizens' Street Railway laid a 6-in. x 18-in. concrete beam under each rail and placed metal ties every 5 ft. The same construction is now used on new track, except that the concrete beam is now made 12 ins. deep instead of 6 ins. deep, because it has been found that the concrete beam 6 ins. deep is so thin that the beam will crack a short distance outside of the rail on each side, thus letting the rail down.



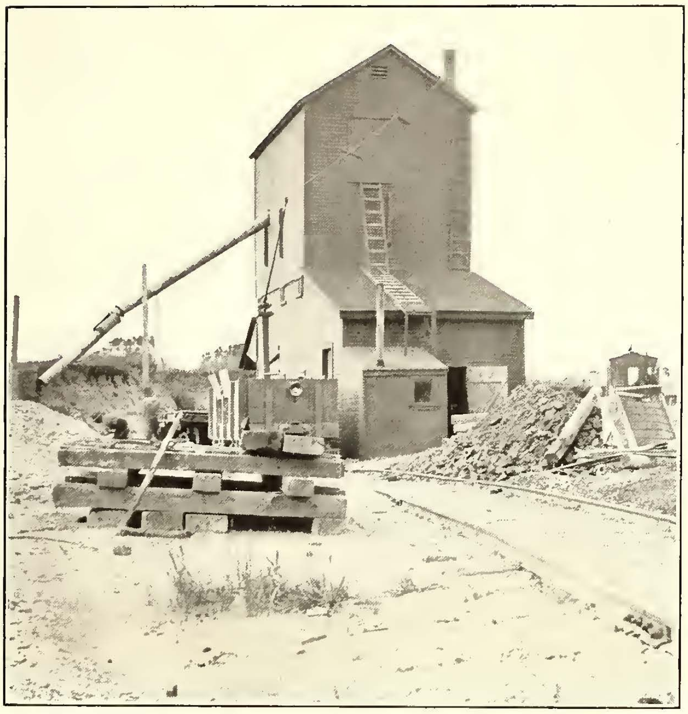
PILE DRIVER FOLDED UP

PILE DRIVER AS A CONCRETE BREAKER



PILE DRIVER AT A WASHOUT

The Detroit Railway Company laid track without entirely removing the pavement between the tracks. This was done by simply cutting a trench wide enough for the rails and concrete supporting beams and for the tie-rods, which were used to hold the track in gage. This construction



SAND DRYING PLANT AT A GRAVEL PIT

has practically gone to pieces since it had no foundation in common with the pavement.

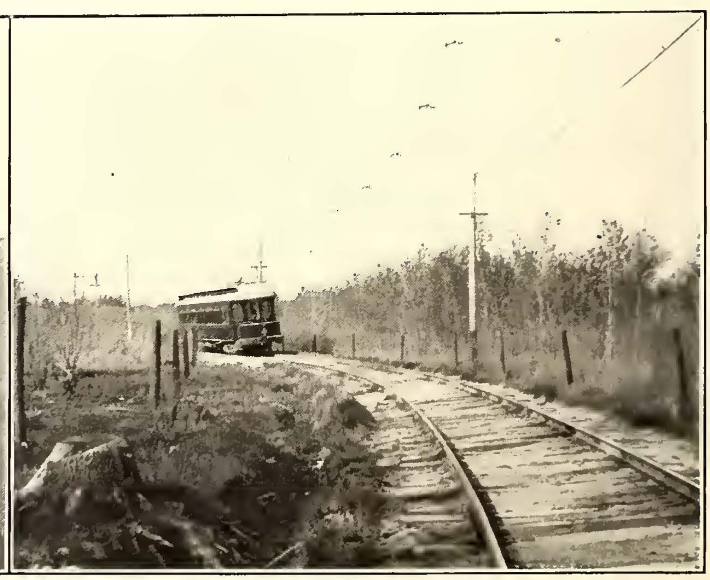
In regard to the present standard concrete stringer construction with metal ties to hold the tracks in gage, Mr. Kerwin does not agree with the popular idea among track men that the concrete stringer is a more expensive type of construction than that with wood ties. Wood ties require considerable more excavation if their concrete foundation is carried to a proper depth below the ties, and there is the further possibility of wood ties rotting. Even considering the durability to be the same, which it is not, the first cost of good concrete stringer construction, without ties as against wood tie construction, he considers to be in favor of the concrete ties.

For breaking up concrete in laying new tracks, Mr. Kerwin has devised a blunt cutting tool, which is fitted on the pile driver used in interurban construction and repair work. This pile driver with the cutting tool will break up as much concrete in a day as a gang of twenty men. It is, furthermore, much easier to keep at work than track labor, because breaking up concrete seems to be especially distasteful to track laborers, and it is difficult to find men who will stay at his work. Views of this pile driver accompany this article.

In some cases low joints have been raised by putting in continuous rail joints, and it is desirable to surface off the joint after having raised it. For use in this connection and around special work a portable emery wheel grinder has been built, an illustration of which is shown. This grinder is mounted on a three-wheeled truck, and the height of the emery wheel can be governed at will. It is operated by a motor connected to the emery wheel by a flexible shaft. The motor and flexible shaft are not shown in the engraving. The wheel can be run up or down by means of the worm operated by the crank on top. The end of the flexible shaft where it enters the grinder is supported in a bearing, which bearing is supported by a link hung from a counterbalance lever with a sliding weight which can be adjusted to just take the weight and so cause a minimum of friction in the emery wheel bearing to which the shaft is attached.

Track tools are especially liable to get lost or broken or to get into possession of track men other than those to whom they were originally given out. All tools in this department are numbered with the box number from which they came. Each foreman has his box and is responsible for tools therein, making reports once each month as to the number and condition of tools in his box. One track gang cannot, therefore, take tools from another without evidence of that fact appearing in the report, and the necessity of making frequent tool reports is a constant reminder to men to keep track of all tools belonging in the box.

A sand-drying plant is maintained at a gravel pit near Farmington. The sand dryer is built somewhat on the

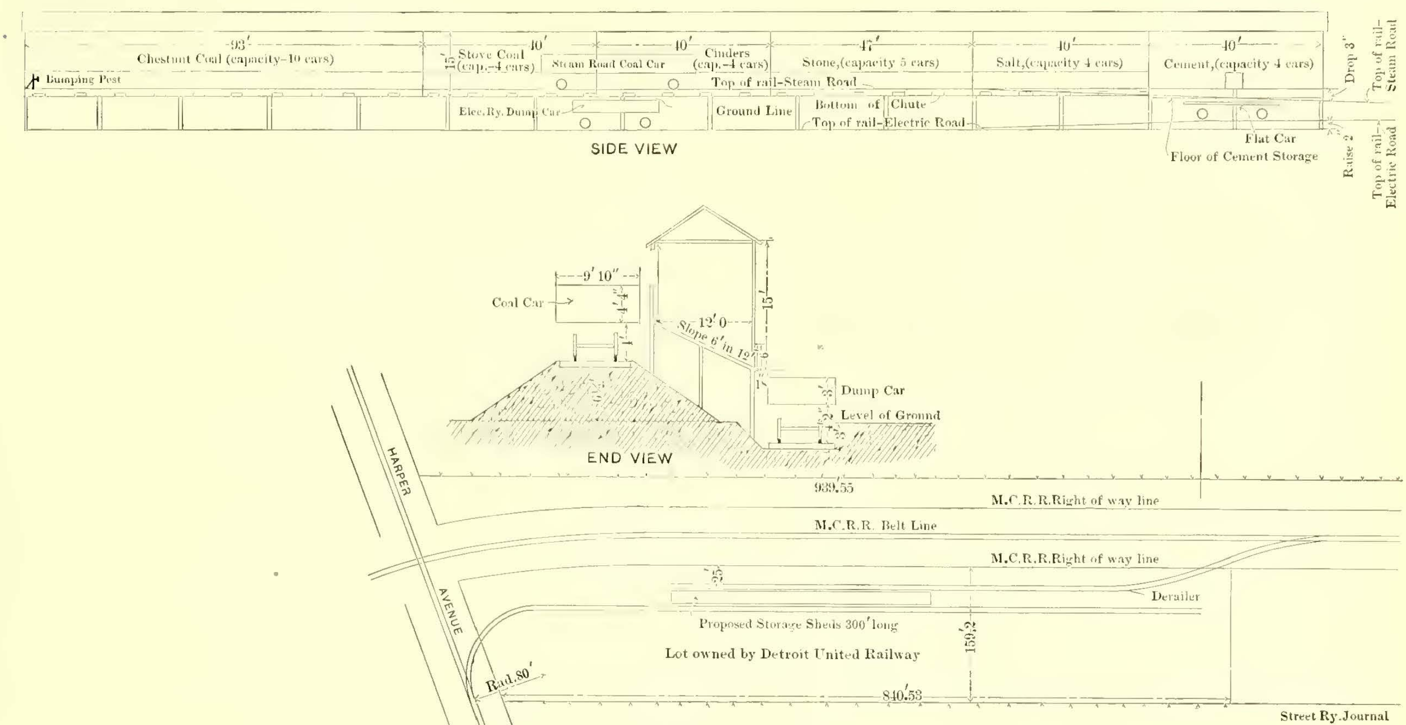


SOME INTERURBAN TRACKS

principle of a grain elevator. Sand is dried in a revolving cylinder under which a fire is built. The cylinder is slightly inclined, so that the sand and gravel are fed in at one end and come out at the other. At the discharge end is a screen which separates the sand from the gravel. Sand is taken in conveyers to a bin in the upper part of the building, from whence it is drawn on to cars as necessity requires. Gravel is discharged by the outlet pipe, seen in the accompanying engraving. This gravel, after screening, yields roofing gravel and coarse gravel, the income from which is sufficient to nearly pay the expenses of operating the sand-drying plant.

In previous years coal for use in the car heaters has been hauled by wagons to the various car houses from coal yards on the steam railroads at a cost of about $13 per car. At the Harper Avenue yards of the company, which are located at the Michigan Central Belt Line, a very complete storage shed will be built for the storage of chestnut coal, stove coal, cinders, stone, salt and cement and for the easy transfer from steam to electric cars. The steam road tracks will be elevated on a 6½-ft. bank, from which they will be unloaded into a storage house with sloping floors. This storage house is 12 ft. wide, the floor having a slope of 6 ft. 2 ins. On the opposite side of the storage house is the electric railway track, placed 3 ft. below the level of the ground. As seen by the accompanying drawing, the material can be unloaded from the storage house to the dump car by simply opening slide doors. The dump car on the electric road will have a slanting bottom that will unload itself, and to compensate for the consequent unevenness of the load on the two sides of the car, the car box will be mounted slightly to one side of the center.

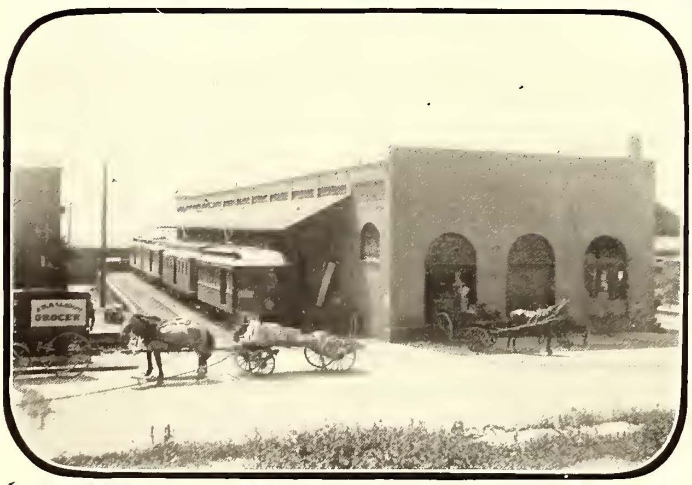
On the north end of Woodward Avenue some track was laid several years ago with a lawn between tracks as a substitute for asphalt paving. The street is wide, and since this was in a suburban district the space between the street railway tracks was not needed for driving purposes, hence the experiment was tried with the grass plot. At street intersections the space between tracks was paved in the regular manner. In the sod of the roadbed T-rail was laid, while at the paved street intersections the grooved rail required by the city was put down. The transition from grooved T-rail was made by cast-welded joints. This has permitted the use of T-rail on part of the road, has saved the cost of paving, and has kept teams from driving on the track to a certain extent. There is, however, a tendency for the ties to rot under the sod, and the grass plot must be kept cut very short to prevent its wiping grease from the motors and trucks. The frequent transition from T to grooved rail has hardly proved an economy, and the use of the same section of rail for the entire distance would be advisable for future work of this kind.



PLAN OF STORAGE SHEDS AT HARPER AVENUE

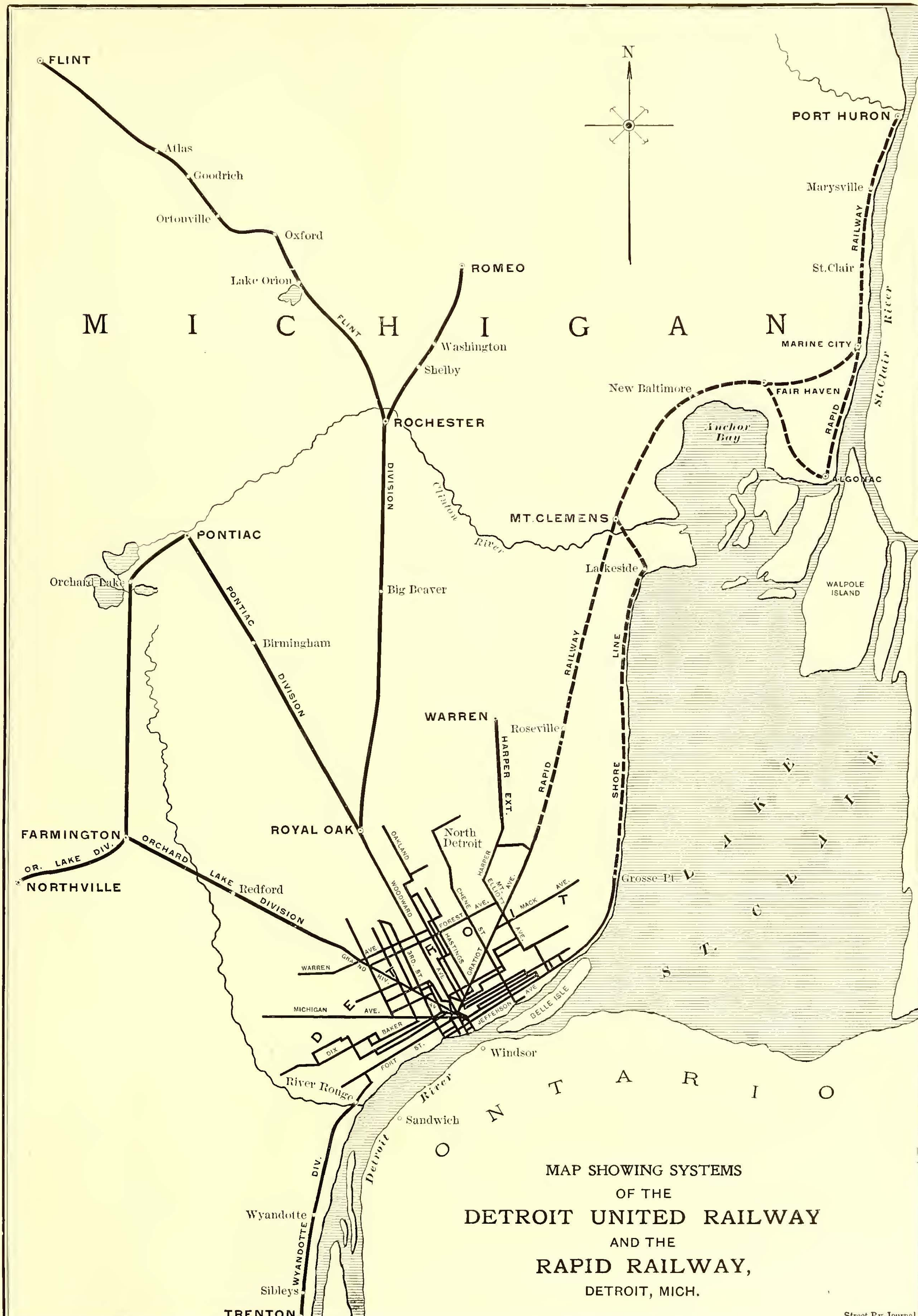
Freight Business on Detroit Interurban Roads

The freight business handled by electric interurban roads around Detroit is probably the greatest of that done at any of the interurban centers of the United States. The freight and express business, as carried on by these interurban roads in competition with steam roads in the vicinity of Detroit, has brought out the fact very forcibly that the same elements which have gone to build up a successful electric interurban passenger business are the elements which must be depended upon for the success of the interurban freight and express business. One of the great reasons for the success of the electric interurban passenger business is the frequency of cars as compared with trains on steam railroads. The lower fares, of course, have also had something to do with it. It has been found that the element of frequent service is a most important one in determining whether shippers sending goods from Detroit to nearby towns will patronize the electric road in preference to the steam railways. The electric road offers to the shipper practically the same advantages as to convenience and quickness of transit in comparison with the steam railways for short distances as it offers to the passenger; that is, for shipping short distances, the electric road, with



A Load of Freight.
Freight Motor with Milk Trailer.
The Union Freight House (Car Side.)
Along the Way.

The Milk Trailer.
A Country Freight Depot and Waiting Room.
The Union Freight House (Team Side.)
In the Union Freight House.



MAP SHOWING SYSTEMS
OF THE
DETROIT UNITED RAILWAY
AND THE
RAPID RAILWAY,
DETROIT, MICH.

its freight cars running frequently and at definite times, can make sure of the delivery of goods from Detroit to suburban and interurban points in the shortest possible time. Shipping by steam road for such short distances involves considerable uncertainty as to the time of delivery, and it frequently happens that owing to the infrequency of the steam road trains, there is a long interval before the goods delivered at the Detroit freight houses are actually shipped. In other words, steam roads are built and operated mainly for through business, both passenger and freight. Their methods are not such as cater best to the small local traffic of either passenger or freight classification. The strength of the electric lines lies in their ability to deliver goods frequently and promptly between city and suburban points. The frequency of express service on the electric roads is conducive to building up a small shipment business, because it makes it possible for the grocers and merchants in towns several miles from the city to order goods in smaller lots and more frequently than they would if they were dependent on steam railroad freight service. This is especially true of perishable goods. Of course, the competition is bitter at points where both steam and electric roads have freight depots. Steam railroads having seen the electric interurbans take their local passenger business and create a lot more are now making a hard fight to retain local freight business. To an unprejudiced observer it would seem that in the course of a few years these matters would adjust themselves into their legitimate places, and that the result would be that the local business for short and frequent service would be carried on by the electric roads, which would in a way act as feeders for the through business of the steam railroads. In other words, there is a place for each, and they can best work in harmony.

The following facts and figures give an idea as to the extent of interurban freight business around Detroit. On the Rapid Railway system freight cars leave the electric union freight depot in Detroit three times per day to distribute freight over the 109 miles of track which constitutes the Rapid Railway system. The accompanying map is of the entire system, while the small map shows the extent of the interurban freight service and also indicates the number of freight cars per day over various portions of the different divisions. On the Flint Division of the Detroit United Railway there are two cars per day; on the Pontiac Division, two cars; on the Orchard Lake Division, two cars; on the Wyandotte Division, two cars, and on the Detroit, Ypsilanti, Ann Arbor & Jackson Railway there are three cars per day. On the latter line the competition with the steam railroad is probably the most severe, the Michigan Central having cut its rates in half between Detroit and the competitive points in order to meet the electric competition. The electric rates remain the same as the rates of the steam railroad before the reduction was made. In Ypsilanti and Ann Arbor, however, the electric road gives a free delivery for ordinary freight. The methods of freight handling as carried on by the various electric railway systems are similar to those used on steam roads.

A. R. Patterson, joint express agent in the Detroit freight depot, is a former steam road freight man. The same classification of freight that is used on steam roads prevails on the Detroit United Railway, and the rates are the same to points where there is competition with the steam railroads. There are two men in an express car crew. In addition to the regular express business, a large milk business is carried on in connection with it. There are four milk routes. On the Flint Division there is a milk route from Rochester and intermediate points to Detroit, 27 miles. On the Pontiac Division milk is taken by special cars from Pontiac to Detroit, 28 miles, and on the Rapid Railway system, 25 miles. The milk car is hauled as a trailer on the regular express cars, and a good idea of the business can be obtained from the accompanying engravings. On the Detroit United Railway system the number of cans hauled per month is as follows:

Flint Division	3,900
Pontiac Division	6,000
Orchard Lake Division	3,800
Total	13,700

The revenue from this milk business is about $1,850 per month. The rates are 10 cents per can for distances under 30 miles, and 12½ cents per can for distances over 30 miles, but near the city where there is a possibility that the milk would be hauled in by team this rate has to be reduced.

Regular freight cars are substantially built and of neat outside appearance. They are from 35 ft. to 40 ft. long, and are equipped with air brakes. Tools for handling freight in the way of beef hooks, hay hooks and skids, are provided. At the joint express depot in Detroit, which is at the corner of Fifth and Congress Streets, near some of the steam road freight depots, the companies maintain a joint express agent, as before mentioned. At this depot freight is received from the wagons on one side and delivered to cars on the opposite side. Besides the road track next to the freight platform of this depot there is an extra siding for temporary storage of express and milk cars. No baggage or express is carried on passenger cars. Baggage is checked, but is carried only on express cars, and it must be delivered to the joint express depot in Detroit or at one of the depots along the line. A good example of a rural freight depot and waiting room, that of Clawson, on the Flint Division, is illustrated in the group on the preceding page. The companies interested in the joint express depot in Detroit issue a card something larger than an office calendar, giving an alphabetical list of towns reached by electric express and the time at which express cars leave for the various towns enumerated. Goods must be left at the electric depot one hour before leaving time of cars.

Agents are maintained at eighteen points on the Detroit United Railway system; at ten points on the Rapid Railway system, and at twelve points on the Detroit, Ypsilanti, Ann Arbor & Jackson Railway.

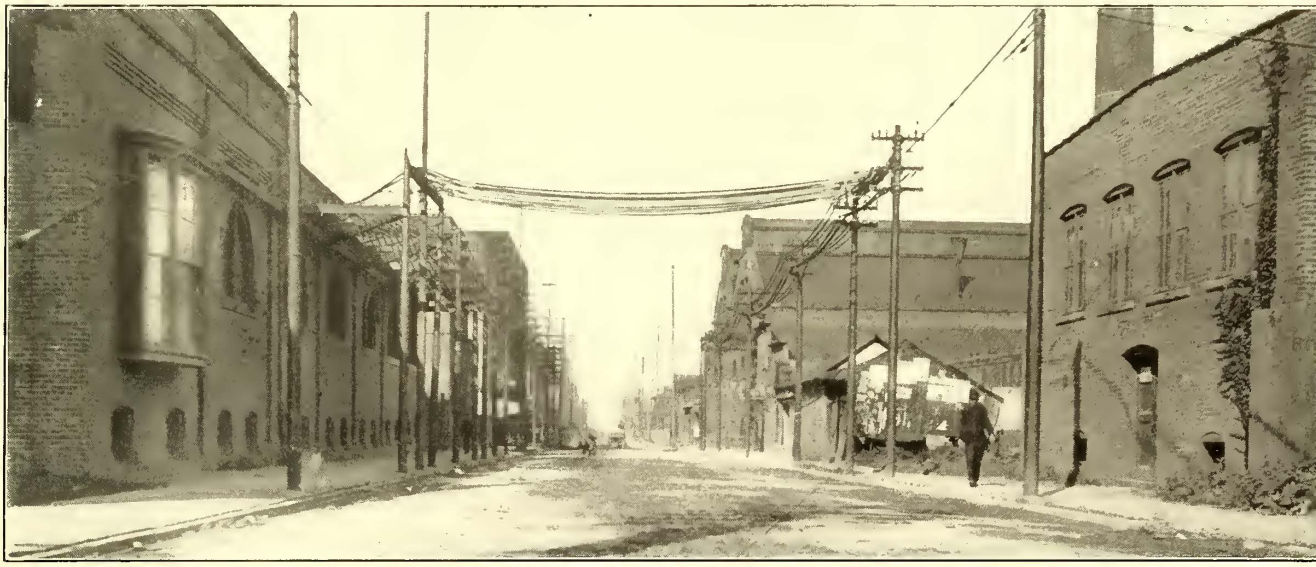
The greater part of the express and freight carried on the electric roads passes through the Detroit joint electric depot, but a small per cent going from one point on a line to another. The following figures showing the tonnage of freight passing to or from the Detroit depot will give a good idea of the volume of business done:

	Tons
March, 1902	
D., Y., A. A. & J. Ry	934,071
Detroit United Railway	3,311,497
Rapid Railway	1,353,504
April, 1902	
D., Y., A. A. & J. Ry	907,202
Detroit United Railway	3,461,067
Rapid Railway	966,678

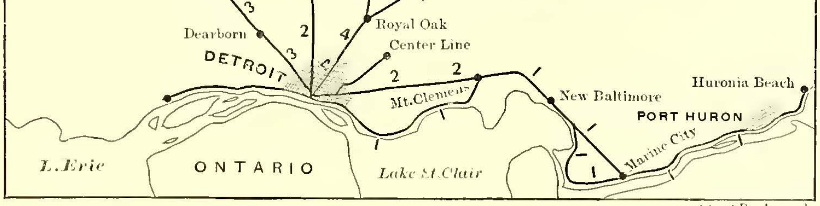
May, 1902	
D., Y., A. A. & J. Ry	1,066,358
Detroit United Railway	3,680,720
Rapid Railway	1,049,167
June, 1902	
D., Y., A. A. & J. Ry	1,033,773
Detroit United Railway	3,433,521
Rapid Railway	915,684
July, 1902	
D., Y., A. A. & J. Ry	1,111,828
Detroit United Railway	3,677,636
Rapid Railway	1,155,725

The freight business on the Detroit United Railway and Rapid Railway systems is under the charge of George W. Parker, general express and passenger agent, who is ably assisted by A. F. Eastman, traveling express agent, who keeps closely in touch with shippers along the line.

An arrangement has recently been made whereby baggage can be checked by passengers at any point on the Detroit United interurban system, to the railroad depots or to points touched by the steamers of the White Star Line, the Detroit & Buffalo Line or the Detroit & Cleveland Line. This is by an arrangement made with the Detroit Omnibus Line. Passengers must, of course, pay for the cost of transfer of baggage from the electric depot to the depot or dock desired. Baggage is not handled free on the interurban lines because of the low rates of fare which already prevail. A charge of 25 cents each for trunks under 150 lbs. is made.



GENERATOR LEADS BETWEEN STATIONS A AND B



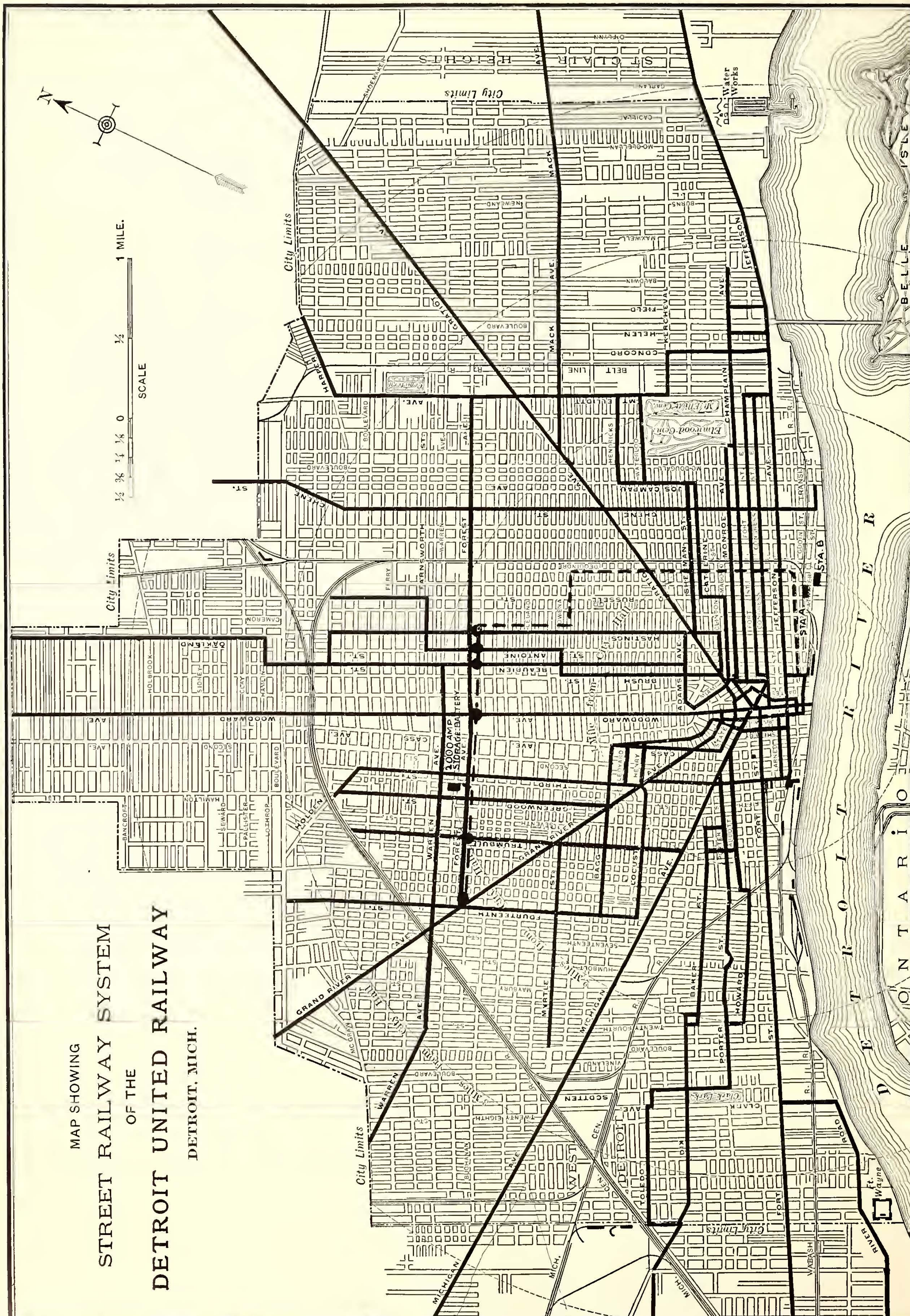
MAP SHOWING DISTRIBUTION OF FREIGHT CARS ON DETROIT INTERURBAN RAILWAYS

Overhead Construction and Electric Power Distribution of the Detroit United Railway System

The overhead line construction on the interurban lines of the Detroit United Railway is decidedly varied on the different divisions, because of the different ideas of the original builders of these lines. The illustrations herewith, and with the article on the track department, elsewhere in this issue, from photographs taken on the different divisions, illustrate this well. However, a certain standard type of overhead construction is now being put in wherever new work is called for. This is shown in the engraving on another page, giving the two forms adopted for future work, one with a supporting brace below the bracket, the other without. A truss rod is used in both cases, because of the large amount of support it gives with a small weight of material. The drawing shows the bracket fittings of the Ohio Brass Company. The tubing is $1\frac{1}{2}$ ins. and the truss rod $\frac{1}{2}$ in. Two figure 8 trolley wires are used. All poles are numbered with miles and tenths of miles from Detroit, which proves a great convenience in many ways. The exact location of track or line defects can be reported by motormen, and it saves the taking of measurements for distances in planning new work or making tests of various kinds.

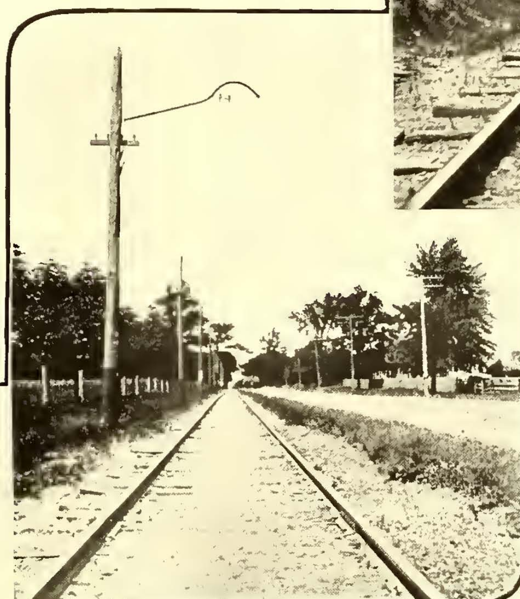
INTERURBAN POWER DISTRIBUTION

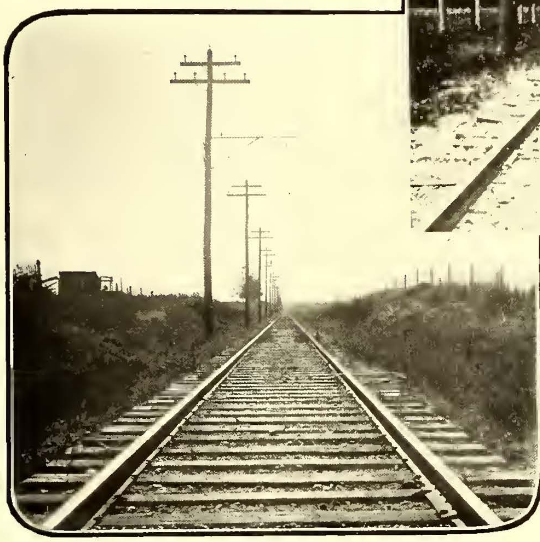
While the system of the Detroit United Railway, taken as a whole, offers splendid opportunities for a comprehensive system of alternating current high-tension distribution with sub-stations for supplying both city and interurban lines, no such comprehensive system has yet been begun, since it is but recently that the four interurban divisions were brought under the same ownership. The power distribution is therefore by a somewhat temporary patchwork of direct current and alternating current. The accompanying map shows the present arrangement of power supply.



MAP OF DETROIT CITY DISTRIBUTION, SHOWING POWER HOUSES, BATTERY STATION AND EQUALIZATION SCHEME

On the Orchard Lake division running to Farmington, Northville and Orchard Lake the power distribution is all by direct current with boosters from a power house at Farmington Junction. On the Pontiac division the distribution is all by direct current from a power house at Birmingham. On the Flint division, running from Royal Oak Junction to Rochester, Romeo, Lake Orion and Flint, there is a direct-current power house, at Rochester, which, with the aid of a booster, feeds south 14.6 miles towards Detroit as far as Royal Oak, and also to Romeo and toward Lake Orion. In the power house at Rochester there is an inverted rotary converter run as a motor from the direct-current bus-bars of the station. This is a Stanley machine of 250-kw rated capacity, but is being run regularly to tide over present emergencies at 100 per cent, without going above its heating or sparkless commutation limit. This converter gives alternating current at 360 volts three-phase from its collector rings. This is raised by step-up transformers to 15,000 volts, and transmitted over two circuits of No. 4 aluminium cable to sub-stations at Oxford,





SOME SAMPLES OF OVERHEAD CONSTRUCTION

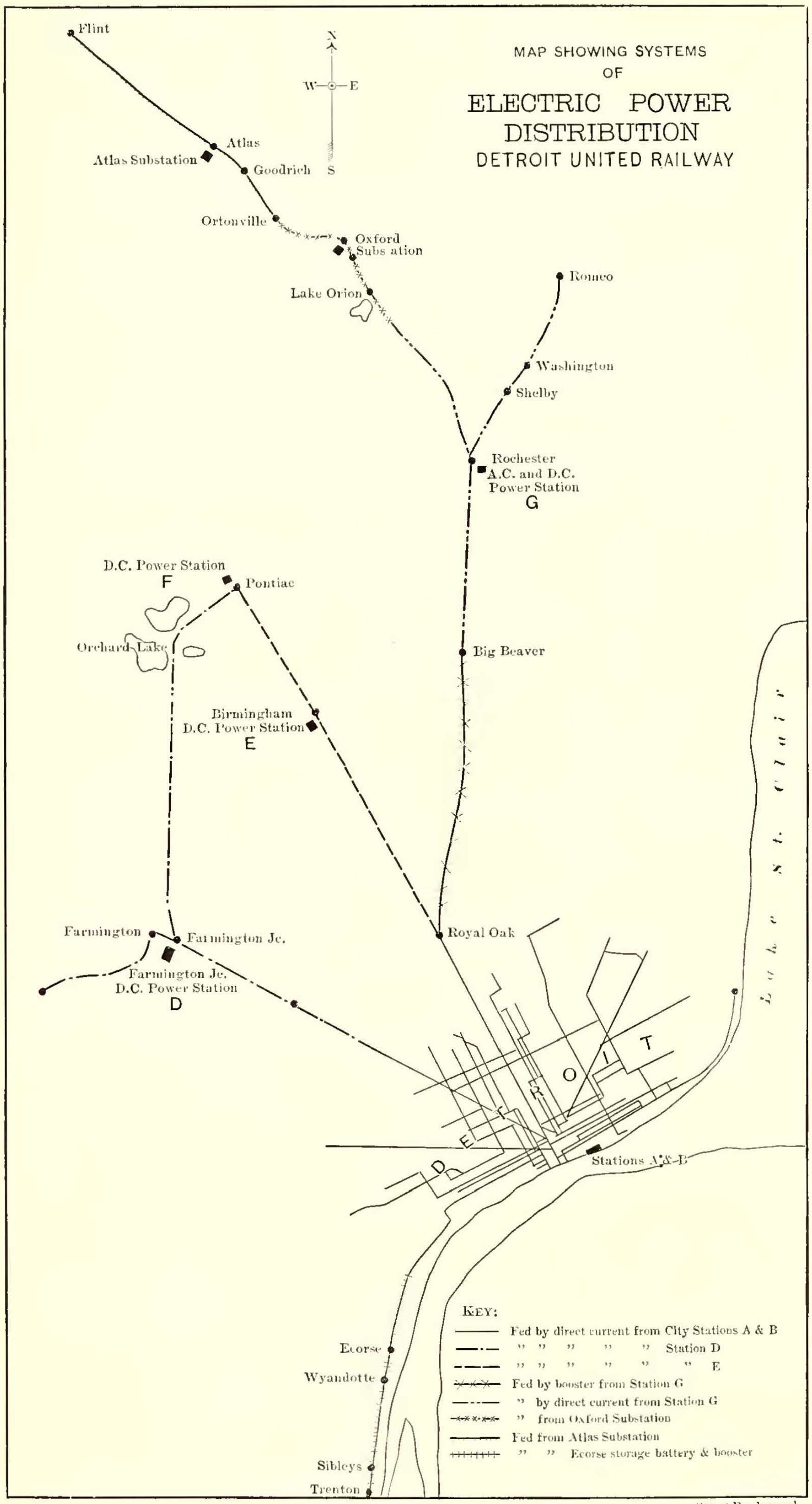
13 miles north, and Atlas, 30.4 miles north. The rotary converters in these sub-stations are started ordinarily (if the voltage on the trolley lines is not being lowered by the presence of a car drawing current between the power house and the sub-station) by starting them as shunt direct-current motors from the trolley line. When the direct-current voltage is so low that it will not bring the rotary converter up to synchronism by this means, the rotary is run up to as high a speed as the direct current will bring it, and the main switch throwing it onto the alternating-current mains is partially closed. By the auxiliary contacts on this switch when it is partially closed, the rotary converter armature is connected with the three-phase bus-bars through an inductance coil in each leg of the circuit. This cuts down the current to a permissible amount until the converter is jerked into step. When this latter occurs, the main switch is entirely closed, connecting the converter directly to the alternating-current bus-bars. Of course, this is heroic treatment to get machines into step, but no evil results seem to come of it. Another method of starting these rotary converters, of course, would be to weaken the fields when running as a shunt motor, and so increase the speed until a point was reached where the machine would synchronize. To do this more field resistance than is ordinarily provided would have to be used. A modification of this plan has ben successfully tried, though not regularly used. This is to run the machine up to the highest speed possible as a shunt motor, cutting in as much field resistance as possible, and then momentarily opening the field circuit altogether, letting the machine run on the residual magnetism in the fields. Of course with a field so greatly weakened the motor speeds up rapidly and must be cut out of circuit before attaining a dangerous speed. As the speed falls, the switch on the alternating current side can be closed as the point of synchronism is reached. As before mentioned, the high-tension lines are of aluminum No. 4. These two aluminum

EMERGENCY TOWER WAGON, SPECIAL DETROIT DELIVERY

lines are of stranded conductor on Provo type glass insulators made by the Hemingray Glass Company, of Muncie, Ind. Experiences with this aluminum line when first strung have demonstrated the importance of educating linemen who are used to stringing copper to the necessity of allowing a liberal amount of contraction in cold weather, as aluminum contracts more than copper, and is not strong enough to stand the tension that could be put on copper.

An alternating current generator has been ordered for the Rochester power house, which will do away with the inverted rotary.

The interurban line to Wyandotte is run from the city power houses with the aid of a booster and a 280-amp. hour storage batter at Ecorse.

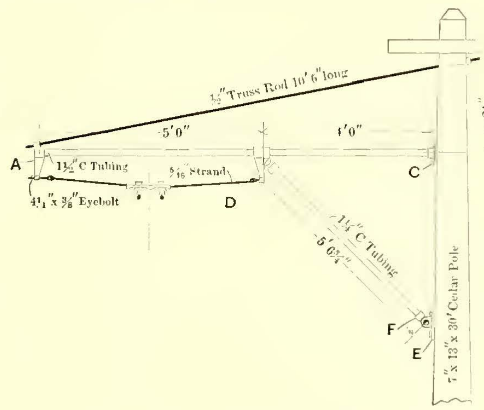


MAP SHOWING SYSTEM OF ELECTRIC POWER DISTRIBUTION, DETROIT UNITED RAILWAY

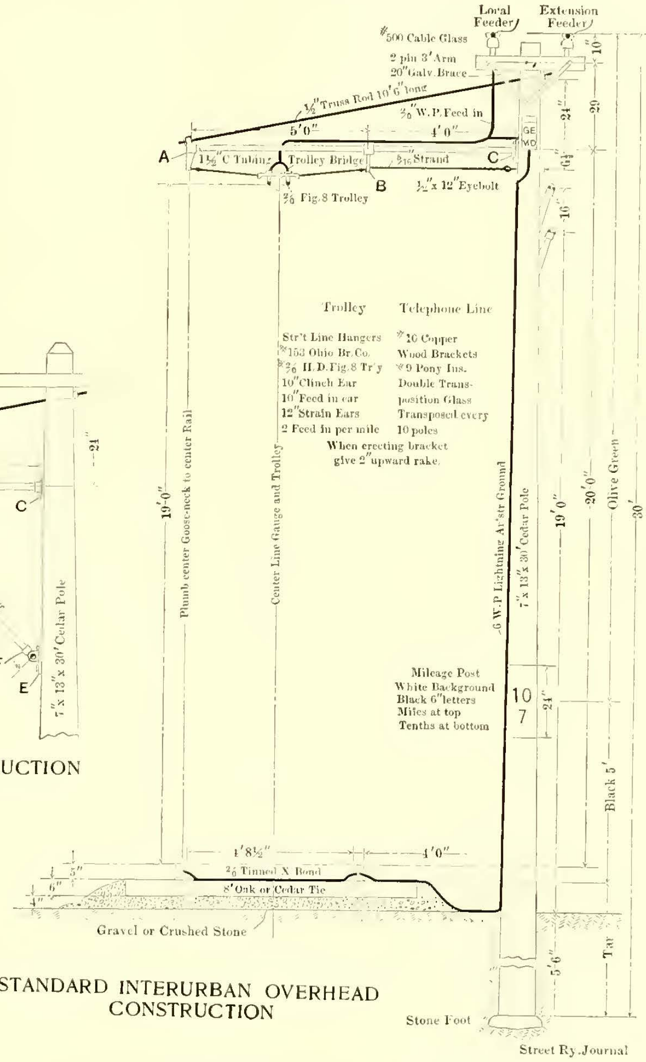
CITY POWER DISTRIBUTION

The city power distribution of the Detroit United Railway Company is all by direct current from two power houses, located diagonally across the street from each other near Riopelle Street and the river front. One of these power houses was originally built by the Detroit Citizens' Street Railway Company, and is called Station A. The other was built by the Detroit Railway Company, and is called Station B. Since the consolidation the operation of these two power houses has been combined in a rather unusual manner, which, as it affects the electrical distribution, will be described here. The switchboard for both power houses is all combined in one power house, and the two power houses are operated electrically, just as if they were one, although the engines and generators are under different roofs with a street intervening, and nothing but telephonic means of quick communication between them. The positive generator switchboard leads and shunt field leads in Station B are run across the street to the other power house, and there terminate on regular generator panels. No switches are located in the Station B, save the equalizing switches on the generators, and these are on the negative side. The negative leads have no switches, but are connected permanently to the negative and ground. All other switches are in Station A. The average length of the leads from the Station B generators to their switchboard panels in the other power house is about 600 ft. The generator leads between the two power houses are carried on poles just as if they were feeders. The accompanying engraving shows these generator leads between the two power houses at the right side of the street, and also the feeders leaving Station A, at the left side of the street. Only the positive leads are brought to the switchboard in any case, and consequently all switching is on the positive side. The equalizing switches being on the machines, the only main switch needed on a generator panel is a positive switch and circuit breaker. This arrangement has worked to the entire satisfaction of all concerned. Its object, of course, is to simplify switchboard attendance, and to make it possible to run all the feeders from one board. This makes the operation of the two power houses more flexible, makes it easy to shut down either one of the power houses at night, and practically makes one power house of them, as far as carrying the load is concerned. The number and capacity of the generators in operation can be adjusted to the load so as to give the generators a more economical load with this arrangement than if they were supplying different sets of feeders.

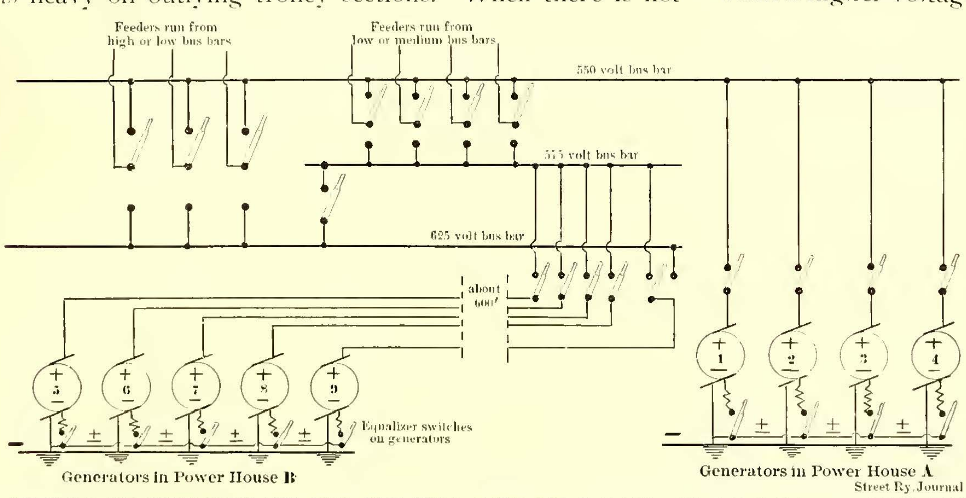
Another feature of interest about the switchboard is the use of three sets of bus-bars, which makes it possible to run feeders on any one of three different voltages. The diagram below shows the arrangement. Two sets of bus-bars are run the entire length of the feeder board. A third bus-bar runs part of the length of the feeder board. Part of the feeders can be connected onto either the high or low bus-bars, and part can be thrown onto the low or medium bus-bars. Each feeder has a double throw single-pole switch for connecting to either set of bus-bars. There is a paralleling switch between the medium and high voltage bus, so that these can be thrown together. The voltage of the highest bus is about 625, that of the medium 575, and that of the lowest 550 when operated independently. Generators 1, 2, 3 and 4, which are located in Station A (the one in which the switchboard is located) are arranged to connect with the low-voltage bus-bars as shown. Generators 5, 6, 7 and 8 in Station B, across the street, have their main switches arranged to connect the medium or 575-volt bus. Generator 9 in Station B has on its switchboard panel two single-pole single-throw main switches, by which it can be connected to either the medium bus in parallel with 5, 6, 7 and 8, or, on the high-voltage bus-bars, by itself as a 625-volt machine. A new generator now going in will be connected as No. 9 now is. When the two switches on the panel of No. 9 are closed the effect is that of throwing the medium and high voltage bus-bars in parallel, just as if the paralleling switch between the two were closed, and, in fact, both the paralleling switch and the two generator switches are usually closed when these busses are to be run in parallel. The 625-volt bus is run separately when the load is heavy on outlying trolley sections. When there is not such a load, and for purposes of economical loading of machines, it is desirable to run the high and medium voltage bus-bars in parallel, they are so connected. Out of 32 feeders leaving this board, 22 are arranged for connection to the high and medium bus-bars, and 10 can be connected to the low or medium bus. One matter which influenced the arrangement of the switchboard as it exists at present was the fact that the generators 1 to 8 cannot be raised as high as 625 volts. With the present arrangement they can be run on the shorter feeders, while generator 9, in power house B, supplies the feeders requiring the higher voltages, when a higher voltage is necessary.



STANDARD OVERHEAD CONSTRUCTION WITH BOTTOM BRACE



STANDARD INTERURBAN OVERHEAD CONSTRUCTION



SCHEME OF SWITCHBOARD FOR THE TWO DETROIT DIRECT CURRENT POWER STATIONS OPERATED AS ONE

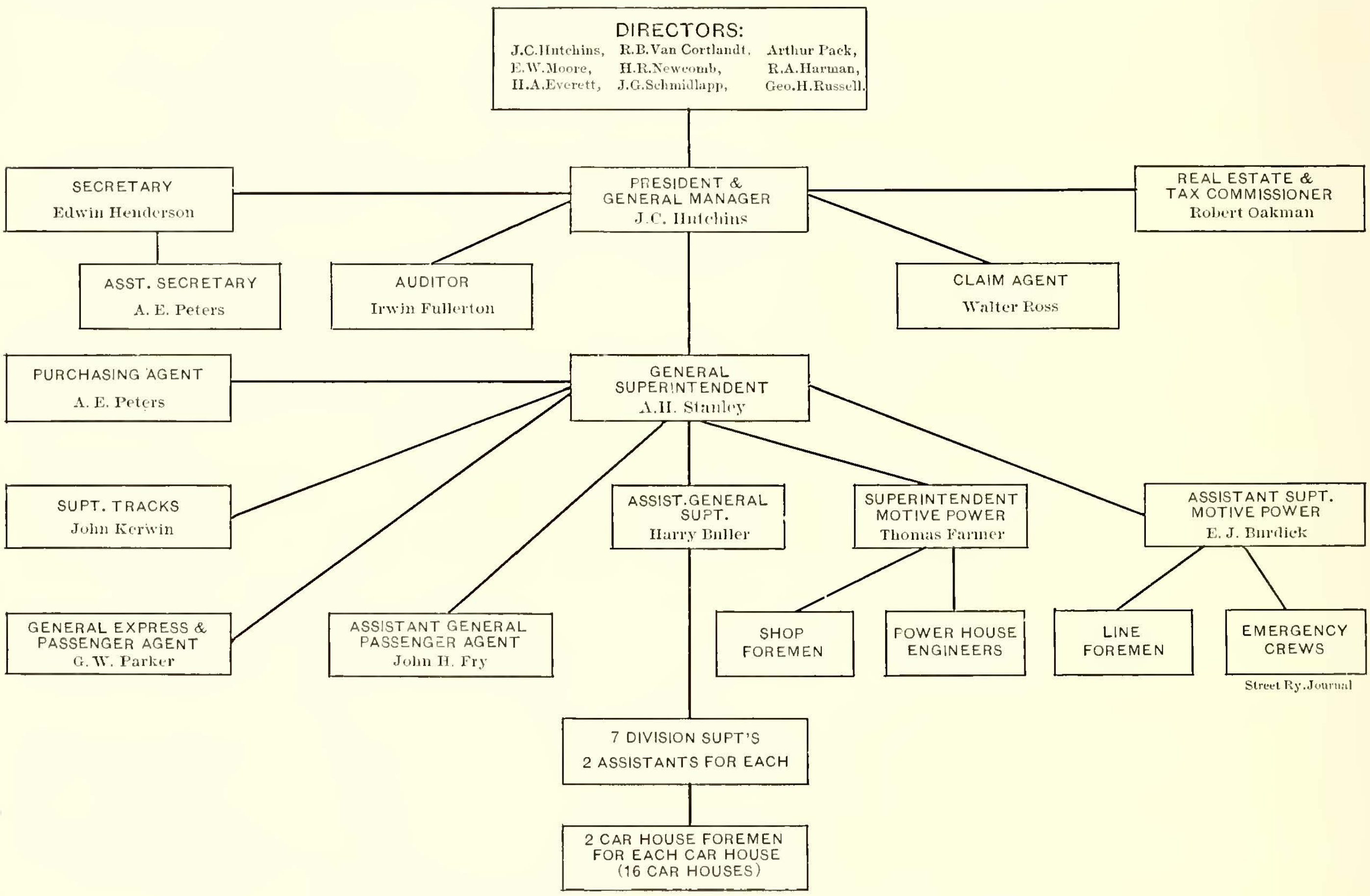
In connection with this company's direct-current distribution in the city of Detroit, two sets of storage batteries are employed and on the Wyandotte & Trenton interurban line, which is fed by direct current and boosters from these city power houses, there is also a storage battery. One of these city batteries is located at Station A, and the other in the northern central part of the city. A map of the street railway lines of the city is shown herewith, giving the locations of power houses and the storage-battery station with reference to the system. The feeder lines along each trolley line are omitted for the sake of clearness, but they parallel practically every trolley line, and in addition a special feeder pole line runs directly north from the power house, supplying a number of intersecting streets, and also connecting with a feeder along Forest Avenue, which acts as an equalizer between lines which it intersects. The storage battery is located near Forest Avenue and Third Street, and equalizing feeders are run east and west on that avenue, connecting to the regular feeders at intersecting streets through Westinghouse "Type A" circuit breakers located in boxes on the poles. In shunt around each circuit breaker is a series of five incandescent lamps, one of which is put in a Dayton Manufacturing Company's signal lamp box on top of the circuit breaker box to protect it from injury. When the lamps are lighted, the employees have a sign in the signal lamp that the circuit breaker is open. When the circuit breaker is closed, of course the lamps are out. A lever at the side of the circuit breaker box makes it possible for employees to close the circuit breaker as soon as the trouble has been cleared from the line. These circuit breakers are necessary to make possible the disconnection of any section from the equalizing feeders and storage battery. The use of automatic circuit breakers outside of power houses, sub-stations and cars, where someone is constantly in attendance, is by no means common, nor has it, as a rule, been found satisfactory in most cases where it has been tried. Under the particular conditions here, however, the plan works well. The type of circuit breaker employed is simple and requires little attention, and the closing of these equalizing circuit breakers is not absolutely necessary to the operation of cars, since the direct feeders from the power houses can supply the lines until such time as these circuit breakers may be closed.

After cars cease operation at night on the interurban lines the interurban power houses are shut down, and switches between the interurban and city lines are closed to supply the interurban car houses with light and power for shunting cars.

The overhead emergency wagons used in Detroit differ in several respects from those kept by most city roads. They are pulled by one horse, and consequently are made light, with a ladder instead of a tower. The chief novelty, however, is in having the lower part enclosed. This closed top is simply the strong frame for supporting the ladder covered with canvas as a delivery wagon top.

In the emergency houses at St. Antoine Street, near Jefferson Avenue, four one-horse emergency wagons are kept in readiness at all times. Two of these are overhead line wagons of the type just described and shown in the accompanying engraving, one is a wreck wagon with tools for derailed cars and broken down wagons, and one is a wagon loaded with hose jumpers for fires.

The work outlined in this article is under the charge of E. J. Burdick, assistant superintendent of motive power.



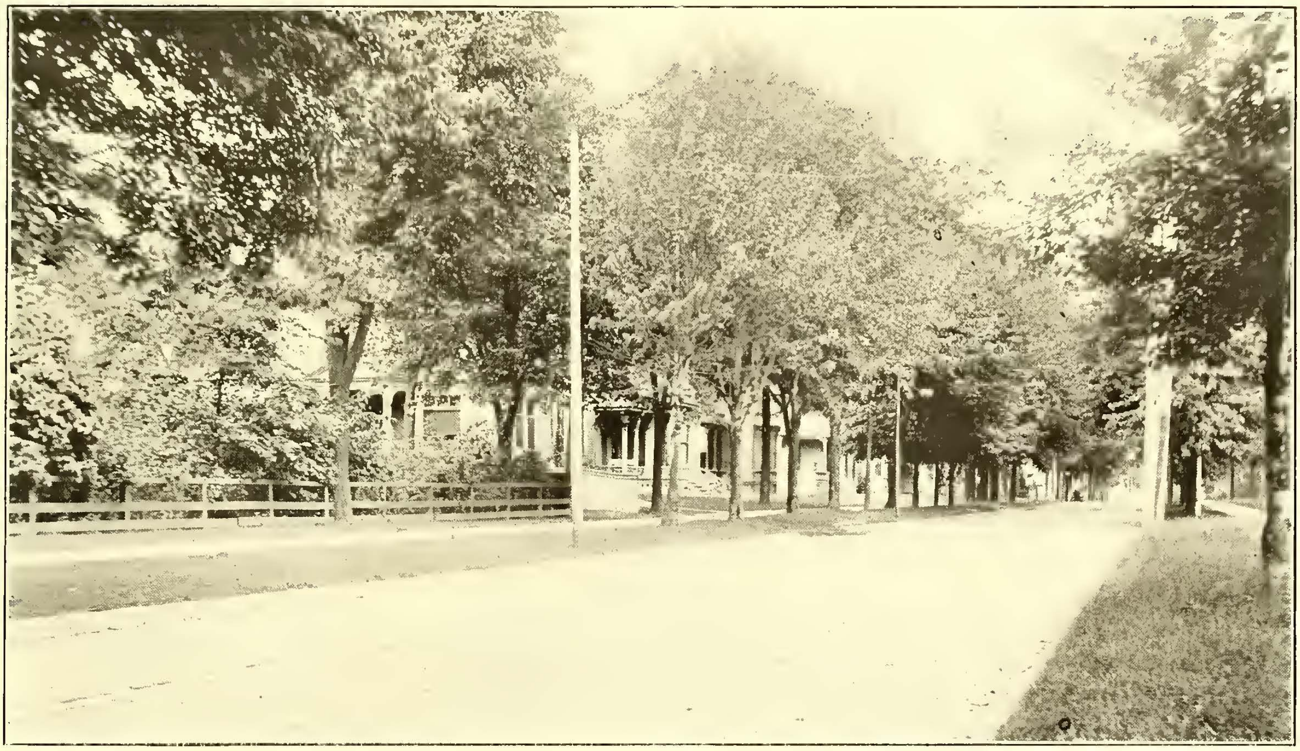
ORGANIZATION CHART OF THE DETROIT UNITED RAILWAY COMPANY

The Organization of the Detroit United Railway Company

The scheme of organization and relation of departments of the Detroit United Railway Company is shown by the accompanying diagram. In some cases the titles are rather misleading, because they are an inheritance from a former different arrangement of departments. As on every well-managed electric railway system the plan of organization and assignment of duties to different departments has been made in accordance with the talent most available to carry on the work of the company.

Legal and financial departments report direct to the president and general manager All other officers report to the general superintendent, who in turn reports to the president.

The offices of assistant secretary and purchasing agent are combined in one man. The superintendent of tracks has charge of all construction and maintenance of way, both on city and interurban lines. The general express and passenger agent looks after the handling and building up of the freight business. The assistant general passenger agent has charge of all matters relating to tickets, rates of interurban fare and promotion of both regular and excursion passenger traffic. The division superintendents have supervision of the motormen and conductors and car service on each division. The superintendent of motive power is responsible for the operation of all power houses, the maintenance of rolling stock and the repair shops. The assistant superintendent of motive power, who is practically the electrical engineer of the company, has charge of all line construction and repairs, plans all electrical work, supervises all electrical testing and advises with the superintendent of motive power in power house electrical work. The duties of the other officers are evident from their titles.



VIEW ON ONE OF DETROIT'S NARROW RESIDENTIAL STREETS

Three-Cent Fares in Detroit

As it has been an impression on the part of the uninformed in various parts of the United States, that a number of street railway lines in Detroit are profitably operated with a 3-cent fare, in place of the usual 5-cent fare, and as arguments based on this erroneous impression are sometimes advanced when street railway legislation is pending in other cities, a statement of the true state of affairs in Detroit will be in order. There is no street railway company which ever carried passengers in Detroit for 3 cents, and there is nothing in the experience at Detroit to indicate that a cash fare of 3 cents could ever be made the basis of successful street railway operation.

In 1895 there was constructed in Detroit a system of street railway lines, which under the terms of the franchises granted must carry a passenger for a 5-cent cash fare, or a ticket costing $3\frac{1}{8}$ cents (8 for 25 cents) between the hours of 5 a. m. and 8 p. m. Between 8 p. m. and 5 a. m. the fare was to be 5 cents cash, or a ticket costing $4\frac{1}{6}$ cents (6 for 25 cents) with universal transfers over the system for one fare.

This system, built under the foregoing franchise terms, was the property of the Detroit Railway Company. This will be designated hereafter in this article as the low-fare line, and constitutes what is popularly known as the "3-cent fare" road. Previous to the building of this system the Detroit Citizens' Street Railway Company, which was the principal company in the field, and the Detroit, Fort Wayne & Belle Isle Railway Company were carrying passengers on a 5-cent cash fare basis, with six-for-a-quarter tickets, but were required by their franchise to honor eight-for-a-quarter "workingmen's tickets," as they were called, between 5:30 a.m. and 7 a.m. and 5:15 p. m. and 6:15 p. m. The Detroit Railway Company owning the low-fare lines was operated as an independent concern for about two years, after which it fell into the hands of the stockholders of the Detroit Citizens' Street Railway Company and Detroit, Fort Wayne & Belle Isle Railway Company. Since then all the roads have been practically operated as one, although actual consolidation into the one company, the Detroit United Railway Company, was not effected until early in 1901. All the lines are, of course, operated in compliance with the terms of the franchises under which they were built. The six-for-a-quarter tickets were discontinued on the 5-cent lines in 1898, after the consolidation of management.

As the present management has never been able to get an accurate statement of the operating expenses of the Detroit Railway under its original owners, it is impossible to say how long the system could have been operated independently, before requiring a receiver, but enough is known from present conditions to make sure that it could not have been for long. The merging of the two systems has made the profits of the combined lines average up fairly well by making the earnings of the 5-cent lines supply the deficit on the cheaper lines, and by making possible greater economies in operation through the elimination of one set of operating officers and assistants, as well as in numerous other small ways.

In the year 1901 the average fare received per passenger on the city lines of the Detroit United Railway, including both the high and low fare lines, but not including interurban lines, was $0.0425. The average fare per passenger on the low-fare line was about $0.0360. Of all the passengers carried in the city, 33 per cent were carried on eight-for-a-quarter tickets. Twenty per cent of all the passengers carried in the city were carried on the low-fare line, and 13 per cent were carried on workingmen's eight-for-a-quarter tickets, between 5:30 a. m. and 7 a. m. and 5.15 p. m. and 6:15 p. m. on the 5-cent lines. The mileage of the low-fare line is 57.9, and that of the high-fare lines is 129.9, so that the low-fare line has not only failed to attract by virtue of the low fares a larger proportionate share of the business in dollars and cents than the high-fare lines, but has failed even to carry as many passengers in proportion to mileage of track at a low rate as the high-fare lines have at 5-cent rates. Of course all the passengers carried on the low-fare line do not get the low rate since the cash fare is 5 cents and transfers to 5-cent lines are given only upon payment of a 5-cent fare. But this does not alter the fact that the 3⅛-cent fares taken on the low-fare line, are only 20 per cent of the total, while the mileage is 30 per cent of the total.

The usual argument made for financial justification by advocates of 3-cent fares is that they increase traffic and gross receipts enough to compensate for the lower revenue per passenger. This is disproved by the results in Detroit just stated, since both lines serve almost identically the same territory. Great care is exercised by the management to maintain the car service as fully up to the traffic demands on the low-fare line as on the high, to avoid any appearance of attempting to force the public to use the higher fare lines. The lower fare line is under some inherent disadvantages as to routes, because it was built after all the widest streets and most direct routes were occupied.

VIEW ON ONE OF DETROIT'S WIDE RESIDENTIAL STREETS

From the foregoing figures it is evident that the eight-for-a-quarter ticket does not appeal strongly enough to the pocketbook of the majority of the people so that they will take the trouble to take advantage of it.

Prior to August, 1898, as stated, there was a universal voluntary six-for-a-quarter ticket on the high-fare lines. The average fare per passenger on all the city lines was $0.0404. The six-for-a-quarter tickets were then abolished on the high-fare lines, which had the result of bringing the average fare on all city lines up to $0.0425, although some had urged that this move would decrease the average fare by driving passengers to the cheaper lines or to walking.

From the maps in this issue it will be seen that Detroit has a number of broad thoroughfares radiating directly from the business part of the city to the outskirts. These streets were occupied by 5-cent fare lines, with eight-for-a-quarter workingmen's tickets morning and evening, long before the low-fare line came into the field. When the low-fare line was built it had to take more indirect routes and narrower streets, but they reached nearly every portion of the city served by the 5-cent lines, and hence the greater portion of the people of Detroit have but to choose between the two.

In 1901 the Detroit United Railway operated for about

54 per cent of the gross receipts. The gross receipts on the city lines averaged $0.0425 per passenger, so that operating expenses, exclusive of fixed charges and sinking fund, to retire the bonds at the expiration of franchises, were $0.0229 per passenger. It does not require elaborate argument to demonstrate that with a fare aveiaging $0.036 on the low-fare lines, and operating expenses $0.0229 per passenger, the remaining $0.0131 will not begin to pay interest on the investment and sinking fund, which sums, on the majority of large street railway systems of to-day, amount to from $0.015 to $0.025 per passenger. In this connection it should be borne in mind that the average receipts per passenger on the low-fare line would be lower than $0.036 but for the fact that in order to obtain transfers to 5-cent lines a 5-cent fare is often paid on the low-fare line. However, it is not within the province of this article to speculate on what would be the case if the conditions were different. Its purpose is rather to set forth a few facts and figures on experiences with low fares in the city of Detroit.

From the foregoing the following conclusions can be reached.:

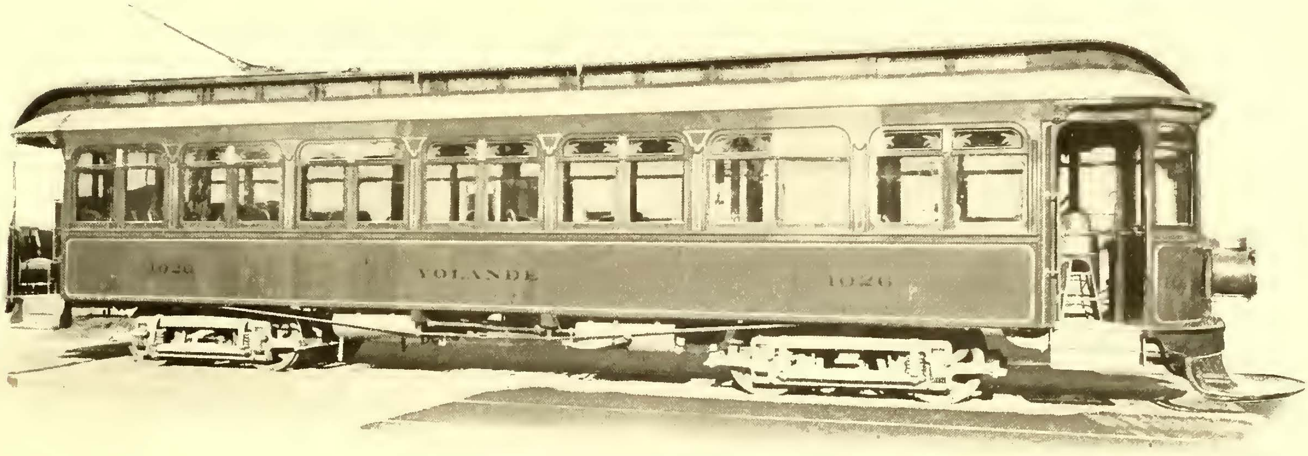
1. The greater part of the street car-riding public cares very little for saving fares, as is shown by the small percentage taking advantage of the privilege.

2. The slight difference in directness of the routes and the necessity of purchasing tickets to obtain low fares, are sufficient to counteract much of the advantage of the low fare in the public mind, and the public seeks the convenience of the moment and saving of time rather than a saving of 1⅝ cents in car fare.

3. The low fares carry so little weight with patrons that there is no increase of riding due to the reduction of fares below 5 cents; hence there is nothing in the argument that an increase in passengers carried will follow reduction of fares below 5 cents.

4. It costs as much to carry the passenger who pays 3⅛ cents as the one who pays 5 cents, and the deficit which would occur in the former case is only made up by the fact that on the entire city system the number of 5-cent passengers brings the average receipts up to $0.0425 per passenger.

5. There is always a happy medium. If passengers were charged $1 per ride the income, gross or net, would not be as great on street railways as it is now in America. The nickel seems to be the happy medium.



THE YOLANDE PARLOR CAR

The General Passenger Department of the Detroit United Railway System

Before discussing the work of the general passenger department of the Detroit United Railway, it will be in order to explain the conditions which make necessary the establishment of such a department on the part of this company. The company owns, not only all the city lines of Detroit but owns or controls 301 miles of interurban lines. On the interurban lines there is as much necessity for a passenger department to take care of the matter of tickets, rates, promotion of traffic and excursion business as there would be on any steam road. Furthermore, as regards the city lines, Detroit has a class of business which is but little considered in many cities, but which is a very important one in Detroit, namely, that coming from summer visitors and excursionists, who are in the city but a short time, and would naturally wish to see as much of the city as possible in that time. There is probably no city in the United States which has as many excursions and conventions visiting it during the summer months as Detroit.

INTERIOR OF THE YOLANDE

Several factors have combined to produce this state of affairs. Detroit is in itself an attractive city, and as it is located at a central point on the system of Great Lakes, all the traffic of the Great Lakes passes up and down the

Detroit River, and all passenger boats stop at Detroit. Excursion steamers run daily from Detroit to many points on Lake Erie and Lake Huron, the excursion business from Toledo and Cleveland being especially large. Thus, while the Detroit United Railway is forced, in a measure, to divide its pleasure traffic with the various steamboat lines, those very steamboat lines also bring it a large number of out-of-town visitors, who are among its best patrons, provided the business is properly looked after. This work comes under the supervision of John H. Fry, assistant general passenger agent, who has recently been giving special advantages of the Detroit United cars for sightseeing by some particular excursion.

In the way of more permanent and expensive literature there is one pamphlet entitled "Detroit, 1902," of sixty-four pages, well illustrated, with half-tone engravings, artistically grouped, several to each page. These engravings are from photographs taken of various attractive spots around the city of Detroit. Eighteen pages are devoted to Detroit; the balance of the book to points around Detroit, timetables, rates and advertisement of steamboat lines. The idea of this book was primarily to call attention to Detroit as a desirable place to make a summer visit. Another booklet, entitled "Along the Way," has been published especially to advertise the Rapid Railway System, the passenger department of which is in common with the Detroit United Railway. The company makes liberal use of the camera and half-tone engravings in the preparation of all of its advertising literature where this is possible.

DETROIT UNITED WEEKLY.

Vol. I. THURSDAY, JULY 17, 1902. No. 4.

Knowledge with the general public of how the electric railways and the boats unite during the summer in rendering an ideal service to those traveling during that period, is in the nature of valuable information. If for any reason it is inconvenient to visit the Flats at the time you can reach them by boat, a trolley car will land you there, the time that you have to enjoy that delightful resort before taking a down boat depending upon the time you can take the car. The same is true of all points on the American shore between Detroit and Port Huron, as it is as to Grosse Ile, Trenton and such other points as the boats touch down the river.

To those living out of the city, to whom the suburban lines are available, the advantages are exceptional. For instance, and just by way of illustration, a party may run in from Flint over the electric road in the morning, see the prettiest parts and chief points of interest in Detroit on the Yolande, board one of the magnificent liners for Buffalo at 4 p. m., reach that city at 7 a. m. the next day, take a trolley ride to the Falls, see all that is most imposing and beautiful at Niagara, having ample time and opportunity, return to the boat in the afternoon and be back in Detroit the next morning. This is a particularly attractive outing, to be commenced on Saturday morning and to end with the return home on the Monday following. The same opportunity and scores of others that cannot be mentioned in so brief an article are open to all within the large territory tributary to this service.

He—They tell me that your friend Madge is connected with the best families in Detroit.
She—Yes—by telephone.

The Bible Conference will open at Lake Orion July 18th and continue until July 29th. The big suburban cars take you to the doors of the meeting hall.

If a trolley meets an auto going to the Fair,
There's the trolley, where's the auto?
Echo answers "Where?"—*Cleveland Plain Dealer*

DETROIT UNITED WEEKLY.

HOW AND WHERE TO GO.

This time table is subject to change without notice.

SUBURBAN RAILWAYS. DETROIT UNITED RAILWAY, (Operates all Detroit City Lines.) Time Tables—Suburban Lines. Cars run on Detroit local time.

Wyandotte Division.—For Trenton half hourly, 6:03 a. m. to 10:35 p. m. and 11:35 p. m. First car one hour later on Sundays.

Pontiac Division.—For Pontiac, 6 a. m., 7 a. m. and half hourly until 7 p. m. Hourly until 11 p. m. First car one hour later on Sundays.

Orchard Lake Division.—For Northville, Orchard Lake and Pontiac, hourly, from 6 a. m. until 11 p. m. First car one hour later on Sundays.

Flint Division.—For Rochester and Romeo at 6 a. m., and every hour thereafter until 11 p. m. For Orion, Oxford and Flint, every hour from 6 a. m. to 9 p. m.; also for Orion and Oxford, at 10 and 11 p. m. Cars on Wyandotte division start fro mCadillac Square, and all other cars from corner Woodward and Jefferson avenues. Last car on all suburban lines leaving Detroit wait for the theaters. Waiting room, 70 Woodward avenue.

Rapid Railway System.—For Port Huron hourly, 7 a. m. to 8 p. m. For Mt. Clemens half hourly, 7 a. m. to 7 p. m., and hourly until 11 p. m. For Mt. Clemens via Shore Line, hourly, 6:30 a. m. to 9:30 p. m. and 11 p. m. Waiting room, 70 Woodward avenue. All cars start from Michigan Central depot.

Detroit, Ypsilanti, Ann Arbor & Jackson Ry.—(Standard time.)—Through cars Detroit to Jackson hourly from 6:00 a. m. until 9:00 p. m. For Ann Arbor half hourly from 6:00 a. m. until 10:45 p. m. First car one hour later on Sundays.

PLEASE NOTICE THIS.

The yellows, greens and reds, which since the installation of the service have been used to distinguish the suburban cars, will soon be disposed of. Soon there will be only one color for these cars that rush you past farm houses and quiet lakes and sylvan scenes. All our suburban cars will be but one color, and that a wine-maroon. The colors of Joseph's coat were all right for a while when the suburban service was new and the people were yet unfamiliar with our out-goings and in-comings. But now we are all pretty well accustomed to it, the lines, the routes and the time-tables. We not only know now where we want to go, but we know on what corner to take the Big Cars and the times of the leaving.

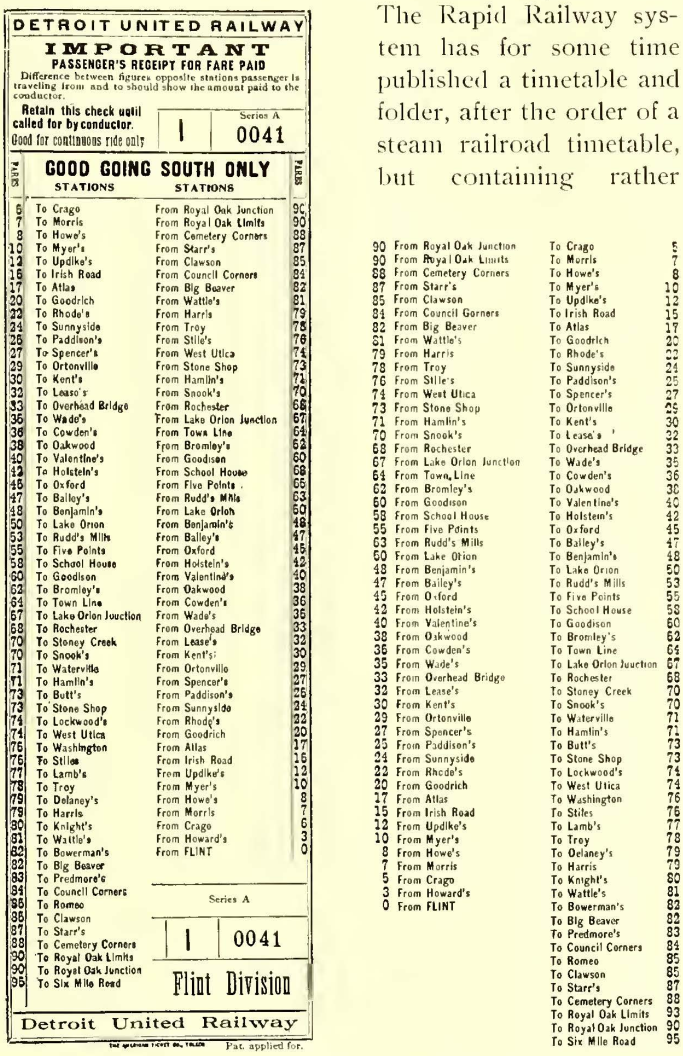
After this, you must look for the sign on the lower right hand side of the front vestibule, which will be absolutely unmistakable. It will by day be large and black, and unequivocable. By night it will be illuminated. Even in the heart of the city, where these Big Cars cross and intersect one another's lines and leave on about the same minute, there can be no confusion—no mistaking colors, no futile attempts to convince the conductor that he is on the wrong track, if you will read those signs, carefully, dispassionately, thoughtfully. These are one of the few varieties of signs to which one can pin his faith and retain one's self-respect.

TWO PAGES OF THE DETROIT UNITED WEEKLY FOR JULY 17

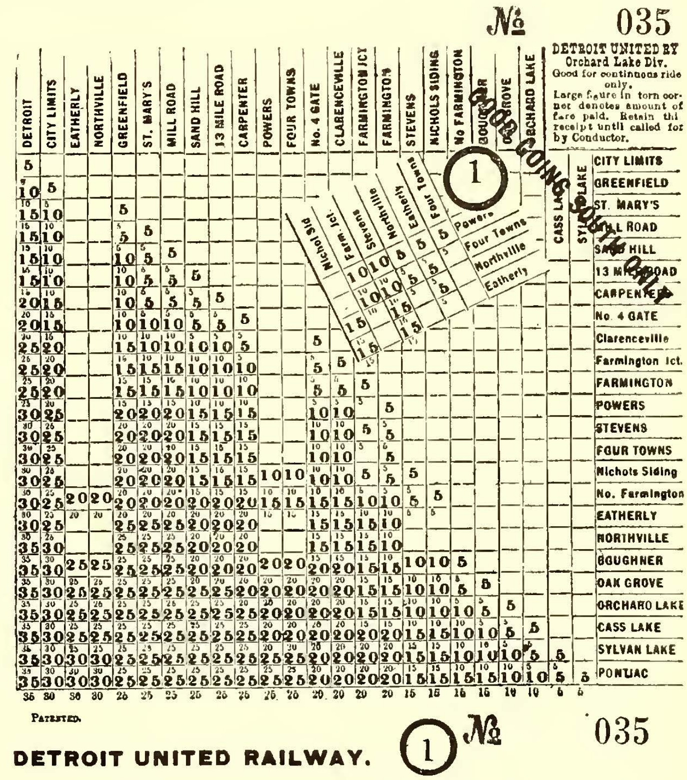
attention to various excursions coming to Detroit from out-of-town points. It has been the experience that unless the members of an excursion are posted before arriving in Detroit as to the possibilities of sight-seeing by means of the electric lines, that the patronage of many of them will be lost, and that it is useless to attempt to reach these people after they have arrived at the dock or railroad depot in Detroit. The practice has been begun, therefore, of sending out traveling passenger agents to distribute literature advertising the Detroit United Railway lines on excursion boats on the way to Detroit. Detroit United Railway literature has also been scattered among northern Ohio cities, from which there is considerable traveling to Detroit. The advertising literature published by the general passenger department forms an interesting collection. This literature takes the form of both small folders and more pretentious pamphlets. The small folders are usually gotten up for some special occasion—advertising advan-

For the special benefit of visitors from out of town, an observation parlor car, "The Yolande," makes five two-hour trips daily over the Detroit United Railway system within the city. These cars leave Cadillac Square at 9:00 a. m., 11:00 a. m., 1:00, 3:00 and 5:00 p. m., giving a two hours' ride over the most interesting and attractive streets. The fare for the round trip is 25 cents. When large excursions come to town, calling for greater seating capacity, additional open cars are run in the summer. "The Yolande" is well advertised around the hotels and also by itself, as it stands waiting for passengers in front of the Russell House, on Cadillac Square. It carries a full length sign, reading: "Take This Car to See Detroit in Two Hours." The sign is prominent without being obtrusive.

The Rapid Railway system has for some time published a timetable and folder, after the order of a steam railroad timetable, but containing rather more descriptive matter than the ordinary steam road timetable. This is the standard timetable folder, size 4 ins. x 8½ ins. No special timetable folder of the interurban lines of the Detroit United Railway lines is published, but the timetables of all these lines are given in the official railway guide of the interurban lines of Cleveland, Detroit and Toledo, which is issued monthly by the Electric Railway Publishing Company, of Detroit. This is a company of which several officials of the Detroit United Railway are directors. This guide is distributed free on all interurban cars of the lines to which it relates, and at all hotels, depots and waiting rooms. Formerly this company published timetables of all the cities enumerated, but recently only those radiating from Detroit and Toledo have been given in full in the Detroit edition, and more detailed information has been given in regard to Detroit lines. This folder contains a map of electric railway lines diverging from Detroit, timetables of all these lines and an index of towns and villages reached by electric interurban lines, giving the line on which they are located, the distance from Detroit, the fare and running time from Detroit.



FLINT DIVISION FARE RECEIPT, FRONT AND BACK



ORCHARD LAKE DIVISION FARE RECEIPT

In order to keep more closely in touch with the riding public, the "Detroit United Weekly" has been started for free distribution on cars, and judging from the demand it is being well read. This is a four-page folder, 4 ins. x 6 ins., printed on cheap paper, and the present edition of 10,000 was soon exhausted This weekly publication serves two purposes. First, to call the attention of the riding public to some of the inherent difficulties of street railway operation, which can be much relieved by the co-operation and thoughtfulness of the public; and, second, to keep the attractions along the street and interurban lines before both strangers and the people who live in Detroit, and who are consequently very naturally inclined to become indifferent to the good things close at hand. This is the only way a street railway company has of talking with the public, and it is undoubtedly often the case that the company's rules and regulations are misunderstood and

RAPID RAILWAY FARE RECEIPT

condemned, as they would not be if the company could talk to the public through the medium of such a publication. To put it briefly, the "Detroit United Weekly" is published with the purpose of keeping the public in closer touch and sympathy with the aims of the company to give good service.

This department has the adjusting of rates of fare and the selection of tickets under its charge. Different forms of tickets are used on each of the interurban divisions. These divisions were originally built by different companies under different franchises. In some cases the too eager promoters accepted franchises with regulations as to rates of fares in the various villages passed through, which have caused much trouble in the regulating of through fares. This simply serves to call the attention of interurban promoters to the importance of hampering themselves as little as possible by the acceptance of franchises requiring different rates per mile over different portions of the road, since it is desirable that the rates be as uniform as possible. They will be complicated at best on most interurban systems, and simplicity is worth a great deal.

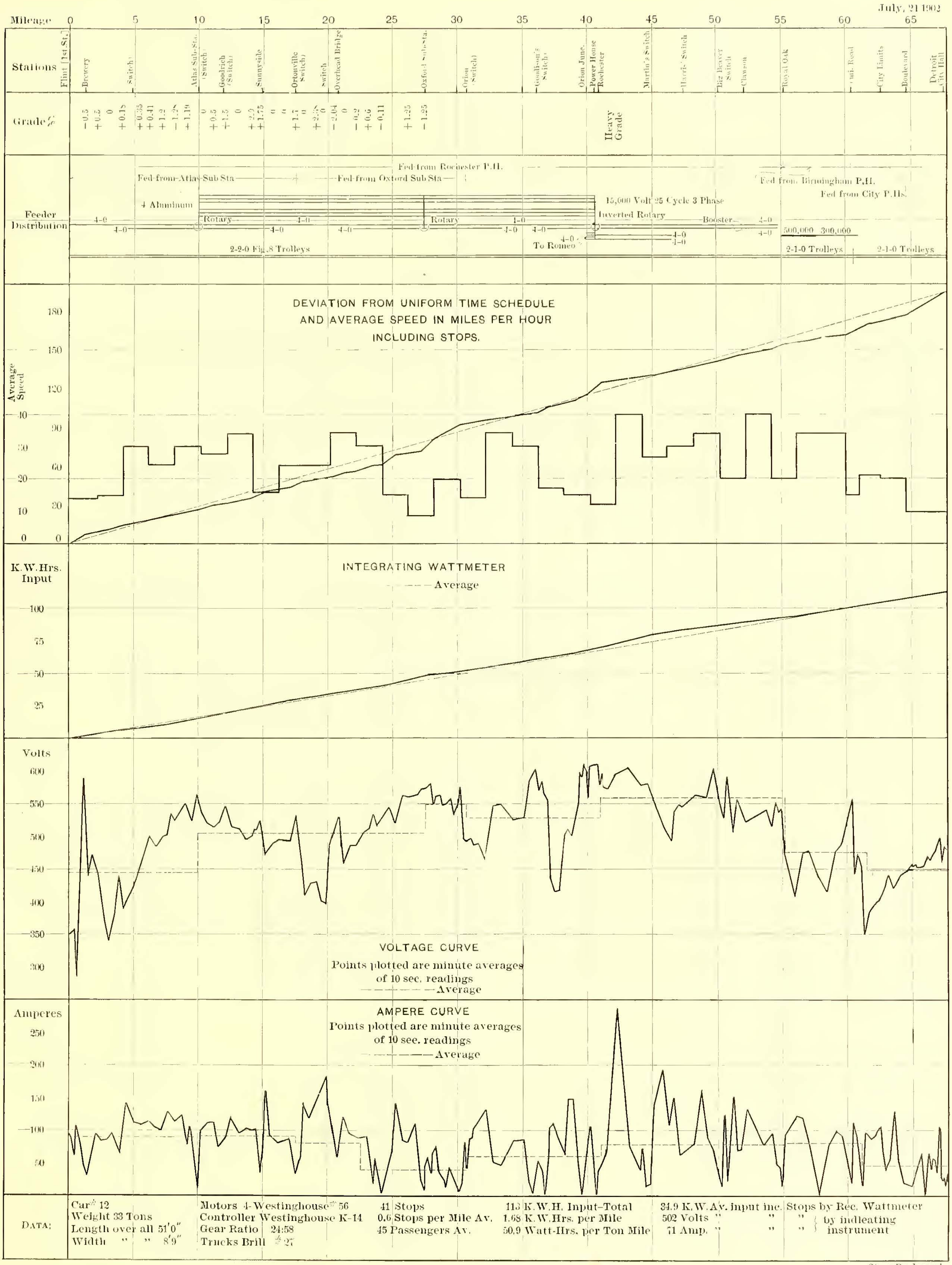
On the Pontiac Division there is practically no ticket problem at all, as there are but four rates of fare outside of the city limits, namely, 5, 10, 15 and 20 cents. On all cars of whatever division the fare inside the city limits is 5 cents, and is collected in the city and rung up on a register, just as if it were a city fare. The interurban cars belonging to the Detroit United Railway proper are run into the city by the same crews that handle them over the interurban lines. The cars of the Rapid Railway and the Detroit, Ypsilanti, Ann Arbor & Jackson Railway are taken into the city by different crews than those which operate them inside of the city, the city crews being in both cases employees of the Detroit United Railway Company, and a collection of fares being made just as if it were a city car. On the Pontiac Division the four rates of fare are registered on an Ohmer register, adapted for them. On the Flint Division the rates are more complicated. A long ticket, made by the American Ticket Company, of Toledo, is used. This has on its face in consecutive order all the stations on the line with the fare from the city limits. A different color is used for each direction. These tickets are carried in a holder, which can be set to tear the tickets at any desired point. The face of the ticket is torn so as to read from one point to another, and the difference between the fares opposite these two points indicates the fare paid. The back of this ticket is arranged in reverse order to the front. The stub, which is left to the conductor, is turned in to the auditor's office, and on the reverse side can be found the reading to correspond with the face, which was torn off and given to the passenger. On the Orchard Lake Division affairs were most complicated; a ticket made by the National Ticket Company, of Cleveland, has been adopted. On this ticket the apparatus instead of consisting of two slides, both of which must be adjusted, consists of a square, which is carried in the conductor's ticket book. Having brought the square to the two towns between which fare is to be paid, the conductor tears off that part of the ticket not covered by the square, giving it to the passenger, who then has the amount of fare paid in the bold-face type in the lower left-hand corner of his receipt. For the benefit of the auditor's office this same figure is put in small type in the next space below, so that the fare which has been paid can be read on the stub.

On the Rapid Railway system the regular steam road duplex cash fare receipt is used, and as far as possible tickets are sold at stations, though the number of passengers carried on tickets is very limited.

Tests on Energy Consumption of Electric Cars in Interurban Service Around Detroit

Tests on the power consumed by electric cars in electric interurban service having not as yet been very extensively carried on, the results of a few tests made on cars in regular service on interurban electric lines radiating from Detroit may be of value as showing the power requirements of cars in such service.

On the Detroit United Railway Company's system, E. J. Burdick, assistant superintendent of motive power, who has charge of the electrical work of the company, has not made any great number of tests, but the few which have been made were carried on with great care as to accuracy of instruments and observation. Car tests No. 10 and 12, made by Mr. Burdick on interurban cars of the Detroit United Railway, have resulted as shown by the accompanying curve and data sheets. These two tests were both made between the interurban waiting room in the city of Detroit and Flint, Mich., a distance of 67.8 miles. Cars were in actual service in each case, and these tests may be taken as representing fairly well the average conditions of interurban service on the Detroit United Railway system. Car test No. 10 covers a complete round trip. Car test No. 12 covers only the distance southbound from Flint to Detroit. Test No. 10 is recorded by two sets of curves, one set relating to schedule speed, and the other set relating to power consumption, as recorded by a carefully calibrated Thomson recording wattmeter. On the test sheet No. 10 the power consumption and schedule speed curves are both laid out on the same general plan, and both are distance curves. The schedule speed curves shown are from time readings taken at various mile posts. The average schedule speed is shown by straight lines between terminals, so that the variation from the average schedule speed for various parts of the line can be seen at a glance. In addition to these curves there are curves on the same sheet showing the schedule speed between various points along the line. This, of course, varies considerably. In this test the highest schedule speed noted between any two points was slightly over 35 miles per hour, for a distance of about 3 miles. In car test No. 12, made on the same kind of car and over the same route as No. 10, curves are given similar to those in No. 10, and in addition are plotted the readings of ammeter and voltmeter. As the data in connection with both of these tests is incorporated on the curve sheets, it will not be necessary here to recapitulate those figures, but as going to show the probable accuracy of the results, attention may be called to the fact that the average power input, as taken from the readings of the recording wattmeter in test No. 12, is 34.9 kw. The power input, as figured from the ammeter and voltmeter readings (502 volts multiplied by 71 amps.), is 35.6 kw. The difference between the results arrived at by the two separate means is therefore so close as to justify considerable confi-



CAR TEST NO. 12, DETROIT UNITED RAILWAY.

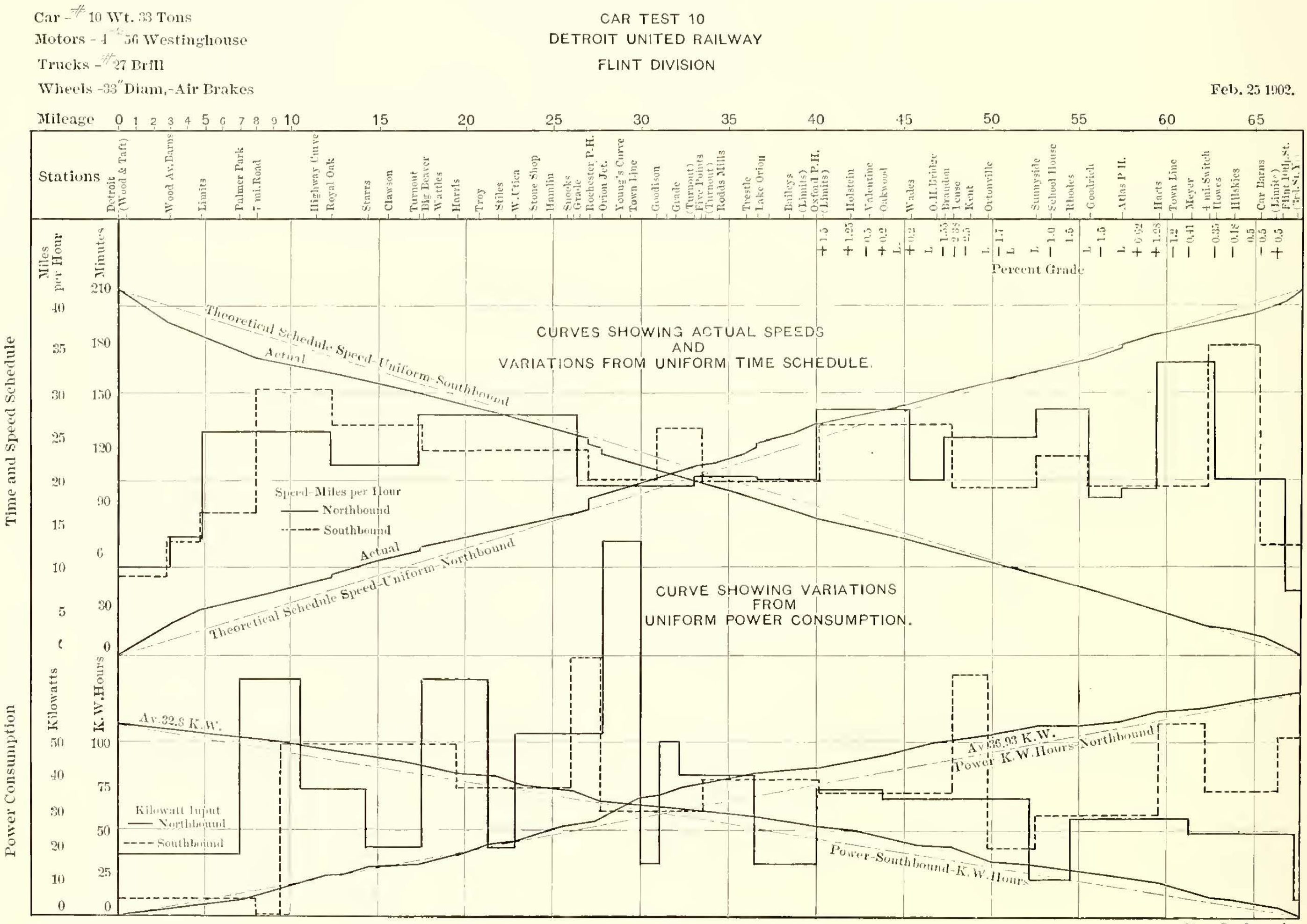
dence that the results can be depended upon, and a further check on their accuracy is that tests No. 10 and 12 also correspond very closely, as can be seen from the following table, which gives the comparative figures on the southbound trip for both tests:

Comparison of car tests on Flint Division, Detroit United Railway, southbound trips:

Date	Car 10 Feb. 25, '02	Car 10 July 24, '02
Car weight	33 tons	33 tons
Car length over all	51 feet	51 feet
Mileage of trip	67.8 mile	67.8 mile
Number of stops	43	41
Stops per mile	0.65	0.60
Time consumed on trip	3.57 hours	3.25 hours
Average speed, miles per hour	19.0	20.8
Kilowatt hours, total	111	113
Kilowatt hours, per car mile	1.64	1.68
Watt hours, per ton mile	49.6	50.9

The cars upon which these tests were made were the same in weight and equipment, as seen from the data given. They have seats for nineteen in the smoking compartment and thirty in the rear compartment. The hot-water heater and closet in the rear of the main compartment take the room of four seats on one side of the car, and the space opposite is left vacant as an aisle, being at the rear of the car, where unobstructed exit is desirable. Although no accurate information is available as to the maximum speed these cars will make on a level, with 500 volts at the motor terminals, this speed is probably in the neighborhood of 43 miles an hour.

Cars of this type, when running at full speed over ordinary interurban track, take from 150 amps. to 200 amps. The accelerating current will usually reach a maximum of 300 amps. to 350 amps., when the motors are thrown in multiple, though if the car is behind time or the grade slightly ascending, this will reach 450 amps. The track over which the two foregoing tests were made is mainly 60-lb. standard T-rail.



CAR TEST NO. 10, DETROIT UNITED RAILWAY

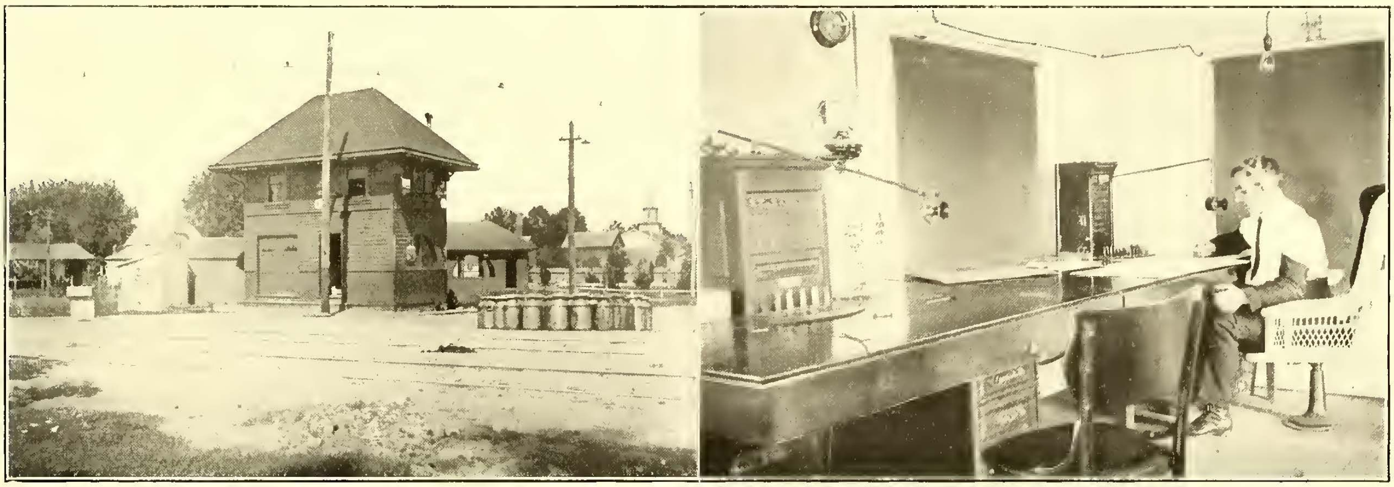
Train Despatching on Interurban Railways Around Detroit

All the electric interurban railways radiating from Detroit operate under despatcher's orders given by telephone. The methods used by the three different managements which operate these lines are very similar and differ only in detail. In each case telephones are located in cabins or booths at sidings along the line, and no attempt is made to carry telephone instruments on the cars. The orders are all received verbally, and no written record is kept on any of the lines.

The Detroit United Railway system operates all its interurban lines, except the Wyandotte Division, from one despatcher's office located at Royal Oak Junction, 14 miles from Detroit. From this point the despatcher has telephonic communication with the whole interurban system controlled by the Detroit United Railway. His office is on the second floor of the freight office and waiting room at that point, and commands a good view of the interurban lines which approach it from three directions.

Although the telephone lines are essentially for train despatching, they are also used in a limited way for transaction of general business. Their use, however, for this purpose is not encouraged, and it is understood that train despatching business has the right of way over anything else on these telephone lines. Should a line be in use for a conversation other than despatching business the employees have strict orders to immediately cease talking the instant a train crew calls the despatcher for orders, and not to continue conversation again until orders have been given. The despatchers work in three watches. They are men thoroughly familiar with the business as carried on by steam railroads and keep train sheets just as on steam roads.

Orders are received at the telephone booths of this company by the conductors and are repeated to the despatcher by the conductor. The motorman must be within hearing to hear the order repeated back. The telephone lines are mainly No. 10 Washburn & Moen gage B.B. iron wire. In the city and when passing through trees a waterproof insulator is used on telephone lines. Telephone lines outside the city are run on brackets with pony insulators, and are transposed every ten poles, except under high-tension alternating-current lines, where they are transposed every five poles. The transposition insulator made by the Hemingray Glass Company is employed for this purpose. The standard telephone equipment for booths consist of Stromsberg-Carlson telephone instrument No. 17 with an 1800-ohm ringer, a five-bar magneto generator which will ring through 60,000 ohms resistance. The instruments in each booth are connected with the line through a double-pole, single-throw baby switch. This switch is open when the telephone is not in use, and strict orders are given that it shall be so opened when not in use that the line may not be rendered inefficient by having a large number of instruments bridged across it. It is possible that some arrangement for automatically cutting out the telephone instrument when the booth is not in use will be employed. At the despatcher's office, the interior of which is illustrated herewith, there are two switchboards in duplicate for the despatcher, so that in case anything goes wrong with one board the other can be immediately switched in. The despatcher has four despatching lines entering his office, as can be seen from the map. Connection with any one of these four lines is established by simply throwing an operator's switch. The plugs shown on the operator's switchboard are for making connections between different despatchers' lines when they are used for general business. In the ordinary despatching operations the despatcher has only to throw his keys to connect his head telephone with the various lines. The circuits are so arranged that communication can be had with many points on the system from two directions, and double-pole switches are placed in a line at frequent intervals. In case a line is short circuited or grounded at a certain point the switches on both sides of the trouble can be opened and the work of despatching can then be carried on without interruption. Between Royal Oak and the general offices of the Detroit United Railway at No. 12 Woodward Avenue there is a main trunk line, and in addition to this there is a line solely for despatching extending from Royal Oak toward the city as far as Six-Mile Road. In case of an emergency the trunk line can be connected with the despatcher's circuit by means of switches located at the two telephone booths between Royal Oak and Six-Mile Road. A private telephone line is maintained by the company between the general offices at Woodward Avenue and the Jefferson Avenue shops. Another line runs from Woodward Avenue to the St. Antoine car house and the two power houses A and B. There is also a line to the Clark Avenue car house, from which car house the despatching of the Wyandotte line is carried on. In the city resort is frequently had to the expedient of running telephone lines suspended from the electric railway span wires by means of porcelain insulators. In some cases a common porcelain insulator is used tied to the span wire with the telephone line wire pulled through the hole in the center, and in other cases a porcelain insulator especially made for this kind of work has been put up. This location for the telephone wire keeps it free from interference with trees, which in Detroit and neighboring towns is a very important consideration, as the foliage is very heavy along many streets traversed by the electric roads.

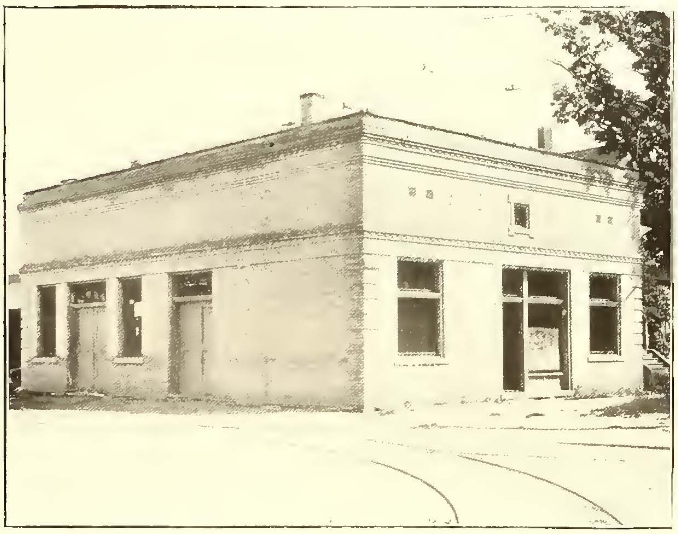


INTERIOR AND EXTERIOR OF DESPATCHER'S OFFICE AT ROYAL OAK JUNCTION

In general, it may be said that the greatest care is exercised to maintain telephonic communication without interruption, and in case there is trouble on any of the telephone lines its repair has the preference over any other work, as communication for despatching is the first essential in the operation of long lines of road. The despatcher not only governs the operation of cars on interurban lines, but is very helpful to all departments because he is in closer touch than anyone else with the actual operation of the entire system and just what is going on from hour to hour on the various parts of the road. He receives the first reports of troubles along the line, both large and small, and is of great assistance to track and overhead departments by reporting to them defects reported by trainmen.

The number of passenger cars under the despatcher's care on the interurban lines on the ordinary schedule is twenty-two. On special occasions this may be increased to forty. To this should be added the work cars, freight cars and supply cars, which, being irregular, run as extras, and so add to the despatcher's cares much more than in proportion to their numbers.

On the Rapid Railway system the telephones used for despatching are rented from the Bell Telephone Company, and are maintained by that company. The orders are received by the motorman and are carefully repeated back to the despatcher. The conductor stands close at hand while the motorman repeats the order back, and then the conductor also steps to the telephone and repeats the order. On the Ypsilanti road the orders are received and repeated back by the motorman.



SUB-STATION AND FREIGHT DEPOT ON RAPID RAILWAY

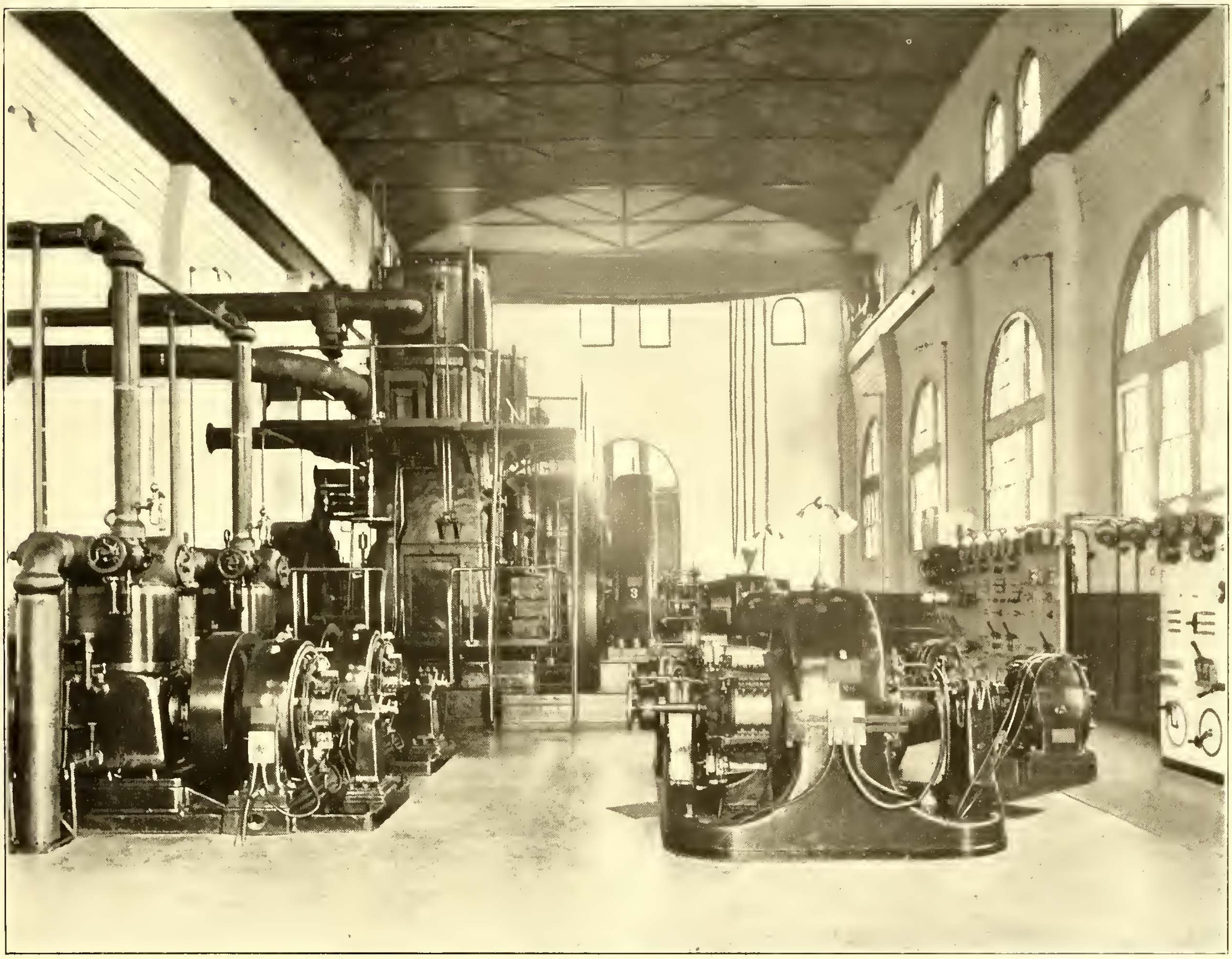
Motive Power and Rolling Stock on the Rapid Railway

The Detroit & Port Huron Shore Line Railway Company, commonly known to the public as the Rapid Railway system, was among the first of the interurban electric roads of the country to adopt an extensive system of alternating-current distribution. The power house which generates all the electrical energy used by the Rapid Railway system is located at New Baltimore, on Lake St. Clair, close to the line of the road. The power house supplies about 110 miles of city and interurban line. The interurban lines are shown by the accompanying map, upon which also are indicated the sub-stations from which direct current is supplied to the trolley line. The power house at New Baltimore is the work of Westinghouse, Church, Kerr & Company, and bears all the familiar engineering features common to the plants erected by that company. At this power house there are three units of 500 kw each. The generators are three-phase, 390-volt machines, and the engines are Westinghouse tandem compound condensing $21\frac{1}{2}$-in. and 37-in. x 22-in. stroke. The two exciters are 35-kw, 125-volt direct-current generators, direct connected to Westinghouse compound engines. In the boiler plant four Babcock & Wilcox water-tube boilers are equipped with Roney mechanical stokers. A centrifugal pump raises the water about 21 ft. for use in the Worthington jet condensers, which are located just under the boiler-room roof. Induced draft is,

EXTERIOR OF STATION AT NEW BALTIMORE

JEFFERSON AVENUE SHOPS

of course, used, there being two steam-driven draft fans, either one of which is sufficient to maintain draft for the plant. Before passing to the draft fans and the low stack, the flue gases are put through Green economizers, which reduce the temperature of the stack gases from about 520 degs. to 440 degs. A continuous record of flue-gas temperature is kept on the power-station log, which is kept daily by the engineer, reproduced herewith. The three alternating-current generators are connected to a common set of three-phase bus-bars through single-throw, three-pole switches. There are no circuit breakers in the generator circuits, the generator panels containing only synchronizing lamps and synchronizing plug receptacles, a three-pole switch, a double-pole field switch, a field rheostat, an alternating-current ammeter in each of the three legs, and an indicating wattmeter. From the 390-volt, three-phase bus-bars two rotary converters of 200-kw capacity each are operated directly. These supply the trolley lines near the power house. There are two sets of step-up transformers also operated from the alternating-current bus-bars. One set supplies the 16,000-volt high-tension transmission lines running north and the other set the high-tension line running south. There are, therefore, six transformers in regular service, with a seventh as reserve. Each bank of three transformers has a low-tension panel, through which the current to it passes. In this panel there are automatic circuit breakers in each leg of the circuit. From this description it will be noticed that the circuit breakers are placed only in the transformer circuits, and not in the generator circuits. The two rotary converters, which are run from the power-house bus-bars, are protected by fuses in each leg. The frequency of the alternating current in this station is 28 cycles, which is rather unusual. The high-tension lines, as indicated by the accompanying map, extend 40 miles north to Port Huron, and 21 miles south toward Detroit, as far as Roseville sub-station. The high-tension mains are all No. 1 copper wire on Locke porcelain insulators, Nos. 3 and 4. As indicated by the map, in addition to the current supplied to the trolley line from the rotary converters at New Baltimore power station, there are sub-stations at Mt. Clemens, at Roseville, at Algonac, at St. Clair, and at Port Huron. The latter supplies city lines in Port Huron. The majority of these sub-stations are equipped with two 200-kw rotary converters.



INTERIOR OF NEW BALTIMORE STATION, RAPID RAILWAY

The arrangement for feeding direct current from the sub-stations to the trolley lines is of interest. The trolley line is sectioned opposite each sub-station, as is customary in alternating-current transmission practice for interurban lines, and, as usual, there are two feeders leaving the direct-current bus-bars at the sub-station, one for supplying the trolley line in one direction and the other for supplying the trolley line in the other direction. Each trolley section, therefore, is fed by the sub-station at each end, so that the sub-stations can, to a certain extent, help each other in carrying the load, and as long as all the feeder-panel switches and circuit breakers are closed all the trolley-wire sections on the road are connected together. In case of short circuit on one section the feeder-panel circuit breakers in the sub-station at each end will open. The peculiar tap, and, even though this resistance may be small, it serves in a measure to reduce the current which may flow. After a direct-current feeder has been tapped into the trolley line about a mile from the sub-station, taps are made to the trolley line after that every twelve to fifteen poles. On the lines between Mt. Clemens and Port Huron the direct-current copper consists of two No. 00 trolley wires supplemented by a 450,000 cm feeder. From Mt. Clemens to

Rapid Railway System New Baltimore Power House

Daily log for twenty-four hours ending 5 a. m. Monday, August 25, 1902

Machinery in Service	Record	Time Started Up	Time Shut Down	Time Run	Men on Duty	On	Off	Hours On
Generator No. 1	390 voltage	6.00 a. m.	1.45 a. m.	19.45	Engineers			
Generator No. 2	390 "	9 00 a. m.	11 20 p. m.	14.20	D. J. Richards	5 30 a. m.	4.00 p. m.	
Generator No. 3	390 "	5.30 a. m.	12.30 a m	19.00	Thos. Hubbard	4.00 p. m.	2.30 a. m.	
Exciter No. 4					Fireman			
Exciter No. 5	1:0 "	5.00 a. m.	5.00 a. m.	24.00	Geo. Rivard	6.00 a. m.	4 00 p. m.	
					Ed. Munion	4.00 p. m.	2 00 a. m.	
Rotary No. 1	600 "	6.00 a. m.	1.45 a. m.	19.45				
Rotary No 2	600 "	6.00 a. m.	12.00 m.	18.00	Oilers			
					Robt. Kleehammer	5.30 a. m.	4.00 p. m.	
Boiler No. 1	155 pressure	5 00 a. m.	5 00 a. m.	24.00	Arthur Rivard	4.00 p. m.	2.00 a. m.	
Boiler No. 2	155 "	"	"	24.00				
Boiler No. 3	155 "	"	"	24.00	Dynamo Tenders			
Boiler No. 4	155 "	"	"	24.00	Steven Mildrum	7.00 a. m.	5.00 p. m.	
Boiler feed pump No. 1		5.00 a. m.	2.30 a. m.	21 30	Coal & Ash Handlers			
Boiler feed pump No. 2					Joe Heuser	6.00 a. m.	4.00 p. m.	
					Dan McEachran	6.00 a. m.	4.00 p. m.	
Rotary Pump No. 1		5.00 a. m.	1.45 a. m.	20.45	A. Lapouse	4 00 p. m.	2.00 a. m	
					Abe. Rivard	4.00 p. m.	2.00 a. m.	
Air pump No. 1		5.00 a. m.	7.00 a. m.	2.00	John Hubarth	7.00 a m.	5.00 p. m.	
Auxiliary pump					Boiler Cleaners			
					D. Butler	7.00 a. m.	5.00 p m.	
Stoker engine		5.00 a. m.	1.45	20.45				
					Watchman			
Fan Engine No. 1		5 00 a. m.	1.45	20.45	Wm. Carter	7.00 p. m,	5.00 a. m.	
Fan engine No. 2								
Economizer		5 00 a. m.	5 00 a. m.	24.00				
Feed water temp at pump	70 degs. Fah.				Laborers			
" " after first heater	115 "							
" " after second heater	177 "							
" " after economizer	237 "							
Flue gas temperature	515 "							
Flue gas temp. after economizer	433 "							
Temperature condensing water	88 "							
Vacuum gage	25 inches							
Insulation of high tension line	Volt. to ground							
South line, leg 1	0 volts							
" leg 2	0 "							
" leg 3	0 "							
North line, leg 1	0 "							
" leg 2	0 "							
" leg 3	0 "							
Weather— 6 a. m., fair								
" 12 noon "								
" 6 p. m., cloudy								
" 12 m., clear								

Watt-Meter Readings	Left Hand Meter	Right Hand Meter
Reading to-day, 5 a m.	5,575,500	5,954,100
Read'g yesterday, 5 a.m.	5,565,000	5,943,100
Difference	10,500	11,000
Total kw hours	21,500	.....

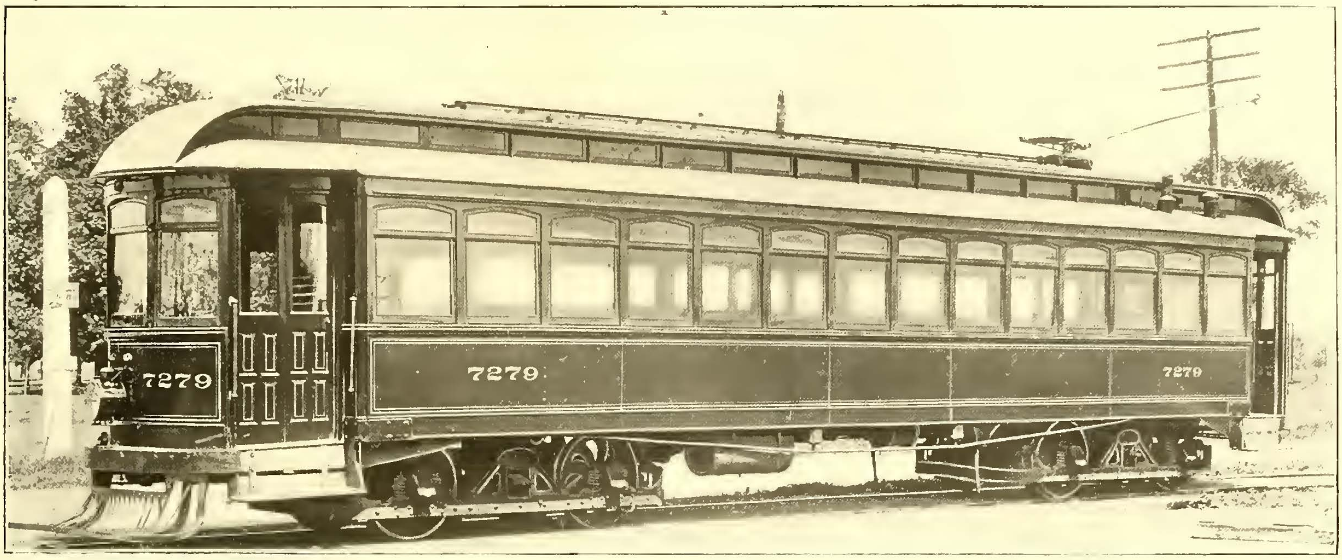
Remarks

POWER STATION LOG, RAPID RAILWAY

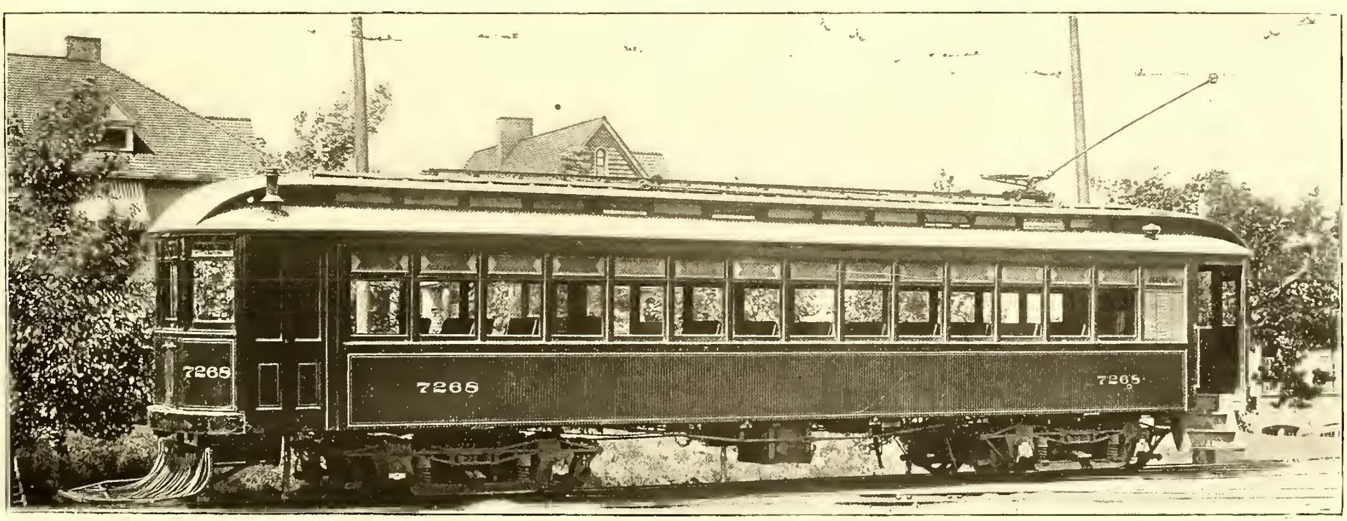
thing about the direct-current feed on the Rapid Railway system is that instead of connecting the feeders directly to the trolley line at the sub-station no tap is made to the trolley line until about a mile from the sub-station. Mr. Marshall, the chief engineer, believes that this is a very good plan, because it does not throw so great a strain on the sub-station machinery in case there is a ground or short circuit near the sub-station. The current that will flow in case of a short circuit is reduced somewhat by the resistance of the feed wire between the sub-station and the first trolley

Detroit along the Shore Line there are two No. 00 trolleys supplemented at Mt. Clemens by a 450,000-cm feeder from the Mt. Clemens sub-station and at the Detroit end by a 450,000-cm feeder run across country from the Roseville sub-station. On the Shore Line between Mt. Clemens and Detroit, where interurban traffic is the heaviest, there are two No. 00 trolleys and three No. 0000 running each direction, as indicated on the map.

Before the Port Huron and city lines were operated from the New Baltimore power house a good opportunity was afforded for determining the power required per car mile for interurban cars of the kind used on the Rapid Railway. Most of the cars on the Rapid Railway are geared for a maximum speed of about 45 miles per hour, some of them being four-motor equipments, and some two-motor. The four-motor equipments usually reach maximum speed sooner than the two-motor equipments, although when up to speed they run about the same. It was found that the power required per car-mile for the interurban cars as measured at the low-tension bus-bars at the power house, and which includes, therefore, the losses in step-up and step-down transformers, high-tension lines, rotary converters and direct-current feeders, was about 3 kw-hours As to the maximum load coming upon the power house when running interurban cars alone, the following figures represent conditions as they existed part of the time before the Port Huron city lines were operated from this power house.



PASSENGER CAR, RAPID RAILWAY



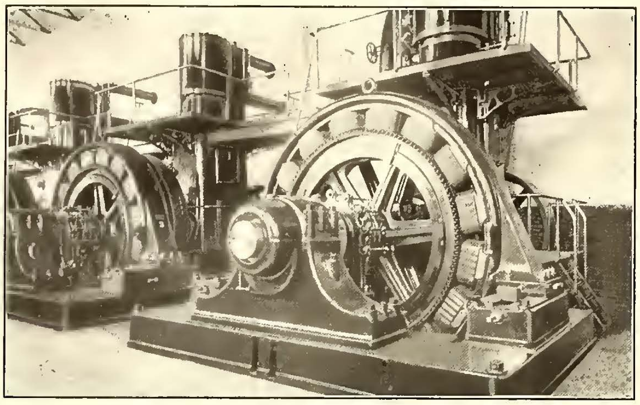
PASSENGER CAR, RAPID RAILWAY

There were in operation cars as follows:

29-ton passenger cars, four-motor equipment..	8
21-ton passenger cars, two-motor equipment..	6
25-ton freight cars, four-motor equipment....	3
Line construction cars......................	2
8-ton city cars in Mt. Clemens..............	2
	—
Total	21

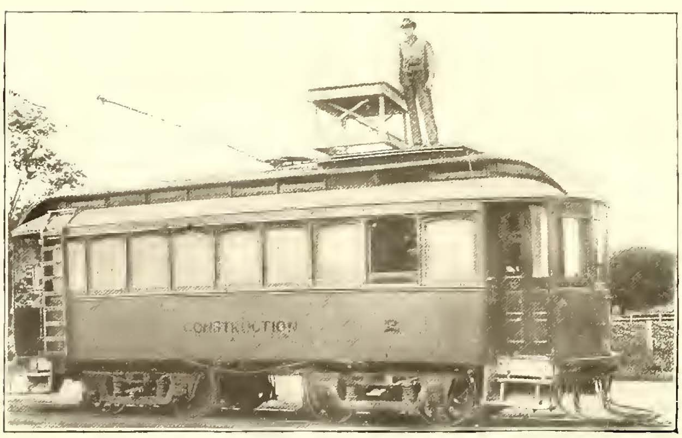
The output for a run of twenty hours was about 14,000 kw-hours, or an average of 700 kw. This represents an average input of 33.3 kw per car in service. Of course, for the interurban passenger cars which are in motion a greater part of the time the input per car would be considerably more than this, as the above list includes the freight cars, line construction cars and two light city cars. Indeed, the power required by the city cars is probably in the neighborhood of 15 kw average, or less than one-half that of an interurban car. With the above list of cars in operation, the maximum evening load, when nearly all the cars would be moving, was about 1384 kw, a maximum of 65.9 kw per car.

Several types of passenger cars are operated by this company, some of which are illustrated herewith. Those now in operation regularly have smoking compartments in the front, and are equipped to run single ended. In these various cars the hot-water heaters are placed in various positions. That preferred by W. O. Wood, general superintendent of the road, who has charge of the operation, is in the front vestibule beside the motorman. When placed in the vestibule it takes up less valuable room than in any other place in the car. The dust and ashes are kept out of the passenger compartment, and the heat is given a better distribution through the car than is possible by placing the heater in any other location. The motorman's vestibule is likely to be the coldest place in the car, as when running against a cold wind considerable cold air is sure to find its way into the vestibule. It seems but logical, therefore,



GENERATOR, RAPID RAILWAY

that the heater should be placed in the vestibule, so that it cannot only keep the motorman warm, but will radiate the most heat from the pipes in the forward end of the car. In case there is much passenger travel the motorman has much more time to attend to the heater than does the conductor. The argument sometimes advanced that if the heater is placed in the vestibule the motorman will keep the fire too low in order to keep the vestibule from getting too hot is an argument against the type of heater used, and not against



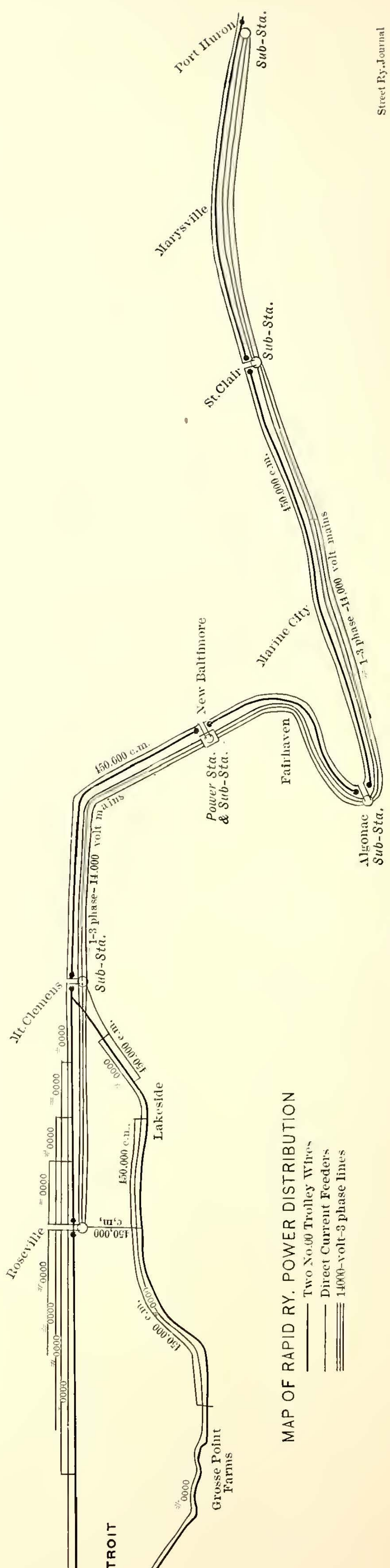
CONSTRUCTION CAR

the practice of placing it in the vestibule. A heater so constructed as to radiate a large amount of heat into its immediate surroundings is not an efficient hot-water car heater.

The mileage of the motor-armature bearings is kept track of closely, and when an armature is run 20,000 miles in a set of bearings it is watched carefully, as it is known to have reached a point where it will not last a great while longer. Kalamazoo trolley wheels are used, from which a life of from 5000 to 10,000 miles is obtained, which is an excellent record for such severe interurban service. The trolley-wheel pressure on the wire is adjusted at about 35 lbs.

A car equipment of four 75-hp motors has proved the most successful, the cars being about 50 ft. over all.

All the mechanical and electrical work on the system, including power station, sub-stations and car equipments, is under the care of A. C. Marshall, chief engineer.

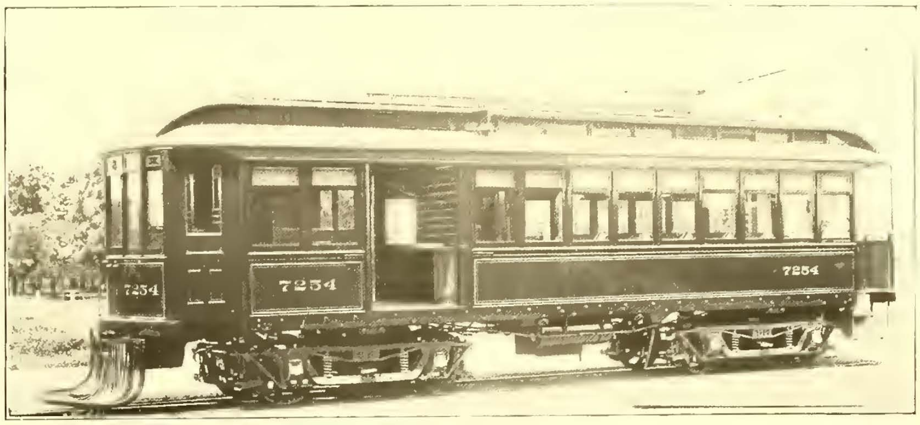


POWER DISTRIBUTION SYSTEM OF RAPID RAILWAY.

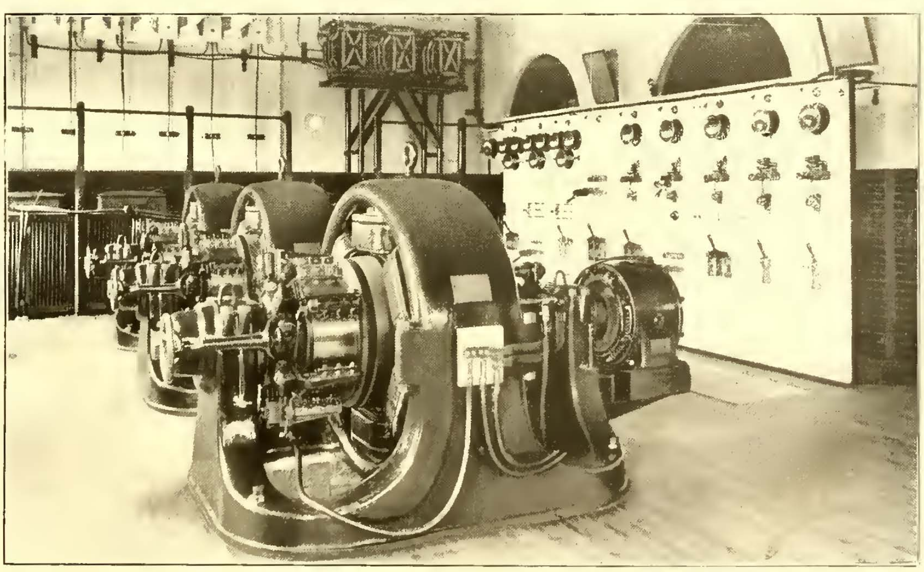
The Operation of Electric Interurban Railways

BY W. O. WOOD, GENERAL SUPERINTENDENT RAPID RAILWAY SYSTEM.

The manager of an interurban electric railway must meet many of the problems which are involved in the operation of electric street railway in city and suburban districts, and at the same time be thoroughly conversant with the laws of transportation which have been evolved in the operation of our steam railways. To the steam railroad man, who is accustomed to dealing with large train units and large mileage of track, the operation of an interurban electric railway of 4 miles to 100 miles in length is likely to appear at first a very simple proposition. With the steam railroad superintendent, who has given up steam railroading to engage in the supervision of an interurban electric railway, there is no such illusion, however. He may think upon first assuming his duties that as compared with operating a division of a steam railroad of double the length, operating an electric interurban road will be an easy proposition. The small scale upon which many operations are carried on upon an electric road has a tendency to make the steam road man feel something akin to contempt until he has faced the problems himself. After he has done this he realizes that the great number of small train units and the amount of detail which goes to make up successful operation of an electric interurban road call for an immense amount of care and work on the part of the successful operating superintendent. The same thing holds true all down the line, even to the conductors and motormen. A former steam railroad engineer once applied for work as a motorman upon the system with which the writer is connected. Upon being informed that he must take six weeks as student to learn the road before he could be put regularly in charge of a car, he gave up his application in disgust, with the remark that if he could not learn the whole road in two trips he would eat it. This simply illustrates the feeling among the steam road men above referred to. It was, of course, hard for that engineer to realize that 50 miles of electric interurban road contained far more turnouts and meeting points, sharp curves, possible stops for passengers and points calling for caution than double that length of ordinary steam railroad. It is in the mastering of many details that successful interurban electric railway operation depends, from the motorman and conductor up to the general superintendent. Owing to the great number of train units and the local character of the business of the electric interurban road, the promptness of action required by the operating force of such a road is second only to that of a city street railway, and there is no time for the red tape which characterizes the management of our great steam railway trunk lines. Steam railroads to-day are organized upon the one-man power principle, all matters being referred up from one official to a higher official, until frequently the man least conversant with the local needs and conditions makes the final decision. While of course a perfect organization requires a certain amount of red tape of this kind in order that the system may be operated as a unit under the control of a single head, it is not practicable to carry it to such an extent in the operation of an electric road. The responsibility must be placed to a large extent with the man who is on the scene of action, and he will frequently be called upon to decide, upon short notice, as to the proper course, because there is no time to refer to higher authorities. The men upon the ground must be held responsible for the results, and given responsibility, rather than depended upon as machines for referring all matters to higher officials.



COMBINATION BAGGAGE AND EXPRESS CAR RAPID RAILWAY



ROSEVILLE SUB-STATION, RAPID RAILWAY

The operation of the Detroit & Port Huron Shore Line Railway, commonly known as the Rapid Railway System, is carried on in many respects like a steam railroad, with the necessary deviations from steam railroad rules of practice and management called for by the conditions. The company operates 107 miles of interurban electric road, and about 16 miles of city street railway in the cities of Port Huron and Mt. Clemens. The distance from Detroit to Port Huron, which is the greatest distance over which cars are operated, is 73 miles. The line from Detroit to Port Huron is divided into two operating divisions. Motormen and conductors starting from Port Huron, leave their cars at a point about half way to Detroit, changing to cars bound toward Port Huron at meeting points near the division line. The divisioning of the road in this way is believed to be a desirable feature on any electric interurban line of this length. While it is the tendency in steam railway practice to lengthen divisions, it must be remembered first that steam-railroad speeds have been gradually increasing, and second, that the motorman and conductor of an electric car have many more details to think of than the conductor or engineer on a steam railroad. Furthermore, the average conductor and motorman obtainable for service on an electric interurban road have not anywhere near the previous training and experience in the business that engineers and other trainmen on steam roads have had. Trainmen perform their duties best only when they have had such former practice in them that many of their operations become a kind of second nature or mechanical. By working train crews over short divisions on an electric road they are given a better opportunity to learn thoroughly everything pertaining to that division. A man running several times a day over a road comes to know it much better than a man who passes over it only twice a day. The men come to know the regular passengers and the points at which they board and leave the cars. They learn more accurately the exact location of stopping points, the rates of fare, the streets in the numerous towns and villages passed through and the hundreds of little points which go to make up efficient train service. Motormen learn grades, curves and turn-outs, and just where it is possible to make fast time and where it is not safe to do so. Were electric interurban roads all constructed as steam trunk lines, so that it would be possible to make high speeds over a large per cent of the route, regardless of curves and passage through towns, they could operate cars well without changing crews over much longer divisions than at present.

As before intimated, men are required to take from four to six weeks to learn our 107 miles of interurban road. This does not include operation in the city of Detroit, as the Detroit United Railway Company's crews take our cars at the city limits. The conductor on an interurban car which will seat fifty passengers, and which frequently carries many more on special occasions, must be well educated to his work if he is to perform it with anything like efficiency. Once educated, there are many things which come, as said before, a kind of second nature, but for a new man there is an immense amount of detail to remember and to get practice in. If it were possible to have all passengers purchase tickets before boarding the cars and to relieve the conductors of as many duties as possible, as is being done on steam roads, the problem would be very much simplified.

The Rapid Railway system maintains ticket offices at its terminals and in all the principal villages which it passes through, but there are necessarily a large number of places where ticket offices cannot be maintained. Even where there are ticket offices there is little inducement for a passenger to purchase tickets, because, under the conditions, it is impossible for the company to discriminate against cash fares either by charging extra or by an extra charge with a rebate, for the simple reason that so many passengers must necessarily get on at points where tickets cannot be purchased. The collection of cash fares, therefore, puts a great amount of work on a conductor which would not fall to him were it possible to do all business by tickets, as on steam roads, and, furthermore, the conductor must be better trained for his work than if he were simply collecting straight 5-cent fares on city lines.

The average distance traveled per passenger on our interurban lines has been found to be about 12 miles, which goes to show the number of passengers the conductor must deal with on a run of 73 miles. Although, as said before, conductors and motormen on the through cars of the Rapid Railway System only operate over half the length of the road under ordinary conditions, they are required to learn the whole road during the student period, so that in emergencies they can do service on either the northern or southern divisions. The movement of trains is under a modification of the standard code of train rules as adopted by the American Railway Association, with the telephonic train orders given by the despatchers at Mt. Clemens and repeated by both motorman and conductor, who are held equally responsible for their execution. The distances between sidings are so short that it is not desirable to take time to write out an order as it is received, but the danger of accident due to lapse of memory is provided against by not giving an order an unnecessary length of time (seldom more than ten minutes) before it is to be executed. Definite meeting points are given instead of "wait" or "time" orders. Trains running on time move against other trains, as provided in time table, without orders from despatcher. A train sheet and order book shows a record of train movement and train orders that is complete and comprehensive.

The handling of extra traffic on Sundays and holidays is accomplished on the Rapid Railway System in two ways. It may be noted here that the fact that the road reaches a number of pleasure resorts along Lake St. Clair and the St. Clair River makes the amount of pleasure riding greater than it would be on many interurban lines where no such special attractions existed. We have one division called the Shore Line Division which follows the shore of Lake St. Clair and the Detroit River from Mt. Clemens to Detroit which has cars regularly during the week at one-hour intervals. During the summer as a regular thing this service is doubled on Sundays, and since such doubling up of the service is generally known to people who patronize this line regularly it is a more efficient and desirable way of taking care of the extra traffic than running two or three cars upon one-car time as different sections of the same train. This plan of doubling the frequency works well where people who patronize the cars know in advance that the extra service is being given. On our main line, however, which is the short line from Detroit to Mt. Clemens, and runs from Mt. Clemens along the shore to Port Huron, a great deal of the extra traffic comes from strangers, and we have no means of posting these people as to the fact that any extra cars are being run. The most feasible thing then is to run two or more cars upon the time given on our time tables for one car. This, of course, causes some delay at meeting points, because cars must always wait for the different sections of an opposing train. In case two cars are being run on one car's time there will be a delay of one or

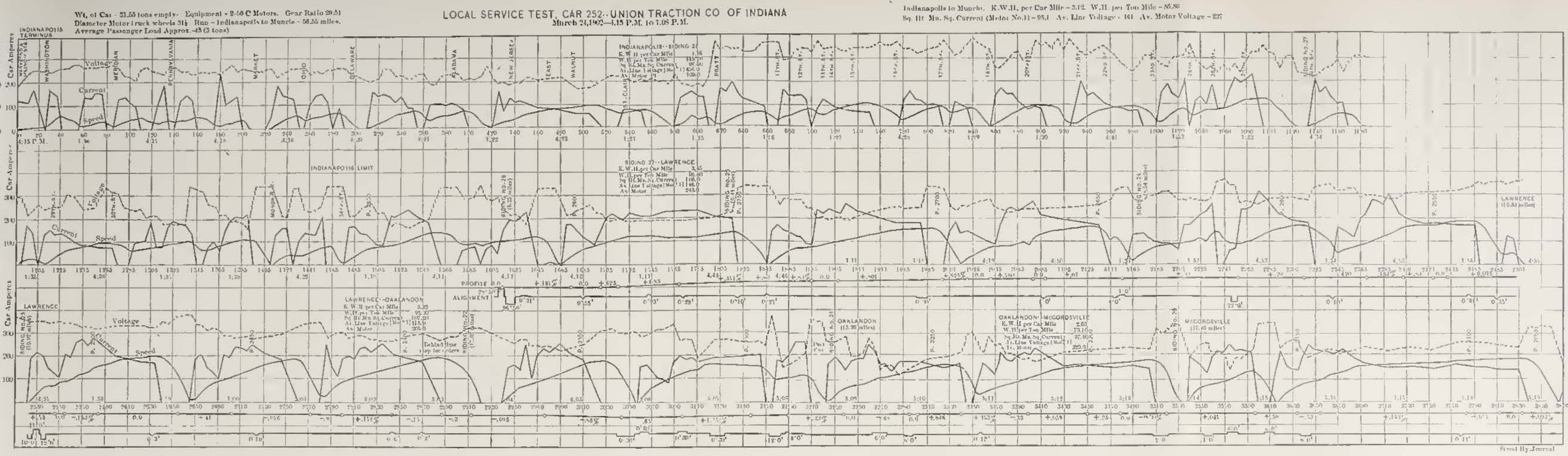


FIG. 4

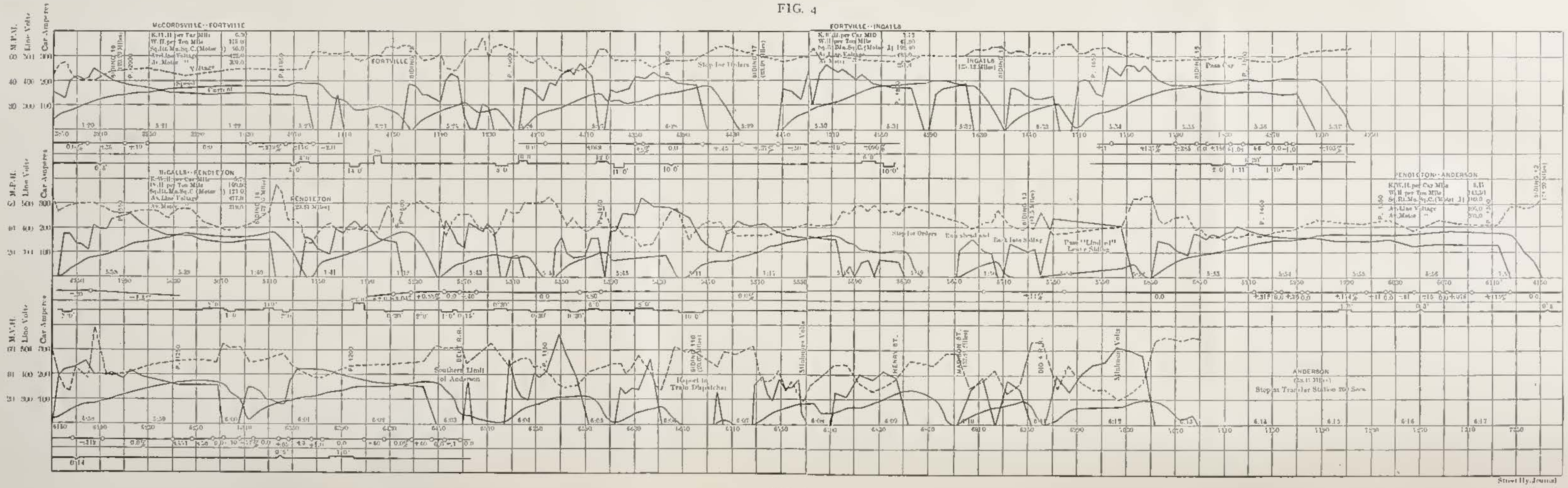


FIG. 5

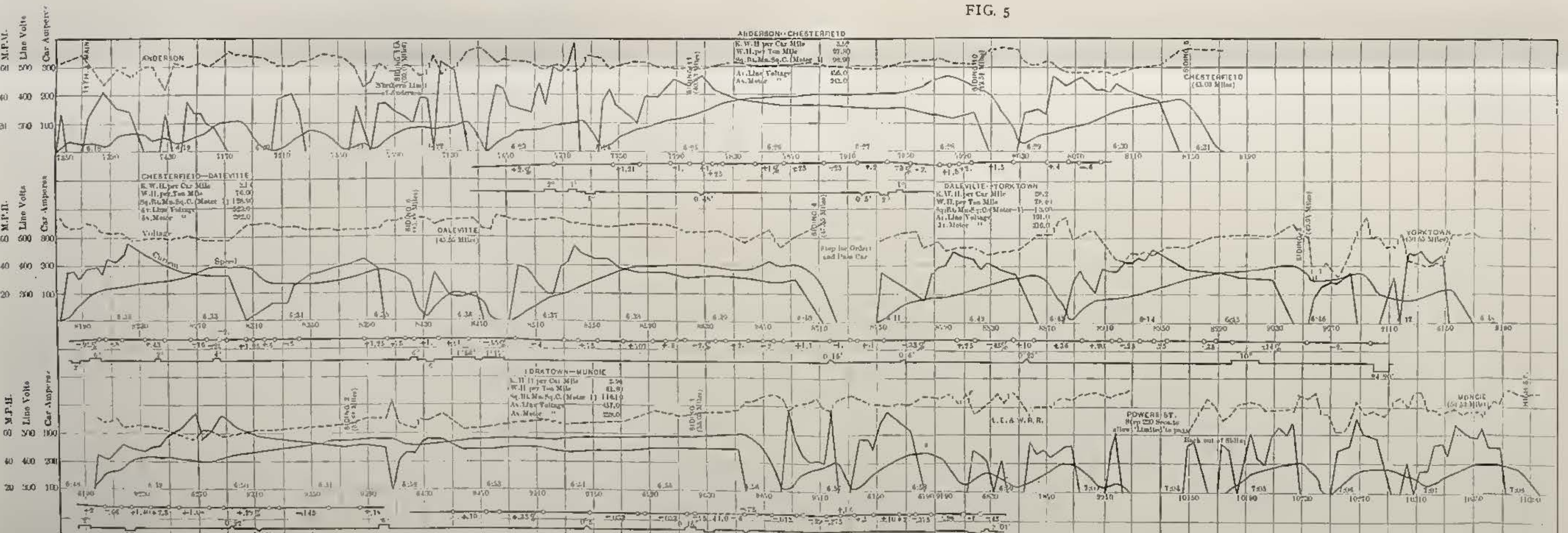


FIG. 6

Accompanying Article on Tests of Interurban Cars of Union Traction Company of Indiana

By Clarence Renshaw

two minutes while the second section is arriving at a meeting point. However, this delay is partly made up for by allowing the car ahead to leave some of the local stops for passengers to the following car. On the main or short line between Detroit and Mt. Clemens a half-hour service is regularly maintained. From Mt. Clemens on to Port Huron the cars run at one-hour intervals.

A car leaves Mt. Clemens on the regular time every half hour without regard to whether the cars from Port Huron are on time. That is, if the through car from Port Huron should be delayed by the heavy rush of summer business, a car is started to Detroit from Mt. Clemens upon its time and the car from Port Huron can then run through from Mt. Clemens to Detroit without any stops save for letting off passengers from points north of Mt. Clemens. The through Port Huron car can, therefore, arrive at its destination, Detroit, on time. The suburban business into Port Huron is cared for in a similar manner to that just described, and insures compliance with the timetable.

It might well be the work of the American Street Railway Association, which now numbers among its members so many interurban companies, to appoint a committee of interurban superintendents to codify what ought to be the operating rules for interurban lines. It seems to me that we are getting to a point where there should be some such recognized standards in operating rules and methods. It would mean much to those of us who at present have to contend with totally inexperienced help in times of heavy business.

The Rapid Railway system keeps about eighty motormen and conductors on its regular runs, with from ten to twenty extra men. This brings up an operating point wherein interurban roads are at considerable advantage over city lines, namely, in the small number of extra motormen and conductors required and the relatively large amount of work which it is usually found possible to give these extra men on an interurban road, thereby keeping them well paid and satisfied, where the city road would have difficulty in doing the same thing.

In the maintenance of our track and right of way, which comes under the operating department, the interurban road is divided into sections from 8 miles to 10 miles in length with one foreman and six men for each section. These track men are employed by the company the year around, although, of course, during the frozen period in winter they cannot do much track work. At such times they are put at such other work as needs to be done, walking track, shoveling snow, coal, etc., and thus are kept in readiness for their regular work in the spring. It is considered that better results are obtained by assigning a number of foremen to sections of the above length than by working a large floating gang.

One of the great needs of electric interurban roads is the adoption of standards of permanent construction of roadway and especially of operating methods, that will secure uniformity in practice so far as is consistent with local conditions on what are to be the leading interurban systems of the country. Such a forward step will lay the foundation for the education of employees along established lines and for the development of what has not up to this time existed —a thoroughly experienced interurban railway employee, versed in standard practices and available for immediate service on any line.

Power Distribution and Operating Points on the Detroit, Ypsilanti, Ann Arbor & Jackson Railway

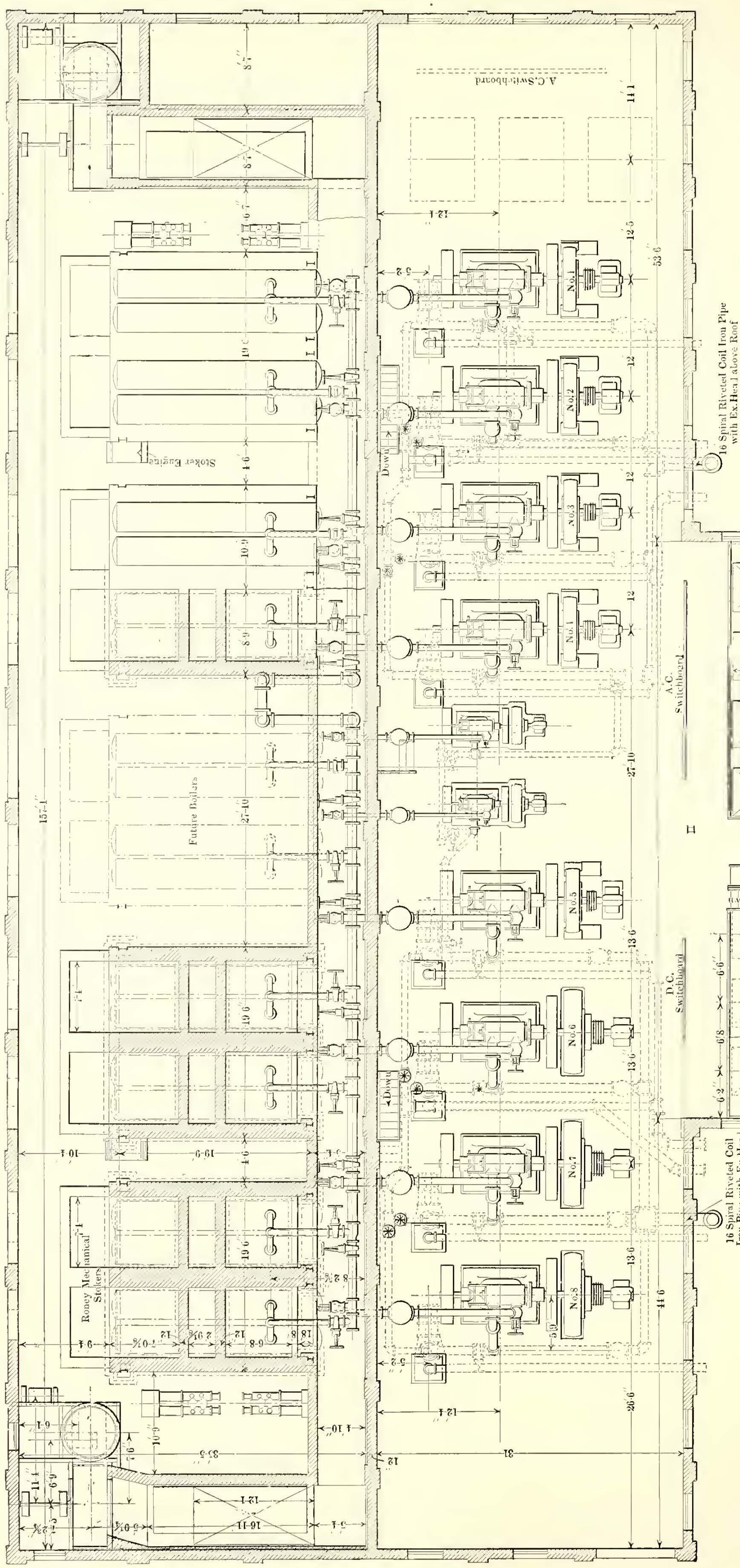
The Detroit, Ypsilanti, Ann Arbor & Jackson Railway operates the longest continuous line of interurban electric road out of Detroit, extending from the Detroit city limits to Jackson, a distance of 76 miles, with a branch to Saline. It was formerly operated by two power houses, but these have recently been combined into one combination alternating and direct-current power station at Ypsilanti. This power station being the most modern of any in the vicinity of Detroit, representing the latest engineering practice of Westinghouse, Church, Kerr & Company, who installed

TRACK AND LINE CONSTRUCTION, DETROIT, YPSILANTI & ANN ARBOR RAILWAY

it, is worthy of more than passing notice. The plan and sectional elevation of this power house are given in the drawings accompanying this article, which show the general arrangement and dimensions.

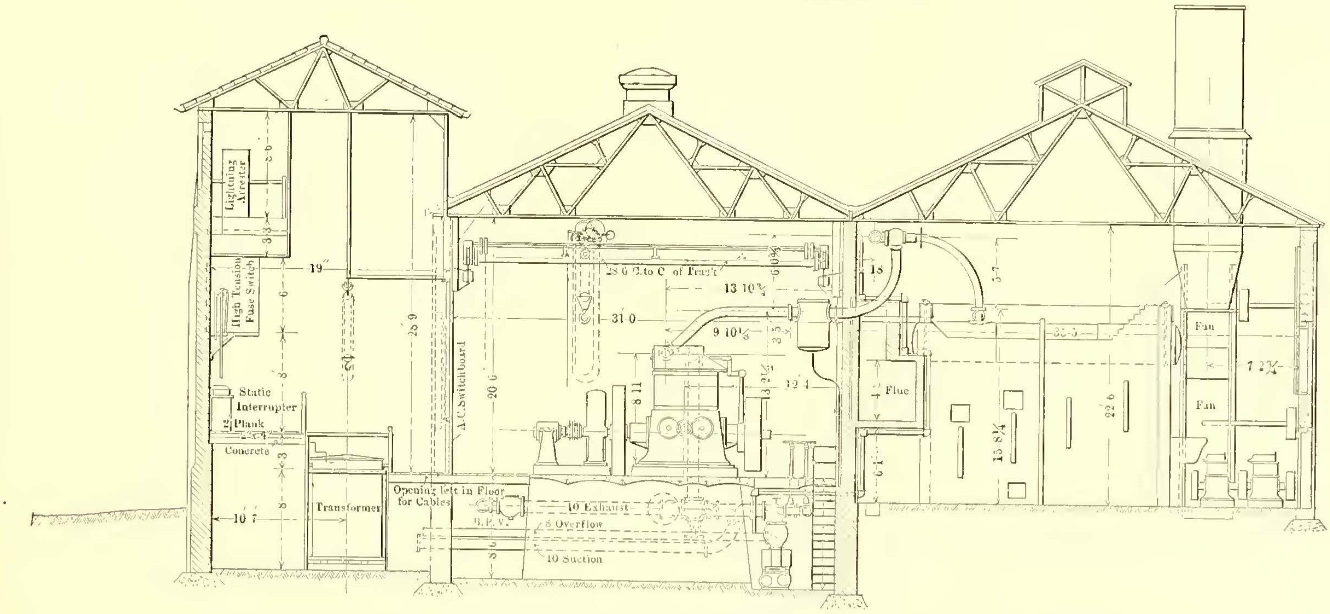
Beginning at the boiler room, there are eight 225-hp Babcock & Wilcox boilers, carrying 160 lbs. steam pressure. These are supplied with feed water by four Worthington outside packed plunger feed pumps. Acording to the usual practice of this engineering company, induced draft is employed furnished by a steam-driven fan, of which a duplicate is kept in reserve. These fans are driven by Westinghouse junior engines. The flue gases pass through Green economizers. The boiler firing is done by Roney mechanical stokers divided in two sections, four boilers on each section. The boilers are piped to a 10-in. main header which is divided into sections between each boiler, with cut-off valves. The connections from the boilers to the engines are made by bends of pipe of long radius.

The main engines, of which there are eight, are all the same size, being Westinghouse high-speed compound con-



PLAN OF POWER STATION, DETROIT, YPSILANTI, ANN ARBOR & JACKSON RAILWAY densing 18-in. and 30-in. x 16-in. stroke, running 200 r. p. m. Each engine has one Worthington compound jet condenser. The two engine-driving exciters are Westinghouse compound, 9-in. and 15-in. x 9-in. stroke, running condensing or non-condensing.

switch, the rheostat in the generator field circuit, three alternating-current ammeters, one indicating wattmeter, synchronizing lamps and voltmeter and synchronizing plug receptacles. Generators connect through their three-pole main switches without any further circuit breaking de-

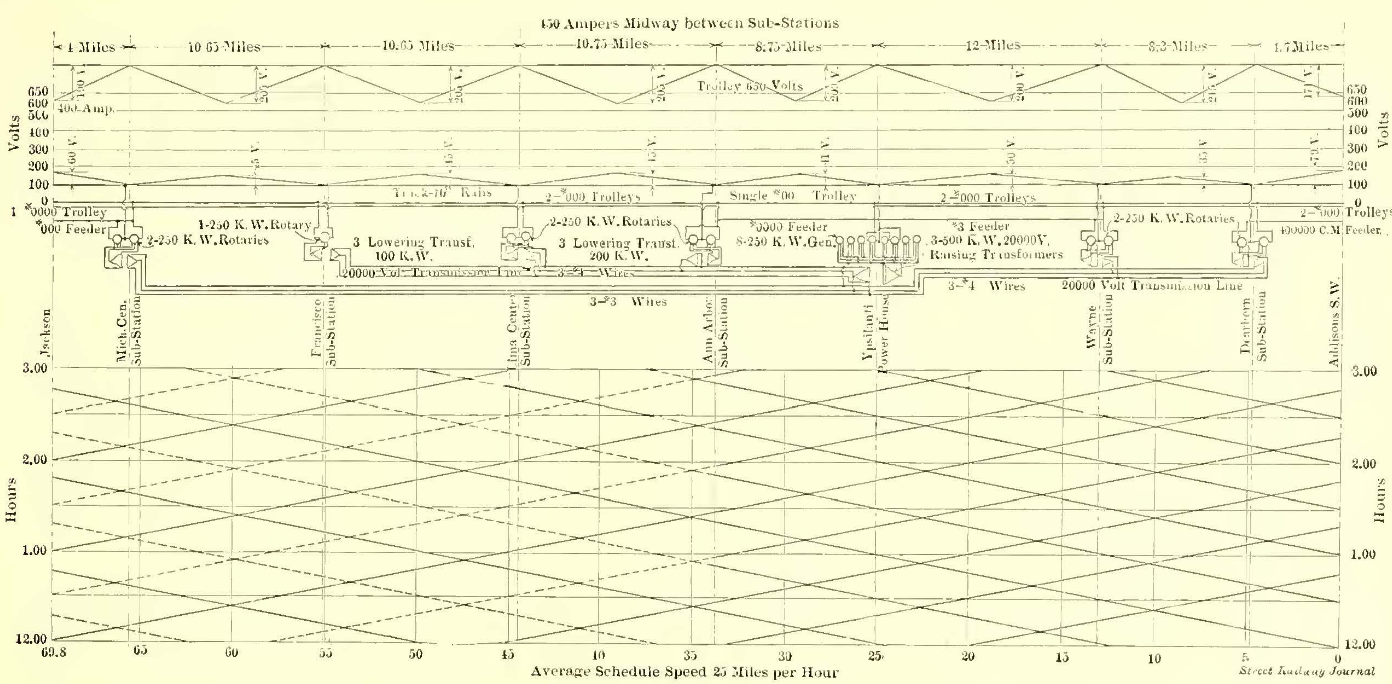


CROSS SECTION OF POWER STATION

To five of these engines 250-kw three-phase alternators are connected. These are 390-volt machines operating at the unusual frequency of 29 cycles per second. The remaining three engines have 250-kw double-current generators, giving 650 volts on the direct-current commutator, or 390 volts at the alternating-current collector rings. The

vices, directly to the low-tension alternating-current bus-bars.

The entire alternating-current output is delivered to one bank of three delta connected step-up transformers. The only automatic circuit breakers in connection with the low-tension switching in the station are in the three legs of the



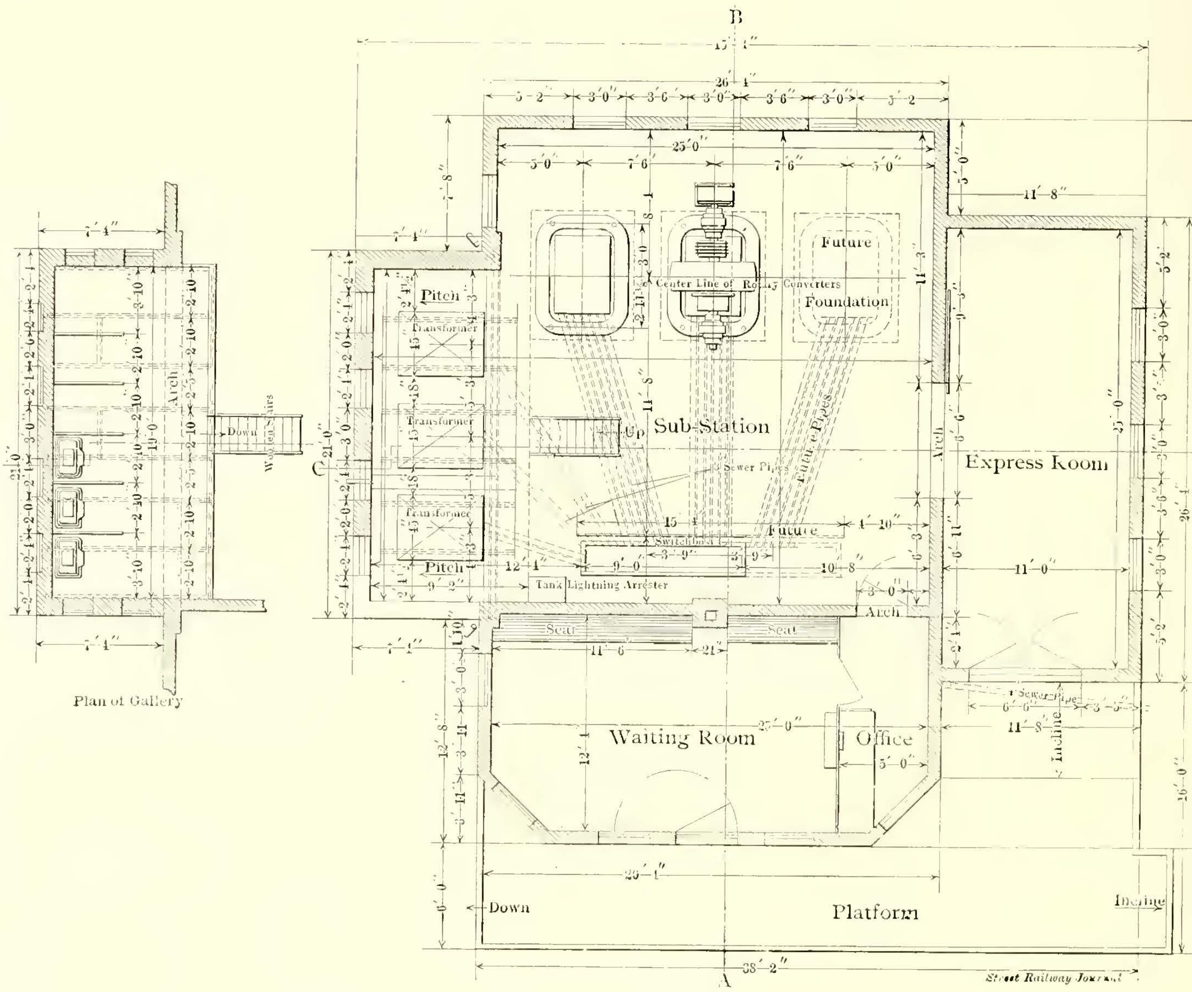
TRAIN SHEET AND POWER DISTRIBUTION

two exciters are 50-kw, 125-volt machines. These are also used to light the offices and shops. All the alternating-current generators are operated in parallel, and there is no provision for other than parallel operation. Coming to the switchboard, there are eight alternating-current generator panels, each of which has a three-pole knife switch for breaking the main generator circuit, a double-pole field

circuit supplying these transformers. Each leg of this main circuit has a switchboard panel, upon which a Westinghouse alternating-current automatic circuit breaker with a time limit is placed. The time limit is put on these breakers, so that in case there is a short circuit at one of the sub-stations the circuit breakers at the sub-stations will open before those at the main station, the idea being that frequently this will save shutting down the whole system by the opening of the circuit breakers in the main power house, where opening the sub-station breakers would do as well. In each leg of the circuit there are also single-pole knife switches of 3000-amp. capacity. The total output is measured by a polyphase induction integrating wattmeter at one end of the low-tension switchboard just described, which contains the generator and transformer panels. There are two voltmeters on brackets at the end of the board. One of these is connected permanently to the bus-bars, the other to any generator which is being prepared for connection to

but containing galleries for the high-tension switches and lightning arresters. The high-tension apparatus is therefore isolated to a certain extent from the rest of the plant. This same idea is carried out in the sub-stations, which have towers on a smaller scale for containing the high-tension apparatus.

The direct-current terminals of the double-current generators are connected to the ordinary direct-current generator panels and supply lines adjacent to the power house through three direct-current feeder panels. These generator panels have three single-pole main switches—for positive, negative



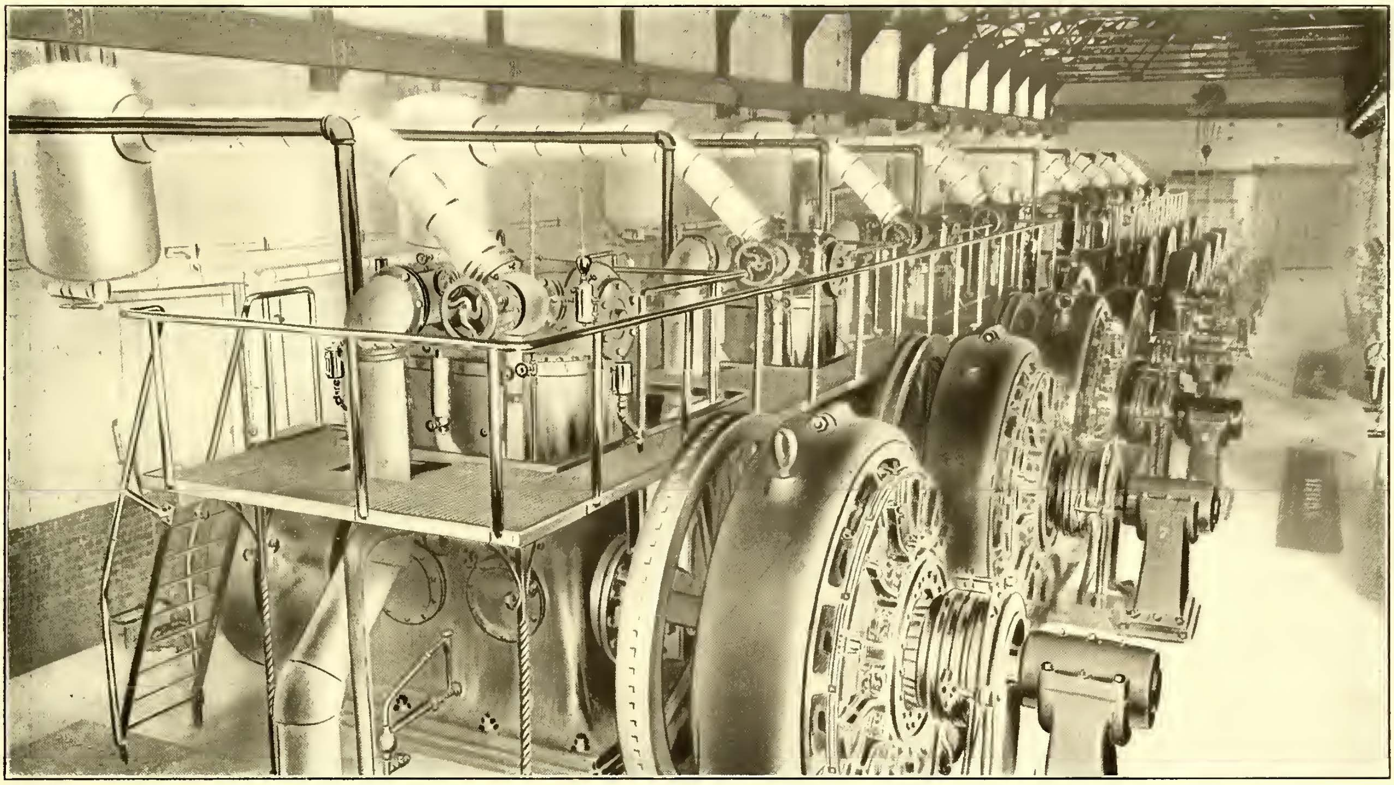
SUB-STATION PLAN WITH WAITING AND EXPRESS ROOMS

the bus-bars. Along with the voltmeters there is also a Westinghouse synchroscope for use in getting generators in step with the bus-bars before connecting them in. This indicates directly the amount that the generator is out of step, and it is a much more accurate guide than synchronizing with lamps.

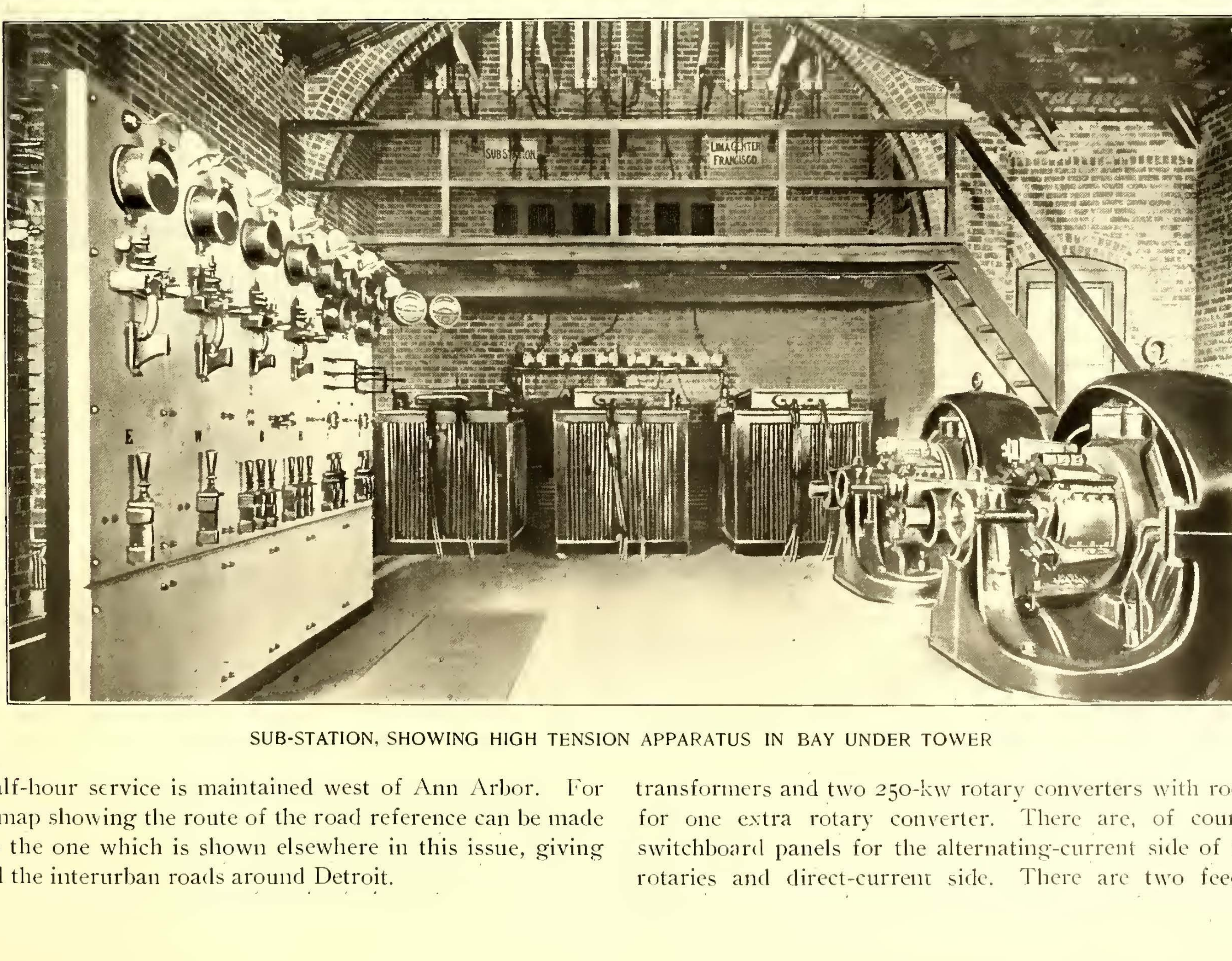
The step-up transformers raise the voltage from 390 volts to 21,000 volts. The high-tension leads from the transformers are taken to plug switches, which serve simply to transfer or open connections, and then to static interrupters, from which they pass to the regular Westinghouse long-break combination switch and fuse. The Westinghouse low-equivalent lightning arresters are connected between each leg of the high-tension line and ground. As seen by the plan of the power house accompanying this article, all the high-tension apparatus is in a bay or tower built on one side of the generating room and providing not only a wire tower for the entrance of the high-tension lines,

and equalizer. The automatic circuit breaker is on the negative side. The feeder panels have the usual equipment of an ammeter, circuit breaker, and single-pole switch. The direct-current output is also measured by recording wattmeter. A previous diagram illustrates graphically the relative position of the power house and sub-station, and the high-tension lines, giving also the capacity of each sub-station. This diagram, of course, includes only that portion of the line from a point near the Detroit city limits to Jackson. Outside of Detroit the cars are operated by the Detroit United Railway. The distance from Addison's switch to Jackson is 69.8 miles, which is covered at an average speed of 25 miles per hour. The diagram gives the drop to potential midway between substations with 450 amps. flowing between trolley and track. As seen by the train sheet, this represents almost extreme conditions, which would occur in ordinary operation only once every half hour.

The regular passenger schedule for the cars is at one-hour intervals for the points west of Ann Arbor, and half-hour intervals for points east of Ann Arbor. The dotted lines on the train sheet indicate the conditions when half-hour service is maintained west of Ann Arbor. For a map showing the route of the road reference can be made to the one which is shown elsewhere in this issue, giving all the interurban roads around Detroit.



INTERIOR OF POWER STATION



SUB-STATION, SHOWING HIGH TENSION APPARATUS IN BAY UNDER TOWER

The design and equipment of each of the sub-stations being alike, are all practically illustrated in the views herewith. The sub-station buildings are of steel and brick with towers, as mentioned, and each is laid out to contain three 200-kw transformers and two 250-kw rotary converters with room for one extra rotary converter. There are, of course, switchboard panels for the alternating-current side of the rotaries and direct-current side. There are two feeder panels at each sub-station, one feeding east and the other west. The trolley lines are sectioned in front of each sub-station.

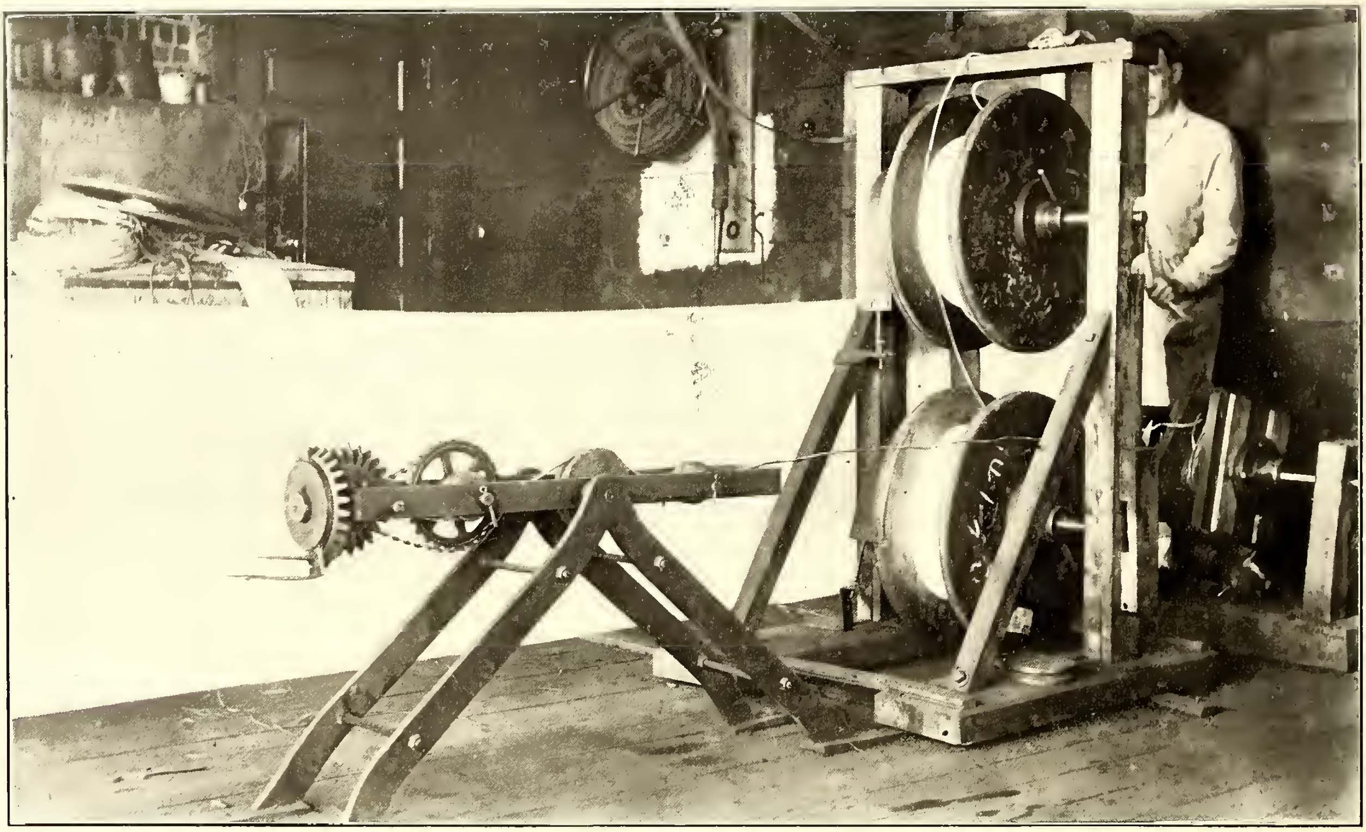
The cars operated regularly are as follows:

Interurban passenger cars	13
Local city cars at Ann Arbor	4
Freight cars	4
Construction car	1
Total	22

On this load five of the 250-kw units are run.

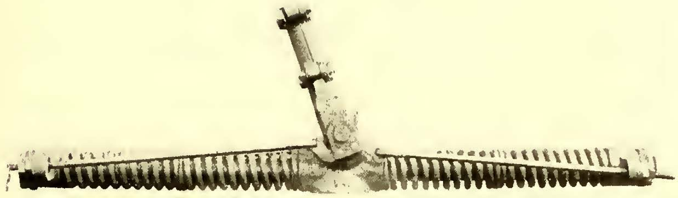
The rolling stock on this road is fairly uniform, although the sizes, both of car bodies and equipment, have been increased as the road grew older. New cars have a seating capacity of sixty people. They contain closets and drinking-water tanks, but no room is taken for hot-water heaters; the heating is by electricity. The heater would take up the seats of three or four persons unless placed in the front vestibule. The motor equipment is four Westinghouse No. 76 motors. The trucks and car bodies were built by the Barney & Smith Car Company, the trucks being master car builders' type. Axles are $5\frac{1}{4}$ ins. in diameter; wheels, 36 ins. in diameter; wheel tread, $2\frac{1}{2}$ ins., with a bevel at the outer edge to give the outer edge strength, and flanges $\frac{3}{4}$ ins. deep. These cars take from 150 amps. to 200 amps. running at their maximum speed of about 45 miles per hour. The accelerating current is from 150 amps. to 200 amps., with motors in series, and from 300 amps. to 350 amps. when they are thrown in parallel making ordinary starts. This accelerating current sometimes reaches 450 amps., though not frequently. All the cars on the road are of the same general type, with Barney & Smith car bodies and trucks, Westinghouse motors, Westinghouse straight air brakes, and on the latter cars gearless compressors. The latter have proved a great improvement over the old-style geared compressors, requiring less cost of maintenance, and being much more pleasant from a passenger's standpoint because of the absence of noise from the gears. The cars were formerly equipped with Westinghouse automatic air brakes, but these have been changed to Westinghouse straight air brakes, because of the greater ease and accuracy with which a motorman can regulate exactly the pressure on the brake-shoes with a straight air brake. The first cars built have Baker hot-water heaters. The windows are the ordinary steam-road car type on the new cars, the drop sash having been abandoned on this road.

The company does most of its own repair work in a well-equipped shop at Ypsilanti, which also is the main car



MACHINE FOR SCRAPING AND RECOVERING FIELD WIRE

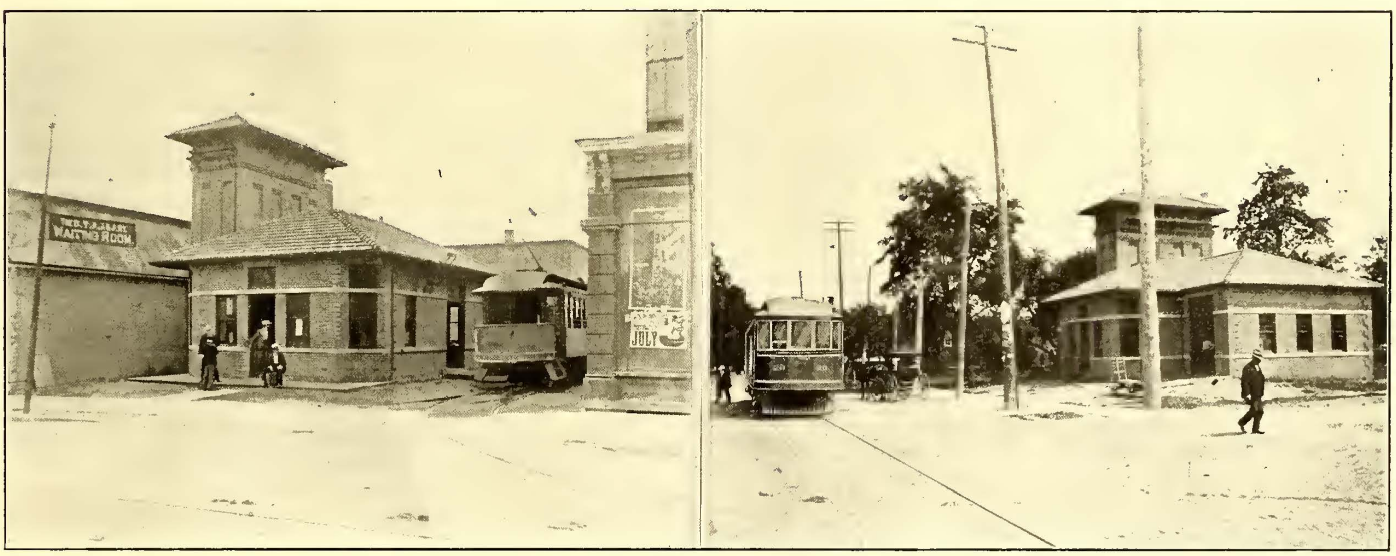
house. J. M. Miller is master mechanic. The armature-winding department is able to rewind most of the ordinary types of armatures used on the interurban cars at a cost of about $12 per armature. Instead of selling burned-out field coils for scrap copper, these coils are run through a machine which scrapes off all the old insulation and winds on a layer of tape. This makes the wire as good as new for field-coil winding, and, as the wire is pulled through this machine in the process of winding a new field coil, the expense of the operation is very low. This machine is illustrated herewith. There are no sharp edges in connection with this machine, the wire simply passes over pulleys and past dull edges which take off the insulation. The insulation must be burned, however, before this machine will take it off. Unless the field coil has already been so hot as to carbonize the insulation it must be put in the fire before being put through the machine. Mr. Miller reports an unusual high average for trolley-wheel life for such severe interurban service, namely, about 10,000 miles. A roller-bearing wheel, with side contact spring, is used. The trolley-wheel pressure against the wire is unusually heavy, being about 40 lbs. It is thought that this pressure, together with the fact that the trolley has a roller bearing which permits of considerable pressure, is responsible largely for the high average mileage of trolley wheels. The wheel being held firmly against the wire, there is little chance for incipient arcing due to poor contact between wheel and wire, and hence the grooves do not wear rough. To enable so much pressure to be put on the trolley poles without undue strain on the springs of the trolley base, a slight modification has been made in the usual Nuttall trolley base, by which both springs work together to keep the



MODIFIED TROLLEY BASE

tension on the trolley. In the base as ordinarily used the tension is on one spring at a time only, the other spring being free until the trolley pole is turned over. One of the trolley bases changed so as to give simultaneous tension on both springs is herewith illustrated. All that is necessarry to make this change is to put in a different shaped curved piece for the rods which carry the tension to be hooked into.

The plan has been adopted of replacing all broken cast-iron lower gear cases with gear cases made of sheet steel. These are made in the company's shops. The corners are 1-in. angle iron bent to the proper shape. The sides are No. 14 sheet steel. The hangers are bent up from $\frac{3}{8}$-in. x

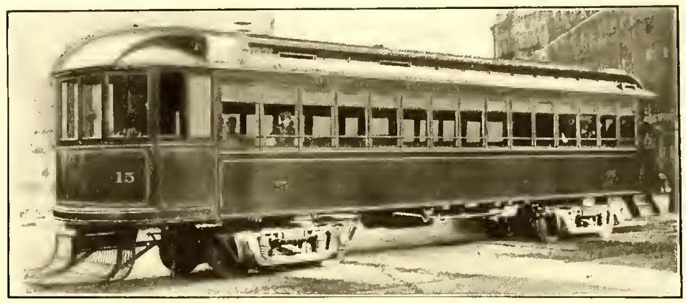


TWO SUB-STATIONS OF THE DETROIT. YPSILANTI, ANN ARBOR & JACKSON RAILWAY

$\frac{1}{4}$-in. bar iron. The sheet steel is riveted to the angle-iron corners at frequent intervals with cold rivets. These cases will hold water and oil, so well is this fitting done. The great advantage found in the sheet-steel case is that when obstructions are struck by the gear case it does not cause as great risk to the car or equipment as when heavy cast-iron gear cases are used. A sheet-steel gear case will come loose or bend before doing any serious damage. A cast-iron case may derail the car.

To maintain the 100 miles of interurban track owned by this company five section gangs are employed with four men in each gang.

The regular schedule calls for cars every half hour east of Ypsilanti and cars every hour west of Ypsilanti. When special traffic is handled from Jackson, the western terminus of the road, cars are run every half hour, the fact that these cars will be run being advertised in the local papers. It is found that this is sufficient to prevent overloading of the regular cars running on the one-hour intervals. Spe-



STANDARD PASSENGER CAR

cial cars can be chartered when ordered, and the charge is made on the mileage basis.

About seventy conductors and motormen are kept on the pay roll. All runs less than eight hours are termed "extra runs," and the men having them are given chances at the ordinary runs whenever the regular men are off. The road is not operated in divisions, but train crews make the entire run through from Jackson to Detroit and return. Twelve freight offices with regular agents are maintained. This road is under the management of F. E. Merrill, with S. J. Dill, formerly of the Metropolitan Street Railway, of New York, as superintendent. The road is controlled by what is popularly known as the Hawks-Angus syndicate, J. D. Hawks being president; S. F. Angus, vice-president and treasurer, and F. A. Hinchman, secretary and purchasing agent.

The Union Traction Company, of Medina, N. Y., was incorporated Sept. 24, with a capital of $600,000, to operate an electric railroad 50 miles long from Batavia, Genesee County, to the Lake Ontario shore, near Olcott, Niagara County. The directors include: Isidor H. Geballe, Fred L. Downs, Darius Fuller, Samuel Landauer, of Medina; Joseph W. Holmes, of Batavia, and Howard Hendrickson, of Albany.

STREET RAILWAY JOURNAL

OCTOBER 4, 1902.

PUBLISHED WEEKLY BY

THE STREET RAILWAY PUBLISHING COMPANY

Main Office:

NEW YORK, Engineering Building, 114 Liberty Street.

Chicago Office: Monadnock Block.
Philadelphia Office: 929 Chestnut Street.
London Office: Hastings House, Norfolk St., Strand.

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

TERMS OF SUBSCRIPTION

In the United States and Canada..............................$4.00 per annum

To all Countries outside of the United States, Canada and Mexico.... $6.00 / £1-5s / M25 / 31f

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

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

NOTICE.

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

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

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

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

Address all communications to

The Street Railway Publishing Co.,
Engineering Building, 114 *Liberty Street, New York.*

With this number, the Street Railway Journal closes the eighteenth year of its life as a publication. These years have been full of activity, and, as we hope and believe, of usefulness to the entire street railway industry. Our first number was unpretentious and contained only twenty-four pages, but the paper has kept pace with the increase in size and importance of the street railway companies of the country, and this number, which is the largest ever issued by us or by a publisher of any technical paper, contains in the neighborhood of 500 pages. Our special October numbers have been issued for so many years that they are looked upon to a certain extent as a matter of course, not only by our readers, but by the publishers as well, yet few probably, except the publishers, realize the enormous amount of work and expense entailed in the preparation of a number like the present. There is literally no parallel in the way of a publication of this size issued from any of the technical presses abroad, where the October number of the Street Railway Journal, as well as the paper itself, is looked upon as representative, as well as typical, of the American enterprise and energy back of the industry of which it treats.

* * *

The importance of Detroit as an interurban center and the present interest that is being taken in the construction of electric interurban railways has naturally led to the devotion of much space in this issue to interurban work around Detroit and elsewhere. There are a few features of the city street railway service in Detroit, however, which are sufficiently notable to warrant the calling of special attention to them. The so-called 3-cent fare in Detroit, about which much has been said in various parts of the country in an attempt to prove the soundness of the 3-cent fare idea, has been before taken up in an article giving facts and figures showing the true situation, which is far from what the advocates of the straight 3-cent fare have been wont to represent it. Experience at Detroit has gone not only to show that a 3-cent fare is financially impracticable from the standpoint of the investor in street railway securities, but that it does not appeal strongly to any great portion of the street car patronizing public. A straight nickel fare with good service seems to suit the public best, and is the happy medium which will enable the company to make money and keep its service up to a high standard without making unduly high profits.

In another respect Detroit city street railway service is unique, namely, in the enormous number of cars sent out to carry the traffic during the rush hours mornings and evenings as compared with the number of cars in service during the middle of the day, this increase amounting during the winter to 75 per cent over the midday schedule in the morning and 125 per cent over the midday schedule in the evening. It is doubtful if there is any city in the United States where such figures as to increase in the number of cars in service during the rush hours can be shown. As every practical street railway operator knows, such excellent provision for rush-hour traffic means an enormous number of tripper crews, and the problem of giving these extra men enough work to keep them in the employ of the company is an extremely difficult one, this problem being further increased by the iron-clad agreement which the company has with the employees' union as to hours of service and wages.

This leads up to another notable feature in the street railway situation at Detroit. There is probably no street railway in the country which has such an exacting agreement with the union of its employees, this agreement covering a large number of detail points, as well as some rules under which it would seem at first thought very difficult to operate. The success of the Detroit United Railway Company so far, in dealing with its employees as represented by their union, is undoubtedly due to the fairness of the position taken by the company at all times upon all matters relating to relations between company and employees. The willingness of the company to arbitrate matters which might come under dispute, and even to allow responsible representatives of its employees to pass judgment upon matters of discipline, should there be any charge of unfairness, has put the company in practically an impregnable position as long as there is any sense of justice and fairness on the part of the employees and the public.

Another point which must be a source of gratification to the company, as it is to all visitors to Detroit, is the regard for appearances as shown by the condition in which its property is kept in various parts of the city, and which is in full keeping with the spirit which seems to be shown everywhere on Detroit's streets. Car houses and car shops are not usually considered great additions to the beauty of a street upon which they are situated, but in Detroit the various foremen vie with each other in keeping the premises under their charge in good condition. Well kept lawns, flowers and vines are found in places around the various car houses where too frequently nothing but dust and gravel are to be seen.

* * *

The student of interurban electric railroading will find much to interest him around Detroit. The electric railways from this city, as shown in the maps which are published in this number, radiate in all directions except to the east, where expansion is prevented by the Detroit River, and reach Port Huron on the north, Toledo and Cleveland on the south and southeast, while they extend to the west as far as the eastern shores of Lake Michigan. In fact, Southern Michigan, owing partly to liberal laws which encourage the transportation of freight, as well as passengers, by electric railways, and partly to its topographical features, which are favorable to railroad construction, is now provided with a system of interurban electric railway transportation which is probably not rivaled by any other territory in this country, and certainly not abroad. In our Detroit article, which occupies the opening pages of this paper, no attempt has been made to describe any of these interurban railways except those which actually enter the city, as the more important lines outside of the city have been made the subjects of extended articles in recent issues of this paper. These roads, moreover, are among the latest in equipment of any in the country, and represent in size of rolling stock and in many other ways the tendency to copy steam-railroad models so far as they are applicable to electric railway conditions. Following the articles descriptive of the Detroit system in this issue will be found a series of contributions on different departments of interurban railroading. The writers are authorities on the topics discussed by them, and their suggestions will be found of great benefit to the designer and builder, as well as the operator. In view of the importance which interurban electric railroading has acquired during the past five years, and particularly during the past year, no excuse seems necessary for devoting so much space to this subject. Following these articles are three on some of the latest interurban roads in New England, the Middle States and the West. The space at our disposal in this issue would prevent us from commenting at length upon these signed articles, if this were necessary, but we feel as if we could not add to the treatment given the topics by the respective authors.

* * *

Passing now from the theory to the realization, we believe that the description of each of the three interurban roads selected for discussion in this issue, i. e., the Boston & Worcester, the Oley Valley and the Aurora, Elgin & Chicago, will be especially interesting, as each represents a distinct advance over any previous line which has been built in the territory through which it operates. Of these, the latter is probably the best known, not only to electric engineers and railway managers, but to the public as well. It is seldom that the inauguration of any single electric railway enterprise marks such an important advance in the art as has that of the Aurora, Elgin & Chicago Railway. Although the attention of our readers has been called to the work of this company numerous times during the past year and a half, and those who have followed the subject in our columns are tolerably familiar with what the road is doing and proposes to do, it will not be out of place at this time to sum up the probable bearing of this new undertaking on the future of the electric railway business. The road is perhaps nothing more than the natural result of the gradual evolution the interurban electric railway has been undergoing for the past five years, but it without doubt, on the whole, represents the highest development the electric interurban railway has yet attained. Indeed, it is a pleasure in this number of the Street Railway Journal, which number by its contents illustrates so fully the magnificent strides made in interurban work, to be able to point to such an excellent example of interurban electric railway engineering and solid financial confidence in the undertaking, as is afforded by the Aurora, Elgin & Chicago Railway. This road marks a considerable advance over previous interurban undertakings in several respects, namely: (1) in the solidity of its track and roadbed, which is equal to that of the best steam trunk lines and which will admit of the low, long, continuous runs at the highest speed known to-day in railroad work; (2) in the high maximum speed for which the equipment is designed, which speed is over 60 miles per hour, and (3) in the fast schedules that are possible, including frequent stops, a schedule speed of 40 miles per hour being obtainable, with stops every 3 miles. It is evident, when these points are considered and fully appreciated, that the electric interurban railway, having gradually evolved from a local service, with a schedule speed of from 10 miles to 15 miles per hour along a country highway, up to the present common interurban schedule of 20 miles to 25 miles per hour on a private right of way, is now to take another decided step in advance in the matter of speed, thereby opening up to itself new fields of usefulness. This will be practically the first electric railway in this country to give a through service between cities 38 miles apart, which will equal or exceed the best speed made by the steam roads covering the same distance. It is worth noting that while the through traffic between such cities as Aurora and Chicago would undoubtedly not be such as to justify the operation of steam trains at half-hour intervals, it has been sufficient even at the time of the opening of this new electric road, to take a majority of the seats in the cars running between Chicago and Aurora at half-hour intervals, even though the schedule of the electric road is not as fast as that ultimately contemplated by the management.

* * *

In other words, the electric road having worked its way up, as a carrier par excellence of short haul local traffic, is beginning to give frequent high-speed through service between neighboring cities, and with every indication that it will cover this field as thoroughly as it is covering that of shorter hauls. It is the same old story, electric traction lends itself to profitable operation of small train units at frequent intervals, whether at high speed or low speed. Steam does not. The most frequent train service gets the business if it can land the passenger at his destination in anywhere near the same time, and, in fact, experience has proved that a very great increase in speed must be offered a passenger to induce him to wait for infrequent trains. Futhermore, the frequent service creates a habit of riding which makes business, which never exists with infrequent service. It is through this created business that electric interurban roads have been able to exist and thrive.

* * *

So far we have considered mainly the bearing of this new road on future work as a carrier of through business between cities. But the local service is in its way equally remarkable, and likely to have an equally important bearing on future electric railway work. This local service is of a kind that has been much talked of among electric railway engineers in the past few years, but of which, until this road opened, we had no actual examples. It is a kind of magnified elevated railway service, if we may be allowed the expression. That is, the acceleration is very rapid and is carried up to a point where the current must be shut off and the car allowed to drift but a short distance before the brakes must be applied. Although the stations are much farther apart than on a city elevated road, the maximum and resulting schedule speeds have been shoved up correspondingly, so that the general form of the speed diagrams for this local service is the same as on a city elevated road, the essential difference being that the distance between stations is from 2000 ft to 3000 ft. in one case and 3 miles in the other, and the maximum speed 25 miles to 30 miles an hour in one case and 65 miles an hour in the other. Heretofore, electric railway companies operating in the outskirts of our largest cities and acting as feeders to the elevated lines have confined themselves to slow service over suburban highways, leaving suburban communities dependent upon steam suburban service for anything like rapid transportation to the city. The road under discussion, in connection with the Metropolitan Elevated, offers rapid transit to suburban passengers living from five to ten miles beyond the city limits, which will equal, and in some cases exceed, the speed offered by the suburban steam trains, figuring in the time required to reach the downtown office from the railroad depot. From this brief outline, it will be seen that it is certain that if this new undertaking is financially successful (and all the present indications are that it will be) it will mark the beginning of an important new period in electric railway building, both as regards high-speed roads, over considerable distances, and local suburban traffic. Aside from the interest centered in this road, because of the problems which it will solve as regards possible passenger traffic, it is needless to say that it is full of interest to the electric railway engineer from a purely engineering standpoint. The high maximum speed of the cars and the rapid acceleration at the rate of 2 miles per hour per second, at which the cars are brought up to maximum speed and the unusual weight of the motor car equipment per car, are features in themselves enough to arouse interest. To add to all this, it is generally understood that preparations are being made for a series of very extensive tests on this road, with electric cars, at speeds of from 70 miles to 100 miles per hour and over. Electric railway engineers certainly have reason to be grateful to builders of a road on which the track conditions and power supply are so good as to make such tests possible.

* * *

The survey of the interurban situation around such important centers as Detroit, Indianapolis, Cleveland, Dayton and Cincinnati, as well as a consideration of the service already given and faster service contemplated by the Aurora, Elgin & Chicago Railway, leaves no room for doubt but that all places where local traffic is of any volume, it will be taken care of by electric interurban and suburban roads, resulting in the abandonment of everything but through business by the steam roads. This has to a large extent already taken place around the interurban centers mentioned. Of course, there is a possibility that steam railroads will see fit to head off this paralleling movement by the introduction of electricity for handling local traffic. Indeed, from the purely economic standpoint, it would seem that steam roads could add a local electric service cheaper than new electric railways could be built to parallel them. However, steam roads have not seen fit to do this in the past, and it is a question whether they will do it in the future before parallel roads have been built everywhere that they would prove profitable. As we have many times remarked, the opportunity for the steam railroad companies of this country to create a large local traffic by the adoption of a local electric service in addition to their present train service, has been excellent. It is missing the point entirely to argue that the present local or suburban traffic carried by steam trains is not profitable nor sufficient to warrant investment in electrical equipment for local traffic. It is the created business brought into existence by the frequency of service that makes electric interurban roads pay and would make a local and suburban electric service pay on steam roads under proper conditions of population.

* * *

It has been too often considered that steam and electric roads are natural competitors. We have many times maintained that the proper relation of electric and steam roads is for steam roads to follow out the same lines of policy which they have been following for a number of years as regards the better handling of through business, decreasing the number of local stops and increasing the size of train units, leaving to the electric roads the work of carrying the local traffic, both passenger and freight. The electric roads would thus act as feeders to the steam roads, carrying at a profit the class of business which steam roads can carry only at a loss. The efficiency of steam roads as carriers of through business would be increased because they would be relieved of any hampering by local business. This, of course, presupposes that the steam and electric roads act in harmony. It would seem that the natural position of the electric road as a feeder and carrier of local traffic for a steam road would become so apparent in the course of the next few years of operation that the owners of these properties would find some means of getting together, either by traffic agreements, the buying of controlling interests in the electric roads by steam railway companies, or vice versa, or by actual consolidation.

C. W. WASON.

E. C. FOSTER.

H. M. SLOAN.

H. H. VREELAND.

W. H. HOLMES.

D. B. DYER.

OFFICERS AND EXECUTIVE COMMITTEE, AMERICAN STREET RAILWAY ASSOCIATION

JOHN A. RIGG.

T. J. NICHOLL.

T. C. PENINGTON.

G. W. DICKINSON.

C. L. S. TINGLEY.

W. B. LONGYEAR.

S. C. COOPER.

H. C. MACKAY.

IRWIN FULLERTON.

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

W. F. HAM.

F. R. HENRY.

W. B. BROCKWAY.

D. D. BARTLETT.

THE DESIGNING OF STEAM POWER PLANTS

BY WALTER C. KERR

THERE is a great difference between the consideration of power-plant designing and the description of a power-plant design. The latter is concrete and limited to special conditions. It is, therefore, easy to describe, analyze and illustrate. The former is less tangible. In it good practice may be as widely variable as are the conditions to be met. It does not involve a discussion of the merits of apparatus so much as the methods and means of adaptation. There are, however, principles and engineering duties which underlie the whole subject or design quite unrelated to any specific feature.

The main object of this paper is to point out some of the ways and means by which the engineer should find it well to deal first with the general and then with the specific questions involved, also to indicate to the purchaser, manager or securityholder something of the service he may reasonably expect the engineer to render in making determinations and plans underlying large expenditures.

While forming one of a series of articles on the engineering of interurban railways, the principles underlying the designing of steam power plants are scarcely limited to any type of property, the limitations only appearing when specific design is being adapted to the conditions of a given property.

The mental attitude of an engineer in approaching any undertaking has much influence upon the character of his work. It is the well-balanced perception that gives due importance to each factor and enables all of the features to be so corelated as to secure the best results. Harmony and consistency are of the first importance in the conception of general features, and they are equally essential in the design of specific detail to the production of a plant best suited to its purpose.

Altogether too much importance is often attached to the power plant as an end in itself rather than as a means to an end, and when critically reviewed by engineers it is usually so considered. Physically it is more or less a separate construction, and, therefore, by apparent isolation, more readily considered a thing apart from the system it serves, but operatively it is not, and commercially it is not; it has no true cause for distinction as a separate creation; it should not be regarded as competitive with other plants, or a monument to its designer. It is the servant of its system, a sharer of its limitations, and to excel should be consistent throughout with the commercial characteristics of the entire property of which it forms only a part.

Certain interurban properties have had the benefit of a civil engineer's disposition to consider the roadway the road while suffering from inferior power plant and equipment. Another may have profited by a mechanical engineer's excellent power plant while losing traffic on an improperly designed and constructed roadway. Another may have found an electrical engineer's highest type of electric equipment quite inoperative because the other 80 per cent of the property was not in keeping with its excellence. Such anomalies are usually not so much a matter of neglect as they are the natural result of human talent working from a wrong or too limited standpoint, and therefore not simultaneously wielding skill of sufficient diversity. This is sometimes unkindly called ignorance. Power-house design, therefore, is in many instances, and notably in interurban railways, quite inseparable from the general problem of producing the entire property.

Economic commercial adaptation is the very essence of good engineering, and takes precedence over all technical detail, even over engineering standards and conventions, and especially over preconceived desires and ambitions. An engineer's personality and preference must be subordinated to material and commercial requirements, and show chiefly in the methods adopted to secure the required ends. There is ample room for individuality in engineering work after the impersonal elements have been disposed of along cold lines of fact and necessity. It follows that the engineer must not be afraid of his facts, and it requires study to know and interpret the facts and conditions involved in any engineering problem. It has been remarked that there are more mistaken facts than theories.

The best lawyer may be the one who knows the most law or he may be the best court pleader or the most sagacious adviser on difficult legal points, but there can be little doubt that the most useful lawyer is the man with strong business instinct supplemented by legal knowledge and experience. Similarly, while the most successful engineer must needs have engineering skill, he must, in order to achieve real and permanent greatness, have primarily a correct commercial sense of the relation of structures, plants, projects and undertakings to the world at large, financial risks and personal equations, and then be capable of applying his engineering skill to bring forth results. He must not forget that operating cost is not only the coal and labor cost, but involves fixed charges, liabilities, deterioration, and to a certain degree the possible future unsuitability of his work to the then existing conditions.

The first requisite of a power plant is that it shall be so adapted in cost, running quality and sufficiency as to give the highest value and least risk to the securities underlying the entire property which it serves. This raises the question, how far the engineer should enter the commercial and operative field in the interest of his client. He can scarcely go into it too far. It is inconsistent with the profession and the importance of its undertakings to assume that an engineer is to close his eyes and proceed with work which may, through his skill, be rendered technically good engineering, yet by reason of conditions prove bad business.

To have been ordered is no excuse for transgressing good business principles without direct and explicit remonstrance. Mere difference of opinion, sugested or implied, is not the full performance of duty when an engineer with his wide opportunities detects commercial defects in an undertaking entrusted to him for design or construction. If engineers more scrupulously and more boldly exercised this function many properties would not have been constructed and their securities wasted. Whatever prospective opportunity may have led to financing a project, a time arrives when a competent engineer with possession of all the facts, together with knowledge of costs, necessary to proper design and construction, is, or should be, the best commercial adviser. Under circumstances adverse to the project it should be his duty to take the initiative in the protection of capital. This is partly because any man's duty lies toward whatever chance throws across his path regardless of instructions, conventionalities or professional etiquette. The best design for some power plants would be the demonstration of why they should not be built at all.

Certain power plants, especially very large ones, may obviously be designed with comparatively little reference to the system served or to first cost—the problem being practically to produce as large an output as possible per square foot of available area at the lowest operative cost. Again, power plants for certain railway properties must sacrifice ultimate efficiency and other merits to low first cost, simplicity and reliability, their chief mission being to furnish sufficient power to operate a system within fixed charges consistent with traffic obtainable. There must be a well-judged balance maintained between allowable costs and desirable economies, and before this balance is determined the problem too often drifts along the lines of least resistance into the settling of details before disposal of the larger and more important elements.

Power plants must serve present needs, the immediate future, and have due regard for the more distant future. That the future cannot be foreseen is no excuse for not giving due heed to what it will most probably require. Engineering history shows that even much experience seldom leads to placing large enough quantitative values upon future requirements.

While it may be resented by some, it is nevertheless true that too much power-plant design consists only of the selection of apparatus. Some would produce drawings to refute this statement, but inspection will often show that such plans are but little more than the pictorial arrangement of apparatus drawings reduced to the same scale. It is fearlessly stated that many engineers do not know what it means to design a power plant; they merely arrange it on the ground by inspection and selection. There are many plants containing the best apparatus that money can buy, which, on engineering analysis, cannot be regarded as other than operatively bad. They are not operatively designed.

The selection of apparatus and the determination of power-house features with their many details intimately involve methods of subsequent operation. Good judgment must be exercised to weigh between the inefficiency of crudeness and the complication of refinement. In this, as in many other features requiring skilled judgment, it is desired to emphasize the difference between believing that a thing should be done and the practical doing of it. Too often the nice distinctions between one thing and another or a method and its alternative are considered, yet the decisions are finally based on price, delivery, convenience, minor expediency, or even unwarranted notions of the kind that link preventable difficulty with extreme refinement and complication. It is not always easy to be wholly consistent, but a systematic engineering measure applied to apparatus, design and method should carry with it the requisite courage firmly to adopt the measured results.

Those who are fond of analyzing cause and effect could outline a large number of underlying, fundamental requisites for good power-plant design, but two are seldom mentioned which should be ranked first. They are: experience in having actually conducted work of construction as distinct from having told someone else how to do it, and experience in operation after construction. The power-house design of all countries is full of academic work of the learned and guesses of the ignorant. The degree to which many engineers are divorced from responsibility by having no large contract relations noticeably weakens their judgment or fails to strengthen it. This is most conspicuously seen in features which of necessity must be creatively designed and constructed, rather than bought as manufactured product.

Another thing deserving attention is the tendency which has sometimes appeared to specialize unduly. This is, perhaps, less frequent of recent years, with the great improvements in quality and variety of standard apparatus, but it occurs sufficiently often to call forth protest. It is doubtful if in most cases the refined improvements sought by such means do not fall short of their object because of the offsetting cost of the complication usually involved.

By way of simple illustration, a certain pumping plant was very "specially" designed and installed in a way to take advantage of high efficiencies where ordinary centrifugal pumps driven by any small compound engines of standard make would have performed the service more reliably and would have required less fuel for their total operation than could have been bought for the interest charges of the capital differences in the cost of the two plants. Sometimes these things are apparent; again they are not so plainly evident. They exist more often than they are apprehended.

After the property which a power plant must serve has been sufficiently studied to enable the design to be rationally contemplated and the work of design is actually in hand, come the many more or less perplexing decisions which are often hastily made to gain time or contemplated until they become so involved in a multitude of considerations that final solutions are hard to reach. The way is then paved for error. Some more bold than wise gain the temporary admiration of their associates or clients by settling everything "with an axe." It is often the so-called "practical way." In fact, what is needed at just this juncture is hard, careful work and much more of it than is often put on power-plant design. A guess is occasionally a good one, but a series of guesses too rarely succeeds to warrant the method so often adopted in important matters which can be resolved into good engineering decisions by the application of hard work.

Power-plant design involves something more than mere drawings and specifications. It broadly includes ways and means of getting work done, which in turn involves purchasing and providing that all things come together in proper sequence, reasonably on time and in condition for erection. The failures in this art of construction can always be shifted to other shoulders, for the fault is widely distributed through broken promises, imperfect material, inevitable delay, accidents, clerical error, misunderstandings, insufficiency here and there, all of which lined up will show that a fair degree of error spreads over all who have duties or obligations toward the plant. But how about the duty of the engineer in so designing and broadly executing his design in a way to forestall these numerous faults, defects, neglects and the annoying, expensive and merit impairing obstacles. The duty of the engineer is broad and he cannot wholly shift the responsibility when he does not provide ways and means by which contractors and others will be estopped from error, neglect and failure within reasonable limits. The mere stringency of specifications and the imposing of penalties are inadequate, but the hand and power of a competent engineer, whom no one doubts is an engineer, compels accuracy and fulfillment.

I think it is a fair general criticism upon the engineering of power plants, and more particularly those designed for interurban service, that enough work is not done upon them. They are not susceptible to strokes of genius. They are not chiefly composed of devices designed by the engineer, but rather an assemblage of machines, apparatus and devices regularly manufactured, and hence obtainable. There is too much presumption that things called by the same name are substantially the same in fact, from which follows a looseness in design and specification. It is a fine engineering art to design, select, order, receive, erect and put in operation all of a power plant and have it from start to finish just what was intended. The sooner it is recognized that most plants do not meet expectations in their general performance and that the intentions underlying their design were not quite as accurate as they should have been the sooner will there be more hard work done in getting all things right in the first instance, instead of trying to improve by changes during the progress of construction, or by remodelling after experience in operation. No one can properly build a plant that has not been properly and completely designed. No one can concretely design with hazy or uncertain ideas of what he is designing. If the difficulties met in design are not solved they will usually gain added complications and new limitations as construction progresses.

A complete power plant design is rare. It is never made very quickly. The time for rough and ready methods has passed. The expenditures involved call for the highest skill and the most refined methods of determination. The larger work is being given to those who have equipped for this thoroughness, and those who would succeed must abandon methods in which many of the existing power plants have been thrown together and utilize all of the best-known methods of the art to insure good practice, however much the design of one may differ from that of another.

The engineering developments of the last twenty years have caused power plant design frequently to demand a grade of service beyond the scope of individual effort. Conditions have grown more complex, limitations greater and the necessity of practicing economies more important. Thus the skill of many men and many experiences must often combine to produce results consistent with the best state of all of the arts employed. There are some who fully appreciate this, but more who do not. In it there is food for reflection and an opportunity for any man to take a conservative view of his own personal talents as compared with such service as he might render as one of several engineers of diversified talent co-operating in the design and conduct of extensive work.

When the columns of our engineering press publish the plans of new power plants, with pleasant comments upon them and their designers, it would seem ungracious to dissect them and precipitate critical discussion which might become personal, yet in these columns there have appeared plans of plants in which, by reason of inefficient design of buildings, a large amount of money could have been saved with great improvement to the plants and their housings. In one instance the same cost could have built a better and more suitable building and equipped in addition the entire plant with needed facilities which it lacks. If such facilities were omitted because of expense, it must have been very untrustworthy engineering that could have wasted more than their cost in the inefficient design of the balance. There is a plant in which external fireproof coal storage is provided, and coal and ash handling machinery is installed at large expense, yet the fuel needs to be rehandled by manual labor. It happened also that enough room was wasted within this power house to have held sufficient fuel storage and appliances.

I have known a clever engineer in a few hours of hard work to cut $50,000 out of the cost of a power house design, leaving a stronger and better structure than a less perceptive engineer had created. Hard work pays.

There is scarcely a more important feature for the engineer to keep constantly in mind than first cost—not necessarily the lowest possible first cost, but the warranted cost. This involves judgment, even nice distinction, to secure sufficient quality without waste.

A proper sense of relative cost is also essential to good design, and this can be cultivated by the exercise of care. This sense is not simply the knowledge of costs, as taken from formal estimates, and therefore more or less a matter of exact record even though it is largely acquired by the making and studying of estimates. It is rather the constant accompanying cost sense that should unconsciously accompany skilled design and which leads to no surprises when final estimates are completed.

If there is any notable shortcoming in the engineering design of interurban power plants it is the lack of sufficiency on every hand. It is perhaps found less in foundations, engines and electric generators than elsewhere, but seems ever present in building structures, steam-making appliances and accessories, coal and ash handling, piping, and until very recently in switchboards. In all of the small details of the kind not furnished as articles of manufacture, which are supplied in accordance with the design and specifications, or more often omitted and furnished as found needed, there is a conspicuous lack of sufficiency, which it is the engineer's duty to prevent by fore and not afterthought.

Sufficiency, as broadly used, with reference to a power plant is not easily defined, and while it may be illustrated by specific example it is not the purpose of this writing to attempt the detail of demonstration, but rather to direct engineering consideration by suggestion. Among the power plant features which seem notably to require better engineering than is now usually practiced, are type and sufficiency of power house structures, feed-water purification, feed-water saving, furnace efficiency, steam piping, protective devices for electric circuits and the proper co-relation of all features with each other.

There is no royal road to the elimination of all of the errors and difficulties which beset the path of the engineer, but if he will continually use his best senses and the knowledge of others, who know more than he, and do enough hard work it is probable that he will find a way to do credit to his profession and justice to his clients.

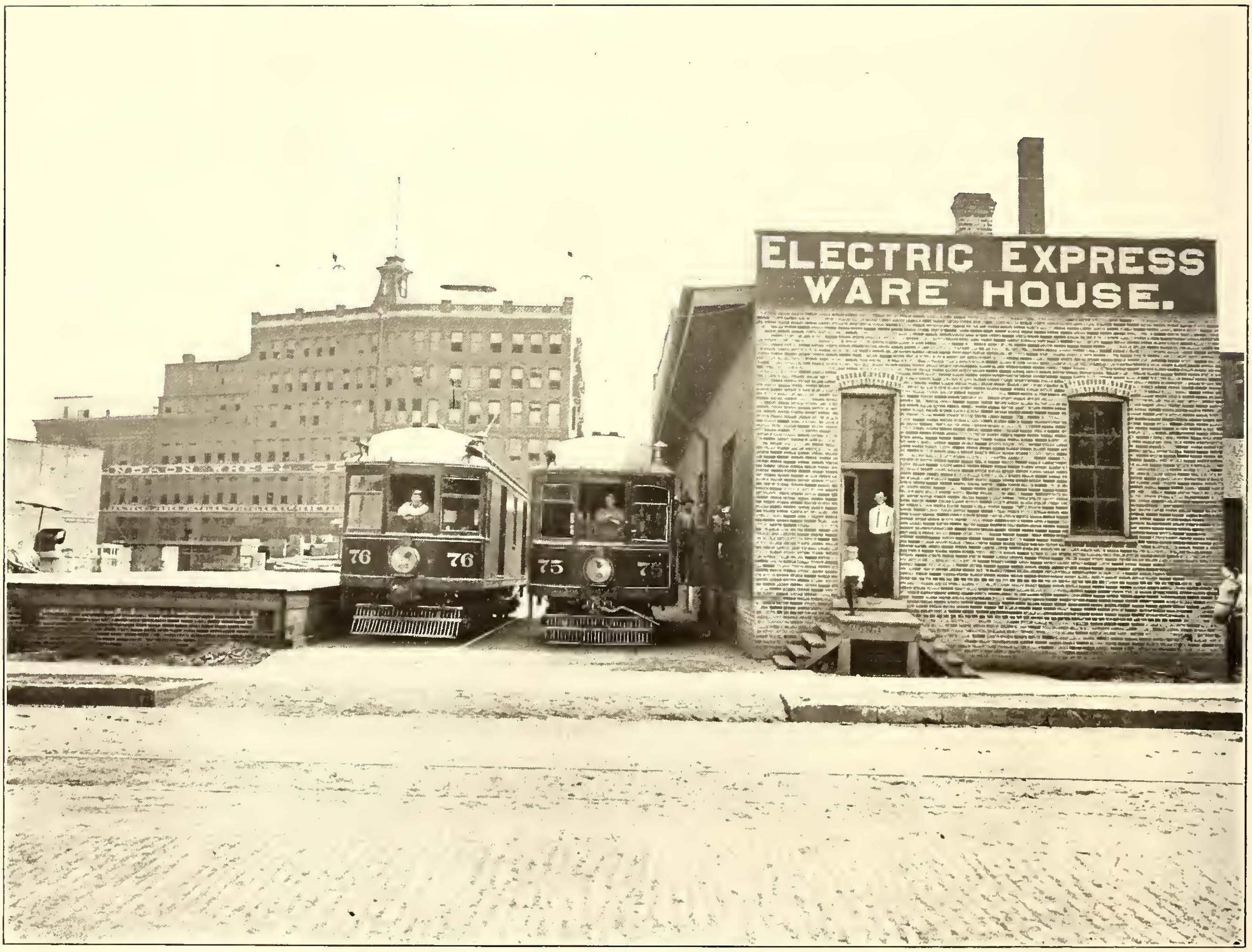
HANDLING FREIGHT AND EXPRESS ON INTERURBAN ELECTRIC RAILWAYS

BY ALBION E. LANG

THE transportation and handling of freight and express by the interurban roads of Northwestern Ohio have presented the same problems and reached about the same degree of development as elsewhere. This feature of electric railway business is generally treated as of secondary importance to the financial success of the roads, hence provision is, or usually has been, made for it only as necessity has actually required.

& Maumee Valley Railway, the interurban roads which are now in operation. They enter the city over the tracks of the Toledo Railways & Light Company, having practically a uniform traffic arrangement.

Freight cars run alongside a regular freight house on one side, and a large unloading platform on the other, as shown in the accompanying cut. Six cars can be accommodated at the same time, and room is left for growth.



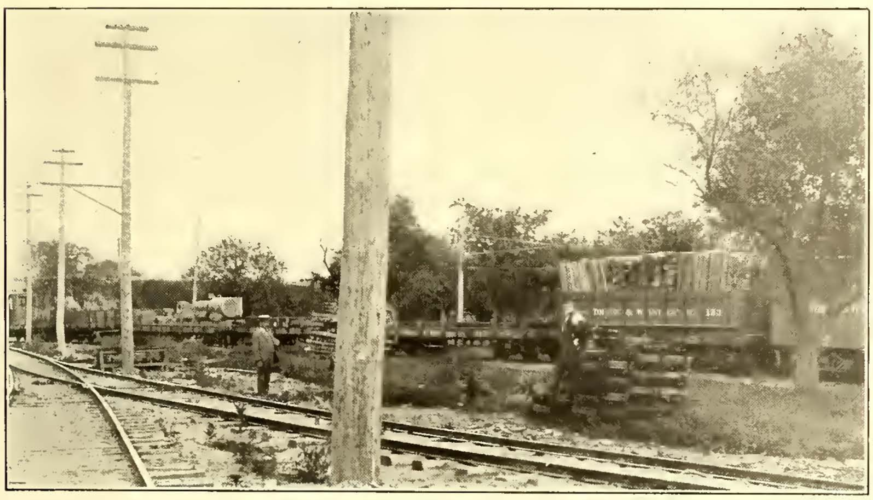
UNION INTERURBAN FREIGHT STATION AT TOLEDO

In practice the term freight is all-embracing, covering all classes and grades of goods and merchandise, perishable and non-perishable, as well as such as are handled by express companies. Freight is usually handled in single cars, and is taken on at stations or sidings, carried to its destination, and unloaded in stations, or in the street, according as means have been provided. In Toledo a central location has been provided, on private grounds, by the city company for the Lake Shore Electric Railway, Toledo & Western Railway, Toledo & Monroe Railway, and Toledo

There is ample space for drays to load and unload, the floor of the freight house, as well as the unloading platform, being on a level with the car floor. Cars are run at such hours of the day and night as least to interfere with regular schedules of passenger cars. At present cars back away from the freight station over a Y to reach the proper track for the return trip, but a connection will be made later with tracks on a parallel street, enabling them to be looped in either direction. The freight station faces on Huron Street, and extends through to Superior Street, cars switching into the yard from the latter. The property is owned by the city company, and each interurban company is charged a certain rental. There is more than sufficient space available to double the present facilities, both in the way of buildings and platforms. The present freight station is a substantial one-story brick warehouse, the front of which is partitioned off for the office.

The schedules of the several roads are arranged so that the freight cars do not leave the station at the same time. In this way the work is equalized throughout the day, and the tracks are seldom overcrowded. The Lake Shore Electric Railway operates six freight runs, three cars a day each way. The Toledo & Monroe and the Toledo & Maumee Valley have two cars each way apiece, while the Toledo & Western has two runs out of the station each day, but they are double headers, one car for each division.

HEAVY FREIGHT TRAIN ON TOLEDO & WESTERN RAILWAY


FREIGHT TRAIN IN SYLVANIA YARDS OF TOLEDO AND WESTERN RAILWAY

The departure of cars is scheduled as follows:

Toledo & Maumee Valley, 9 a. m., 3 p. m.

Lake Shore Electric, 7:30 a. m., 12 m. and 5:30 p. m.

Toledo & Monroe, 10:40 a. m., 4:40 p. m.

Toledo & Western, 11:45 a. m. and 7:25 p. m., both double-headers.

Besides these regular cars extra cars are frequently operated. The Lake Shore Electric sends a special meat car out of Toledo every day, and the Toledo & Western brings a special milk car into the city each morning. Special carload lots are handled at special rates, the Toledo station agent being authorized to give a carload rate over any of the roads. Milk is handled by all the roads at a straight rate of 1½ cents per gallon for any distance. Milk tickets are sold by the general offices and agents of each company. The minimum charge for any article carried is 25 cents.

While the freight traffic of the Toledo interurbans has passed the experimental stage, it can hardly be said to be fully developed, because of the fact that none of the roads has sufficient facilities in the way of cars and power to take care of all the business that could be secured by them were it pushed. Notwithstanding the fact that one interurban, the Toledo, Bowling Green & Southern Traction Company, has not attempted to take any freight business because of lack of power, while the other roads are practically turning down business, through lack of proper facilities, it is claimed that the freight business of the Toledo interurbans already exceeds the express business of the steam lines into Toledo. The reason for the rapidly increasing popularity of this service is the fact that it is practically express service at freight rates. Each road has its own scale of prices divided into classes, charges being made at so much

SPECIAL FREIGHT DELIVERY BY ELECTRIC LOCOMOTIVE per hundredweight. The class of any article is determined by the regular official freight classification tariff used by all steam roads. The scale of prices for the several roads is shown in the table on this page.

Very little freight or express is carried in combination cars on the lines entering Toledo, but in other sections this is common practice. One agent, with the necessary help, attends to all shipments and receipts at the Toledo headquarters, and is paid by the several roads, in proportion to the tonnage hauled by each. Other expenses, such as telephones, stationery, fuel, etc., are paid in like manner. The freight station is managed by a committee, composed of the general managers of the companies interested. Each year a general manager for the station is elected from the members of this committee, the present incumbent being L. E. Beilstein, general manager of the city company and the Toledo & Maumee Valley Railway. The Toledo & Maumee Valley Company advances such money as is required during the month, and settlements are made each month at a meeting of the managing committee. The city company pays nothing towards the maintenance of the station, but it receives a percentage of the income derived from freight by each road, figured on the mileage handled. The station is in charge of F. W Fisher, who has had long experience handling freight. He has five assistants in the freight depot, and the car crews aid in loading and unloading.

The business of each road is conducted separately, and there are separate blanks of all kinds, so that although it is a union freight station, it is at the same time practically a station for each road, and is conducted exactly as are the single stations on the several roads. A way bill accompanies each shipment. When freight is received from the consignor a receipt is made in duplicate, one copy

Name of System and Stations	Classes					
	1	2	3	4	5	6
Lake Shore Electric Ry. Co.						
Genoa	7½	7½	7½	7	..	..
Woodville	7½	7½	7½	7	..	..
Hessville	7½	7½	7½	7	..	..
Gibsonburg	7½	7½	7½	6½	..	..
Tremont	7½	7½	7½	7	..	..
Clyde	9½	9½	9	8	..	..
Bellevue	10½	10½	10	8	..	..
Monroeville	14½	13	12	10	..	..
Norwalk	14½	13	12	10	..	..
Toledo & Western Ry. Co.						
Sylvania	7½	7½	7½	7	5	3½
Riga	10	9	8	7½	5½	4½
Blissfield	11	10	8	7½	5½	4½
Palmyra	12½	11½	9	8	6	5
Adrain	13	12	10	8½	6½	5
Berkey*	11	10	8½	7½	6	5
Metamora	12	11	9	8½	6½	5½
Whiteville	13	12	10	8½	6½	5½
Seward*	13	12	10	8½	6½	5½
Lyons	13	12	10	8½	6½	5½
Densen*	15	12	10	8½	6½	5½
Morenci	15	12	10	8½	6½	5½
Toledo & Monroe Ry.						
Monroe	12	11	8½	7½	5½	4
Erie	11	10	8	7	5	3½
Tol. & Maumee Val. R. R. Co.						
Maumee	7½	7½	7	6	5	..
Perrysburg	7½	7½	7	6	4½	..
Waterville	7½	7½	7½	7	5	..

* Prepay station.

FREIGHT TERMINAL YARDS OF THE TOLEDO & WESTERN AT WEST TOLEDO being given to the consignor and the other kept on file for reference and tracing. When goods are delivered to the consignee a receipt is received in duplicate, a copy going to the consignor. A book of cash receipts and cash disbursements is kept, also a record book of freight bills received. An abstract of freight way bills received and forwarded is sent to the auditor of each road once a month, as well as a monthly balance sheet. There are also blanks for freight over, short or damaged, and for the correction of errors in way bills. Many of the forms used in the freight and express departments of interurban roads are herewith reproduced.

The Lake Shore Electric Railway started its freight business in January, 1901. At present its freight cars operate only to Norwalk, but it is expected that in a short time the through business to Sandusky and Cleveland will be opened up. The Toledo & Monroe Railway, 22 miles in length, commenced freight operations in July, 1901. It is being extended to Detroit. The Toledo & Western commenced operations to Sylvania in September, 1901; at present 60 miles of road are in operation, one branch extending to Morenci and the other to Adrian, Mich. The Toledo & Maumee Valley has 21 miles of road, including a branch to Waterville. It commenced to carry freight on March 1, 1902, when the freight station opened for business. It will be seen, therefore, that it is too early to make

The Dayton & Troy Electric Railway Co.

Abstract of Way-Bills Forwarded.

From .... Office, State of ....

Enter Way-Bills Alphabetically, as Offices appear on List of Agencies. .... to .... 190.... Inclusive.

Date	No.	Where to	Advanced Charges	Our Charges	Total to Collect	Prepaid	Remarks.

The Dayton & Troy Electric Railway Co.

Statement of Way-Bills Received at .... Office, State of ....

Enter Way-Bills Alphabetically, as Offices appear on List of Agencies. *From* .... *to* .... *190* .... *Inclusive.*

Date	No.	From	Advanced Charges	Our Charges	Total to Collect	Prepaid	Add for Under Charges	Deductions as explained on Way-Bills	Prepaid Beyond

THE DAYTON & TROY ELECTRIC RAILWAY COMPANY.
SETTLEMENT SHEET.

FREIGHT AND EXPRESS RECEIPTS AT .... *STATION.*

From .... *190* .... *to* .... *190* .... *inclusive.*

DEBITS.	Amount.	CREDITS.	Amount.
Uncollected bills last report		*Advance charges as per abstract*	
Charges to collect on W. B. recd as per statement		*Amt. of uncollected bills as per statement below*	
Amt. of prepaid as per abstract		*Remittances as per statement below*	
Undercharges as per statement		*Amt. of Prepaid beyond*	
Miscellaneous as itemized below		*Deductions as explained on W. B.*	
		Miscellaneous as itemized below	
Balance due Agent		*Balance due company*	
Total		*Total*	

Uncollected Freight Bills to Date.				Remittances of Freight Receipts.			
Way Bill. Date.	Way Bill. No.	Way Bill From.	Amount.	Way Bill. Date.	Way Bill. No.	Delivered to Messenger.	Amount.

FORM NO. 12 **FREIGHT BILL.** No. ....

CONSIGNEE .... STATION ....

To THE DAYTON & TROY ELECTRIC RAILWAY CO., Dr.

For charges on articles Way-Billed from .... via ....

	No. of Pkgs.	Articles and Marks	Weight.	Rate.	Freight	Advances.
DATE OF WAY-BILL. .... 19....						
NUMBER OF WAY-BILL.						
CONSIGNOR.						
Original Point of Shipment.						
Connecting Line.	Received Payment, ... Agent. Date .... 19....		TOTAL TO COLLECT, DRAYAGE,			

Original paid Freight Bills should accompany all claims for over charges, loss or damage.

FORM NO. 13 **FREIGHT RECEIPT.** No. ....

CONSIGNEE .... STATION ....

To THE DAYTON & TROY ELECTRIC RAILWAY CO., Dr.

For charges on articles Way-Billed from .... via ....

	No. of Pkgs.	Articles and Marks.	Weight.	Rate.	Freight.	Advance.
DATE OF WAY-BILL. .... 19....						
NUMBER OF WAY-BILL.						
CONSIGNOR.						
Original Point of Shipment.						
Connecting Line.	Received the above described property in good condition. .... Consignee. Date .... 19....		TOTAL TO COLLECT, DRAYAGE,			

The Dayton & Troy Electric Railway Company.
RECEIPT BOOK.

Date.	Way Bill. Money	Way Bill. Freight	Way Billed From	Way Billed To	Receipt.

The Dayton & Troy Electric Ry. Co. *Via FREIGHT* / *Via EXPRESS* *Way Bill No.* .... *190* ....

Freight and Express Department. *Freight Way Bill from* .... *to* ....

No. Pkgs.	Articles.	Recd From	Consignee.	Destination.	Weight.	Rate Per Cwt.	Advanced Charges	Our Charges	Total to Collect	Amt. Prepaid.	Add for Undercharges.	Received the property hereon described opposite our respective names in good condition except as noted

The Dayton & Troy Electric Ry. Co. *Via EXPRESS* *Way Bill No.* .... *190* ....

Freight and Express Department. *Money Way Bill from* .... *to* ....

No. Pkgs.	Articles.	Recd From.	Consignee.	Destination.	Value.	Rate Per $100.	Advanced Charges	Our Charges	Total to Collect	Amt. Prepaid.	Add for Undercharges.	Received the property hereon described opposite our respective names in good condition except as noted

FORMS AND HEADINGS ADOPTED BY FREIGHT AND EXPRESS DEPARTMENT OF THE DAYTON & TROY ELECTRIC RAILWAY

TRANSIT RECORD.

Every Messenger, Agent and Transfer Man through whose hands this Way Bill passes must stamp his name and check mark in regular rotation hereon.

	MESSENGER.	Ck. Mk.
1		
2		
3		
4		
5		
6		

NOTICE.

Every article (either freight or express) must be accompanied by a Way Bill and if received en route or at destination without same it shall be the duty of Agent or Messenger to make an "Over" Way Bill from the marks on the package.

NOTICE TO MESSENGERS.

This W. B. must be delivered to Agent at station named on opposite side. In case the goods are delivered by messenger it shall be his duty to receive consignee's signature on face of Way Bill before turning same over to Agent.

BACK OF FREIGHT AND MONEY WAY BILLS

No.__________

The Dayton & Troy Electric Ry. Co.

FREIGHT AND EXPRESS DEPARTMENT.

$__________ *Amount of Bill for Collection.*

$__________ *Charges for Return of Money.*

$__________ *Total Amount to be Returned.*

From__________

On__________

Date of Shipment__________19

C. O. D.

Bill to be Collected on Delivery of Goods.

Goods Way Billed to__________

NOTICE TO SHIPPERS.

Goods received by this Company subject to C. O. D. are accepted only under conditions of its Receipt and Instructions to its Agents. If delivery of goods cannot be effected within 30 days, on account of inability to collect the amount due on them, the shipper agrees that the same may be returned to him and that he will pay the charges for transportation both ways, and that liability of this Company for such property while in its possession for the purpose of collection, shall be that of warehouseman only.

NOTICE TO AGENTS.

All employes through whose hands this C. O. D. passes will be held responsible for the same and must adhere to the Company's instructions concerning C. O. D. matter, as given in book of rules.

REMARKS

Counted and Sealed by

AGENT'S MEMO. ON BILLS TO BE COLLECTED

comparisons as to the growth of monthly shipments and receipts of freight on any of the roads, but the following figures for the month of June, 1902, are interesting:

	Receipts in pounds	Shipments in pounds
Lake Shore Electric Railway...........	226,573	803,644
Toledo & Maumee Valley Railway......	56,574	241,570
Toledo & Monroe Railway............	232,003	272,755
Toledo & Western Railway............	350,712	804,378
Total Toledo Station................	865,862	2,122,347

The tonnage received at the electric freight station during the month of July was reported by the management as follows:

	Pounds
Out-bound	2,416,390
In-bound	854,291
Total received and forwarded........................	3,270,681

These figures do not include the carload shipments which are made over the Toledo & Western from its terminal station in West Toledo, neither do they include similar shipments which have been made over the Lake Shore Electric Railway outside the city limits.

An interesting feature of the statement is that the outgoing shipments are more than double the receipts, and that they are constantly increasing at a much greater rate. At first glance this might be taken to indicate that the enterprising merchants of Toledo have been more prompt to realize the benefits of the new system than the citizens along the several roads, but, as a matter of fact, the contrary seems to be true. The country store keepers, who, in the majority of cases, pay the freight bills, make a point to order goods purchased in the city to be shipped by interurban express. The reason for this is evident. The country merchant steps to his telephone and calls up the Toledo wholesaler, directing that the goods be sent on the next car. It is an everyday occurrence for merchants in Adrian, Mich., or Norwalk, the latter 65 miles from Toledo, to order goods in the forenoon and have them delivered in the afternoon. With sharp connections on the part of the wholesaler it is possible to deliver goods within three hours at any of the towns in this large zone. Some of the good housekeepers in a large city have waited longer for a basket of groceries from the corner store.

The plans for the future point to the development of this utility in new directions. Some of the Toledo wholesalers are agitating the question of laying spurs into their shipping sheds, thereby shortening the time of delivery and saving drayage. The Toledo managers are also seriously considering the purchase of inexpensive box cars to be used as trailers. The idea is to have them built similar in appearance to the present freight cars, and to be drawn by the electric cars, one at a time. Under this plan the several roads could interchange carload shipments. For instance, when the Lake Shore Electric Railway is completed carload shipments could be made from Cleveland to Detroit or to Adrian, Mich.

So much for the interurban lines entering Toledo and the freight and express business of that territory. There are many other sections of the country in which similar development may be noted. It will be especially interesting to refer to the efforts that have been made by individual companies, including some that are not favored with the patronage of large cities. The experience of the Cleveland & Eastern Railway in developing the package freight business of the section in which it operates, was very thoroughly described in the STREET RAILWAY JOURNAL of May 31. This road passes through a farming country and has developed a large milk carrying trade.

FREIGHT BILLS PAYABLE ONLY IN BANKABLE FUNDS.

NOTICE.

Freight Office Dayton & Troy Electric RAILWAY CO.

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

....

There has arrived at this Station, consigned to you from..

the following articles, viz:

....

No. Car................ Weight................

Which are ready for delivery to you on payment of Freight and Charges, $................

Make Checks payable to "Order D. & T. E. R'y. Co."

N. B.—All Freight Bills to be paid before the Goods are removed from the Station.

The contract of this Company, as common carriers, ends upon the arrival of Goods at our freight stations; and if consignees are not then ready there to pay charges and receive the goods, we dispose of them in thebest manner we can, and hold them as gratuitous warehousemen for twenty four hours from the time they arrive, subject only to the risks of such warehousemen.

The Company will not be responsible for Damage from ordinary Leakage, Breakage or Insufficient Cooperage; and no Damage will be allowed after the Goods leave the Station, unless by consent.

....Freight Agent.

☞ RETURN THIS NOTICE.

NOTICE OF FREIGHT AWAITING PAYMENT OF CHARGES

LOCAL POINTS OF Dayton & Troy ELECTRIC RY.

Piqua
Farrington
Eldean
Troy
Cowlesville
Tippecanoe Cy.
Evanston
Ginghamsburg
Vandalia
Chambersburg
Ebenezer
Dayton

....190....

To..

....

Hereafter and until further notice we especially desire that all goods ordered by freight consigned to points on the D. & T. Ry. be shipped via that line when practical to do so.

....

(OVER)

NOTICE TO SHIPPERS

The Steubenville Traction & Light Company, of Steubenville, Ohio, recently established a freight department, but the volume of business handled is as yet rather small. The management reports, however, that the indications are favorable, as the service is appreciated quite generally. Unlike the Toledo practice, freight is handled on this road in combination cars, and in the principal towns along the line stations have been established, but the company does not as yet maintain delivery wagons. The rates are not so high as the express rates, but are slightly in advance of the steam railroad freight charges. This is permissible, as the service is much superior to that of the steam lines. Blanks used by the large shippers and also the duplex excess tickets, which are carried by the conductors on the line and issued for all small shipments, are reproduced, together with a photograph of one of the combination cars which are operated in this service. These cars are of the following dimensions: Length of body, 30 ft. 9 ins.; length of platform, 4 ft. 5 ins.; length over bumpers, 40 ft. 8 ins.; width over all, 8 ft. 2 ins. The baggage room is the length of four windows, about 11 ft. 6 ins. The passenger compartment is finished in white birch.

The Dayton & Troy Electric Railway Company, of Piqua, Ohio, has developed a very satisfactory system of accounting for freight and express service, which may prove valuable to other lines of a similar character. Way bills are made in duplicate by having every alternate sheet in the pads plain, cheap paper, and using carbon paper between the sheets. There are two styles of way bills—freight and money. Every article transported must be billed whether company business or not. The messenger has a receipt book in which he takes a receipt for every bill delivered. The goods are checked by the bills in practically the same manner as is done by the express companies.

SHIPPING ORDER

THE STEUBENVILLE TRACTION AND LIGHT COMPANY.

NOT NEGOTIABLE. *Ohio,* .... *190* ....

Shipped by

Via THE STEUBENVILLE TRACTION AND LIGHT COMPANY, the property described below, in apparent good order, except as noted, (contents and condition of contents of packages unknown), marked, consigned and destined as indicated below.

CONDITIONS.

The liability of The Steubenville Traction & Light Co shall be at all times that of a forwarder only, and in no event shall it be liable for loss or damage to said property, caused or resulting from the same being improperly packed, secured or addressed; nor by or from any act of the law, or of a person acting as an officer of the law, whether acting with or without lawful process, warrant or authority; nor shall it be liable for any loss thereof or damage thereto by causes beyond its control, or by floods or by fire from any causes whatsoever occurring, or by riots, strikes or stoppage of labor, or by leakage, breakage, chafing, loss in weight, changes in weather, heat, frost, wet or decay, or from any cause if it be necessary to carry such property in open cars; nor for loss or damage to articles consisting of or contained in glass.

Nor shall said company be liable for loss or damage to said property in any event or for any cause whatever, unless said loss or damage shall be proved to have been caused by or to have resulted from fraud or gross negligence of said company or its servants, nor in any event shall said company be held liable for any loss or damage to said property unless written claim be made therefor to said company within ninety days from this date.

The Company is not responsible for safe delivery of freight to consignee, but will deliver same at its freight depots, where established, otherwise at side of roadway, on side of streets, or roads only as are traversed by this Railway and at regular stopping places, nearest to address marked on package. All freight offered must have address of consignee plainly marked on outside of package, or it will not be received.

All of the stipulations and conditions in this receipt shall extend to, and inure to the benefit of each and every person or company to whom this company may entrust or deliver the above described property for transportation, storage or delivery.

The party accepting this receipt thereby agrees to its conditions.

MARKS, CONSIGNEES AND DESTINATION	DESCRIPTION OF ARTICLES	WEIGHT Subject to Correction

FORM TO BE SIGNED BY SHIPPER, COPY SENT TO THE CONSIGNEE AND THE THIRD, SIGNED BY AGENT, KEPT BY SHIPPER AS RECEIPT

THE STEUBENVILLE TRACTION & LIGHT COMPANY.

Freight Department. BOOK No. 1 TICKET No. 19

From: Steubenville, Alikanna, Costonia, Jedoo, Toronto, North End, Freemans, Empire

To: ★ ★ ★ ★ ★ ★ ★ ★

$ 2 3 4 6 / 6 7 8 9

65 Cts. BOX; 60 10 BBL.; 66 15 KEG; 70 20 BASKET; 76 25 CRATE; 80 30 BUNDLE; 86 35 ROLL; 90 40 CAN; 95 46 JUG; 100 60 PIECES

TOTAL PACKAGES: 1 2 3 4 6 / 6 7 8 9 10

JAN. FEB. MAR. APR. MAY. JUNE JULY AUG. SEPT. OCT NOV DEC

1902 1903 1904 1905

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

READ THIS CONTRACT.

The Duplex Ticket must be punched before it is detached from the book and one half given to consignor, who will receive five cents for it upon presentation at the Company's office, Steubenville, O., or it will be received as one fare upon any one of the Company's divisions. The Company is not responsible for safe delivery of freight to consignee, but will deliver same at its freight depots, where established, otherwise at side of roadway, on side of streets, or roads only as are traversed by this railway and at regular stopping places nearest to address marked on packages. The person accepting this duplex assumes all responsibility in the transportation of freight receipted for and agrees that the Company is not liable for loss or damage. All freight offered must have address of Consignee plainly marked on outside of package or it will not be received.

DUPLEX FREIGHT TICKET

When goods are delivered by the messenger before reaching the station he gets the consignee's receipt in the space provided, but when delivered by the agent an expense bill is made. Settlement is made every ten days by the agent on blanks specified as "Abstract Statement" and "Settlement Sheet." Two classes of service have been developed, freight and express, and these are indicated on the way bill. In larger stations the company has its own wagons for express service, but in the smaller places it pays 20 per cent of the charges for delivery to the parcel delivery wagons. It has through billing arrangements with the Southern Ohio Express Company, which operates on the Southern Ohio Traction Company's cars, and its express rates are considerably under those of the old express companies, being calculated on the regular graduated scale. The freight rates are about one cent under those of the steam roads. Two 55-ft. freight cars are employed. One of these makes two round trips every day between Piqua and Dayton. It runs on a schedule and is handled by two men. The company has a freight classification which is identical with the regular railroad classification, and rates are fixed accordingly. Arrangements have been made for way billing freight through on the lines of several of the traction companies which enter Dayton, by a division of the charges and sharing the expense of transfer.

COMBINATION CAR OF STEUBENVILLE TRACTION & LIGHT COMPANY

The Mahoning Valley Railway Company, connecting Youngstown, Warren, Niles, Girard, Lowellville, Struthers, Mineral Ridge and Leavittsburg, Ohio, has developed considerable freight and express business in its territory. At this time it is operating two closed cars, built especially for freight and express service. There are three men on each car, the conductor, motorman and laborer. Freight depots have been located in each city and village through which the line operates; but these stations are planned differently, owing to varying conditions. In Warren, Ohio, space is rented, for instance, in a shoe store, and the shoemaker looks after the freight business. At Niles a depot has been built especially for freight business in connection with the company's power house, and the man who acts as despatcher at that point looks after freight and packages. At Girard, Struthers, Lowellville, Ohio, and New Castle, Pa., the company has buildings of its own, which are used as passenger and freight depots. At Youngstown, Ohio, and at Edenburg, Pa., there are freight rooms in connection with the stations, the despatcher looking after the freight. The company does not maintain delivery wagons, neither does it use combination cars. The policy of the management is to keep the passenger traffic entirely distinct from the freight business, as it believes that otherwise positive damage is done to one, while the development of the other is greatly retarded.

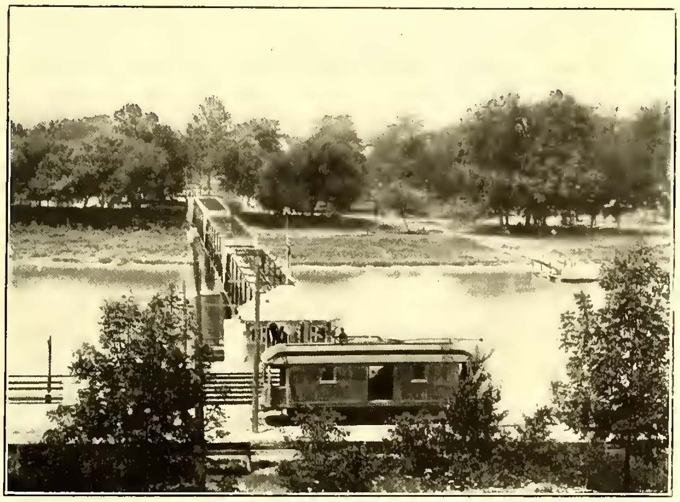
The package freight business of the Cincinnati, Dayton & Toledo Traction Company, formerly the Southern Ohio Traction Company, is conducted by the Southern Express Company. When the Southern Ohio properties were first consolidated the express business was placed in the hands of the Wells-Fargo Express Company on the same basis that it operates on steam roads. The net returns to the traction company were not satisfactory, however, and it was decided to conduct the business itself. The Southern Ohio Express Company is a distinct organization, incorporated with a nominal capital stock of $2,500. The traction company furnishes the cars, crews and power, and receives 10 cents per car-mile for the mileage of the freight cars. At present the company operates two 35-ft. freight cars between Cincinnati and Dayton, making two trips each way per day. Appreciating the possibilities of this business the company adopted at the outset a broad policy, purchasing thirty first-class wagons and teams, sending out numerous solicitors and establishing stations in the leading towns in the territory it intended to occupy. For a time the net loss was quite large, but persistent efforts turned the tide, and this year it is estimated that on the present basis, the net profits of the express company will be about $10,000 for the year. During the last few months the gross receipts have amounted to between $3,000 and $4,000 per month, and it is now making such substantial gains that it will soon be necessary to purchase additional freight cars. The company uses the traction company's passenger and terminal stations in Cincinnati, Hamilton, Middletown, Franklin, Miamisburg and Dayton, paying half the expenses of the maintenance of the station in addition to maintaining its own agent. Under this arrangement the operating expenses amount to about 75 per cent of the gross receipts, leaving a surplus of 25 per cent, which

MILK TRAIN ON CLEVELAND & EASTERN OHIO

is going toward the reduction of previous losses and for improvements to the service. Of course the traction company derives a good profit under the arrangement.

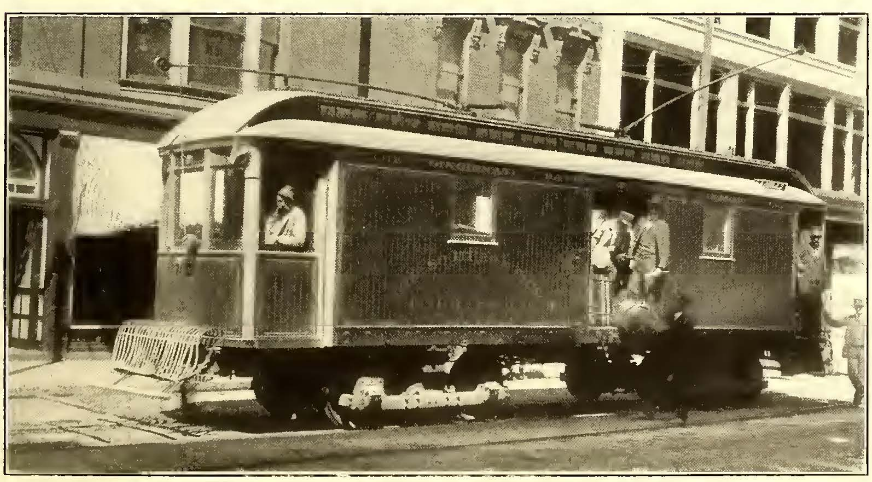
As before stated, delivery wagons are maintained in all the leading towns, and in Cincinnati and Dayton the wagons have regular routes, making four trips per day, to over 1500 leading business houses. The business is closely followed up by solicitors, and country merchants along the line, in ordering from jobbing houses and city merchants. direct that goods shall be shipped by this route.

The company has an arrangement with the Dayton & Xenia, the Dayton & Troy, Dayton & Northern, Dayton, Covington & Piqua, Dayton, Springfield & Urbana, and



SOUTHERN OHIO EXPRESS CAR AT CHAUTAUQUA GROUNDS, BETWEEN FRANKLIN AND MIAMISBURG

Dayton & Western roads, whereby goods are shipped clear through to points on these lines, the receipts being prorated according to the mileage handled. With some of the lines the company has an arrangement whereby their express business is handled in Dayton. In shipping to Springfield goods are sent to Xenia over the Dayton & Xenia, and then to Springfield over the Springfield & Xenia, the reason for this roundabout route being that the last mentioned line is controlled by the same interests as the Cincinnati, Dayton & Toledo. Recently a carload of ponies was



SOUTHERN OHIO EXPRESS CAR AT MIDDLETOWN

shipped through from Cincinnati to Springfield by this route, but no effort is being made to work up this class of through business. By reason of the fact that the various interurban roads entering Dayton maintain independent freight stations, it is necessary to transfer through shipments, and a union freight terminal, which has been talked of for some time, would effect a great saving of time and expense of transfer. At the present time the Western Ohio Railway, which is controlled by the same interests as the Cincinnati, Dayton & Toledo, is conducting a package freight business on a small scale. As soon as this line is completed to Piqua, affording connection with the Dayton & Troy Electric Railway, it is probable the Western Ohio freight business will be handled by the Southern Ohio Express Company, and goods will be shipped through from Cincinnati to Lima and later to Toledo.

The experience of the roads whose methods and equipment have been described may be accepted as fairly representing that of similar systems in other parts of the country. Of course it is well known that the amount of freight and express to be carried by the interurban road, and the profit arising therefrom, cannot be estimated in advance with the same degree of certainty as that of passengers, hence it is not usual, nor would it be wise, to invest great capital to provide for it until circumstances indicate its possibilities.

The Toledo & Western Electric Railway, now entering Toledo, which has been mentioned before in this article, traverses a territory not touched by steam roads, and it is carrying all kinds of freight in single cars and trains, and realizing, it is claimed, a fair profit. But there are few electric roads similarly situated. The value of the ordinary electric road, however, does not depend upon its ability or capacity to carry freight or express. Its value is only enhanced thereby. It should develop the business of carrying freight and express as rapidly as can be done with fair profit, and trust to the future for improved methods for enlarging and improving the same. Right here then is where the builders and operators of interurban roads should exercise the greatest scrutiny and judgment.

The originator or promoter always calculates upon deriving a considerable revenue from the carrying of freight and express, but it appears to me to possess many elements of uncertainty at the present time, where there is steam road competition. Express matter, at express rates, in sufficient volume to demand the full use of a car, or cars, will undoubtedly make an edequate return on the capital invested to provide for it.

The question whether express matter shall be handled by the road itself or entrusted to a company to be owned or controlled by the same ownership, demands careful consideration. In some cities the several interurban roads have formed express companies among their own stockholders, to do business under contract with these roads, thereby separating the liability and securing more efficient management, and at the same time retaining practically all the profits arising therefrom. The wisdom of so doing, however, must depend largely upon local conditions. The time will come when existing companies will be eager to secure contracts with electric roads on terms as favorable, if not better, than they now have with steam roads.

But as to the profit of carrying freight at steam road freight rates there is great doubt, unless cars can be operated in trains and exchanged with intersecting steam or electric roads, as is now done by the steam roads.

If necessity be indeed the mother of invention, we may reasonably expect that the future will provide means and methods of making the freight and express business of the Interurban Electric Railway much more profitable than present conditions seem to indicate.

THE ACCOUNTING DEPARTMENT OF INTERURBAN RAILWAYS

BY W. B. BROCKWAY

THE evolution of cheap transportation for short distances which has occurred during the last half century has been remarkable. The rapid changes from the omnibus of fifty or less years ago through the horse car, the cable system and the steam elevated to the electric system of to-day has made it possible by the rapidity and cleanliness of the latter to link towns and cities together by interurban systems and to fill up the spaces betwen them with houses and factories.

There is one branch of the operation of these systems which has had its problems to solve and its sleepless nights, too, but the public has seen very little of them. Each change of method in operation has caused the accounting department to make its changes accordingly. And while the financial and operating men have been cognizant of the changes, the general public has not marked it, except when, here and there, a company has added another title, that of auditor, to its list of officers. But even to-day the sweeping growth of this recognition can only be gained by comparing the official lists of officers for the recent year of 1895 with the present year. That this recognition is appreciated by the accounting officer goes without saying.

When the first interurban companies were formed they had no precedent to guide—or confuse, as you please—and, as the operating department made its first endeavors of operation along the lines of purely urban companies, the accounting department naturally tried it also. The accounting department worked faithfully along these lines some time, and as late a date as 1897, when the statement was made that "interurban and street railway accounting in the details of the operation are dissimilar, while interurban and steam railway accounts in the same way have more in common," it was received doubtfully. But suddenly, caused somewhat, no doubt, by steam competition, it was recognized that almost the only similarity between urban and interurban roads was electricity as a motive power, and the running over a short mileage of city trackage. Then the pendulum swung to the other extreme, and to-day we have interurban cars operated by train despatchers, substantial station buildings, cattle guards, air brakes, mileage tickets, express, freight and baggage cars, rotary snow plows and numerous other conditions which have made it necessary to have accounting in accordance, and so interurban accounting became a class by itself.

When this change or awakening came there came success and the companies multiplied. It is quite true that the accounting department has kept pace with its new conditions, so that to-day an accountant must approach the requirements of an interurban company in a somewhat different frame of mind than he would one strictly urban.

In planning the system of accounting it must be, of course, governed somewhat by its local conditions, but the prime importance is simplicity; a simple system can always be worked to the final results very much quicker, and the conclusions reached are usually more accurate, because the chances of confusion among the clerical force are lessened. The importance of this prime factor cannot be overdrawn, for the operating department is guided by the records of the accounting department, and wrong plans are easily made, if based upon inaccurate figures.

Another general rule of the accounting department of an interurban line should be, and it easily agrees with the argument for simplicity, to be in a position to furnish upon request operating information seldom asked for. In other words, the accountant should understand the business so well that he will foresee the needs of the operator and be able to assist him promptly. The old criticism that the accounting department "does not produce business" has been broken down, and money is well spent in the accounting department now-a-days if it is not merely a recording medium, but helps by intelligent work to make operating savings.

It is being understood better now than formerly that the reports and records made by conductors and others out on the road should have as little work in them as possible, for the reason that the men from whom the information is required are rarely well equipped by nature or education to grapple anything requiring careful writing or figures. They may be well trained in other directions, but not many of them could hold a place in the office. And so it is well to keep as much as possible of the real work in the office, and the result will be quite satisfactory, for the reason that if little is required from the outside men, that little will be given truthfully, but if much is insisted upon guesswork and hence inaccuracy will permeate much of the office work

The standard classification of construction, equipment and operating expense accounts of the Street Railway Accountants' Association of America is really standard, and with few changes, which it is flexible enough to allow, it is adaptable to the needs of interurban conditions. Its use is earnestly advised for the reasons so well argued since the organization of the association, which have been so publicly spread that there is no need of repeating here.

The great percentage of the passenger income of the company comes, first, from the cash collected on the cars while they are in motion, and second, from the commutation or reduced rate many-ride tickets sold by agents. The first is the more important, not only for the reason that the largest income is from that source, but it is an income coming through the hands of a more or less selected set of agents, conductors, but it comes to the company in various combinations and under conditions trying to the conductor with the operating duties required by his work. Therefore, simplicity is again urged in the composition of the ticket.

The forms of the tickets used are as numerous as the roads in operation, and it is an extremely difficult situation to face; for instance, if each station, or fare point, has its set of tickets reading to every other point, each conductor must be supplied with a quantity of each, and he then becomes the custodian of tickets representing a considerable sum of money, which is a serious risk on the part of the company, or else he should pay for the quantity and remunerate himself when sold, which is quite prohibitive under usual conditions. Again, the system is so easy of manipulation in the conductor's favor that it is not necessary of explanation here. This plan is expensive and cumbersome and is still open to the criticism that if a conductor meets a sudden traffic between points of which his supply of tickets is low, he has a condition to face which is not at all pleasant to him or to the patrons of the line.

Another plan adopted by many companies is the zone plan of making the fare 5 cents between points, at each point of which the conductor has to make a collection of 5 cents, ringing each on a register. The company then has a report from the conductor of the number of rings each day and the money thus called for. This plan is open to objection, as it eliminates the return ticket at a reduced rate, which is very popular with the public; moreover, it is a constant source of annoyance to the passengers, especially on crowded cars running on a rapid schedule, and half fares must also be recorded in a different manner. The plan has its good points, however, for if a conductor passes a passenger during the first zone he is liable to reach him the second, and a passenger can change his mind as to his destination as often as he pleases. To the operating department it is objectionable, for the reason that it makes a traffic statement impossible. This statement will be considered later.

The duplex method of collecting fares is so called because each fare collected has two tickets made simultaneously by the conductor, one half being given to the passenger and the other going to the office to substantiate and check the money turned in by the conductor, the station from and to, etc., being shown by the conductor's punch. The different form these tickets take is multitudinous, some good, some fair, and some wretched, in their operation. I have seen some requiring the conductor to make eight punches for each fare, which is too much work for a large and changing load. One form I have seen in use was designed by a left-handed manager, and the difficulty experienced by the right-handed conductors in handling the ticket can be easily imagined.

Other forms have simply a series of figures representing dollars, dimes and cents, the stations from and to not being considered. Others have the stations from and to perforated in such a manner that the ticket is parted at the proper place, the one section going to the passenger and the other to the office. There are so many forms that they cannot all be explained here, nor their points considered, but all things possible considered, and in view of experience, it seems that if a ticket is used it should be of the duplex style, in some of its phases, for the conductor is then given a pad of tickets at no cost, or rather investment, on his part, and he settles for them in accordance with his reports.

The composition of the ticket is subject to local conditions, that is, the number of fare points, the size of the excursion business, etc., but if the number of stations is not too large it is quite possible so to construct a ticket that the station from, the station to and the amount paid can be shown by one punch mark. If the policy of the company permits round-trip fares it is rather better to make the one-way ticket and the round-trip ticket identical, except to the reading, "good for one round-trip ride, etc.," being substituted for "good for one ride, etc.," and the color of the paper used, white doing very well for the one-way tickets, and red, or some other color distinguishable in uncertain light for the round-trip tickets. At any rate, the form adopted should provide for the definite showing of the beginning and ending of the passenger's ride and the amount paid.

It is not at all necessary, when tickets are used, to add to the work of the conductor the use of a register for each fare collected, as the register then becomes merely a counter of passengers, and that information can be readily found by the beginning and ending numbers of the tickets sold each day. On the other hand, the register can be used for recording the local fares collected in each town en route, but if this is done and the number of local city points is more than one, then no record of fares for use on the traffic sheet can be made without a reading of the totalizer at each point and recording this reading properly on the conductor's report. This adds to the work and possible confusion of the conductor.

There are those who think and substantiate by good arguments that the conductor should have no tickets to use, the different rated fares being recorded within a register which is much more than a counting machine, and further that the conductor should not make up a report of what he has done during the day, but leave that also for the register to tell. In other words, his duty should consist simply of turning in the amount of money collected during the day, the register being opened by an employee of the office, and the amount of money recorded and turned in, compared. As said above, this plan has much to commend it, but it is also subject to the "traffic-statement" argument, and makes the sale of round-trip tickets by the conductor a rather difficult matter. There is no doubt, however, that with some men the desire to do right is governed very much by their opportunities to do wrong, and the methods of reporting fares collected should be safeguarded very carefully.

The commutation many-ride reduced-rate ticket is another problem which needs most careful attention, not only for its proper accounting, but it has been a common experience that rates once reduced are not easily put back to the old condition; hence, a commuter's ticket once put on sale is pretty liable to stick, if not spread to other stations. The common tendency is to overdo the matter, and it soon develops that the conductor has tickets of many sizes and colors to handle and report. The mileage ticket solves much of this problem if the time is given the conductor to detach and mark the stations on the back of the detached strip (for checking and for use on the traffic statement), but the average time consumed in collecting a mileage strip for short hauls and the danger of loss to the conductor by the smallness of the strip and its flexibility make it the subject of much provocation to him and to the office in checking.

It is the writer's opinion that the ticket containing numbered squares for punching by the conductor, one punch for each ride, should never be used; the conductor should always have something to show for every fare, and this will also apply to the annual card pass. They contain dangers to the company and to the record of the conductor which make them and their kind a dangerous element which can easily be avoided, and they should be.

The coupon book is good for commutation uses, if colors are used, but wherever possible each coupon should recite the stations included. These tickets are better sold by almost anyone than the conductor, and when sold by agents or in the office they should be subject to a daily report and remittances. It is always preferable that the cover of the book and the agent's report should recite the name of the purchaser, to guard, when it is deemed necessary, against indiscriminate use. The conductors always learn to know their passengers if regular travelers, and it adds a safeguard to a condition which needs all the checks that can be placed about it.

The traffic statement should be prized by the operating department next in importance to the statement of income and disbursements; it occupies the place to an interurban road that the traffic curve does to the urban. It is subject to many ways of handling, but it may be drawn off into squares as follows:

The upper figures in each square show the one-way tickets, and the lower figures, the round trips. Added across the figures give the one-way and round-trip tickets sold from each station, and added down they show the same information to each station. Reference to a particular statement or series of statements gives the operating department information it really needs for its regular or short-distance cars, concessions regarding the reduction of fares, and the many other matters which are governed by the amount of traffic from and to each station. The commutation rides can be easily added in in red ink, which places the manager in as actual touch with his traffic as he is with his operating expenses.

It should be borne in mind that the figures used in the above example are purely fictitious, but should they come out as shown, the manager is at once placed in contact with the fact that something is wrong with his schedule and, all things being equal, he can find the trouble easily, which, when remedied, the statement quickly improves accordingly. Much other information may be added, making the statement still more valuable, and it is all accomplished with but little extra labor when the system is arranged. Even though it should require the extra expense of a cheap clerk to work up, what road would not spend the small amount necessary to get such positive information.

The statement is based upon the tickets (duplex half) turned into the office by the conductor showing the stations, and they are simply assorted after the conductors' reports are checked by the same tickets.

The reports required from the conductor should be simple as possible to make them effective and accurate, but in a general way they should contain the date, car number, trip number, schedule run number, time out, time in, hours and minutes of service claimed, his name and that of his motorman, with space for another, to provide for at least one change of motormen, their badge number, the opening and closing number of his tickets, the total number of each value of ticket regardless of destinations, a lump number of free tickets and a lump number of all kinds of commutation tickets, the total paying passengers carried (to be checked by the difference in his ticket numbers), the total freight or parcel tickets sold (also checked by the numbers reported), and the total cash. Upon the back may be placed the time of passing the different large towns (not small stations), say the two terminals and one point between for verification of accident claims and perhaps a sometime check by schedules, and it is frequently desirable to have the conductor punch the report in one corner as a record of the punch he is using. This information is much easier for him to give than it looks when written out, and it may all be done without taking much

RAPID TRANSIT COMPANY.
Traffic Statement Week ending June 7, 1902.

From \ To	Hometown	Smithwood	Proteus	Brown Farm	Comus	Jackson	Total from
Hometown	Local / 1000	100 / 20	10 / 40	3 / 5	90 / 310	340 / 600	543 / 975
Smithwood	90 / 32		14 / 20	1 / 0	12 / 2	18 / 10	135 / 64
Proteus	110 / 52	4 / 7		0 / 2	1 / 10	4 / 17	119 / 88
Brown Farm	2 / 10	0 / 0	0 / 0		0 / 1	2 / 0	4 / 11
Comus	72 / 100	2 / 0	2 / 1	3 / 2		90 / 140	169 / 243
Jackson	302 / 408	2 / 4	1 / 5	7 / 3	98 / 46	Local / 107	410 / 466
Total to	576 / 602	108 / 31	27 / 66	14 / 12	201 / 369	454 / 767	1380 / 1847

Hometown Local	1000
Jackson Local	107
Total Carried	4334

Cars per day 5
Trips per car per day . . 9
Trips per day 45
Equals 315 trips for week average 13.76 passengers per trip.

Street Ry. Journal

PROPOSED FORM OF TRAFFIC STATEMENT

time. His duplex tickets being assorted by values for use in his reports regardless of their serial number, become an assistance to the accounting department in checking the report. They have then to be assorted serially in the office to see that none are missing, in which case, should one not be found, he should be required to produce it or pay the highest possible value of the ticket.

The duplex tickets having no actual cash value when issued to the conductor, a simple receipt from him for the pads should be taken and his name written in a book having one hundred numbers printed in a vertical line, his name appearing at the top of the column; then, as the tickets are assorted serially, regardless of the issuing conductor, it is a matter of a few minutes to erase from the record columns the numbers returned each day and an open number quickly shows itself. This book is always a positive check upon the tickets due from a conductor leaving the service. It should be understood that the serial hundreds of the ticket numbers are written at the top of the columns, rather than keeping each conductor's tickets by themselves, as this shows up the possible omission of a whole pad.

The general record of passenger earnings is a serious question, but it seems as though very much labor may be saved and information gained if the time table trips, not runs, be numbered and the record made of what each trip accomplished in general totals; by this is meant that the whole number of paying passengers, except local city fares, should be shown as a total in passengers and money. It is better to show each local town or city 5-cent limit in its own column; then by showing the number of parcels and its money, in the case of a small road, the whole income by trips is arrived at upon one page. A recapitulation of the day's totals for each column will show the passengers carried and the earnings for each day, and by the use of totals brought forward it is possible immediately to show the results to date.

This brings up the question of whether it is better to require daily reports and daily remittances, or a trip report and a trip remittance. I am of the opinion that a report and remittance for every round trip is better, as it reduces the amount of money carried by the conductor, and makes the checking work of the department easier.

The envelopes in which the deposits are made need not bear anything but the date, the conductor's name and the trip number, and they should be large and strong enough to contain the trip report, the tickets (bound by a rubber band), and the money. In consideration of the frequency of deposit, the number of tickets as evidence and the usual lack of time in which to make the return, it seems that the receiver system, or, in other words, the system of counting and checking before the conductor, is not adaptable to this class of work. In addition, there are reasons overshadowing the satisfaction of the conductor for having as much of the work of this department done in the office as can be arranged. It is always better to give the auditor the actual supervision of the accounting work.

Each day's trip sheets, which, by the way, should be printed on paper, rather than on cards, should be fastened together and filed by months in a package away from the dust, and kept forever. It seems best that they should always be accessible for possible checks by professional accountants, and they frequently form an important basis for the sale of the property.

A copy of each change in schedule should be attached to the page of the earnings-register the day the change occurs, so that an understanding may be had of the precise operation of a trip number.

We now reach in our sketch of the accounting department of interurban railways a new source of income, or shall we call it a by-product? I call it "new" advisedly, because it seems to have been hardly considered or anticipated in the planning of the first companies—that income is from freight, express and mail transportation. The methods adopted in this work have been as remarkable and as changeable between companies as the kinds of tickets used in the passenger business. In other words, we find companies still doing as they did some time ago, when the first farmer asked them to take a barrel of apples to town for him, as he couldn't go along, saying Mr. Jones, the grocer, would meet it at the office. It is easily within memory when the first request of this kind occurred how the conductor took the barrel, but he didn't know what to charge, and if he could guess he didn't know how properly to report it to the company.

There are many roads to-day which charge 10 cents a package—at owner's risk—regardless of the size or weight, which have made little or no provision for the proper report to the office of such income, and which have no method of package identification; no record of transportation, nor all the other checks, records, tariffs and reports used by all the rest. And here again appears the comparison with steam railroad practice, for by the changed methods some of the companies have closely reached the basis of steam railroad accounting with the difference coming from another power of movement and the extremely local character of the business.

It also develops a difficulty that is quite real and positive to the accounting department, for, unlike the passenger part of the business, it seems that the more the freight business grows, the more there is needed a complete record of the consignor, consignee, commodity, rate, weight, car number and the other information long ago adopted by the steam roads, so that in an article of this kind which aims to cover the general subject it is quite out of the question to give suggestions to fit the conditions, except in the most general way. However, it may be accepted that where the freight and express business is small with cash collections at point of shipment a very simple system of accounting is most desirable, something, for instance, in the nature of a duplex tag bearing the address, and into which may be punched by the conductor such general information as box, barrel, bag, etc., with the places from and to and the amount paid. One-half of the tag should go to the office with the conductor's money and report, and the other should be attached to the freight, to be detached at delivery, to bear the receipt of the consignee upon its back and to be returned to the office for safekeeping and proof of delivery as against claims of loss, etc. These tags should be numbered, and the non-appearance of any particular one should be inquired into and explained. In this, as in the handling of tickets, those spoiled should be returned to the office, instead of making an attempt to correct them, as this latter course is always liable to, and usually does, result in arguments and unpleasantness between the patron and the company. Enough unpleasantness is sure to arise anyway, so it is better to forestall all that is possible.

But in the case of larger business, where, for instance, freight cars are run on a regular schedule, a more complete system becomes necessary, especially when regular agents and stations are maintained along the line. Then there opens up the need of positive record, for the traffic has now become "freight," as distinguished from "light package" business, and frequently "carload" shipments are made, making a difference in the tariff, as compared with "less than carload."

A positive schedule of rates for differing commodities now is a necessity for the governance of agents and conductors, and the accounting department should add to its duties a rate checking desk, upon which must go the records of all business for checking, the same as the conductors' reports of passenger traffic are checked by the money counters.

It seems, in the face of a large business, which frequently crowds the passenger business for the supremacy as the largest producer of gross income, and to the frequency of "collect" shipments, together with the necessity of "returned empty" shipments as applied to milk cans, beer kegs, etc., that there should be applied the system of regular way bills copied in duplicate in the forwarding agent's book, one tissue copy going to the general office and the way bill to the conductor, and thence to the receiving agent, each making a record to show the proper handling in his hands, and all eventuating in a "freight receipt" and "freight received" notice to consignee at the destination. All this brings into use the system of abstracts made daily, weekly or monthly by the forwarding, and also by the receiving agent, showing the date of shipment, way-bill number, commodity, weight, rate, amount paid and amount to be collected.

The amount collect on the abstract of the forwarding agent should agree with the amount paid on that of the receiving agent's abstract, plus the undelivered freight still on hand. It, of course, appears that an abstract should be made for each station to and from.

Then comes the filing of way bills at the receiving station, the checking in upon the way bill of freight received, the "over, short and damaged" report of received freight, and the numerous other conditions of money and traffic which soon call for the work of a traveling auditor who makes periodical and unexpected examinations for the assistance, not only of the accounting department, but of the operating as well, for an agent who cannot fill the requirements of the accounting department can rarely be a help to the operation.

This enlargement of business calls for a like expansion of the accounting department, for records must now be kept that were unnecessary a few years ago, and the abstracts from the agents must be checked by the way bills' tissue copy, as sent in daily, so that a recapitulation of them may form an accurate basis of record as the income from freight business. Of course, it is still necessary for the conductor to be able to receive package freight along the line, and a simple method must be provided, as first suggested, for him to use, as he is not in a position to carry out the detail required of an agent, but as his business is usually, or can be made to be, cash, his duplex ticket or tag takes the place of a way bill and his report takes the place of the regular abstract.

It is also common to make connections with steam railroads with through rates and tickets for freight and passengers, and sometimes this reaches the need of through cars. It seems uncommon that the electric line should receive the liberal differential which is customary when a large steam road delivers to, or receives from, a smaller one, but such as it is, it is another phase of the work of the accounting department of the electric line which calls for its abstracts to and from the steam line, the same as from its agents, and the monthly settlement is made much in the same way. But where there is only a transfer delivery it is similar to its own handling of its own local business.

Unless the interurban company has more than one line or route the record of freight income should be shown by stations, so that the importance of a freight point may be gained. It is quite feasible to make a traffic statement, somewhat similar to that of the passenger business, when the general volume reaches a point of importance. When it does, the details can be worked up in about the same way; the figures may also show the tons and the dollars, from which statement comes the unit of the "ton-mile," which is the unsatisfactory and misinforming, but "standard," adopted by the steam railroads.

It is advisable that regular freight records should be kept of the material hauled for the company, that is, the supplies sent from the city to the barns or shops, or from barn to barn, as it adds an element of responsibility to the handling of the material that is desirable.

Car mileage records are so important that provision should be made for their proper keeping with as much care as those for the handling of traffic. Even though the comparison of earnings on the car-mile basis has passed from some of its usefulness since the introduction of the car-hour basis of comparison, it is still the proper basis for use in many of the operation features, and these records should be worked up very carefully and promptly. This is easily done from the trip sheets of the conductors. Mileage from this source is better than from the schedule, and the daily statement of car-miles run by each car, including the freight and work cars, should be in the hands of the proper officials promptly each day, as well as recorded in the accounting department.

The daily statement of passenger business, and if possible to include freight, should be rushed through the office with all the speed possible, so that the operating department shall know within as few hours' delay as consistent with accuracy what were the results of the day previous. This statement should include the day's earnings compared with the same day of the week the previous year, the car-miles operated for each class of car also compared. The earnings for the accumulated monthly period (based on the day of the month) also compared, the number of each class of passenger, that is, cash, commutation, and free, also compared, and the weather compared. It is well understood that comparisons with a previous year are always valuable, as they bring up causes and effects quickly for explanation and remedy.

The monthly statement of income and disbursements and other information is an important document, to which should be applied all the energy and ability of the accounting department. The statement of earnings should be in such detail that the totals may be easily understood and the statement of expenses should cover all the requirements of the operating department based upon the classification of the Street Railway Accountants' Association of America, with such additions as the needs of the operation may require. It seems better that this statement should have all possible comparisons, as for instance, this year with last, and period with period, with such basic comparisons as per car-mile, per car-hour, per cent of total and the other percentages usually needed, together with the per cent of increase or decrease. While it sometimes is not considered necessary to show the percentages of each item, it still should be given for the sub totals and grand totals. The condensed balance sheet should also have the comparisons with the previous year because it gives a quick understanding of conditions quite vital to the welfare of the company.

Statements in general divisions of cash received and disbursed are desired usually as a part of this statement, and, in fact, the statement can be expanded to an extent and reduced to a point desired by the president, but it should be considered that while the present management may want but little, some future arrangement may call for quantities of back information which are more easily obtained if complied in the form of a monthly report and thus being preserved for future as well as present use. That reasoning should also apply to the whole system of accounting, for it seems to the writer that no system should ever be planned nor operated without due consideration of the probable needs of future managements. Statements and reports should always be preserved and filed for the use of others, because changes occur and the accounting department is the one called upon to supply information. The golden rule is not a bad one to apply here, because conditions change so completely that we frequently get both points of view, viz.: as the originator of systems and the searcher after information in someone else's system.

Material and Supplies.—What accountant doesn't regret to think of this problem of interurban accounting? Of all the purely accounting propositions it is usually the most provoking. But it cannot be said that it is the accounting alone which makes it difficult to handle, but the conditions which surround the other end of it. That is, the storehouse is usually at the barn, a busy place in charge of a busy man who does not always appreciate the importance of the information asked from him. Or else the statements are put in such shape that he finds himself in the position of the conductor referred to; he gets confused and guesses with the results we know so well. Therefore, the remedy applied to the other troubles, simplicity, will help in this. The best results will be obtained if but two reports are required, one made out upon the receipt of material, showing date, quantity and material from which the bills for supplies may be checked (don't send the bills to him, but keep them in the office), and another for each lot of material issued. These latter should be numbered for office checking and show the date, quantity and material, followed by a few columns with such simple headings as "Repairs to Cars," "Repairs to Motors," etc., in which he puts a simple check mark. Send both of these statements to the office each day, that is, not one for each day, but one for each time the storeroom is unlocked, and then do the compiling in the office under the eyes of the auditor. Don't ask the foreman to do the office work. If greater accuracy is desired, the office should keep a card or other record of the material for charging and crediting, but the supplies usually carried by a company of this kind seldom call for such records. Not that I do not believe in them, because I do most thoroughly where the quantity of the material warrants the expense. The report of each receipt and issue is much better than a daily or weekly summary and when sent to the office daily the foreman is relieved of further worry. The office should check the report numbers to guard against loss in mail or neglect to send in.

The pay rolls for conductors and motormen may be easily made from the conductors' reports daily, and the barn, shop, line and track men may be reported by the foremen daily giving name, usual occupation, rate of pay, and in small columns with proper headings the hours worked in each classification may be entered. From these statements will be made not only the pay rolls themselves, but the distribution of operating and other expense as applying to labor will be gathered. It goes without saying that legal receipts should be taken and that the payments should not be in the hands of the foremen, but preferably by someone from the office. Some point on the line is usually best for the paymaster to go to pay all trainmen passing that point; if this point can be located at a barn, so much the better for safety and gathering together most of the men. The way of reaching the others can be easily decided, but it seems best to have but one man to pay the whole road, because he soon knows all the men, which is always more or less desirable.

The operating expenses are more satisfactorily kept in a record with enough columns to provide for the whole classification . If treated a little differently it may be used as the whole record of accounts payable. At any rate, the totals of these columns added to the same columns of the material and supply statement, the pay rolls and various journal entries applying will be the material from which the operating expense statement may be gathered. If progression totals are used the total for any period can be quickly obtained. Certainly there are other ways of handling the matter, but the above is always satisfactory and quick in its working, and the whole subject is always gathered at a glance.

The company's mail from station to station, to and from the office, barns, etc., has caused many arguments and delays by the failure to deliver, and the other excuses so well known. It seems best, therefore, that certain cars should carry a box into which may be placed at the different points the mail for the office. These cars are known to pass at certain times, and they should be expected to carry to the office all mail to the time of leaving. The box should be locked with the key only at the office, and with a slit or other opening for the insertion of the mail. They pass the office often, and as the runs bring them around the clerk can open and empty them in a moment. The mail to the other points may be handled in small padlocked bags with a tag directing the destination. Each agent and foreman having a key, he is sure to get all of the mail sent and get it on time, because the bags are just too large for a pocket and just heavy enough not to blow away. On regular passenger cars the motorman can better handle the mail than the conductor because he has less to bother him, and the passengers do not have access to the bags.

It seems unnecessary to say that the punches used by the conductors should be recorded in the auditor's office and the record kept so complete that tickets and other punchable matters may be promptly and accurately identified.

The right of way and other deeds and contracts may not be filed with the auditor, but when they are a splendid way to record them is by numbers in boxes and a book kept with a page for each one with its record of dates, cost and other information. The page number should be the same as the file number. Partial payments of contracts may also be shown on the proper page in the record, for quick reference.

The subject of interurban accounting is so very broad to-day that a short article cannot contain a story of it, nor is one writer in a position to cover it all. However, enough has been said to show how different it is from that of purely urban companies and to demonstrate how really needful simplicity is. It is well worth sincere study to those engaged in it, but there should be kept in mind that steam railroad principles cannot govern it in its entirety, although the practices are similar. Originality is best and improvement is of the age, but keep thoroughly in mind that system—if simple—is the lubrication of the business machinery.

INTERURBAN ELECTRIC RAILWAY CAR EQUIPMENTS

BY W. B. POTTER

THE character of what might be termed the individuality of the traffic, whether for business or pleasure, is so greatly diverse in its nature that in each case the best method of serving presents an independent problem in itself. Even more specifically the schedule, modes of operation and equipment depend upon existing conditions, and are determined in essential features by the amount of travel, distribution of the loads throughout the day, the natural characteristics of the country and location of the residential districts. In most cases a compromise has to be effected between the predominating influences affecting operation on the one hand, from whatever cause they may arise, and what may be considered best engineering on the other, leaving unessential details to the choice and fancy of the individual operator.

It may, however, be of interest to discuss some of the general conditions met with in determining the equipment for various types of service, describing in every case only the apparatus which has passed the experimental stage and is established in character. There are three classifications under which interurban roads, that is, roads which operate both inside and outside of the cities, may naturally be subdivided.

1. Roads approximating steam railroading conditions, operating heavy trains over private rights of way in the city and country, starting from a point in the city and stopping only at predetermined points along the route.

2. Roads operating lighter single cars on public highways in the country and running over city tracks through cities encountered on the route, making stops wherever the passenger desires to enter or leave the car.

3. Roads in general combining the two former classes operating single cars or light trains over private rights of way in the country and entering the city over surface lines.

A desirable feature of an interurban service is the ability to maintain a fast schedule, and this is determined by the character of the roadbed as affecting the acceleration and maximum speed, particularly the latter.

When the length of run is less than a mile the acceleration becomes the determining factor in the schedule speed and is the more important the shorter the run. The maximum speed becomes important only when the length of run exceeds 1 mile or 2 miles. In the usual mixed city and interurban service, the stops will vary from 10 to the mile in the city to 1 in 5 miles and over in the interurban portion, averaging 4 stops per mile in the city, 2 in the suburbs, and from 1 to $1\frac{1}{2}$ stops in 2 miles in the country. The average length of the run over the whole route will approximate between $\frac{1}{2}$ mile in length and 1 mile. It is thus seen that a proper acceleration is of considerable importance in securing a fast schedule.

In combining runs of such widely different lengths as characterize this class of service, the average run with its characteristics may be taken to represent the whole route. This has been determined from an extensive investigation employing a number of motors of different sizes and makes, and assuming the same weight of car, operating conditions, number, length and sequence of runs, even where the length of various runs varies as high as 20 to 1, the average run giving characteristics which vary but a few per cent from the average of the integrated characteristics over the whole route. Thus the average run serves as a convenient method of determining the motor equipment, gearing, and secondarily, the power consumption. All values so reckoned are on the safe side, as the schedule speed is slightly less and the losses in the motor and the power consumption slightly greater than the average values integrated over the whole route.

Where the length of run in the city becomes a considerable percentage of the total length of round trip, the schedule speed is greatly affected by the time required to get into and out of the cities, as the speed is usually limited by sharp curves and blocking city cars. To reduce the time on the city portion it may be more profitable to follow the less frequented rather than the main business streets.

Both the safety of the passengers and maintenance of the schedule demand, as a first essential of the roadbed, that it be double-tracked throughout and as straight as possible, to minimize the dangers arising from the high speeds and the short headway between cars. Nearly all disastrous accidents can be credited to a single-track road or to the motorman's not being able to see well ahead.

As curves affect speed of the car and comfort of the passengers they should be of as large radius as possible and with compounded approaches. As affecting the speed the limit may be generally assumed as the square root of the radius of curvature in feet, that is, the running speed would be limited to about 10 miles per hour on a curve of 100 ft. radius, 32 miles on a 1000 ft. and 50 miles on a curve of 2500 ft.

Curves also introduce loss of power, a curve of 143 ft. or 40 degs. being equal to a grade of 1 per cent, and they are, further, the principal cause of flange wear and truck maintenance.

Grades of moderate amount or length are of less importance, as they do not limit the speed nor cause discomfort to the passenger. Over rolling country, where the cars may freely coast down the grades, returning ultimately to the same datum level, the average schedule, heating of the motors and power consumption do not materially differ from the same characteristics determined over the same distance on the level.

A point not ordinarily appreciated is that if the stops are always made at the top of the down grade, so that the acceleration of the grade is added to the acceleration of the motors, it is possible to make a faster schedule with less motor heating, energy consumption, over a rolling profile, than over the same distance on a level with the same number of stops. The down grades add to the acceleration and the up grades assist the braking.

This principle has been utilized to an effective degree in the profile layout of the Central London Underground Railway.

For further illustration of these principles may be cited the familiar "switchback" railway of our pleasure parks.

The worst possible combination results where the stops are made at the bottom of the grade, and for this reason such location of stops should be avoided.

Each per cent of the up grade requires 20 lbs. per ton tractive effort, and the effect of grades upon the schedule is thus greater in proportion, as the normal rate of acceleration is slower.

If trailers are hauled, as in the case of the locomotive, or the grades unusually steep and long, the grades become of serious importance in determining the motor capacity, gear ratio and minimum weight on drivers.

In a general way the preferable maximum speed will be found to be the least that will ensure the schedule.

The selection of the proper gear ratio for a given motor requires careful consideration, and it should be determined only after a full study of all the conditions.

As it is often desirable to determine from a simple test the performance of the motors for a given service, the recommendation of the A. I. E. E., on the testing of railway motors, as adopted at the nineteenth annual meeting, may be followed to advantage.

For the determination of the average run it is necessary to know the desired schedule speed, length of round trip, number of stops per round trip, the average length of stops, including layovers, the weight of loaded car and the average voltage over the route. The most difficult to determine and the most important is the average total number of stops per round trip, as this fixes the length of the average run.

Slow downs from curves and other causes where the power is thrown off and the brakes are applied, have the same effect as, and are equivalent to, fractions of a stop, with values dependent upon the amount of reduction in speed. As such slow downs affect the schedules they should be reckoned accordingly in the total number of stops per round trip. Since ordinary grades are not important in affecting the characteristics of the motor equipment, only the longer and the steeper ones need be considered.

An equipped car may thus be conveniently tested by running it forward and backward upon a level track, over the average length of run, accelerating at the proper current and maintaining the average schedule until the motors reach their maximum temperature, which will be in from eight to twelve hours. The temperatures so obtained will closely approximate what would be obtained in practice.

Higher rates of acceleration, with an ample reserve to provide for contingencies in handling variations in schedule, grades and safe guarding against the abuse of the motors, demand a proper proportioning of the weights on the driving axles to give the necessary available tractive effort. Under ordinary conditions of track the coefficient of friction may be taken from 15 per cent to 18 per cent of the weight on drivers, which permits a gross accelerating power of from 300 lbs. to 360 lbs. per ton when all axles are equipped with motors—200 lbs. per ton or 2 miles per hour per second is a reasonable maximum for comfortable acceleration.

To ensure comfort to passengers at high rates of acceleration it is essential that the control be so handled as to first start the car at a low rate, then increasing to the acceleration desired. That is, the speed curve should be concave at the beginning instead of the straight line of full acceleration, on the same principle that the straight line of braking is concaved at the end, due to easing of the brakes on the final stop.

For the equipment of double-truck cars four motors will be found generally desirable. If the grades exceed 5 per cent, the rate of acceleration exceed 1.75 miles per hour per second, or snow abound to any extent, four motors per car will be found essential to a reliable service.

Two-motor equipments may be expected to have an advantage in requiring less attention and maintenance, and a slightly higher efficiency, but, other things being equal, four motors of the same total horse-power rating will perform the same schedule with the same weight of train with less temperature rise or perform a faster schedule for the same temperature rise, since the total radiating surface of the four motors is greater. This difference, however, is not enough to reduce the cost of the four-motor equipment below the two-motor when making the same schedule with the same weight of train for the same temperature, and thus, when feasible, the two-motor equipment is the cheaper.

Even where conditions would permit the use of two motors, it may be their dimensions for the necessary capacity will be such as to exceed the allowable space, in which case four motors must necessarily be used.

Fortunately, the time is rapidly passing when a purchaser, having bought a motor, feels that he can use it regardless of car weight or gear ratio, although the refinement of application and difficulties of design are not yet fully appreciated. It may be safely said that no other piece of electrical apparatus is subject to so close limitation in dimension or adaptation to its work while being called upon to withstand severer service and abuse.

The greater the number of stops, as in city service, the time the motor is operating at full voltage and speed is but a small per cent of the total time. Hence its average core losses are low and the copper losses high. Where the length of run gives a large percentage of free running at full voltage, the percentage of accelerating current and copper loss is low and the core loss high.

Since the disposition of material determines the losses in the motor, which in turn limits its capacity for service, the service to be performed influences the distribution of the material.

Railway motor capacity may be expressed as the product of turns of copper and magnetic flux, city work permitting low turns and high flux, and long-distance work, high turns and low flux. It is evident that the motor cannot be economically designed to best suit both kinds of service at the same time, and where both classes are combined, as is usually the case, a compromise is required.

Within the past few years the mechanical design of railway motors has been greatly improved and standardized, and the split frame and box-frame motors are now recognized types.

The limitations imposed by the gage, wheel base and space between car body and track are always troublesome, and with bogie trucks become serious when the motors are larger than 125 hp.

A 6-ft. wheel base has apparently, for no sufficient reason, been generally adopted for bogie trucks, and allowing a 6½-in. axle and a 12-in. bolster, there is little space left for the motor. Steam railroad practice, both with regard to locomotives and cars, contains many instances of relatively longer wheel base, even allowing for the larger curves.

In electric service, as the gage is fixed, and the wheel diameter is in many cases limited by required height of car body to 33 ins., it is especially desirable that the wheel base be 7 ft. instead of 6 ft. This will provide for a 200-hp motor, large axles and an ample bolster. Where still larger motors are required, the only solution is to increase the diameter of the wheels and to further lengthen the wheel base.

For the handling of trains the electric locomotive is a natural outgrowth of the motor car and trailer. For the handling of through steam trains at terminals or the movement of freight cars the electric locomotive on electrically-equipped freight car is specially suited. For all general passenger work the equipment of each car in the train as a unit possesses many advantages.

Where each car is equipped with its own motive power, it is possible to make the capacity of the train suit the condition of traffic, whether light or heavy, and maintain the same schedule with any length or weight of train. The safe handling of such a train requires the operator to have a full and immediate control over it at all times, and be capable of accelerating it smoothly.

Safety and reliability are the prime requisites, and simplicity of design an essential to a successful method of control. This has been secured to a marked degree by the electromagnetic system, as operated on the Manhattan Elevated, where each car is equipped with its motor control operated from a master controller on the leading car.

On single cars and locomotives the electromagnetic control offers great advantages in the handling of heavy currents by the reduction of operating controller to a small size of very easy manipulation.

The disposition of the apparatus and method of wiring the car are worthy of special study. The utmost precaution should be taken to prevent any possible arc setting fire to the car or its continuance by arcing to grounded metal. The smaller conductors supplying the heat and light circuits and the cables controlling the electromagnetic switches can, with safety, be run through iron pipe or armored ducts, for should a ground or short circuit occur in these wires their protecting fuses are of such small capacity that they will blow, without danger of fusing the metal armor.

It does not seem advisable to run the main cables and motor circuits through metal ducts, for should a ground or semi-short circuit occur the main fuse or circuit breaker, having considerable capacity, might permit sufficient current to flow to fuse the pipe, although not enough to blow the protecting device. A non-inflammable conduit of asbestos compound is a sufficient protection against fire from a possible arc, and being an insulator would not tend to maintain the arc.

All parts of the under-car flooring in vicinity of the switches and resistances should be protected with substantial sheet asbestos compound, all metal parts of the car framing being especially well protected. All motor controlling apparatus should be beneath the car floor, and while protection should be provided against snow and wheel wash it should be installed with reference to convenient inspection.

For the protection of the smaller circuits, the enclosed type of fuse has been efficient and satisfactory.

For the main circuit the circuit breaker has an advantage on single cars, as it can be quickly reset. It has the disadvantage of requiring careful inspection and being more liable to get out of order than a fuse.

Where cars are operated in trains with several cars equipped the fuse appears to be preferable. The blowing of a fuse on one car does not cripple the train, as the other cars remain operative and the blown fuse can be replaced at leisure. A most effective form of fuse is one of copper ribbon provided with a magnetic blow-out.

For protection against lightning every car operated from overhead feeder lines should be equipped with some form of arrester. Arresters with spark gap, high-resistance ground, magnetic blow-out and a kicking coil, give excellent results. They should preferably be located under the car and connected just inside the main cut-out switch.

The simple trolley has developed a surprising capacity under the increased duty it has been forced to perform; 200 amps. at 60 miles per hour, 400 amps. at 30 miles per hour, and 800 amps. at 10 miles per hour, from a single trolley wheel may be found in practice. It is true, the wheels wear rapidly, but the wonder is they work at all. With a smooth trolley wire and a pressure of 35 lbs. to 40 lbs. the wheels run with very little arcing.

Where the conditions will permit, the third rail is in every way better suited to heavy or high-speed service. Recent investigations indicate the desirability of using a third-rail shoe held in contact with the third rail by a spring, rather than depending on gravity alone. The interruption of the current due to jumping of the third-rail shoe at the joints or elsewhere is apparently conducive to motor flashing. The purpose of the spring is to keep the shoe in more positive contact with the third rail.

The modern electric car in all its appointments and construction has probably received more study and has reached a higher development than any other vehicle moving on land. A coach without outward evidence of power, but carrying on its trucks a silent force capable of hauling backward a puffing locomotive or of running forward at 100 miles per hour speaks eloquently for the future of electric traction.

TRUCKS FOR INTERURBAN SERVICE

BY C. F. UEBELACKER

THE recent extensive development of interurban projects and the consequent increase in speeds of electric cars is necessitating radical changes in the design of double trucks.

Ideas of suitable construction are swinging around in a circle. The early double trucks were all of the long wheel-base type. Then for some time the single truck was developed to keep pace with the demand for longer and heavier cars until it reached its limit on the 20-ft. closed car. The effort to reduce operating expense by increasing the size of car next brought out the maximum-traction type, and later the "short wheel-base" type was introduced to accommodate the narrow car bodies generally in vogue, and at the same time secure the steadiness of motion contributed by swinging bolsters which the increasing speeds in the suburbs rendered imperative.

The interurban roads have now exceeded the safe speed at which the short wheel-base trucks could be operated, and the standard design has again swung back to the long wheel-base.

There is a strong tendency among most of the builders at present to follow a design which is a mixture of the diamond frame freight truck and the equalizing bar passenger-coach types in use on steam roads. This truck combines the cheapest form of all forged frame, and the easy riding features insured by the combination of elliptic and spiral springs in supporting the load, which, together with the fact that the forging work upon it is all light and capable of being shaped in formers, accounts for its popularity with both builders and operators.

The features necessary to meet requirements of high-speed service are many of them difficult to combine in the same machine. The policy of picking up and dropping passengers at every road crossing necessitates steps sufficiently low to be easy of access from the level of the ground. At the same time, in order to cut down the length of each stop, the steps must be as few as possible. The result is that while a few have adopted the steam-road design of car with platforms level with the car floor, and the consequent double or triple steps, the bulk of the interurban roads are still using a form of body which is practically an enlarged horse car, in which one step is formed by dropping the level of the platform below that of the car floor. The space occupied by the heavy knees required to support these platforms, and the consequent limiting of the length or wheel-base, is one of the most serious obstacles in the way of the design of a simple and efficient high-speed truck for interurban work.

Probably the greatest factor in the popularity of the electric railway work when compared to the steam road for interurban service is its ability to deliver passengers at or near their destination. This involves the operation through city streets of the same cars which must make schedule speeds of from 20 miles to 30 miles per hour outside the town limits. Most city franchises were obtained and tracks laid before the interurban propositions became a prominent feature in electric railroading. As a result, the space provided between tracks in cities is seldom so wide but that it must be taken into account when determining the width of cars. This restriction of width is a more serious matter in open cars than closed cars, on account of the space occupied by the run-boards. The long wheel base being necessary for the high speeds, the ends of the trucks swing well out into the run-boards when rounding curves, making it necessary to cut them away to provide clearance.

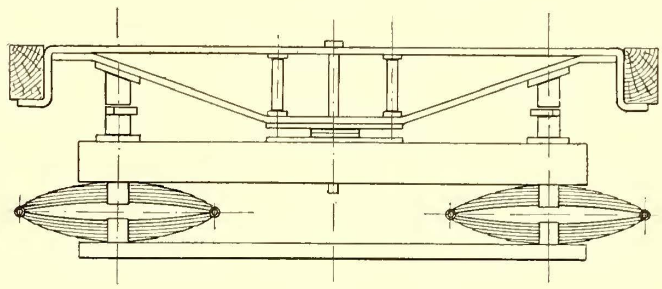


FIG. 1.—M. C. B. ARRANGEMENT OF BOLSTER SPRINGS

These clearance spaces, no matter how carefully covered or boxed in, are always fruitful sources of accidents to passengers boarding or leaving the cars. The only remedy so far devised is to drop the ends of the trucks outside the yokes so far that they can swing under the run-boards. Such a design means either a cast-steel or solid forged side frame, and, as cast-steel has been known to fail in service, it is not an entirely desirable material upon which to depend at high speeds.

This shortening of the truck crowds the spring space under the bolster by reducing its width, crowds the motor

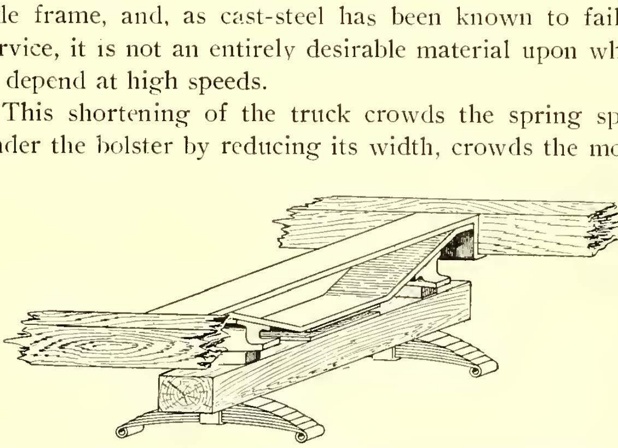


FIG. 2.—LONGITUDINAL ARRANGEMENT OF BOLSTER SPRINGS

supports close against the transoms, making them inconvenient of access, brings the spring plank in the way of the lower half of the motor case when swung down, and, most of all, crowds the space which should be occupied by a brake rigging applying shoes between the wheels so that it becomes either complicated and indirect or wholly impossible.

Assuming for the time that the swinging bolster is an essential feature in the design of any high-speed truck, the obvious and simple method of flexibly supporting the bolster from the frames of the truck is that which the past forty years' experience has made universal in steam passenger practice, and which is shown diagramatically in Fig. 1.

The two principal variations from this plan, both of which have the advantage of allowing a narrower bolster and consequently shorter wheel-base, are shown in diagram in Figs. 2 and 3, and Figs. 4, 5 and 6 are illustrations of trucks embodying the plans shown in Figs. 1, 2 and 3, respectively.

Consider now briefly the function and action of a spring. A 33-in. wheel rolling along the track, Fig. 7, at 20 miles per hour meets a rigid obstruction ¼ in. high. The wheel must then rise ¼ in. in the time taken by the center of the axle to traverse 2.8 ins., namely, about 1-100 part of a second. The result, uncushioned, would be a very sharp shock, and the function of the spring system is to enable the car supported by it to take a longer time in making the rise of ¼ in., which the wheel has to make in 1-100 of a second. Consider again a straight steel bar held securely at one end, *a*, and free at the other, *b*, Fig. 8. If this bar is bent by pulling on the free end, *b*, and then released, it will vibrate, and the greater the distance, *a*, *b*, the slower will be the vibration. Apply this same idea to the elliptic spring, which is a combination of such bars held rigidly at the bands and free to move at the ends, the longer the spring (the number and size of leaves being the same), the more slowly will it respond to a shock, or, in other words, the softer will it be. The same holds true with spirals, namely, the longer the bar from which the spiral is coiled, the softer the spring, the cross section of the bar, of course, remaining constant.

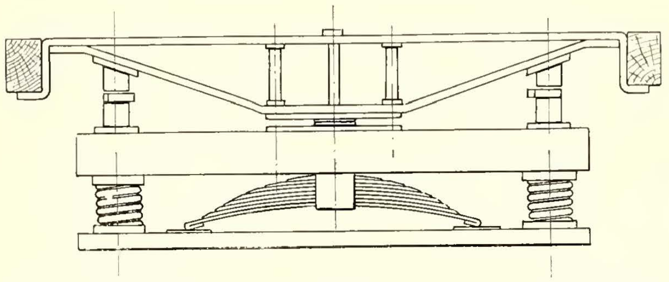


FIG. 3.—ARRANGEMENT OF BOLSTER SPRINGS FOR NARROW BOLSTER

The extent to which softness of riding can be obtained by thus lengthening the springs is limited by the amount of spring play which is practical to allow. Present practice is from 3 ins. to 4 ins. maximum movement of springs. Steam practice would allow one-half of this for the compression of springs by the dead weight of the car body and load, leaving the other half to take up the shock and jar encountered in running. With the present excellent standard of track construction on interurban roads, this allowance of 50 per cent of the total spring motion for riding should certainly be ample, although a few years ago street railway practice was to allow for this from 60 per cent to 70 per cent of the total spring movement, with the result that riding was noticeably easier when the car was loaded than when it was light.

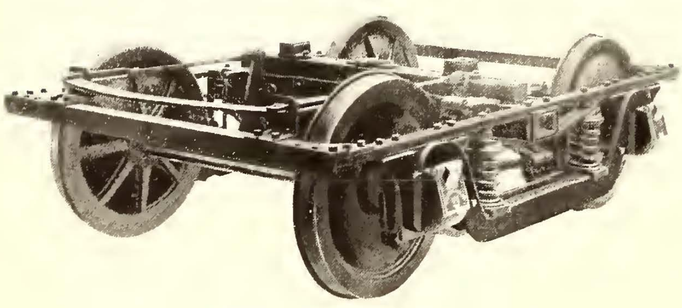


FIG. 4.—ST. LOUIS TRUCK

Refer again to Fig. 8. This shows also that each size of spring has, like a pendulum, a certain "period" or time of oscillation, which is a function of the dimensions of the spring and the load carried. A further investigation into the mechanics of the subject, which it is unnecessary to go into in detail, demonstrates that with a given spring and load, the period of this oscillation is independent of its amplitude. Again it is evident that oscillation, once established by a shock or jar, will continue until damped by the friction of the moving parts. Suppose now a moving car is subjected to a series of jars recurring at stated intervals, such as a wheel imperfectly centered on the axle, a flat spot, or the rail joints themselves; it is evident that as the speed increased, were the car carried on a single set of springs of uniform dimensions, a point might be reached where the successive jolts would fall in step with the period of oscillation of the springs, and thus tend to increase the amplitude of this oscillation before the damping effect of friction has had time to stop it. It is not necessary that such periodic jolts should follow each other with a rapidity equal to the periodicity of the springs, but only that they should fall in step with this periodicity, one impulse to, say, every three or four periods. This effect is at times noticeable as a kind of dancing or bobbing of the car body at certain speeds, especially with trucks that depend too largely on spiral springs. It should be counteracted in designing by placing two or more sets of springs between the car body and wheels, the periodicity of the sets being to each other as 5 is to 7, or some other similar proportion whose least common multiple is large in comparison to its factors.

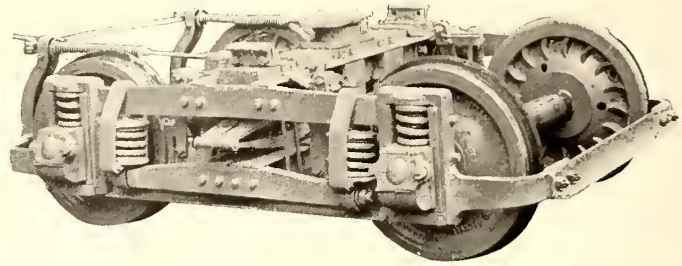


FIG. 5.—BRILL NO. 27 TRUCK

FIG. 6.—PECKHAM 14A XX TRUCK

As pointed out above, a loaded spring started oscillating, continues to do so until damped by friction. With the spiral spring this friction must come from the rubbing together of working parts of the truck, and consequently entails wear and lost motion. With the elliptic, the friction for damping is furnished by the movement of the leaves over each other, and consequently lasts as long as the spring itself. The elliptic also, with its greater weight of material for a given carrying capacity, has a slower period of oscillation. The combination of this rapid damping and slower period has led to the almost universal practice of placing the elliptic, the softest riding member of the spring system, next to the car body, or immediately under the bolster. The limited space available in the side frames and over the journal boxes has made the use of spiral springs for equalizers and yoke springs equally universal.

In the so-called M. C. B. type the yoke springs are generally omitted, and where used their function is not that of furnishing a third set of springs for the support of the car body, but of preventing the tilting of the truck frames by the pull and thrust of the shoes when brakes are applied. The arrangement of this type, as seen in Fig. 4, is as follows: The weight on the bolster is transferred to a spring plank through a set of elliptic springs. The spring plank is hung from two transoms by links, allowing it to swing across the truck from two transoms which serve the double purpose of supporting the links and furnishing a pair of guides between which the bolster is free to move vertically and laterally. These transoms are rigidly secured at each end to the side frames, which again serve a double purpose in transferring the weight from the transoms to the equalizer springs, and furnishing a frame for keeping the journal boxes in line. In other words, the side frames are subjected as trusses loaded at the center, to vertical strains due to the weight carried by the truck; also to a bending moment due to the horizontal thrust of the boxes on the jaws when the car is starting or stopping. Fig. 9 shows in outline the two types of M. C. B. frame commonly used. They are loaded at the points *b*, *b*, with the weight of the body transferred to them by the transoms. They are relieved of this weight at the points *a*, *a*, where the equalizer springs are applied. Both designs present for the carrying of the vertical load a simple truss, and in so far both designs are mechanically correct. Against the thrust of the journals at the points *c*, *c*, on the yokes in starting or

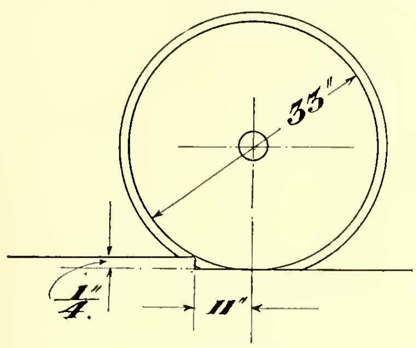


FIG. 7.—LIFT OF WHEEL MOUNTING OBSTRUCTION

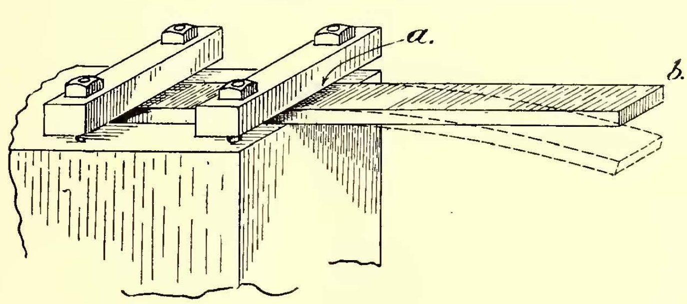


FIG. 8 —VIBRATING STEEL BAR

stopping, however, type *B* offers only the resistance to bending of the bars at the points *e*, *e*, and *d*, *d*, while in form *A* the bottom *d* of each yoke is tied to the top *e* of the other, and the bars constituting the frame are subjected to tensile and compressive strains only. It is evident from the above that the form of frame shown as *B* in Fig. 9 is not suitable for the high accelerations and quick stops which are the rule in interurban work.

It was assumed above for the purpose of argument, that the swinging bolster was an essential feature in the design of a successful high-speed truck. It is not likely that any one in the present time will question the assumption; still it is desirable to examine the principles of its action. Fig. 10 shows usual swing motion and the principles demonstrated from it will apply to all others. The bolster, confined in the direction of locomotion between the transoms, is supported on the spring plank, and with it free to move laterally. Lateral movement is permitted the spring plank by the swing of the links *d*, *d*, which support it, pivoted to the transoms at *a*, *a*, and to the spring plank at *b*, *b*.

It is the function of this swinging support to accomplish

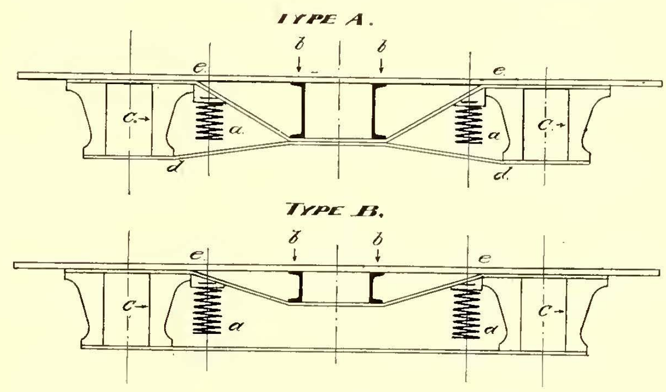


FIG. 9.—TYPES OF M. C. B. FRAMES

the same result in the horizontal plane that the springs do in the vertical, namely, to enable the body to conform to the irregularities and curvatures of the track more gradually than do the wheels and truck frame.

From inspection of Fig. 10 it is evident that the swinging mechanism is practically a double pendulum, and will conform to its law, or the greater the length *a*, *b*, of the links, the slower will it swing. Again it is evident that when the bolster swings either way from the central position, it, together with the car body it carries, is actually raised, and when the force required to raise the body equals the force which swings it from its central position, the lateral movement will stop. If the links are made very short a very short lateral movement is required to raise the body sufficiently to offset the force tending to push it sideways, and the swinging motion becomes quick and jerky. If the links are very long the correspondingly long lateral move-

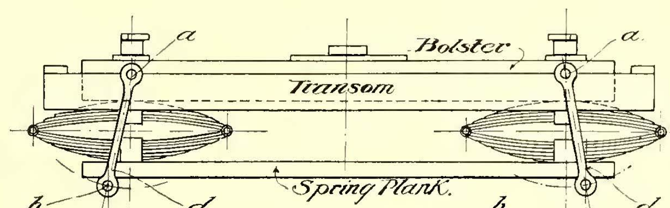


FIG. 10.—M. C. B. ARRANGEMENT OF LINKS AND SPRING PLANK

ment results in the bolster striking the side frames, unless excessive space is allowed at the ends for clearance.

To obtain at the same time the advantage of the slow swing of the long link and the short travel of the short one the plan shown in Fig. 10 is used of spreading the links further apart at the bottom than at the top. The advantages of this arrangement are double. First, as the pin *b* of the link on the end toward which the swing takes place will rise farther for a given lateral displacement than that of the link at the other end will fall. Second, shorter lateral displacement is necessary to raise the car far enough to counter-balance the displacing force, and this is accomplished without the quick, jerky motion that results from the use of short links. Third, the link toward which the swing takes place raises its side of the car, and thus tends to keep the floor of the car at right angles to the direction of the force which is felt by the passengers, and which is

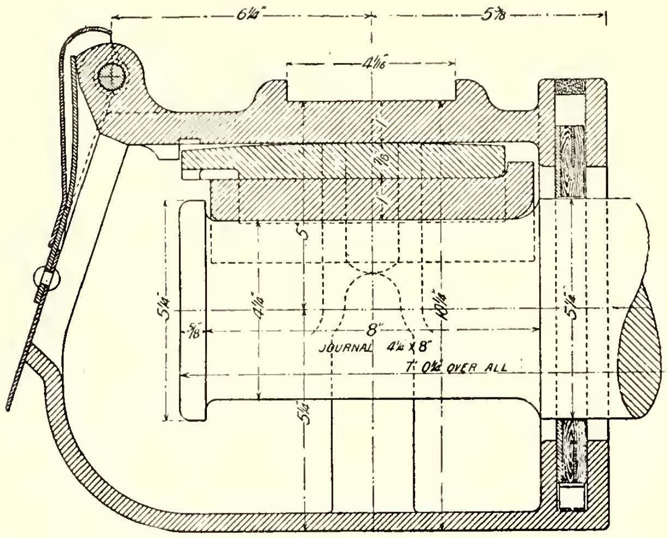


FIG. 11.—M. C. B. JOURNAL BOX

the result of gravity and the force producing the lateral movement. In other words, the effect is the same as elevating the outside rail of the track. It might be noted in passing that this last advantage was overlooked in some of the earlier designs, and the links were spread wider at the top than at the bottom, thus tending to increase the outward tilting of the car body, instead of diminishing it.

Practically, the swing motion has worked down to links about 15 ins. long between pins and spread about 4 ins. wider apart at the bottom than at the top.

Many builders provide cushioning springs at the ends of the bolsters to prevent their striking hard against the side frame, but, with the present good practice prevailing in interurban-truck construction, this would seem to be unnecessary, if 3 ins. or more of swing are allowed the bolster at each end.

Journal-box design is rapidly narrowing down to the form which has given the best results in steam practice, and has been embodied in the Master Car Builders' standard box, Fig. 11. The merits of this design would have un-

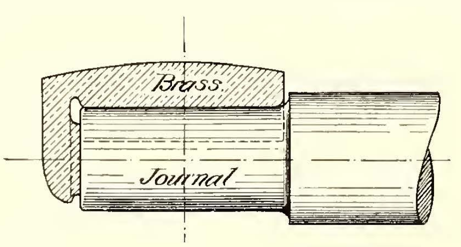


FIG. 12.—JOURNAL WITH PROVISION FOR TAKING UP THRUST ONE WAY ONLY

doubtedly been recognized earlier but for the fact that the small diameters of axles which were current practice would not allow sufficient difference in diameter between the body of the axle and the journal to provide enough surface on the button to properly take care of the end thrust. A common specification used to be 4-in. axle and $3\frac{1}{2}$-in. journal, which left only a $\frac{1}{4}$-in. shoulder.

The main essentials of a journal are: First, sufficient surface to take the load at not to exceed 300 lbs. per square inch; second, ample thrust surface; third and foremost, provision for bringing into contact with the lubricant the *whole* of the wearing surface of the journal each revolution.

The box shown in Fig. 11 provides for the automatic alignment of the brass and journal by means of the circular form of the top of the wedge. This feature is quite essential, as the brass and journal are accurately fitted to each other, while the box inside and out is usually a rough casting.

The form of the journal also is such that the packing can readily be forced up so as to wipe and lubricate not only the

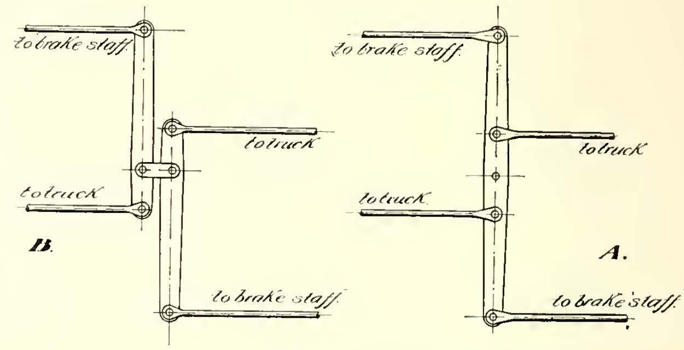


FIG. 13.—EQUALIZING AND PLAIN SWAY BARS

journal proper, but the end thrust surfaces as well. The design also provides thrust surfaces at each end of each journal, with the result that all end motion is taken up on both side frames instead of pressing against one only and tending to spread them apart. Fig. 12 shows a form of journal in which this last point was neglected, and which demonstrates by the excessive wear on the inner ribs of yoke and box the necessity for ample provision for end thrust.

The design of brake rigging for interurban trucks is much complicated by the large space occupied by the heavy motors in use. While air is now almost universally applied, all roads expect to install and occasionally use the hand brakes. To go in detail into the theory of the proportioning of brake rigging would occupy more space than would be appropriate here. A very able discussion of this subject by R. A. Parke can be found in proceedings of the New York Railroad Club for Nov. 18, 1897.

Any brake rigging should provide for the equalization of

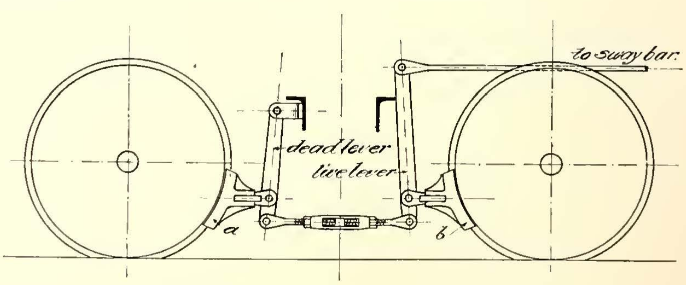


FIG. 14.—INSIDE BRAKE RIGGING

the pressure on all wheels. A partial exception to this might be made in the case of the sway-bar in the hand rigging when placed on cars in conjunction with air or other power brakes for use in case of their failure only. The usual plain sway-bar, Fig. 13A, is so much simpler than the double or equalizer bar, Fig. 13B, and works with so much less friction that it is not advisable to incur the extra complication for a brake which is to be used in emergencies only. The rigging of each truck should, however, be provided with "dead" or equalizing levers, as shown in Fig. 14, to increase the leverage on the shoe *A* enough to compensate for the direct pull on the head of the live lever transmitted to the shoe *B*.

For successful operation, the hand-brake rigging, and to a less extent any power brake, must be very direct in its action in all parts. The fewer the parts and joints that go into its make-up the less will be the lost motion and spring or stretch, and consequently the less will be the number of turns necessary on the brake staff to apply the shoes to the

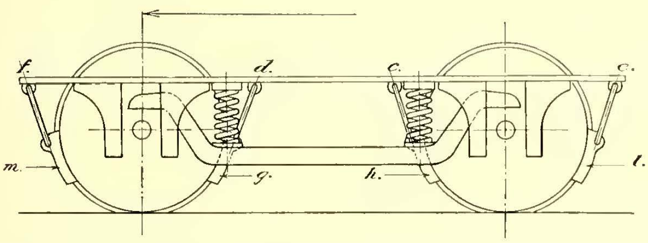


FIG. 15.—REACTIONS OF INSIDE AND OUTSIDE BRAKE RIGGING

wheels. The application of the shoes between the wheels instead of outside shortens up and reduces the number of parts in the brake rigging, and for this reason, and others, generally proves the most satisfactory brake arrangement. The inside brake is convenient also in that the tops of the levers are well away from parts of the car body liable to interfere. The greatest advantage of the inside brake, however, is the reduced tendency toward tipping the truck frame when brakes are applied. This can be best illustrated from Fig. 15. If the shoes between the wheels, as shown at *a* and *b*, be applied while the truck is running in the direction indicated by the arrow, shoe *a* will press up and shoe *b* will pull down, each on its link, thus establishing a couple with a lever arm *d c* tending to raise the end *f* and lower the end *e* of the truck frame. This couple is resisted by the equalizer springs *g h* or the yoke springs, if the design of the truck includes them. If, on the other hand, the shoes are applied at *l* and *m* outside of the wheels, the shoe *l* will thrust up, while *m* pulls down, establishing a couple tending to tilt the truck frame having a lever arm of *f*, *e*, which is quite three times as long as *d*, *c*. If the brakes are applied sharply right up to the time the car comes to a standstill the spring *g* will be, when the car stops, more compressed than the spring *h*. The spring *g* will then recoil, raising end of the frame. This will in turn raise the shoe *m* and cause the wheel with which it is in contact to revolve backward, causing an unpleasant jerk of the car body in an unexpected direction, which is apt to throw passengers who have already risen from their seats before the car comes to a full stop.

When the shoes are applied between the wheels the greatly reduced leverage which they have on the springs *g* and *h*, together with the damping effect of the gears and friction of the motor armatures, so reduces this effect that it is not particularly noticeable.

There can be no question but that in the anxiety to follow the longer experience of steam-road mechanics the advantage of placing springs directly over the journals has been overlooked along with some other features of the strictly street railway truck which are still valuable in the higher-speed service. The design from which the M. C. B. has been copied was intended and used in steam practice strictly as a trailer truck. It is well suited for the moderate braking and acceleration of steam service, but not for extreme limits to which these are carried in electric work. The high ends also of the M. C. B. type are inconvenient to combine with low-hung car bodies, and especially with open-car run-boards.

There are several minor points in design that have never yet been thoroughly worked out. The strains and wear imposed on the bolster and transoms in transmitting to the body the pull of the motors or brakes has never been fully provided for. It is essential for smooth riding that the bolster should be a fairly close fit between the transoms, as otherwise it will tilt between them and bind and jar, yet there has never been any serious attempt made to provide for taking up the wear which occurs at this point. It is important for ease of running and even safety at high speeds, as well as avoiding undue wear, that the axles should be accurately parallel; yet they depend for their alignment on boxes which are inside and out rough castings without any adjustment for the correction of this alignment to compensate for their irregularity. It is necessary for the smooth working of the brakes, and to avoid undue wear and chattering that the connections between the brake-shoes and truck frame should have practically no lost motion, yet very few trucks have any provision for taking up this lost motion as wear takes place.

The tendency toward more machine work and accurate fitting has been very evident in the past few years, and has not yet reached its limit. Truck manufacture, but not necessarily design, is following the same course as locomotive manufacture, and the future high-speed motor truck will be a carefully finished product of the machine shop, instead of the assemblage of rough bolts, castings and forgings from which it has gradually evolved.

The earlier experiments with steel-tired wheels in city service were so uniformly unsuccessful that they have not been tried in the later interurban trucks. It is a question whether in conditions so nearly approximating steam service they would not prove more efficient than the cast-iron. Aside from the question of efficiency, the steel wheel obviates one of the most prominent dangers of higher speed, namely, that of broken flanges. In city service, where the rail is mostly flush with a hard packed or paved roadway, and the speed seldom exceeds 20 miles per hour, a broken flange is seldom more than a matter of annoyance or delay traffic. In interurban service, however, where cars are running over fills and trestles at much higher speeds, broken flanges have been the occasion of several serious accidents. The wheel of the motor truck also has an additional strain imposed upon it, as compared with that of the trail truck, by the uncushioned weight of the motor. That this is an appreciable factor is plainly demonstrated by the failure of the smaller diameter axles, which forced us by successive steps from the $3\frac{3}{8}$ ins. of the early days to the 5 ins. of to-day. These and several other advantages inherent in the steel wheel should insure it another trial under the new conditions of interurban service.

TESTS OF INTERURBAN CARS OF UNION TRACTION COMPANY OF INDIANA

BY CLARENCE RENSHAW

NOTWITHSTANDING the rapid development of interurban electric railways and the large mileage now in operation, there has been but little reliable data available on the general performance and requirements of cars in such service. In order to secure data of this sort for use in recommending equipments for similar railway service, a series of tests on cars of the Union Traction Company, of Indiana, was made recently by the Westinghouse Electric & Manufacturing Company, under the direction of the writer. These car tests formed a part of a general test of the power system of the Union Traction Company by students of Purdue University, under the direction of Professor W. E. Goldsborough, and through his kindness a number of students acted as observers.

The system of the Union Traction Company is a typical example of the most advanced type of interurban railway, completely equipped with modern apparatus. A map of the lines and the power system and an article on operating features were published in the STREET RAILWAY JOURNAL for December, 1901. In brief, the company operates about 100 miles of interurban line, connecting the cities of Indianapolis, Anderson, Muncie, Elwood, Alexandria and Marion, as well as from 50 to 60 miles of local street railways in the cities named. The power station at Anderson contains three 1000-kw Westinghouse alternating-current generators, direct connected to Rice & Sargent cross-compound engines, and there are eight rotary converter sub-stations, to which power is transmitted at 16,000 volts. Service at one-hour intervals is given on each of the interurban lines, and in addition to this "limited," or through cars, are run at reasonable intervals on several of them. Fifteen interurban cars are required for the ordinary schedule.

The operation of this system has been so successful that the company is now building 125 miles of new line, which will nearly double the present mileage. Contracts have been already let to the Westinghouse Company for new apparatus for this line similar to that which is now in use. This apparatus includes two generators, twelve rotary converters, a number of raising and lowering transformers, switchboards, lightning protection and fifteen 4-motor equipments of 75-hp motors. Power for the new line will be transmitted at 32,000 volts.

The tests were made on the line between Muncie and Indianapolis, which also passes through Anderson and through nine intermediate towns. The population of Indianapolis is 169,000, and of Muncie and Anderson about 20,000 each. The intermediate towns have populations of from 150 to 1500 each. The line is 56.55 miles long, and contains many curves and grades. The maximum grades are 3 per cent, but these are short. Most of the grades are less than 2 per cent. Power is supplied by five sub-stations, located respectively at Muncie, Daleville, Anderson (power station), Ingalls and Lawrence.

The cars have 40-ft. bodies and are 52 ft. 6 ins. long over the bumpers. Their height is 9 ft. 6 ins. from bottom of sill to top of roof. At the front end there is a baggage compartment 8 ft. long. This is provided with folding seats and is used also as a smoking compartment. The main part of the car has eleven seats on each side, and will accommodate forty-four people.

These cars are each equipped with two Westinghouse No. 50-C (150 hp) motors, and one L-2 controller. They are operated by overhead trolley. The characteristics of the motors are shown in Fig. 1. Both motors are

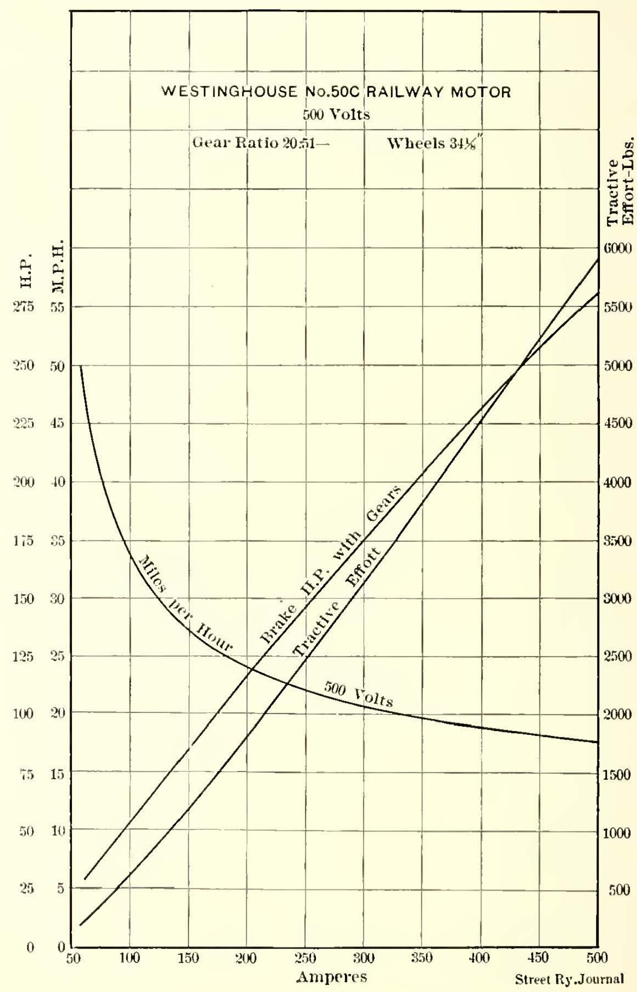


FIG. 1

mounted on the forward truck by means of the Baldwin-Westinghouse method of spring suspension. The gearing consists of a 20-tooth pinion and a 51-tooth gear, and the wheels are nominally 36 ins. in diameter. On car No. 252, however, which was used in the tests, the wheels had worn to a diameter of 34⅛ ins. The weight of this car complete, but without passengers, was 63,100 lbs., divided approximately as follows:

	Pounds
Car body, including heater and brake equipment..........	34,065
Motor truck	9,565
Trail truck	6,670
Electrical equipment	12,800
Total	63,100

Sixty-four per cent of this weight was on the driving wheels.

In addition to the cars just described, the company has a few smaller cars of the same general construction. These cars are about 12 ft. shorter than the others, and are not as high. They are equipped with four Westinghouse No. 56 (60 hp) motors and K-14 controller. Tests were made also on one of these cars, No. 237, which weighed 51,560 lbs.; 13,500 lbs. of this was electrical equipment. Both styles of cars are equipped with Christensen brakes.

In addition to the ordinary local service between Muncie and Indianapolis, in which the cars stop regularly at each of the several towns and make numerous other flag stops, "limited" or through cars, which stop for passengers at Anderson only, are run at intervals. In these tests a detailed record was taken of the entire performance of each test car during a complete round trip (113 miles), carrying passengers in regular service and running first as a local and then as a limited car. In making these tests one side of the baggage or smoking compartment of the car was shut off from the public by means of a heavy canvas curtain, and the instruments and observers were located there. Fig. 2 shows the instruments in car No. 252.

FIG 2.—INSTRUMENTS ON CAR NO. 252

Besides an ammeter and a voltmeter for measuring the current and line voltage, a car wattmeter was connected in the main circuit of the car for measuring the total power consumption, a voltmeter was placed across the terminals of the forward motor inside of the starting resistance, for measuring the exact voltage on the motor at all times, and an instrument for measuring the square root of mean square current was connected in the circuit of the same motor.

This latter instrument consisted of a car wattmeter, in which the usual 12,000-ohm resistance in series with the shunt circuit had been replaced by a lesser resistance suitable for the purpose and the instrument especially calibrated. This wattmeter was connected so as to measure the energy (in watt hours) lost in the field windings of the motor. Knowing the time during which a given total loss in watt hours occurred in the field windings, the average loss in watts could be readily calculated, and from this and the resistance of the field windings the average square of the current and its square root were easily determined. The resistance of the field windings was taken at intervals and an average value used.

This method of measuring a quantity which it is so necessary to know in all cases where the capacity of a motor for the service it is performing is in question, is believed to be new and to have been used for the first time in these tests. The method is a convenient and accurate one, and saves entirely the lengthy calculations which would be necessary in order to find the square root of mean square from the current readings.

For measuring the speed of the car a small magneto generator, such as is ordinarily used for sparking gas engines, was mounted on the trail truck, belted to the axle and connected with a 15-volt voltmeter in the baggage compartment. The generator gave a pressure of 10 volts at normal speed, and a careful calibration showed that it had a straight line relation between voltage and speed. The pulleys were so arranged that a speed of 5 miles per hour gave a pressure of 1 volt. Fig. 3 shows this machine in place on car No. 252.

Since all the conditions of speed, current and voltage change very rapidly when a car is starting, it was essential to obtain readings at short intervals during such times. When a car has attained a reasonable speed, however, these quantities are fairly uniform, and longer intervals between readings would suffice. To avoid taking an unnecessarily large number of readings it was decided not to take them at regular intervals, as would naturally be done, but to suit the intervals to the conditions. Under the direction of an observer, located beside the motorman, readings were taken at intervals of 5 seconds, when the car was starting or stopping, but at other times the interval was extended to 10, 15 or 20 seconds, and a record kept of the actual time in each case. Even with this method of taking observations, about 12,000 instrument readings were taken on each round trip. A crew of seven men was required for conducting each test, and to complete the series required about two weeks work.

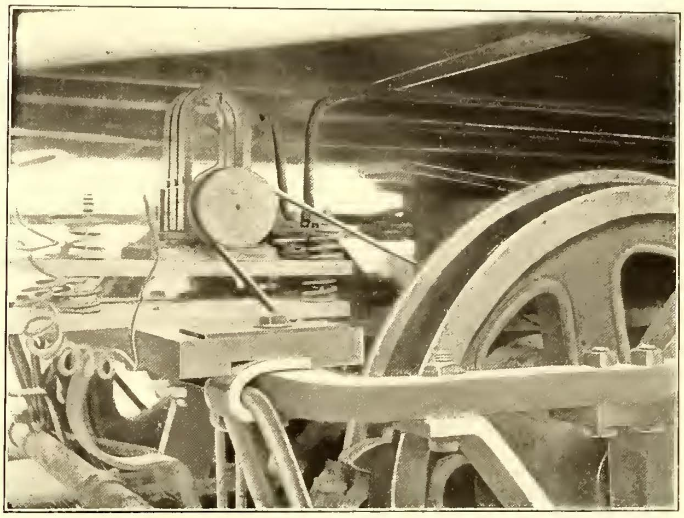


FIG. 3.—SPEED INDICATOR ON CAR NO. 252

The transmission line follows the track during most of the distance, and the poles are spaced at uniform distances of 100 ft. Each fifth pole is numbered, and a record of the locations of the car during each run was kept by noting the time of passing each of these numbered poles.

The results of the tests have been plotted in a series of curves, of which Figs. 4 to 6, inclusive, are samples, and they form the most complete data on the operation of interurban cars within the knowledge of the writer. Figs.

4 to 6 give a record of the speed, current, line voltage and power consumption for car No. 252 from Indianapolis to Muncie in local service. All of the curves are plotted with reference to the time in seconds as abscissæ, and the profile and alignment have also been located approximately on the same basis. Every fiftieth pole number has been marked on the curves, and these give reference marks 5000 ft. apart, by means of which distances may be estimated. A few of the results may now be noted.

SPEEDS

In local service the running time between Muncie and Indianapolis is two and a half hours, giving a schedule speed of 22.6 m. p. h. The run shown by Figs. 4, 5 and 6, however, was an unusually heavy trip; the car was delayed by frequent stops at sidings, and was 23 minutes late. In making this run 37 minutes is required for covering 6.5 miles in the cities of Indianapolis, Anderson and Muncie, where the speed must be limited, so that the schedule over the remaining 50 miles is 26.6 m. p. h.

In the cities here mentioned the schedule speed is from 10 m. p. h. to 13 m. p. h. The cars are rarely run with the controller beyond the series position, and it is usually on the first or second notch, giving from 100 volts to 200 volts on the motors.

In limited service the cars, with exactly the same equipment and gearing, make the entire run in two hours—a schedule of 28.3 m. p. h.—while outside of the cities their average speed is 35.3 m. p. h.

With a line voltage of 500 or more the cars maintain uniform speeds of from 40 m. p. h. to 45 m. p. h. over the light rolling grades, of which the road is largely composed. On slight down grades speeds in the neighborhood of 50 m. p. h. are common, and on one particular part of the road a speed of 60 m. p. h. is sometimes reached.

It will be noted at once from Figs. 4, 5 and 6 that the cars are handled in a manner very similar to steam trains. The starts are slow, from 35 seconds to 50 seconds being ordinarily required to reach a speed of 25 m. p. h., and the power is kept on until the last moment before braking. This method of operating, although it causes a greater average power consumption than would be the case with more rapid acceleration and a corresponding amount of coasting, is almost a necessity on a road of this character. Rapid acceleration is not practicable on account of the large feeder capacity which would be needed to maintain the voltage when one or more cars were starting at a distance from the sub-stations.

When making flag stops, moreover, coasting is difficult. About 750 ft. is usually required for a service stop from the ordinary speed of 40 m. p. h. to 45 m. p. h., and the motorman could not see a passenger at a much greater distance than this.

It will be seen from Figs 4, 5 and 6 that the cars in starting took a maximum current of from 200 amps. to 250 amps., with the motors in series, and from 250 amps. to 330 amps. or 340 amps. in multiple.

When running at uniform speeds of from 40 m. p. h. to 45 m. p. h. over the slightly rolling grades—there are no levels to speak of—the car required repeatedly from 140 amps. to 150 amps. This corresponds to a train resistance of a trifle less than 20 lbs. per ton.

STOPS

The total number of stops outside of the cities of Anderson, Muncie and Indianapolis varies, as a rule, on different trips, from about 30 to 35, occasionally reaching 45. This makes the average run about 1.6 miles. One stop is made at each of the several towns, and from two to three stops between towns.

Some of these stops are merely slow downs to a speed of 5 m. p. h. to 6 m. p. h., and they vary from this up to an actual standstill of 25 seconds or 30 seconds. The average duration calculated from a large number of stops was 10 seconds. This, of course, refers to passenger stops, and does not include accidental delays on sidings.

The effect of stops on the schedule speed is shown very clearly by the difference in the running time of the cars in limited and local service. In the latter the cars make about thirty more stops than in the former, and their running time is just thirty minutes longer. Thus, although the average duration of the actual stop is only ten seconds, the entire time lost by slowing down, stopping and getting up to speed again is very closely one minute for each stop.

POWER CONSUMPTION

The power consumption shown by the wattmeter readings varied on six different trips in local service from 2.24 kw-hours to 2.78 kw-hours per car mile (66.7 to 81 watt-hours per ton mile) from Muncie to Indianapolis, and from 2.62 kw-hours to 3.12 kw-hours per car mile (77 watt-hours to 89.5 watt-hours per ton mile) for the return trip. The average for the six round trips was 2.62 kw-hours per car-mile, or 76.6 watt-hours per ton-mile.

In limited service the consumption of power was 2.1 kw-hours per car mile (58.7 watt-hours per ton mile) from Muncie to Indianapolis, and 2.31 kw-hours (71.6 watt-hours) on the return. The average for the round trip in limited service is thus 15 per cent less than for the locals, which is entirely due to the omission of stops.

The effect of stops on the power consumption may be shown by the following comparison.

In making the run from Indianapolis to Muncie on three different occasions, the number of stops outside of the cities of Anderson, Muncie and Indianapolis, together with the respective power consumptions, were as follows:

Run No.	Service	Stops	Watt-hours Per Ton Mile	Time
1	Limited	4	71.6	2 hrs.
2	Local	31	83.3	2 hrs. 36 min.
3	Local	44	89.5	2 hrs. 53 min.

The handling of the cars in the three cities was closely the same in each case. It will be seen that the power consumption in run No. 3 was almost exactly equal to that in run No. 1, plus 27/40 of the difference between the consumption of run No. 1 and run No. 3. That is, the excess power required when making the stops was almost exactly proportional to the number of stops, and was $\frac{5}{8}$ of 1 per cent for each.

SQUARE ROOT OF MEAN SQUARE CURRENT

The heating current, or the square root of mean square current per motor, as measured by the special wattmeter, already described, varied in four different round trips in local service from about 87 amps. to 99 amps., averaging 94 amps. for the four trips. This means that the heating effect of the varying currents used by the motors in making the runs was equivalent to that which would be produced by uniform currents equal to the foregoing figures, applied to each motor continuously for the same length of time in each case, as was required to make the trip. For the trip in limited service this quantity averaged 83 amps., that is, 12 per cent less than the average for local service. This, of course, is due to the omission of frequent starting currents. The above currents are well within the continuous capacity of the motors, and show that the equipments are of the proper size for the work.

It is often supposed that the running of interurban cars at very slow speeds in the cities and towns through which they pass is easier on the motors than the regular high-speed runs in the open country. This idea is erroneous. It will be seen from the curves that the square root of mean square current, while running through the city of Indianapolis at an average speed of about 10 m. p. h. was not materially different from the average value for the entire trip (over which the schedule was 19.6 m. p. h. in this case), and taking the average value for four round trips the heating current per motor was 7 per cent greater for the portion of the run in the city of Indianapolis than for the run as a whole.

AVERAGE VOLTAGE

The average line voltage for the trip shown in Figs. 4, 5 and 6 was 454 volts. In computing this only those voltage readings which were taken while the car was using current were considered, since an average which included the no-load readings would be misleading.

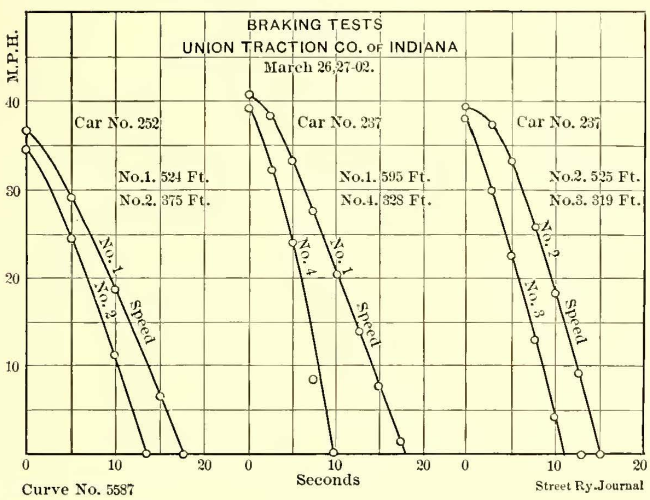


FIG. 7

In considering the question of motor capacity the average voltage at the terminals of the motors must be taken into account as well as the square root of mean square current, since the iron loss depends on this. In computing this average all readings (including zero readings as well as others) must be included, and the average result based on the entire time of the run. Owing to the fact that the motors were sometimes in series, sometimes on resistance and sometimes, as in braking or when at rest, with no voltage at all, the average voltage at the terminals of the motors for the run shown by Figs. 4, 5 and 6 was only 237.

BRAKING

The braking curves obtained in the service tests show a retardation varying from about 1.1 miles to 2 miles per hour per second. The rate of retardation, after the brakes were set, for twenty-five different stops, averaged 1.6 miles per hour per second.

Fig. 7 shows the results of some special tests in which the retardation is much more rapid than the foregoing. These were emergency stops, and were much too rapid for use in ordinary service.

TESTS WITH 4-MOTOR CAR

In the tests with the 4-motor car the results were all of the same general character as here attained. With this car the acceleration was somewhat faster and the starting currents consequently greater than with car No. 252. This was apparently due rather to the handling of the controller than to any essential difference in the cars. On a basis of the empty weights, this car had 9.3 nominal horse-power per ton, while car No. 252 had a little over 9.5. On a basis of the same tractive effort, i. e., 20 lbs. per ton, car No. 237 should have attained an ultimate speed of 47 m. p. h. on a straight, level track with 500 volts, while car No. 252 should only have reached 44 m. p. h., so that the gear reduction on the latter car was somewhat greater than on the former. This fact should tend to make car No. 237 less economical of power than No. 252. The maximum speed of this car and its current consumption under uniform conditions were almost exactly the same as with car No. 252. On account of the lighter weight, however, the train resistance calculated on this basis was $24\frac{1}{2}$ lbs., instead of 20 lbs. per ton. This increase was partly accounted for by the fact that the car had been equipped only about a week before the tests, and was still somewhat stiff.

The average power consumption of the 4-motor car in limited service was 72.8 watt-hours per ton-mile, or 11.2 per cent greater than that for the 2-motor car. In local service the average power for two round trips was 85.4 watt-hours per ton mile, which was 11 per cent greater than the average of six trips with car No. 252. A considerable part of this difference in power consumption, however, was due no doubt to the stiffness of the car, and the difference in gearing, although, even with all conditions exactly alike, it is probable that the power consumption per ton mile of the 4-motor equipment would have been somewhat greater than that of the 2-motor equipment. A discussion of this matter, however, is beyond the scope of this paper.

CONCLUSION

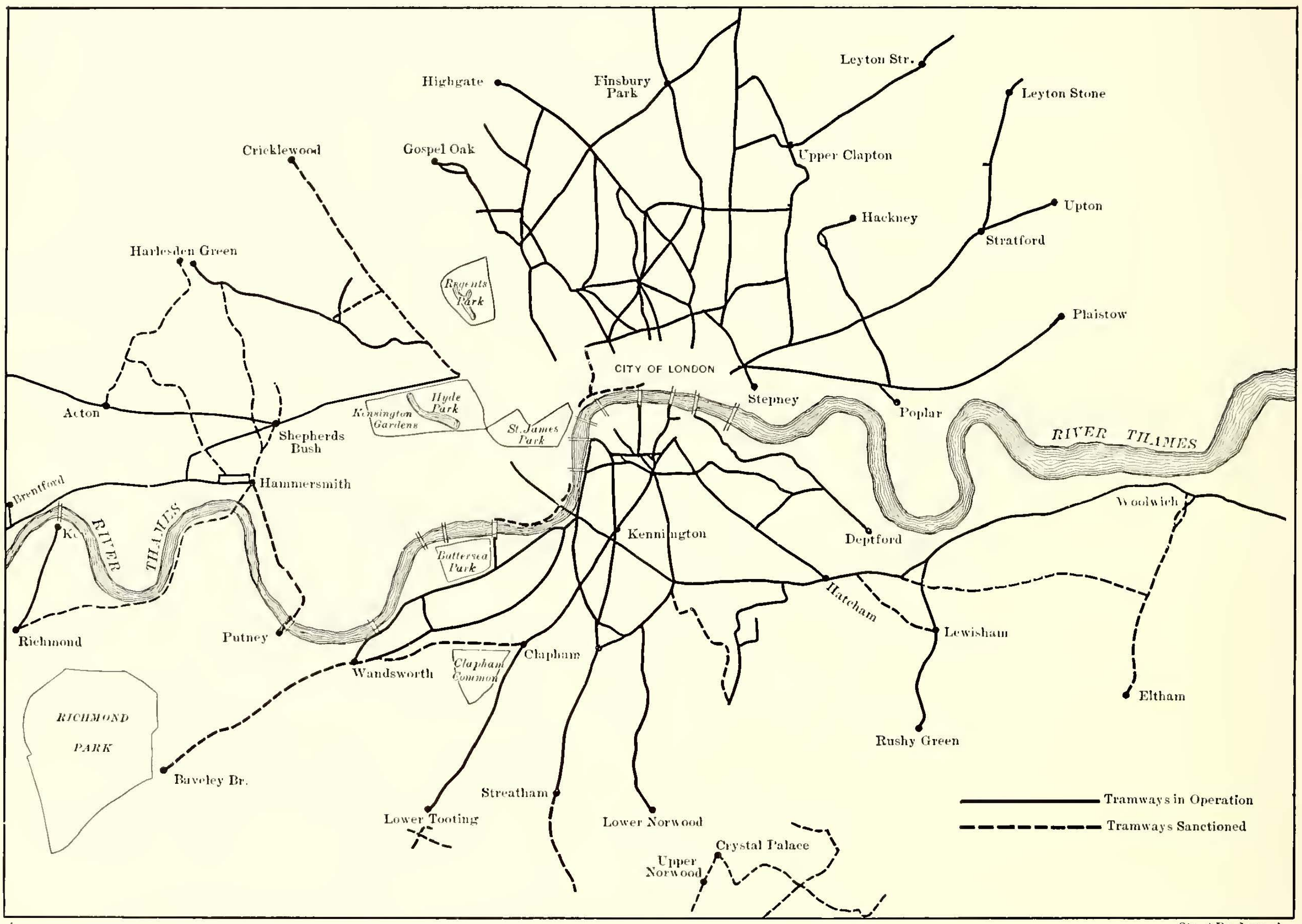
It has not been the object of this article or of the tests to bring out any specific conclusions, but rather to present the general operating conditions of a most successful interurban railway in a form which it is hoped will make them useful to engineers and railway managers. A number of the results, however, are of particular interest. The figures on train resistance, obtained by direct measurement of the power required by two different styles of cars at uniform speeds of from 40 m. p. h. to 45 m. p. h., should add something to the recent discussion on this subject. The average results in regard to acceleration, braking, number and duration of stops and so on, furnish useful data as to the proper values to use in making theoretical calculations, and the schedule speeds and power consumption are concrete examples of modern practice.

The writer is indebted to the officials of the Union Traction Company, and especially to A. S. Richey, electrical engineer; Charles A. Baldwin, superintendent of transportation, and John Matson, master mechanic, for their hearty co-operation; to Messrs. Dostal, Zapp, Peticolas, Hollingsworth, Dinsmore and other students of Purdue University, and to B. B. Abry, of the Westinghouse Company, for general assistance in preparing for and carrying out the tests.

SUBURBAN TRAFFIC CONDITIONS OF LONDON, ENGLAND

BY PHILIP DAWSON

In the last convention issue of the Street Railway Journal there was a series of articles by Messrs. Ford, Vreeland, Starrett, Pearson and others, in which the subject of the rapid transit facilities in Greater New York was most ably handled. It may, perhaps, interest the readers of the Street Railway Journal if some of the conditions that obtain in and around London are brought before them more clearly than has hitherto been done.



Street Ry. Journal

MAP SHOWING TRAMWAYS IN LONDON

The following figures show the population and the area of London and Greater London:

	Area Square Miles.	Population		
		1881	1891	1901
County of London....	117.87	3,834,194	4,232,118	4,803,010
Greater London	692.84	4,766,661	5,633,806	6,600,000

The want of rapid transit facilities has been long felt and is well known to the American visitor in London, who up till recently had generally either to use a cab or a 'bus to be taken from one part of London to the other. It is especially noticeable in the center portion of London; the existing 'buses are neither convenient nor economical in time, and, owing to the conditions that obtain, tramways or street railways will never be tolerated in the center of London, and consequently other methods had to be resorted to. The solution, which has so far been most successful, and which was introduced by the late Mr. Greathead, is the tube system of railways, constructed at such a depth (from 50 ft. to 100 ft.) underneath the existing roads as not to interfere in any way with existing buildings, sewers, and such like.

There should be no difficulty in getting near the center of the city without being deposited within it, since there exists a network of railways which, provided proper methods of traction are used, should, in conjunction with the tramways which are now being equipped by the London County Council, completely satisfy all requirements.

To show the excellent system of railway lines which came into London, as well as the system of tramways, which is now being electrically equipped by the London County Council, and the tube franchises which have already been granted, the three maps which accompany this article have been reproduced. A series of diagrams showing the area covered by each of the various railway systems entering London have been added. When electric traction has been introduced (as undoubtedly it will be within the next few years) these will give "the hub of the universe" one of the best rapid transit systems the world has ever seen.

Table I. gives the various existing tube tramways and railway and omnibus lines which exist at the present moment, and shows the passengers carried, as well as the mileage run and the mileage operated. According to British usage, the mileage operated is not given in miles of single track, as is generally done in America, but in miles of route operated, this in some cases being double, and in others single track. With railways it is sometimes quadruple and more. From this table it will be seen that last year the total number of passengers conveyed by omnibus, steam railway, tube or tramway was nearly 900,000,000,

TABLE I.—EXISTING TRAMWAY, OMNIBUS AND UNDERGROUND RAILWAY LINES IN LONDON, TRAFFIC TRAIN MILES AND MILES OF ROUTE.

	Passenger Carried in 1901	Train Miles Run	Miles of Routes
Central London Railway.........	41,188,389	1,243,730	6½
City & South London Railway...	12,896,628	939,666	6⅛
East Ham Urban District Council Electric Trams...............	*3,663,422	245,047	4⅛
Waterloo & City Railway........	†4,324,594	... .	1⅛
London United Trams...	40,000,000	....	:6
Harrow Road & Paddington Tramways Co.................	2,706,367	299,363	3
Highgate Hill Tramway Co......	1,122,855	91,255	7-10
London County Council—			
Southern System.............	118,281,320	10,399,058	24⅜
Northern System	160,801,393	16,514,353	62¼
London, Deptford & Greenwich..	8,205,285	754,314	6
London Southern Tramway Co..	6,454,657	654.522	5¾
South Eastern Metropolitan Tramways Co.........	3,252,330	263,020	2⅛
South London Tramways Co , Ltd	17,392,115	1,666,049	13
Woolwich & S. E. London Tramways Co.. Ltd...........	4,353,821	446,031	7⅔
London General Omnibus Co....	202,024,222	32,288,606	....
London Omnibus & Carriage Co.	....	....	....
London Road Co...............	67,909,537	....	....
Railways & Metropolitan Omnibus Co......................	2,281,053	214,816	....
Metropolitan Railway	88,000,000	2,295,640	64
Metropolitan District	40,444,073	1,380,996	18¼
North London Railway..........	49,500,000	2,187,391	12‡
Metropolitan Dist. & City Exten..	1,399,043	218,166	2
East London Railway...........	7,072,492	322,252	6⅛
London, Tilbury & Southend....	15,774 822	1,393,175	79

* For six months. † Exclusive of season ticket holders. ‡ Operates over 100 miles of route. § One mile of single, double or triple track, etc., counted as one mile only.

not including the passengers carried by the suburban lines of our great railways, such as the Northwestern, Great Northern, Midland, Great Eastern, Southeastern & Chatham, London, Brighton & South Coast, Southwestern & Great Western. It is impossible to get accurately the number of passengers carried by these, but it must be considerable, as it will be seen by a glance at the railway map (next page) published by the Clearing House of London, which accompanies this article, as well as a series of diagrams showing the suburban ground covered by the various steam railway companies whose termini are in London.

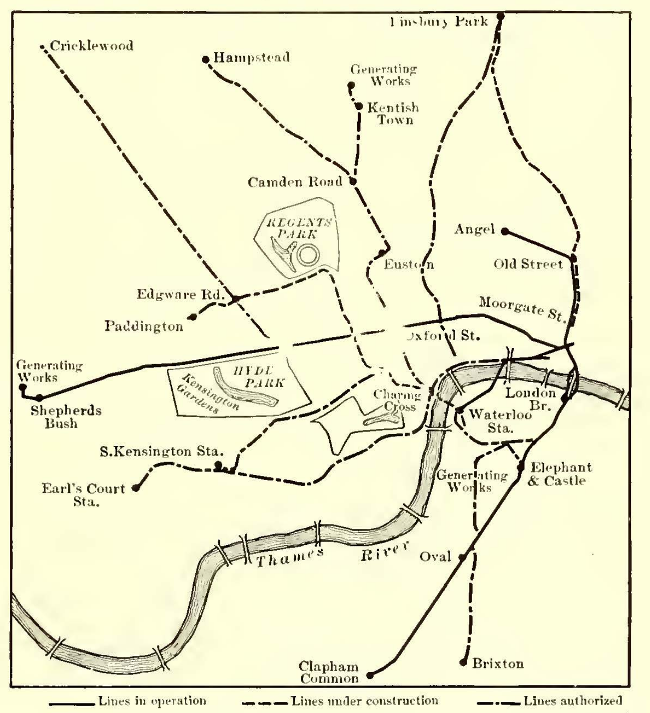
The accompanying Table II. has been constructed from data which was specially taken at some of the busy portions in London between 8 a. m. and 8 p. m. by independent witnesses appointed by the metropolitan police, and they may serve to give some idea of the traffic that exists at some of the chief points which has to be catered for.

TABLE II.—AVERAGE NUMBER OF VEHICLES AND PEDESTRIANS PASSING DIFFERENT POINTS IN LONDON BETWEEN 8 A. M. AND 8 P. M.

	Vehicles	Pedestrians
Marble Arch..........................	10,974	21,080
Oxford Circus........................	12,331	54,100
Holborn Bars.........................	14,301	59,455
Knightsbridge........................	18,874	?7,036
Piccadilly Circus....................	12,551	52,930
Strand	11,997	56,927

Already the competition of electric tramways is being very seriously felt by the railways, and the same process will probably be gone through in this country as was experienced in America. This is clearly demonstrated by the speeches made at the annual meetings of most of our big railway companies. The following extracts in this connection may be of interest:

"With regard to the decrease in numbers—in first-class and second-class passengers—the reason is that the short-



MAP SHOWING TUBE RAILWAYS IN LONDON

distance passengers have decreased in London, Birkenhead and Bristol, and this is chiefly, if not entirely, due to the competition of electric trams. You will find, of course, that the result is that we have been carrying more passengers for longer distances, and that has increased the receipts per passenger. The competition of electric trams, of course, is one which we have been watching very carefully. I do not think that there is any doubt that electric trams, for short distances especially, are taking away a certain amount of traffic."—Earl Cawdor, at the Great Western Railway meeting, Feb. 15, 1902.

"With regard to the passenger and parcel traffic, I think I have said that the receipts are down £14,000, and this I consider a very disappointing account. And this is mainly due to the strike of the fishermen at Grimsby. Apart from this, the loss chiefly arose from the competition of electric trams in Yorkshire. We have had a decrease there of 507,000 passengers; short-distance passengers, it is true, but, nevertheless, a serious loss."—The Rt. Hon. W. J. Jackson, M. P., at the Great Northern Railway meeting, Feb. 14, 1902.

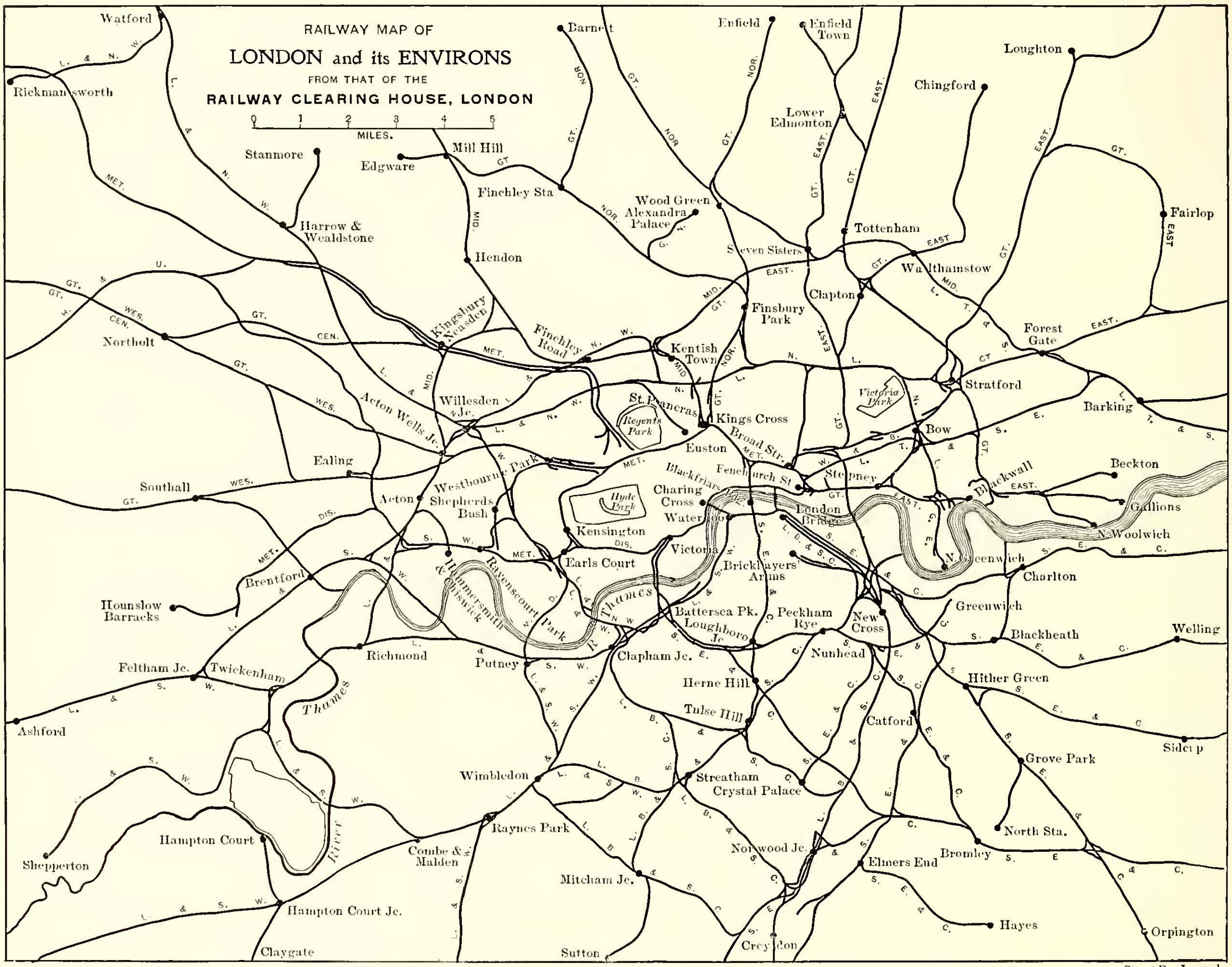
"Proceeding, the chairman had something to say with reference to the competition which has recently sprung up in the shape of extended and improved tram services. Here he thought the railway people had a real grievance. These tramways, whether electrical or otherwise, were constructed upon roads made and maintained out of the rates, and when it was found that these roads were used, in some cases almost monopolized by these tram undertakings, it was surely only reasonable to expect that they should contribute to the rates, that the railway companies might be relieved of some of the burdens which pressed so heavily upon them."—Alexander Henderson, M. P., at the Great Central Railway meeting, Feb. 12, 1902.

"He still, however, felt the same apprehension as to the future that he expressed when last addressing the shareholders. He felt that the pace was too hot to last, and they had the danger before them of the competition and opening of tramways in the district, and which, if they were authorized and made, must necessarily compete with their railway."—R. L. G. Vassall, at the Taff Vale Railway meeting, Feb. 11, 1902.

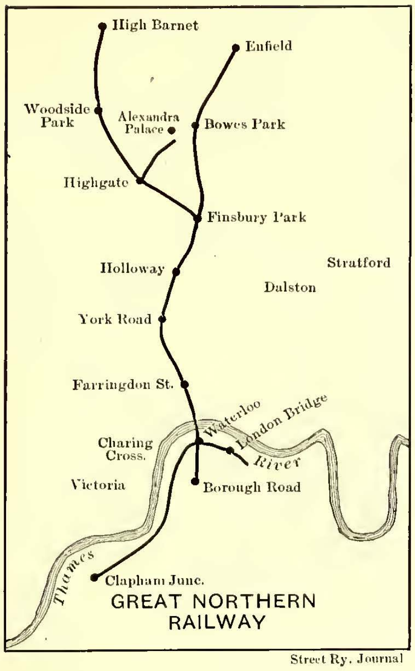
"The directors had not lost sight of the new conditions that had to be faced by railway companies. These conditions were increased obligations, and last, though not least, the construction by the public bodies, at the cost of the rates, of tramways and electric railways, which would compete with existing lines."—Lord Claud Hamilton, at the Great Eastern Railway meeting, Jan. 28, 1902.

"When I addressed you on this subject a year ago, I mentioned that it was the first time we had had to record a decrease in the number of passengers carried, which I attributed to the loss of suburban traffic by reason of tramway competition, and to which I referred at our last meeting. With a view to ascertaining how we have been affected during the past half year by reason of this competition, I have had the figures carefully taken out, and can with certainty say that we have lost 620,000 passengers and £6,053 in receipts; not so much as I should have expected. We must also remember that in some districts where the tramways are non-competitive they act as feeders to our line."—Sir G. Armytage, at the Lancashire & Yorkshire Railway meeting, Feb. 5, 1902.

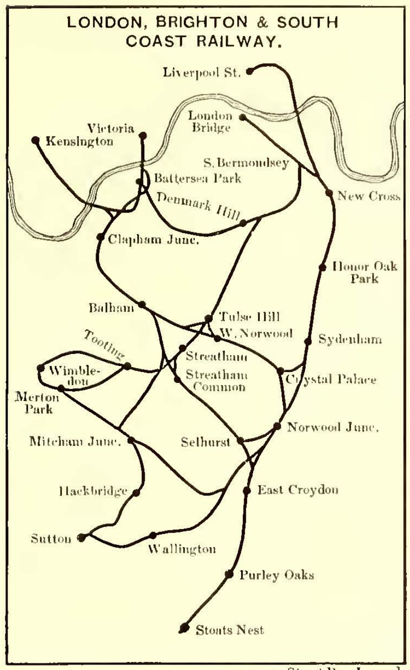
"There are, no doubt, many cases giving great anxiety to those who have the responsibility from day to day of carrying on this enterprise. There is the effect upon these companies—all railway companies, and especially a company like ours, with a dense population—of competition on the public roads by people who are not subject to taxation, who pay nothing for rights of way—rights of way to



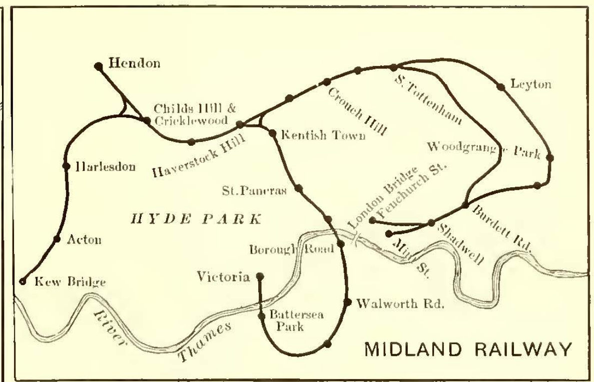
MAP SHOWING STEAM RAILWAYS TERMINATING IN LONDON



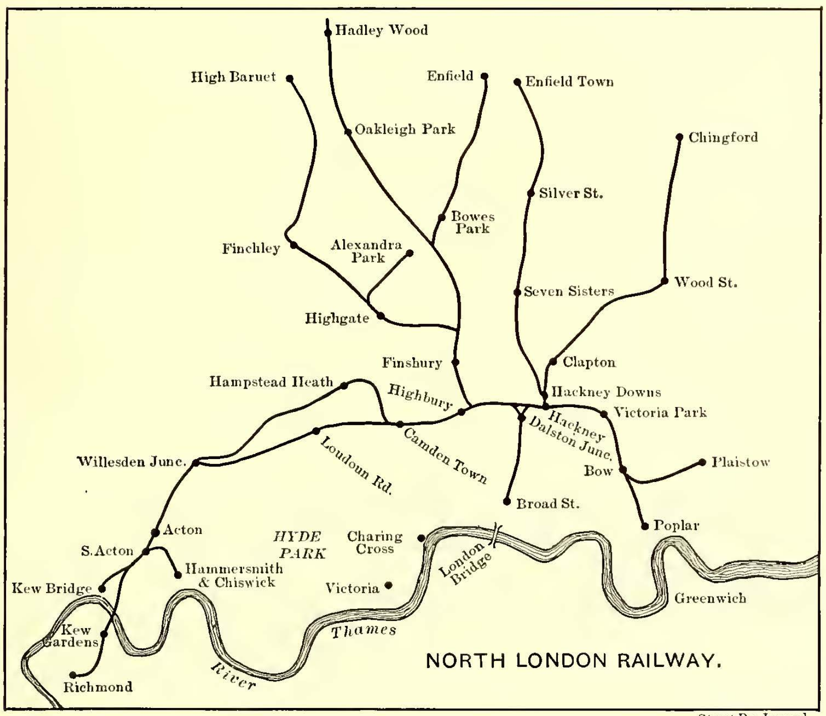
Street Ry. Journal



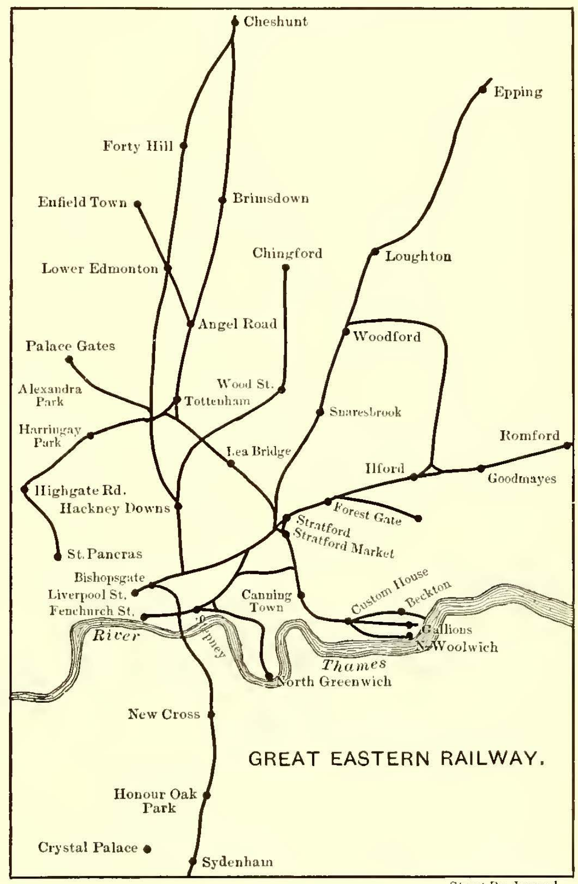
Street Ry. Journal



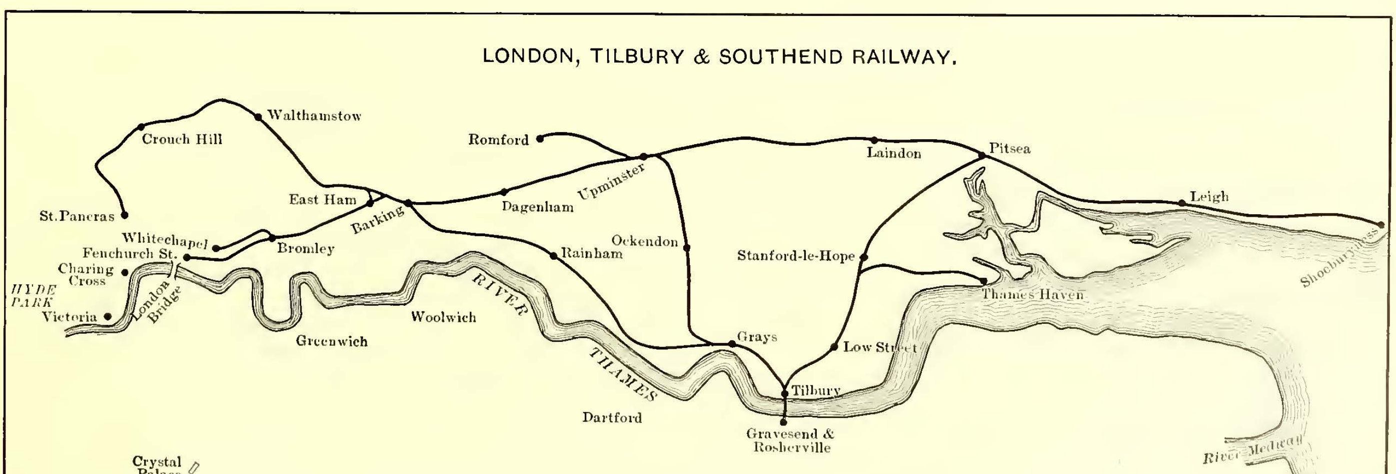
Street Ry. Journal



Street Ry. Journal



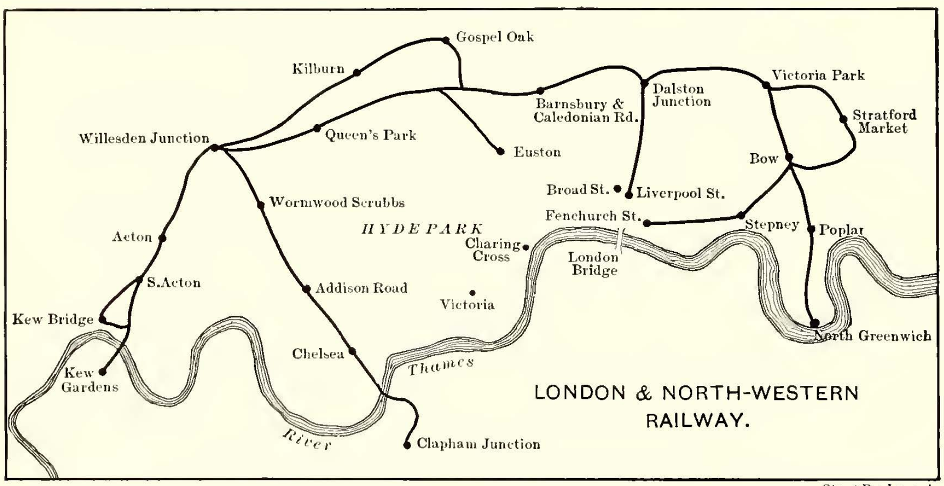
Street Ry. Journal



Street Ry. Journal

MAPS SHOWING THE CITY TERMINALS OF A NUMBER OF THE STEAM RAILROADS IN LONDON which you in every parish, on every road, are enormous contributors. You are actually now being used by county councils, road authorities and private adventurers, running upon the roads which you largely maintain free of cost to them, as a means of competition against yourselves."—J. Staats Forbes, at the London, Chatham & Dover Railway meeting, Feb. 3, 1902.

"We are, as nearly all railway companies are, more or less feeling the effects of electric tramway competition in the suburban districts, not only of London, but of other large towns. With the advance which has been made in electric traction such competition was inevitable. But such competition ought fairly to be limited to crowded dis-



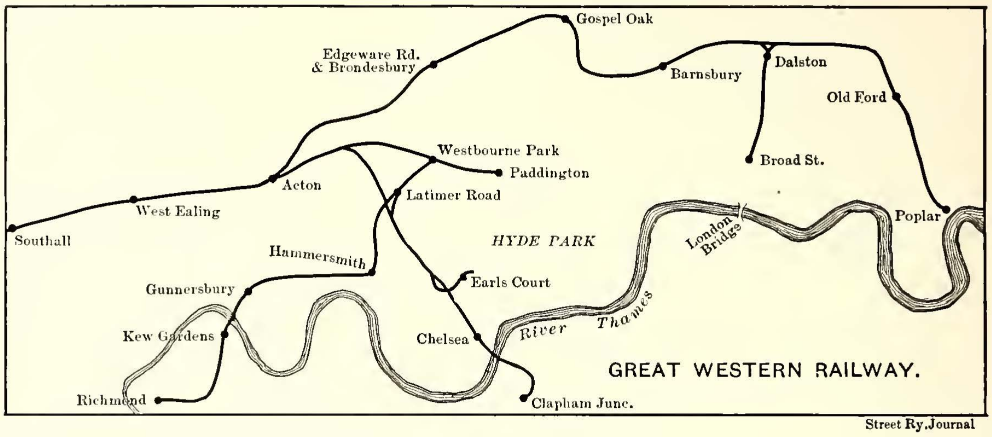
CITY TERMINAL OF LONDON & NORTHWESTERN RAILWAY

tricts, and it would not be reasonable to allow it to extend beyond the immediate suburbs, or it would become a most improper and unfair competition. The districts beyond the immediate suburbs have been built up by the railways, which have spent millions to provide transit accommodation for the public, and which have provided their own roads, while the rates they have paid have largely built up the funds by which the highways, of which tramway companies ask for free use, have been made."—The Hon. W. Campbell, at the London & Southwestern Railway meeting, Feb. 6, 1902.

"It was hardly fair to the present companies, who had expended millions of money on making their roads, that they should have to face competition from electric railways and tramways running along the public thoroughfares."—Lord Cottesloe, at the London, Brighton & South Coast meeting, Jan. 29, 1902.

The figures (see table on next page) in this connection are also of interest, showing that the competition of electric tramways is a very serious thing for the railway companies.

The railway traffic receipts between all places was reduced from £2,985 in 1900 to £1,785 in 1901. The number of season ticket holders was reduced from forty-one to thirty-five. Half-hour trains are run on the railways, while

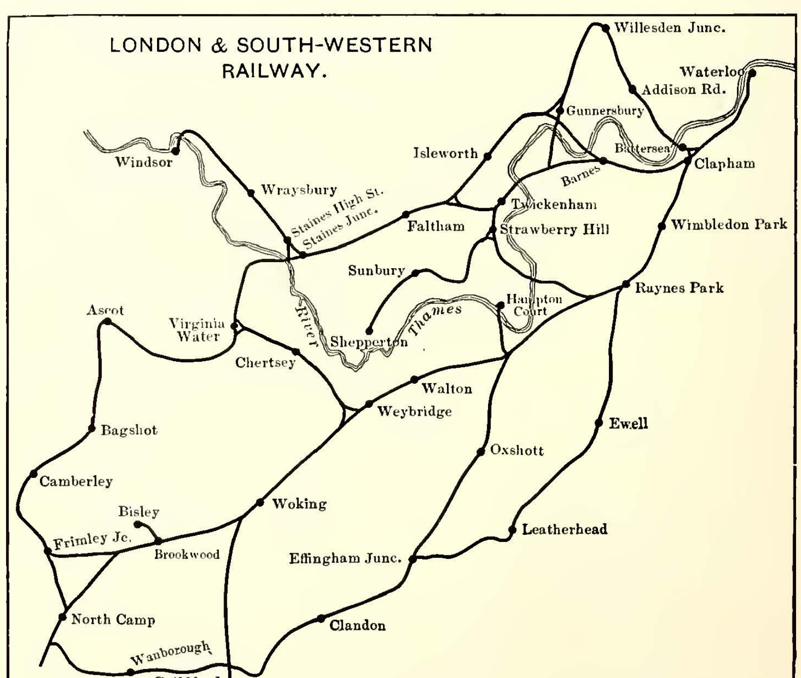


CITY TERMINAL OF GREAT WESTERN RAILWAY

there is a 9½-minute car service on the electric tramway which has caused this reduction in the railway receipts. The total light railway traffics from April 6, 1901, to April 5, 1902, was 1,985,769, while from April 6, 1901, to Dec. 31, 1901, it was only 1,558,676.

Between Hartlepool and West Hartlepool the Northeastern Railway states that its traffic has decreased by about 36 per cent. The distance is 2 miles. The competing electric tramways carried 1,960,122 passengers for year ended Dec. 31, 1901, but this is on the whole system.

Between North Shields and Monkseaton the traffic on the steam railway has decreased 58 per cent during 1901, while from March 18 to Dec. 31, the



CITY TERMINAL OF LONDON & SOUTHWESTERN RAILWAY

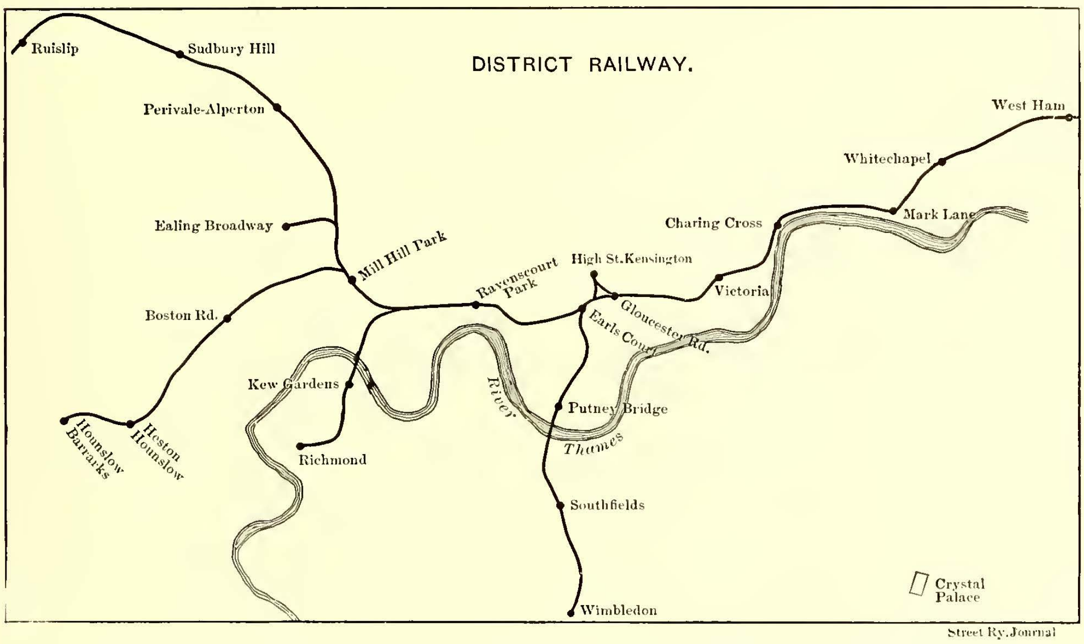
electric tramway system carried 1,515,511 passengers.

Between Stockton and Middlesbrough, a distance of 6

POOLE & DISTRICT LIGHT RAILWAYS
(Opened April 6, 1900.)

	Passengers Carried	
	1900	1901
Poole & Parkstone	135,292	63,482
Poole & Branksome	55,592	26,816
Branksome & Parkstone	24,917	15,611
Parkstone & Bournemouth	140 992	105,793
	359,793	211,702

miles, the railway bookings have decreased by 21 per cent, and between Middlesbrough and Newport, 90 per cent. The Middlesbrough, Stockton-on-Tees and Thornaby Electric Tramways, which also serve these localities, have a total length of 9 miles $4\frac{1}{2}$ furlongs. The number of passengers carried by this tramway was: July 16, 1898, to Dec. 31, 1898, 3,759,605; Jan. 1, 1899, to Dec. 31, 1899, 8,307,322, and Jan. 1, 1900, to Dec. 31, 1900, 8,782,970.



MAP OF CITY TRANSPORTATION SYSTEM OF THE (UNDERGROUND) DISTRICT RAILWAY

The Northeastern Railway Company has realized what is happening, and has decided to electrify the loop which connects the Newcastle Central station with Tynemouth. The total miles of route covered by this line will be 36 miles.

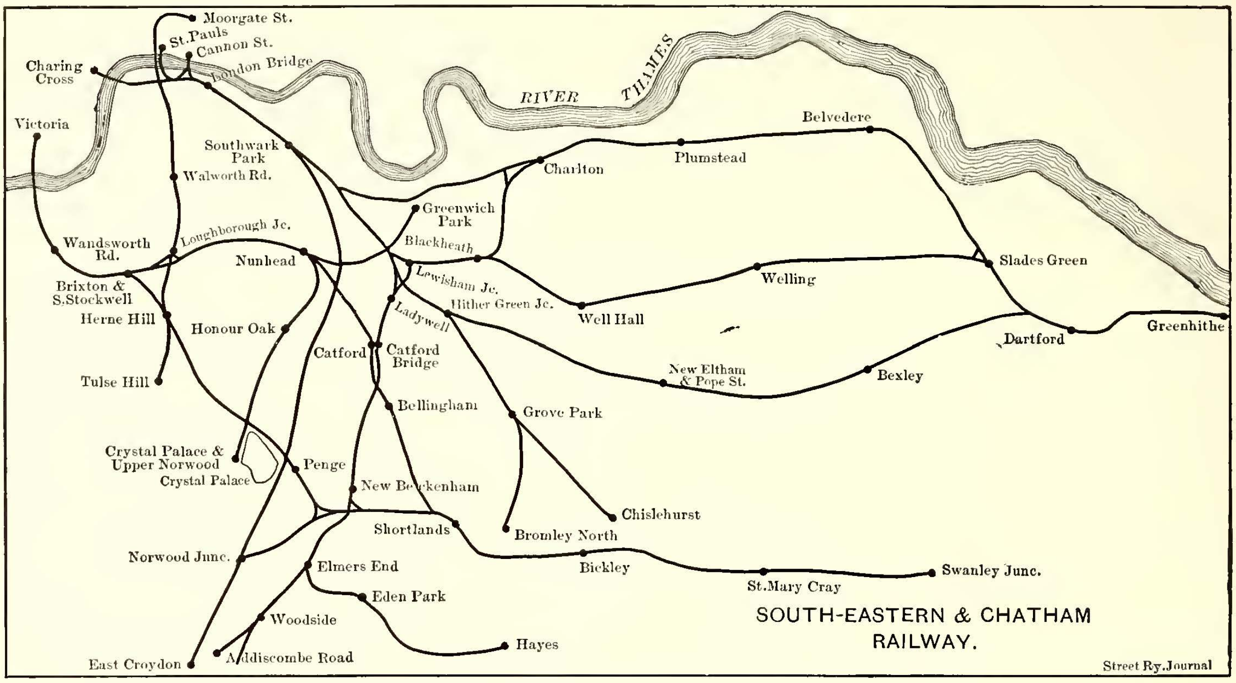
The present position is in some respects very similar to the conditions that obtained when some routes were first introduced into London; thus in 1845, owing to the difficulties of getting from the railway termini into London, nineteen bills were presented to Parliament for railways in the metropolis. A line which now forms part of the Inner Circle was promoted in 1854 to connect the northern termini. The bill was successful, but it was difficult to get capital for such a novel undertaking, and the line was only actually commenced six years later, and was not open until 1863. The opening of this line was soon followed by the construction of the District Railway from Westminster to Kensington, which was opened in 1868, and extensions were built after that till the Inner Circle was finally completed in 1884. There is no doubt that those who undertook to build the Inner Circle were true pioneers, and that it was a very heroic effort on their part. The cost of construction was in some parts terrific, amounting in some cases to £1,000,000 per mile, and in places, owing to shallow tunnels adopted, whole streets had to be reconstructed. These underground railways were at first intended to be worked by hot-water locomotives, and they were, in fact, the pioneers of the shallow tunnel which has of late been so successfully adopted in America.

The problem of rapid transit in London may be divided into two great sections; (1) the methods of inter-communication between the various portions of London, that is to say, giving facilities for getting about in London itself from place to place; (2) the facilities for getting in and out of London from the suburbs and increasing the radius, as far as distance is concerned, without increasing the time taken in the journey, this time being practically a limited quantity.

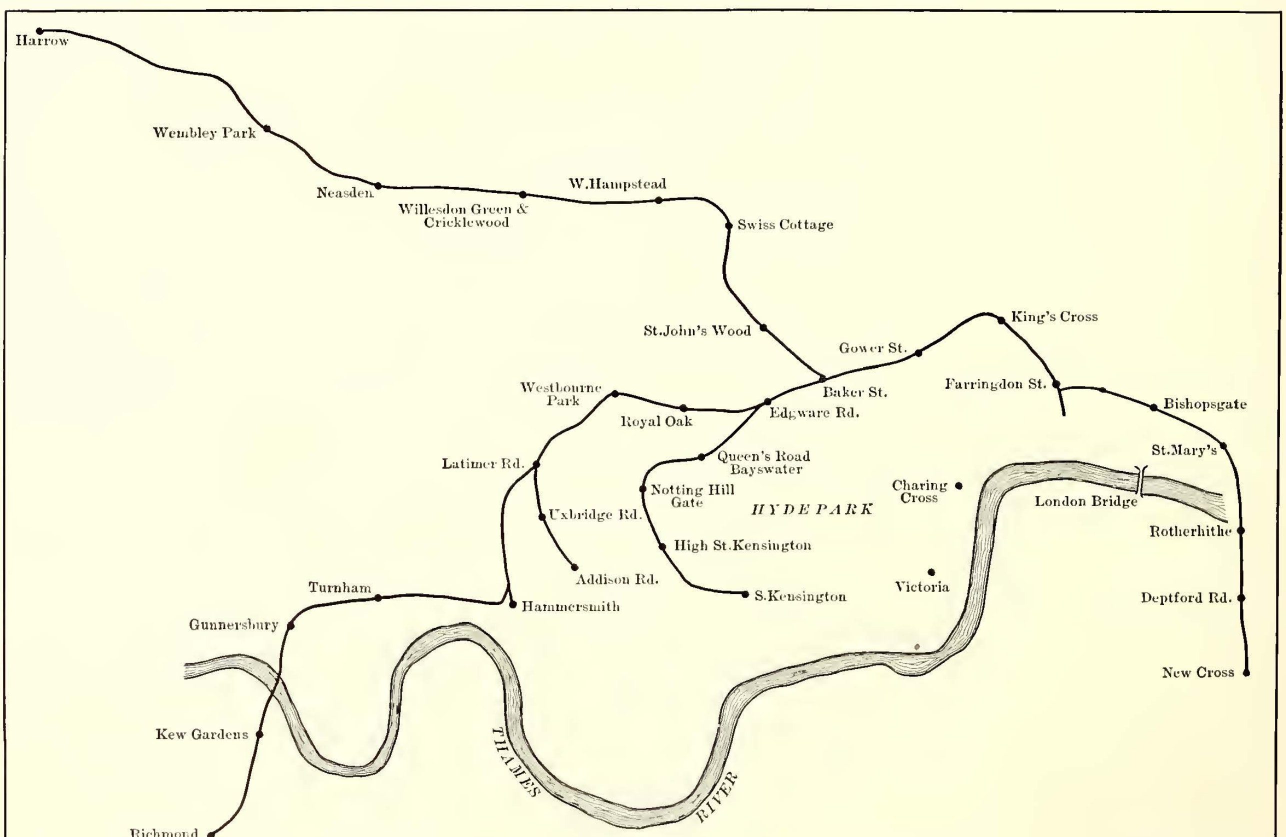
The first requirement is being more or less solved by the Metropolitan and District Railways and by the Yerkes and Morgan interests, as well as by the Central London, the City & South London, the Great Northern & City, the tube lines, and by the London County Council Tramways, and the shallow tunnels which this body proposes to construct to connect the tramway termini on the north and south sides of the river through the heart of London. This problem is comparatively easy of solution, and we are within sight of a very complete rapid transit system as far as getting about from one part of London to the other.

But the second problem is by far the most important, and nothing definite has yet been done toward its solution. So far, the main line railways, particularly those of which diagrams accompany this article, have been the means of conveying the business man to and from his work every day. The present methods of transportation are very obsolete, and the railway companies will have to wake up to existing circumstances and be prepared to spend additional capital and transform their suburban services into electric ones, unless they are willing to discontinue handling suburban traffic entirely and hand the same over to some separate organization.

The greatest difficulty in the way of the railway companies moving is a financial one. The conversion from steam to electric traction will undoubtedly be very costly, and will involve the scrapping of a large amount of rolling stock, locomotives, signals and other material, in addition to calling for a heavy capital expenditure to pay for new rolling stock and electrical equipment. Even if our railway companies were not very heavily handicapped by their enormous capitalization, the step would be one so serious as only to be taken when absolutely forced to do so. That this is the case has been proved in America, where only quite recently the main line railways have considered discontinuing the use of steam for operating their local trains



CITY TERMINAL OF THE SOUTHEASTERN & CHATHAM RAILWAY



Street Ry.Journal

MAP OF CITY TRANSPORTATION SYSTEM OF THE (UNDERGROUND) METROPOLITAN RAILWAY AND CONNECTIONS

into the city by electricity. It is only after such an accident as that which happened recently that the New York Central and the other lines which come into this station have been forced to decide on electrification.

Some idea of the enormous burden which our railway companies have to bear may be gained by the following figures, taken from the Board of Trade returns, and applying up to the end of the year 1900. At the time the capitalization of the railways of the United Kingdom was £1,176,001,890. The annual gross receipts were £104,801,858, the ratio of operating expenses to receipts 62 per cent and the average interest on the paid-up capital 3.41 per cent. The total miles of route open were 21,855, of which 12,162 had two or more tracks, and 9693 were single track, and the total number of passengers carried, exclusive of season ticket holders, was nearly one passenger per pound sterling of capitalization. Adding the number of season ticket holders, which was, approximately, 1,600,000, and adding a fair average of journeys for this, would probably bring the total number of passengers carried on the railways of the United Kingdom to 1,500,000,000,000 per annum.

Notwithstanding this fact, the railway companies, when

TABLE IV.—RUNNING TIME OF SUBURBAN TRAINS ON THE LONDON, BRIGHTON & SOUTH COAST RAILWAY

Miles	Name of Station	Time Taken to do Distance as per Time Table in Minutes	Average Speed Mile per Hour
	London Bridge to—		
2¾	New Cross	6	27½
7	Brockley	4	15
7	Honor Oak Park	5	12
¾	Forest Hill	4	11¼
7	Sydenham	3	20
1	Crystal Palace	10	6
¾	Gipsy Hill	4	11¼
1	West Norwood	3	20
1¾	Streatham Hill	4	26¼
1	Balham	3	20
¾	Wandsworth Common	3	15
1¼	Clapham Junction	4	18¾
1½	Battersea Park	4	22½
½	Grosvenor Road	2	15
½	Victoria	5	6

Total distance, 16½ miles; total time taken, 55 minutes; average speed for whole distance, 18 miles per hour; average distance between stations, 1.1 miles.

they want to, could raise money easily, and they should not hesitate to inaugurate the conversion to electric traction of the suburban portion of their systems. As already shown, our railway companies realize that they are undergoing a steady and substantial decrease in their suburban

TABLE V.—METROPOLITAN BOROUGHS

Borough	Acres Excluding Water	Population	Persons per Acre
Stepney	1,691	298,600	177
Bethnal Green	743	129,680	174
Hackney	3,250	219,272	67
Shoreditch	642	118,637	185
Spitalfields	87.5	27,969	319
St. George's North	114.0	40,976	279
Mile End, New Town	146.6	28,718	251

TABLE VI.—INCREASE OF POPULATION BETWEEN 1871 AND 1901

(Extract from Census Returns.)

Acres	District	1871	1881	1891	1901	Increase Each 10 Years		
						1881	1891	1901
18,786	West Ham Division	99,142	200,752	365,134	580,306	102%	81%	58%
1,072	Stratford	------	------	38,612	44,825	----	----	16
1,249	Blaistow	------	------	58,030	90,920	----	----	56
1,556	Canning Town	------	------	54,750	70,666	----	----	29
806	Forest Gate	------	------	53,511	60,897	----	----	13
3,268	East Ham	------	------	32,713	95,970	----	----	193
7,951	Total	67,928	139,513	237,616	363,278	105	70	52
1,737	Wanstead	------	------	7,042	9,198	----	----	30
631	South Leyton	------	------	38,232	50,458	----	----	32
1,963	North Leyton	------	------	24,874	48,441	----	----	94
4.331	Total	15,913	32,400	70,148	108,097	101	116	54
6,504	Walthamstow	15,301	28,839	57,370	108,931	89	98	89
----	Romford	------	------	------	------	----	----	--
8,496	Ilford	5,947	7,645	10,913	41,240	28	42	277
3,803	Barking Town	6,576	9,155	14,301	21,547	39	56	50
12,299	Total	12,523	16,800	25,214	62,787	34	50	149

traffic, owing to the competition of electric tubes and tramways. The same thing has happened in America. In order to compete with electric tramways, steam railways will have to do a great deal more than simply operate their trains electrically, they will have to change the whole system of operation of their suburban traffic, which will have to be entirely separated from their main-line trains.

A great deal has recently been heard of operating main-line trains electrically; thus in this country Mr. Langdon, the late president of the Institution of Electrical Engineers, Messrs. Mordey, Jenkins, Swinburne and others have dilated on the subject. In Germany experiments at Zossen have been carried out, and in Switzerland Messrs. Brown and Boveri have equipped a main-line railway, the Burgdorf-Thun. Messrs. Ganz have equipped the Valtelina line, which, up to date, is not yet completely operated electrically. The Mediterranean Thomson-Houston Company has built a line from Milan to Gallarate, which has

TABLE VII.—POPULATION OF METROPOLITAN BOROUGHS

Name	Area in Square Miles	Population	Population per Acre in 1896
Battersea	3½	In 1855, 14,000 1871, 107,262 1891, 150,558	94
Bermondsey	2 2-5	1841, 68,701 1881, 134,632 1891, 136,660	97
Bethnal Green	1⅙	1871, 120,104 1881, 126,961 1891, 129,132	171
Camberwell	7	1861, 71,488 1881, 186,593 1891, 235,344	57
Chelsea	650 (acres)	1851, 56,185 1891, 96,253	148
Deptford	2½	1891, 107,273	68
Finsbury	588 (acres)	1891, 109,961	192
Fulham	2⅔	1850, 10,000 1881, 42,900 1891, 91,639	61
Greenwich	6	1891, 84,429	22
Hackney	5¼	1861, 70,000 1896, 213,044	80
Hammersmith	3½	1800, 5,600 1881, 71,939 1891, 97,239 1896, 104,199	50
Hampstead	3½	1851, 12,000 1881, 45,452 1896, 75,449	38
Holborn	409 (acres)	....	165
Islington	4¾	1801, 10,212 1891, 319,143 1896, 336,764	110
Kensington	3½	1861, 70,108 1881, 163,151 1896, 170,465	148
Lambeth	6¼	1851, 138,000 1891, 275,000 1896, 295,033	74
Lewisham	11	1896, 99,962	14
Paddington	2	1871, 96,813 1896, 124,506	98
St. Pancras	4	1881, 236,363 1891, 234,375 1896, 240,764	102
Poplar	3½	1896, 21,898	110
Marylebone	2⅓	1896, 141,188	130
Southwark	1¾	1881, 195,164 1896, 206,582	187
Stepney	2¾	1891, 285,225 1896, 295,547	170
Stoke Newington	...	....	52
Wandsworth	14½	1891, 156,912 1896, 187,264	20
Westminster	4	1861, 257,232 1896, 193,465	107
Woolwich	13	1891, 98,966 1896, 106,477	14
Penge	1 1-5	1896, 21,308	...
Shoreditch	1	1861, 129,364 1896, 122,358	190
City of London	670 (acres)	1901, 31,108	...

already been described in the STREET RAILWAY JOURNAL, but the conditions that obtain in these instances are totally different from those met with in Great Britain.

The British railways, particularly in London, by electrifying their suburban lines, will be able greatly to increase the average speed; this will, of course, probably entail separate tracks for handling this traffic and separate terminal stations with loops such as have been already adopted at the terminal station at Boston, Mass., and at the terminal of the electric street railway on the New York side of the Brooklyn Bridge and at some of the termini of the Metropolitan Underground Electric Railway of Paris.

TABLE VIII.—INCREASE OF PRESENT POPULATION OVER:

	1871	1881	1891	1871	1881	1891
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Stratford						
Plaistow.........						
Canning Town...	434	160	52			
Forest Gate						
East Ham.......						
Wanstead				485	189	58
South Leyton....	585	233	54			
North Leyton....						
Walthamstow....	613	278	89			
Ilford.............	593	439	277			
Barking Town.....	227	135	50	401	273	149

TABLE IX.—EXTRACT FROM CENSUS RETURNS, 1901, SHOWING CONGESTION OF POPULATION

Rooms. No.	Occupiers No.	Metropolitan Boroughs of: Bethnal Green, Tenements	Bethnal Green, Occupiers	Hackney, Tenements	Hackney, Occupiers	Shoreditch, Tenements	Shoreditch, Occupiers	Stepney, Tenements	Stepney, Occupiers
1	3	1,110	3,330	679	2,037	1,318	3,954	2,879	8,637
1	4	594	2,376	292	1,168	678	2,712	1,734	6,936
1	5	208	1,040	71	355	216	1,080	824	4,120
1	6	85	510	18	108	73	438	309	1,854
1	7	33	231	7	49	12	84	131	917
1	8 to 12	12	115	2	18	8	67	51	428
2	6	684	4,104	356	2,136	694	4,164	1,798	10,788
2	7	383	2,681	154	1,078	280	1,960	1,126	7,882
2	8	173	1,384	57	456	155	1,240	577	4,616
2	9	55	495	14	126	48	432	278	2,502
2	10 to 12	27	278	11	114	26	266	149	1,564
3	9	211	1,899	100	900	175	1,575	511	4,599
3	10	82	820	37	370	64	640	278	2,780
3	11	33	363	10	110	21	231	112	2,541
3	12	16	192	6	72	9	108	68	816
4	12	35	420	18	216	27	324	127	1,524
Total in less than 5 rooms and 3 per room		3,741	20,238	1,832	9,313	3,804	19,275	10,952	62,504
Total tenements..		28,209		48,794		37,031		61,113	
5 rooms and less ..		23,732	82%	29,089	59%	22,940	84%	49,182	80%
2 rooms each......		7,264	25	7,211	14	7,509	27	15,690	25
1 room each		5,378	19	4,827	9	6,705	24	13,282	21

By the adoption of electric traction, railways will be able to run trains in accordance with the requirements of the traffic, and to increase greatly their average speed.

The accompanying Table IV., taken from one of the time tables of our railways—the London, Brighton & South Coast Railway—for which the writer is acting as consulting engineer, may be of interest.

From this will be seen what improvements may be expected by the introduction of electric traction It must, therefore, be pointed out that as regards the two last stations, Grosvenor Road and Victoria, all tickets are collected at the former, and that between Grosvenor Road and Victoria there are only two tracks available for ingoing as well as out-going traffic, and that there are between 350 to 400 trains, according to the season of the year, going in and out every day. To obviate the delays due to this "bottle neck," the company is at the present moment spending over £1,000,000 to widen the approaches to the bridge over the Thames, which leads into Victoria station.

An idea of the urgent necessity of improving methods of rapid transit may be gained from the following figures, showing the increase in population in some of the suburban districts of London within the last few years, and the terrible state of overcrowding that obtains in certain of them. The only method of getting over this trouble is to give increased facilities for getting in and out of London and getting long distances in a shorter time, so as to enable the working and the poorer classes to have increased accommodation at a reduced rent.

TABLE X.—EXTRACT FROM CENSUS RETURNS, 1901

District	Acres	Population	Persons Per Acre
LONDON			
Bethnel Green, S.W*...........	300	65,926	219.7
Whitechapel *..................	378	78,624	208.0
Stepney*........................	314	63,689	202.8
Hoxton Shoreditch*.....	343	62,461	182.1
Haggerston*....................	305	55.437	181.7
St. George's (Tower Hamlets)*..	286	51,071	178.5
Bethnal Green, N.E*............	455	63,786	140.2
Mile End *................	363	48,348	133.2
Limehouse*.....................	423	55,996	132.3
Bow and Bromley...............	1,001	91,081	90.9
Hackney, Central..............	822	67,612	82.2
Hackney, South.................	1,541	101,350	65.7
Poplar.....................	1,332	78,430	58.8
Hackney, North	1,574	84,253	53.5
ESSEX			
South Leyton...................	631	50,458	80.0
Forest Gate	806	60,897	75.5
Plaistow........................	1,249	90,920	72.8
Stratford.....	1,072	44,825	41 8
East Ham	3,268	95,970	29.4
North Leyton....................	1,963	48,441	24.6
Walthamstow	6,504	108,931	16.7
Wanstead........................	1,737	9,198	5.3
Ilford.............................	8,496	41,240	4.8
Chigwell...............	13,975	17,653	1.2
Waltham Abbey	11,017	6,547	.6
Epping	17,101	6,595	.4
Harlow..........................	17,041	6,211	.4
MIDDLESEX, N.E.			
Tottenham Division............	4,638	136,702	29.4
Hornsey "	2,875	72,056	25.0
Edmonton "	7,491	61,892	8.2
Enfield "	12,601	42,738	3.4
Chestnut "	8,479	12,288	1.4
MIDDLESEX, W. and N. W.			
Brentford Division.............	20,980	178,849	8.5
Hendon "	33,569	167,307	5.0
Barnet "	25,767	58,970	2.3
Uxbridge "	26,858	39,003	1.4
Staines (part)..................	24,331	33,861	1.4
KENT			
Bromley Division..............	40,978	85,755	2.1
Dartford "	52,316	96,046	1.8
SURREY			
Richmond Division...........	5,009	49,459	9.9
Croydon "	32,540	194,425	6.0
Kingston "	24,551	137,563	5.6
Carshalton "	12,228	32,997	2.7
Epsom "	13,074	17,429	1.3

* Have a total population of 545,338, covering 4.94 square miles.

A large amount of evidence was given before Lord Windsor's committee of the House of Lords during the discussion on tube railways as to the great delays which were encountered owing to the congestion of traffic on the existing railways. Thus, to get from Highgate to the city, a distance of under 5 miles, an hour had to be allowed, and it took sometimes as long as 45 minutes to get from

Wood Green to Moorgate Street station. A glance at the map of the London railways will show what this means.

The service which has to be improved is not so much what we might call the metropolitan one, served by the tubes and tramways and the District and Metropolitan Railways, but what might justly be called an interurban service which is required to connect the outlying districts around London, which are alreadv in steam railway communication with London by means of an improved and accelerated electric service. This, however, owing to the expensive procedure of procuring Parliamentary bills and to the oposition which independent undertakings, seeking franchises to do this class of work, would necessarily offer, can only be performed if the railway companies themselves realize their duty and seriously put their hand to the plow and effect a change rationally and not piecemeal, as, unfortunately, seems to be quite probable. What is required is an interurban service between the towns which surround London, such as Tilbury, Chelmsford, Brentford, Romford, Epping Forest, Waltham Abbey, St. Albans, Watford, Richmond, Rickmansworth, Uxbridge, Staines, Woking, Guildford, Dorking, Leatherhead, Epsom, Reigate, Sevenoaks, Maidstone, Chatham and Gravesend, and stations somewhere near the center of London from which the traffic could be distributed to the various parts of the metropolis by means of interconnected service of tramways, shallow tunnel tramways or tubes, and the existing District and Metropolitan system. In other words, from experienced gained and from the conditions that obtain near the metropolis, it seems evident that within a radius of, say from 25 to 35 miles, all the traffic on the railways should be handled electrically with the exception of the main-line long-distance trains.

One great advantage which would be obtained would be to avoid to a large extent the serious delays which are met with, particularly on the southern railway systems, where the main-line trains are generally punctual till they get within 10 or 15 miles of London, after which they are constantly delayed by suburban trains in front of them. By the increase in the average traveling speed of the suburban trains which would result from electrification, owing to the more rapid acceleration possible and to the introduction of modern methods and up-to-date rolling stock, whereby the stops at stations would be greatly reduced, the serious delays of main-line trains would be considerably reduced. Furthermore, by absolutely separating the long-distance and the suburban traffic at the terminal stations, the general public would greatly benefit.

By means of multiple-unit trains considerable time would be saved even at terminal stations, as the shunting of locomotives at present required could be done away with. As an example of what electric traction renders possible, the Central London and the District Railway, as it now exists operated by steam, may be compared. On the former the average time of stoppages at stations does not much exceed 10 seconds, whereas on the latter it is over 50 seconds.

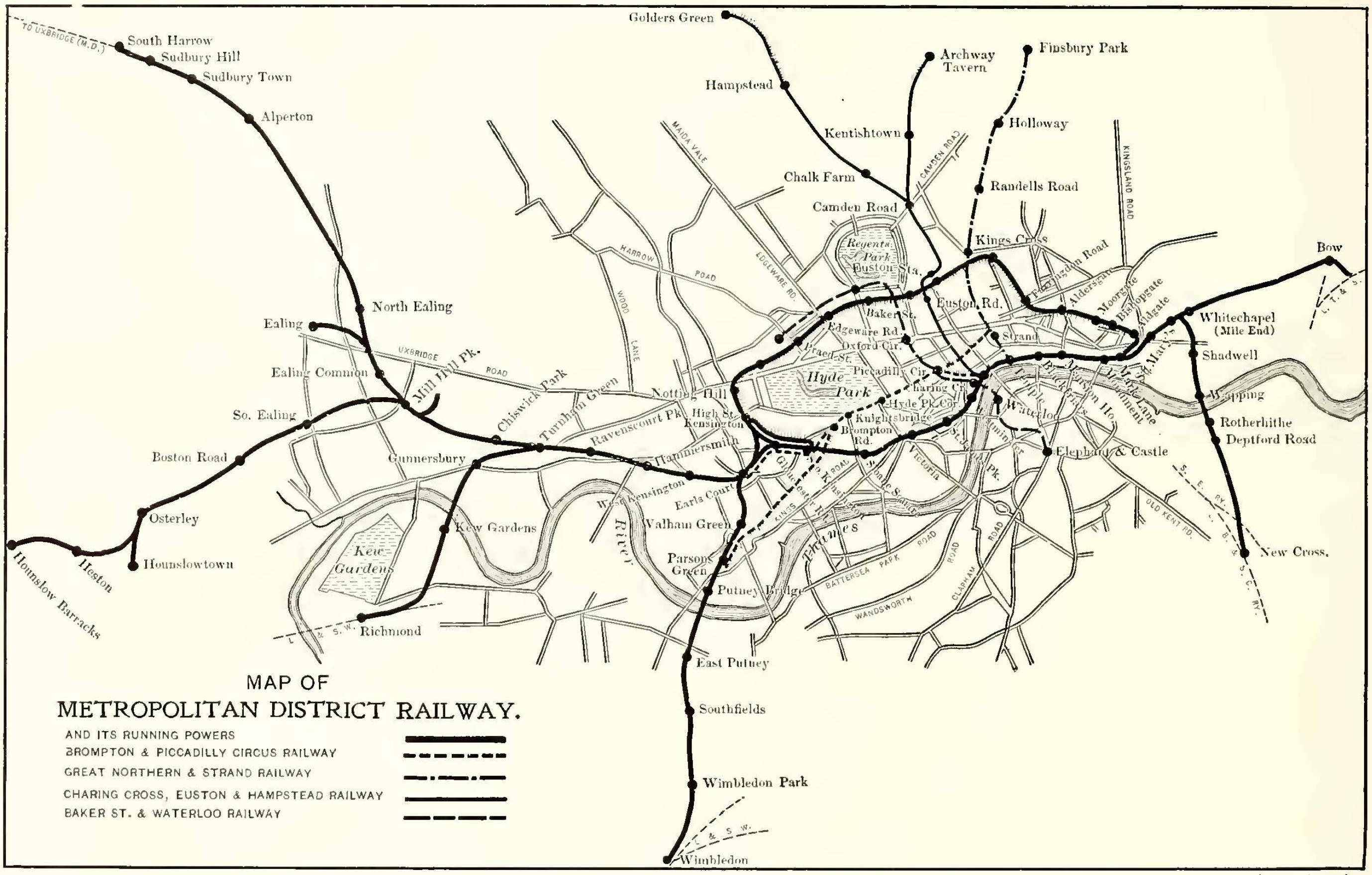
MAP OF LONDON BY BOROUGHS, SHOWING POPULATION PER ACRE

This is not due to the handling of smaller traffic, in the first case, as the trains of both systems have practically the same capacity, and the Central London Railway, as a matter of fact, at the present moment carries nearly double the number of passengers that are carried by the District Railway.

In considering the position of tube railways and tramways in London as compared to what has been done in America, the item of the average fare received must not be lost sight of. In this connection some figures as regards the average receipts actually obtained on London lines may be of interest.

The average receipt on the District Railway per passenger carried is 1.49d., and on the North London 1.34d. The average fares on the London Tramways system per passenger carried work out at 1.08d.; on the omnibus lines, 1.3d., and on the East London Railway, 1.47d., from which it will be seen that, as far as metropolitan travel is concerned in London, it is not safe to reckon on an average fare of more than $1\frac{1}{2}$d. per passenger carried. A few figures taken from Mr. Dredge's excellent article in a recent issue of Traction and Transmission which apply to some main-line railways for the year 1900 are interesting for the sake of comparison. Thus, on the London & Southwestern the average fare was 6.7d.; on the London, Brighton & South Coast, 7.13d.; on the Southeastern & Chatham, 7.41d., and on the Great Eastern, 4.59d. These lines have been particularly chosen, as they handle a very heavy suburban traffic. The Great Eastern is the one which has to lay itself open as much as any to catering for the suburban resident, and over a large area it has adopted the fixed-rate system, especially for workmen's trains.

The great problem which will have to be solved is how to carry persons cheaply and rapidly distances of from 15 to 30 miles between their homes and their places of business. At the present moment the railway companies with termini in London are attempting to do it, but with very moderate success, and with very grave inconvenience to the passengers. The want of terminal facilities and the enormous price of the land necessary to afford extra accommodation, the complexity of ownership and running powers held by various railway companies over each other's lines, and that great enemy of all railway traffic in London during the winter months—London fog—have to be reckoned with, and all these points make the problem an exceedingly difficult one to solve. Owing to the present poor rapid transit facilities only very few business men can manage to live more than 6 miles or 7 miles out of London, and for this short journey very often an hour is required, and a large amount of time has thus to be wasted by people who can ill afford it, and whose hours of business attendance are absolutely fixed.



MAP OF METROPOLITAN DISTRICT RAILWAY AND RUNNING POWERS

Besides this suburban traffic, there is another traffic which is not sufficiently considered in Great Britain, and that is the so-called pleasure traffic, which has been cultivated to so large an extent by electric railways in the United States. There are a large number of places in the neighborhood of London, such as the Crystal Palace, the Alexandra Palace, Kew Gardens, Richmond, Hampton Court and many other places which, if proper facilities were granted and a good train service maintained, could be greatly developed to the advantage of their shareholders, as well as to the benefit of the railway companies. The supply of greater traveling facilities with higher speeds would change the map of London very rapidly, and would greatly increase the value of the surrounding property.

From a careful study of the conditions that obtain in London, and bearing in mind the difficulties and the expenses which have to be faced, both as regards preliminary Parlimentary expenses and the cost of construction, etc., it is hardly likely that many new systems will be constructed to connect the various portions of London with its various suburbs. A study of the official railway map published by the Railway Clearing House, of London, which accompanies this article, and a glance at the diagram showing the district served by the various railway companies who enter London, will convince anyone that the areas served by these lines are amply sufficient to meet the wants of the worker in the metropolis for years to come, provided, of course, that they are utilized to the fullest extent and proper systems of tramways installed which will enable an easy concentration to be effected.

Owing to the limits of speed imposed on electric tramways it is not likely that these will compete with railways for distances exceeding 5 miles. It will be some time before the London County Council will complete its system of electric tramways, of which a general idea can be obtained by looking at the tramway map of London which accompanies this article, but each consecutive year will see the scheme nearer completion. Most probably we shall soon see the London County Council Tramways connected with other electric tramways now being constructed at Gravesend, Chatham, Croydon, Sutton, not to speak of the enterprising London United Tramways, whose network, as shown by the map, connects a large number of residential towns and districts situated at the west side of London. The railway companies must act quickly if they wish to prevent the business population satisfying themselves by settling on a tramway route.

That tramway competition, instead of being disastrous, can really benefit railways, has been proved in the United States, as in Chicago and the Greater New York, where by the electrification of the suburban lines and of the lines running out into the neighboring country it has been found that the tramways carry their district passengers from their offices into the trains and deliver them at the other ends from the suburban stations to their homes. In other cases it has been found possible to run a through traffic. It is certain that under the existing conditions railway companies find it impossible to handle their suburban traffic better than they do at present. Are they prepared to sit still and let other concerns arise who will commence by taking their suburban traffic from them, and will eventually end by absorbing a large portion of the other traffic as well, as has been demonstrated over and over again, both in Europe and America? The table which has been prepared for this article, with the diagramatic map of London, shows how densely populated London is, and an inspection of the former will show the rapid growth of population. This means that there will continue to be an increasing demand upon the railway companies from the suburban population, and it is an ascertained fact that there is an everswelling traffic on the main lines. If the railway companies do not act or decide on some radical remedy shortly their service and receipts cannot improve, but must deteriorate.

In this discussion there must be no mistake about the meaning of the word suburban, which is merely relative, as the distance of the London suburbs from the center will increase as traveling facilities increase. The result will probably be that the railway companies will concentrate their energies on cultivating the distant districts which at the present moment lie beyond the suburbs. By this means they can open up a new residential area which would become a source of profit to the railway companies, not only by supplying them with new traffic, but also by increasing the value of the land thus developed.

The whole question, therefore, as has already been stated, is complicated, owing to the very heavy capitalization of the existing tramways, underground railways, tube lines and suburban lines owned by the other railway companies. Some idea of what this burden is will be gained from the statement that, neglecting the capital invested in omnibuses, over £100,000,000 is at the present moment invested in what might be called the rapid transit service of London—an amount nearly equal to the capital invested in Greater New York. From this it will be seen that the present traffic will have to be enormously increased if anything like a fair interest is to be paid on the capital already involved. This is another reason for supposing that the suburban lines in London will have to be electrified at no distant date. The results of this will be extremely interesting, as it will make London far ahead of any other town in the world. It is already the pioneer city of tubes, and when the various tubes now under construction, or for which franchises have already been granted, are working, the methods of intercommunication of London itself will be exceptionally good. It may possibly be of interest to American readers to give them some idea of the actual approximate cost of tubes per yard of single tunnel; in some cases, under special conditions, the cost may be far greater than that given:

Diameter.	Cost per Yard.		
11 ft. 6 in.	£37	0	0
12 ft.	40	5	0
12 ft. 6 in.	42	10	0
13 ft.	44	10	0
13 ft. 6 in.	47	15	0
21 ft.	140	10	0

The diameter of tubes at present varies from 10 ft. 2 ins. internal diameter (City & South London Railway), 11 ft. 8 ins. (Central London), 12 ft., as proposed (Mr. Yerkes'), and 13 ft. 6 ins., as proposed by the Morgan interests.

It is unnecessary in this article to discuss the various engineering details which will have to be considered by those steam roads who eventually decide to go in for electrification. It is no longer necessary now to demonstrate the feasibility of running the heaviest trains economically electrically.

It seems probable that by a proper combination or community of interests, if such can be arranged between the tramways, whether owned by company or municipality, and between the tube and main-line railways, that electricity may be utilized to improve the situation of all of them. Thus tramways and tubes in London would serve to distribute inside the city and to concentrate at the various exchange stations from which the suburban lines start. These having their own right of way can run at high speed between the centers of the population and deposit passengers there, where they would be distributed by surface tramways. The results would probably be eventually that the railways would be duplicated by tramways along their whole route, but if properly managed this should not be to the disadvantage of either, as the tramway would take the short distance and the railway the long-distance traffic.

CARS FOR HIGH-SPEED INTERURBAN SERVICE

THE interurban of the present day, with its exceptionally high speed, has developed many entirely new conditions. Those which involve the operation of passenger cars are both novel and trying. It is too early to say what the final type will be; possibly many entirely new designs will be found necessary. The question of what is the best type for the interurban car, with its high speed, frequent stops and its combination of city and suburban service, is one which has been put to every car builder, as well as nearly every electric railway company, in the country. Neither the steam railroad car, nor the enlarged electric car of street railways, is entirely suitable for the service.

In view of the importance of this subject, a study of some of the recent interurban cars as used by the latest electric interurban railways in the country has been thought to be of interest.

Figs. 1-4 illustrate the standard cars of the Canton & Akron Railway Company. Two cars are illustrated, as the company intends to operate trains of two cars each. One of the cars is a straight passenger coach, and the other a combination car, having the novel feature of three compartments. Figs. 1, 2 and 3 show plans, elevation, seating arrangement and details of floor framing, while Fig. 4 shows the interior of the car illustrated in Fig. 1.

Referring to Fig. 1, it will be seen that the leading car is intended to run on a loop in one direction only; that it has a cow-catcher; is mounted on double trucks, and has a "steam roof" and a round-end vestibule. It is 58 ft. over all and is intended for a speed of 60 miles per hour. The passenger coach will seat seventy-two persons. Its interior arrangement, as shown in Fig. 4, indicates the finish to be of unusual elegance, the decorations being of the Empire style. The baggage racks are made nearly continuous, and the number of lamps is greater than is usually provided, even in steam coaches. The seats are walk-over, high rolled back, covered with plush. The interior finish is mahogany, decorated with inlaid marquetry. The high backs are a feature highly appreciated by passengers.

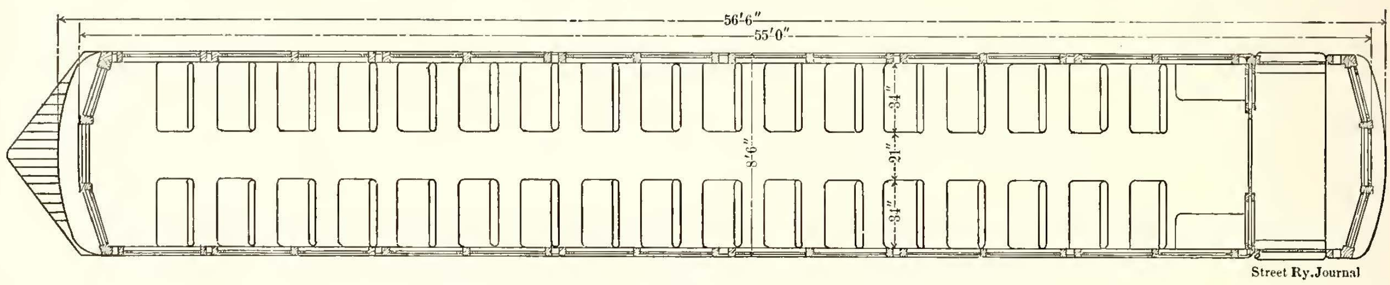


FIG. 1.—PLAN OF ORDINARY PASSENGER CAR, CANTON & AKRON RAILWAY

Of the seating arrangement, see Fig. 1, little can be said beyond noting that it is plain, straightforward and sensible for a coach of the kind. The question arises, however, whether, if the cars are to be run in trains, it would not have been advisable to put an end door into the vestibules in such a way as to make passage from one car to another possible. This would have given the occupants of the passenger coach access to the smoking compartment of the car shown in Fig. 2.

This engraving shows a car with the unusual feature of three compartments—baggage, smoking and passenger. The baggage doors are carried so far forward that they do not interfere in any way with the side truss of the car. This remains intact from bolster to bolster.

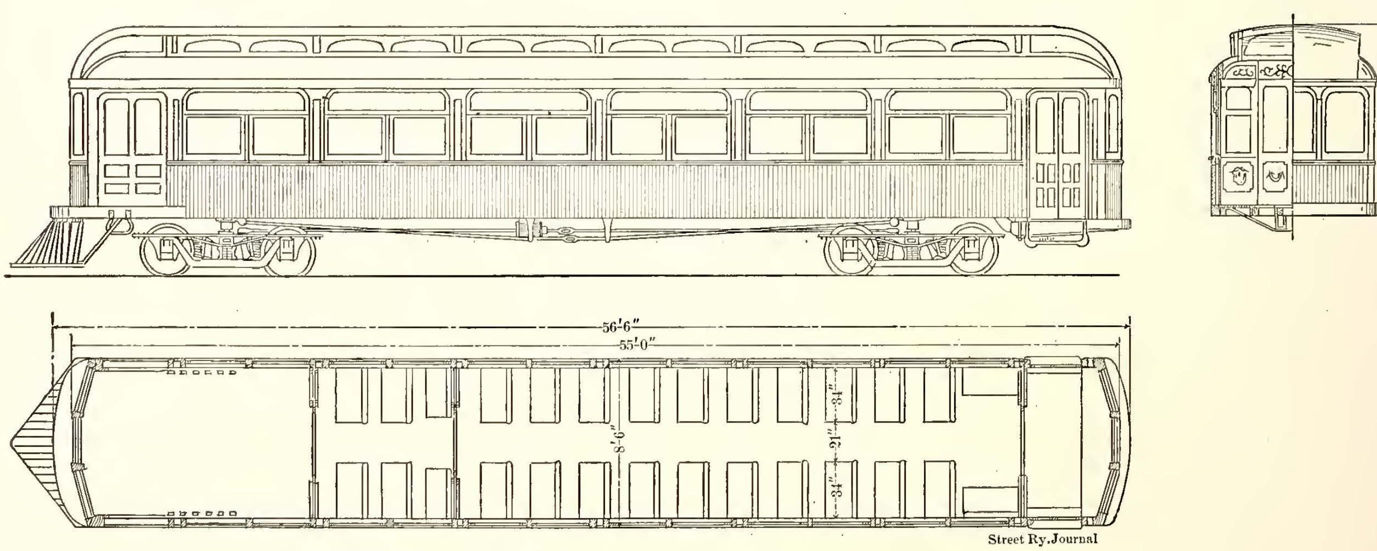


FIG. 2.—PLAN AND SIDE ELEVATION OF BAGGAGE AND PASSENGER CAR, CANTON & AKRON RAILWAY

The floor framing of these cars, see Fig. 3, is of unusual interest, as it shows a decided step toward a complete metal floor frame. There are six sills, all of them strengthened with channel-irons. The two intermediates have not only a channel-iron on one side, but are plated on the outside as well. The side-sills have a channel and bar on the inside, which in turn has a filler of wood. All the sills are of yellow pine, extending in a single length from end-sill to end-sill. The corner posts are of oak and the intermediates of ash. These are spaced in such a way as to bring the windows in pairs with a double post between them. The single posts are made in two pieces with the tie-rods running in the center. The sides of the car are built in a manner which is becoming generally popular, with inside sheathing laid horizontally, and this in turn covered by narrow fatched stuff put on vertically.

Owing to the great length of this car, which is 35 ft. 7 ins. between the bolsters, unusual care was taken in the trussing, as will be seen by the upper portion of Fig. 3. The truss-rods are carried by deep saddles on the needle-beams. The upper, or window, truss is not only well secured by a large plate iron washer, but has what is uncommon, a good anchorage on a special metal post. It may be noted here that in a large part of the cars where a window truss is used it is of no possible value. In many cases its only supports at the points where the greatest strain comes upon it are a couple of insignificant wood screws and a shoulder of wood no thicker than itself.

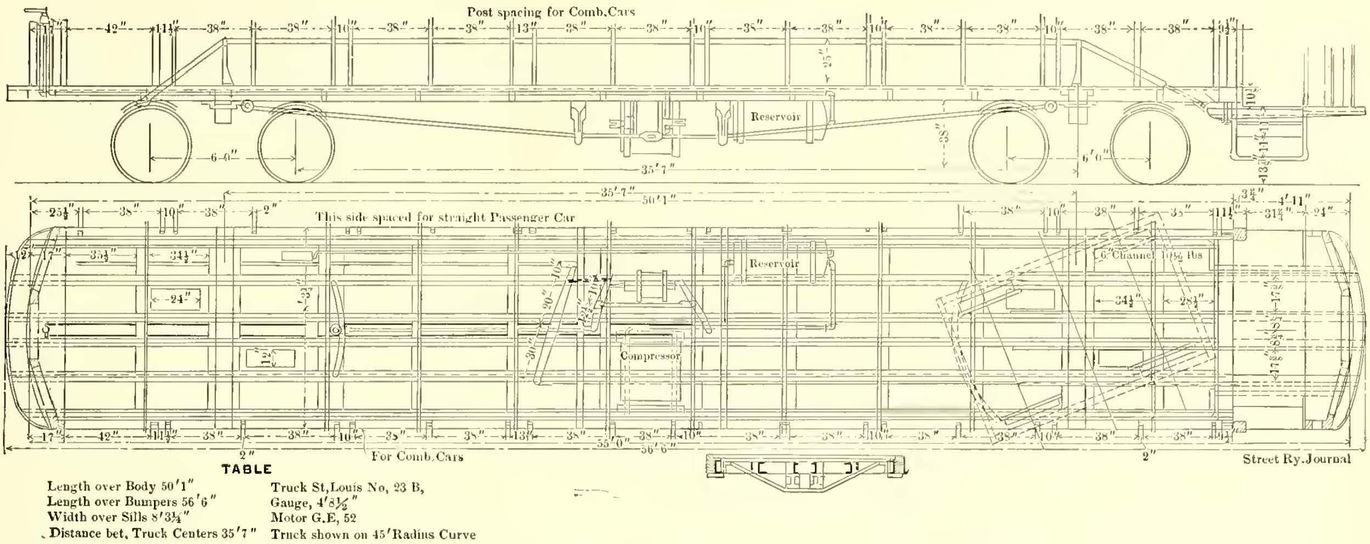


FIG. 3.—FLOOR FRAMING OF CANTON & AKRON CARS

FIG. 4.—INTERIOR OF CANTON & AKRON CAR

These cars, which were built by the St. Louis Car Company, are mounted on the St. Louis Car Company's No. 23-B high-speed motor trucks. They have a 6-ft. wheel-base, 6-in. axles and 33-in. steel tired wheels. The equipment consists of four General Electric No. 52 (75-hp) motors, with multiple-unit control. The weight of the car body, motor and trucks complete and ready for operation is 67,000 lbs. This is about the same as that of a steam coach having an equal seating capacity.

The exterior view, Fig. 5, and the plans and elevations, Figs. 6 and 7, show an entirely different type of interurban car used by the Cleveland & Eastern Railway Company. The body is short, being but 45 ft. 11 ins. over the buffers, and the trucks are spaced but little more than 21 ft. between centers. The car itself is divided into passenger and smoking compartments. The forward vestibule, however, might be considered a compartment by itself, since it provides not only for the motorman, but for the hot-water heating apparatus. At the opposite end there is a separate compartment for the toilet room. Provision is made for seating forty-six passengers. The general features of construction present but few novelties, but the floor frame in Fig. 7 is worth careful study. Here diagonal braces are introduced. All the sills are strengthened with metal. The side-sills have a channel-bar sandwiched in them. The intermediates are plated, while the center-sills are composed of I-beams, a filler with a steel plate on the outside of them. The arrangement of the platform and platform timbers is unusual, as will be seen by a study of the plan. The end-sill is practically plated all over, having an angle-iron on one edge, and the ends of the sills or the angle-pieces from them covering its inner surface. Straps for the platform

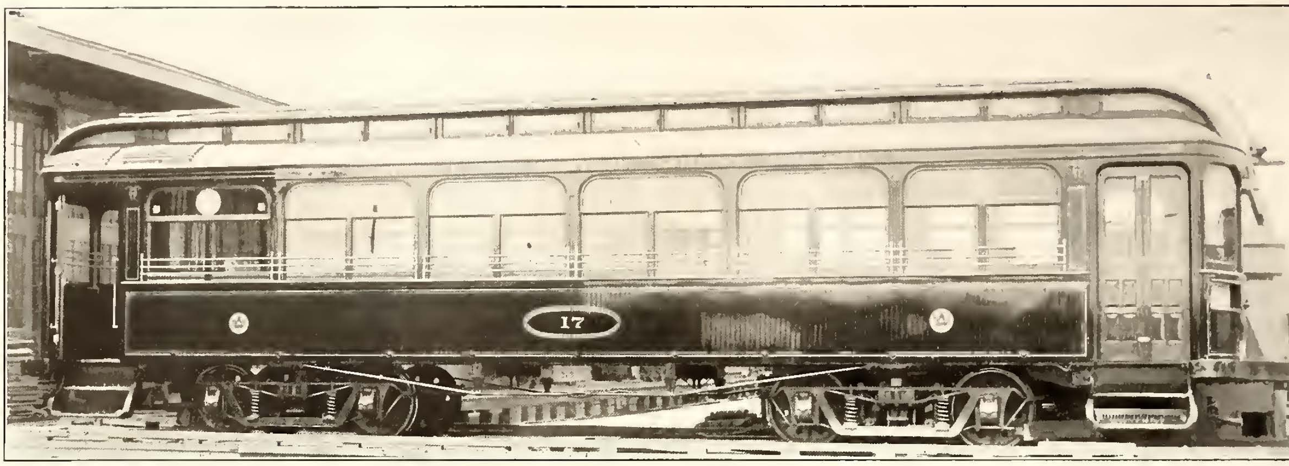


FIG. 5.—HIGH-SPEED INTERURBAN CAR, CLEVELAND & EASTERN RAILWAY

timber bolts protect its top. With the exception of the side-sills, the construction of this floor frame is almost entirely iron, as the wooden pieces employed serve as fillers rather than as sills.

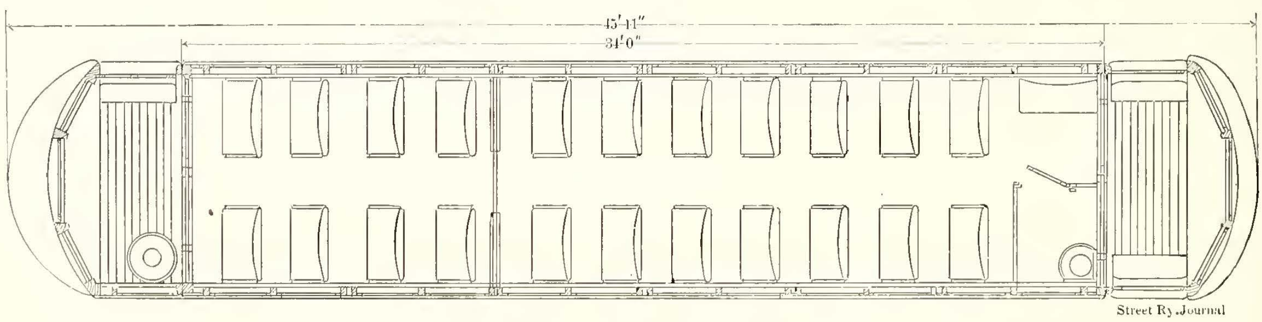


FIG. 6.—PLAN OF CAR SHOWN IN FIG. 5

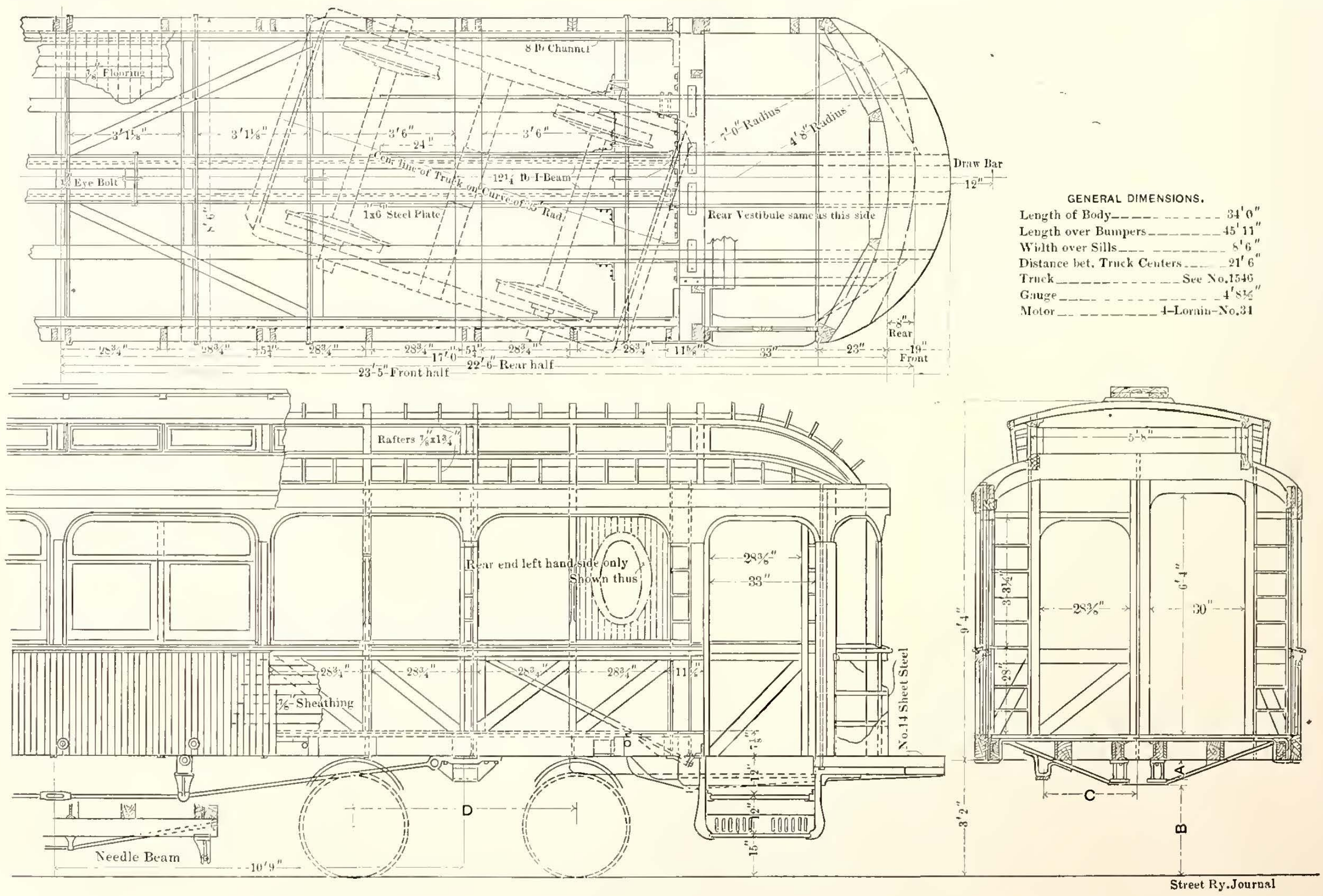


FIG. 7.—FLOOR FRAMING OF CAR SHOWN IN FIG. 5

To meet the requirements of a high-speed interurban car for a mild, uniform climate, like that of California, the car illustrated in Fig. 8 is very popular, and should be included in any article on interurban-car construction. This car, as well as that illustrated in Fig. 7, was built by the St. Louis Car Company, and is a material modification from the type originally known as the California type. The ends are open in the usual style, but the entrances are from steps at

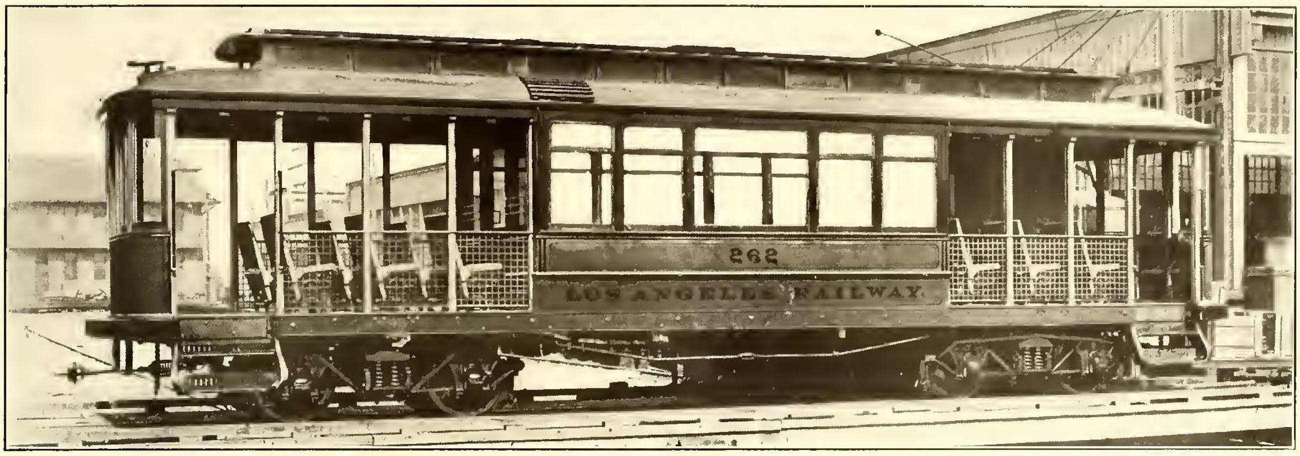


FIG. 8.—HIGH-SPEED INTERURBAN CAR OF THE CALIFORNIA TYPE

the corners, instead of from a running-board. Another novel feature for a high-speed interurban car is the use of longitudinal seats in the closed part. Peculiar conditions may render this necessary, but for long runs the longitudinal seat is not altogether desirable. Cars of this class are particularly adapted to the Pacific Coast, where practice has shown that the riders at all seasons of the year usually divide themselves equally between the open and the closed compartments. These cars are 37 ft. long and weigh complete 40,000 lbs. each.

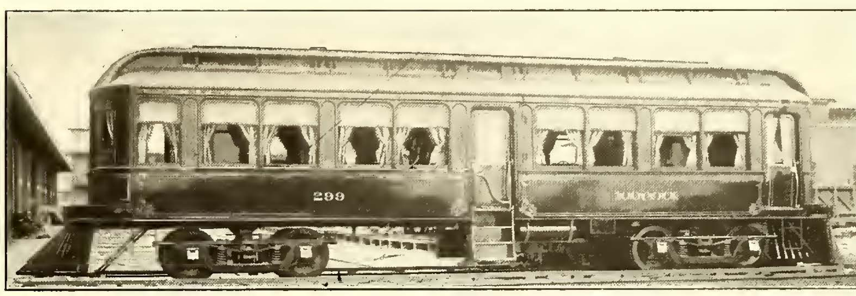


FIG. 9.—PARLOR AND SLEEPING CAR OF THE UNION TRACTION COMPANY, OF INDIANA

The palace-car, or sleeper, design shown in Fig. 9 may at first sight seem inappropriate in this connection, but with the introduction of great electric systems extending over hundreds of miles, the parlor car and the sleeper will undoubtedly become necessities, and this car may be taken as one of the first answers to the question, what shall be the

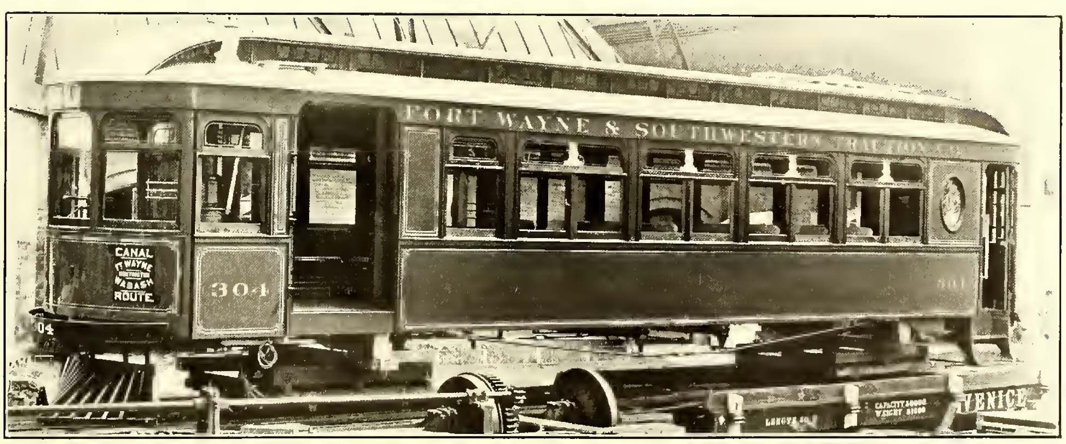


FIG. 10.—HIGH-SPEED COMBINATION CAR FOR FORT WAYNE & SOUTHWESTERN TRACTION COMPANY

form and style of the high-speed electric sleeping car. This car has been illustrated before in these pages, but is included in this article owing to the interest attaching to it in connection with interurban service. It was built by the St. Louis Car Company for the Union Traction Company, of Anderson, Ind. Its extreme length is 50 ft. The entrance is in the center of the car, which divides it into two compartments. One of these has desks, library, smoking and observation room. The other compartment on the other side of the entrance comprises a drawing room, sleeping compartment with upper and lower berths, bath room, dressing room and kitchen. The interior is richly decorated. The only possible objectionable feature in the design is the central door, which destroys the continuity of the side of the car, but adds greatly to its convenience. This, however, is a mere detail of the design. End entrances could be provided without difficulty and without changing the interior arrangement in any essential. The car weighs complete 60,000 lbs.

Figs. 10 and 11 show another car, which has been illustrated in these pages, but, as it is the standard of one of the latest interurban roads in Indiana, and as it is of a type of which its builders, the John Stephenson Company, have sold a number, it deserves special study. It is not of unusual size, measuring only 43 ft. 6 ins. over the dashers. The design, however, has been adapted to much longer coaches, and can be built of any desired length. What is known as the Pullman window is employed, with a steam hood and a round-end vestibule. This particular car is intended to run in one direction only, and hence the motorman's vesti-

FIG. 11.—INTERIOR OF CAR SHOWN IN FIG. 10

bule is closed on one side. In the space thus gained the hot-water heater is placed. The door of the baggage compartment is placed beyond the bolster and, as the partition comes a short distance inside of this, the two sides of the car are well braced, so that there is almost an equivalent of two end frames. By a peculiar arrangement of the seats, as shown in Fig. 12, the car has in effect baggage, smoking and passenger compartments. The passenger compartment is arranged with walk-over seats in the usual fashion. The corner next to the rear door is occupied by a toilet room. A considerable gain in space is made by using sliding doors at both ends of the car and in the partition. In the baggage compartment the seats are longitudinal. They are divided in the center so that one-half of the seat folds lengthwise over the other. This is to permit the baggage door to be used and at the same time occupy the space for seats. The method of doing this will also be seen from a reference of Fig. 11. In case of necessity, both parts of the seat can be dropped flat against the side of the car, being supported on brackets. In a very long car a separate compartment would be employed, instead of utilizing the baggage compartment for smokers. The baggage compartment would then be placed at the extreme end of the car. In that case a passageway is placed at the side of the smoking compartment, so as to isolate it entirely.

The framing of this car is shown in Fig. 13. It is comparatively light, but very solid. The six sills run continuously from end to end of the car. Those on the outside are plated with steel, or rather the outside sills are double, forming a sandwich. The end-sill is also steel-plated, the ends of the plates being turned up and bolted into the side-sills. The cross-framing is spaced 26 ins. apart, and each piece is mortised into the sills. Tie-rods are placed at each

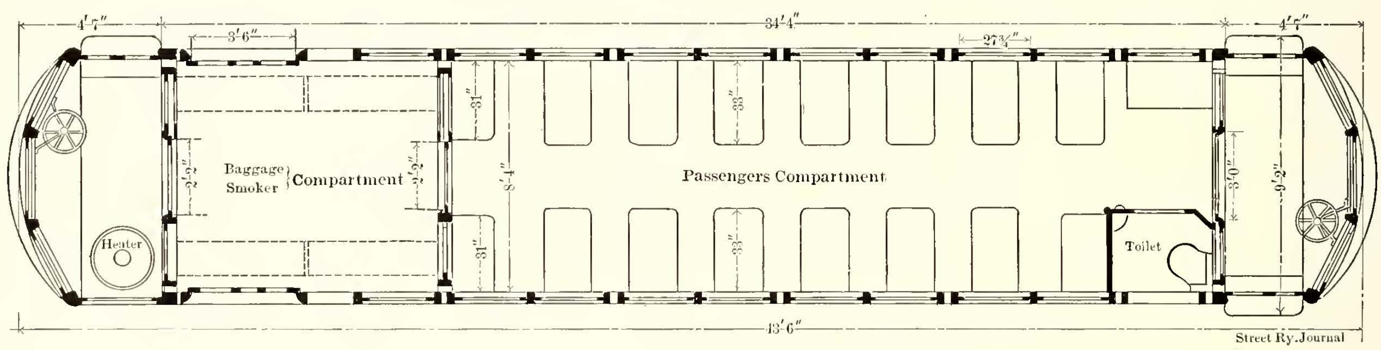
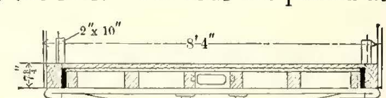


FIG. 12.—PART OF PLAN OF CAR SHOWN IN FIG. 10



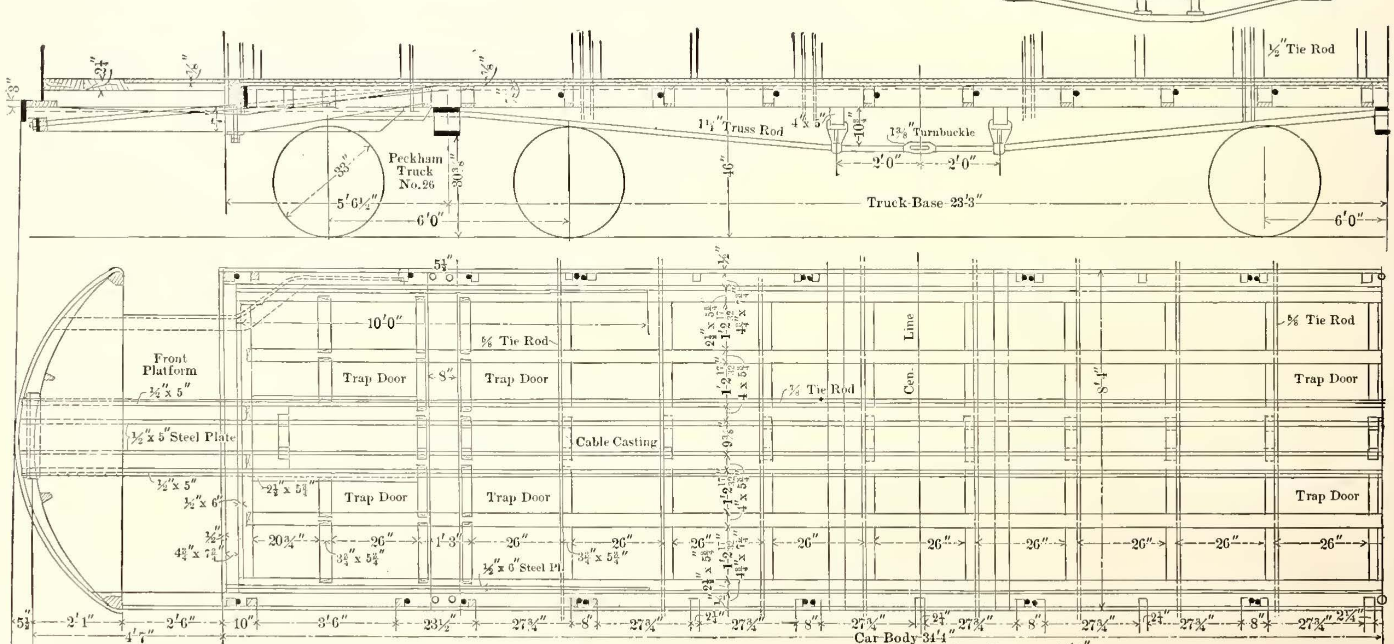


FIG. 13.—PART OF FLOOR FRAME OF CAR SHOWN IN FIG. 10

one of the crossings, so that the whole frame is held together and made exceedingly stiff. One feature is worth particular attention. The center member of each of the crossings is a casting (see cross-section of the floor frame

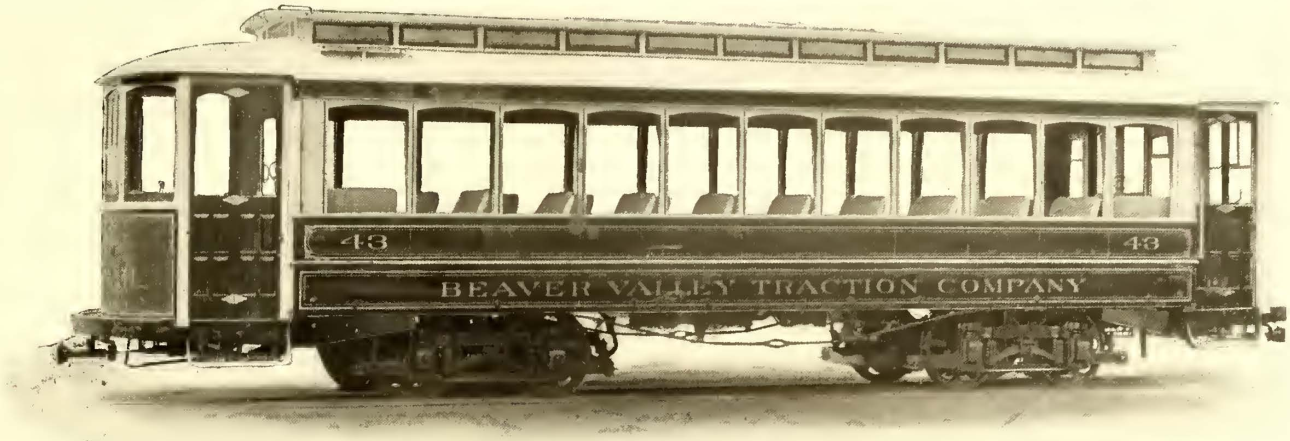


FIG. 14.—SEMI-CONVERTIBLE CAR OF BEAVER VALLEY TRACTION COMPANY

in Fig. 13). These castings, being perforated, afford an opening the whole length of the floor frame, which is closed below by a floor. The top of this pocket forms the floor of the car, and is made in removable sections, so that there is a longitudinal pocket, in which are placed the brake air-pipes, cables, wires, etc. The structure not only adds strength to the car, but is a great convenience.

Outside of the center-sills, and taking a bearing against plates at the ends of the platform timbers, are two rods, which combine the offices of tie and truss-rods. Through the center of the car they become tie-rods. At the ends they drop sufficiently to truss both platforms. The bolsters are of wide, thick iron, and have a superabundance of strength. From them are anchored the $1\frac{1}{4}$-in. truss-rods under the side-sills of the car. The exact weight of these cars is not available at the time of writing this article, but, from the care which is taken in disposing of the metal and the effort made in framing to make the structure as strong and light as possible, it is thought that the weight must be low.

The side of the car is built of two thicknesses, the inner

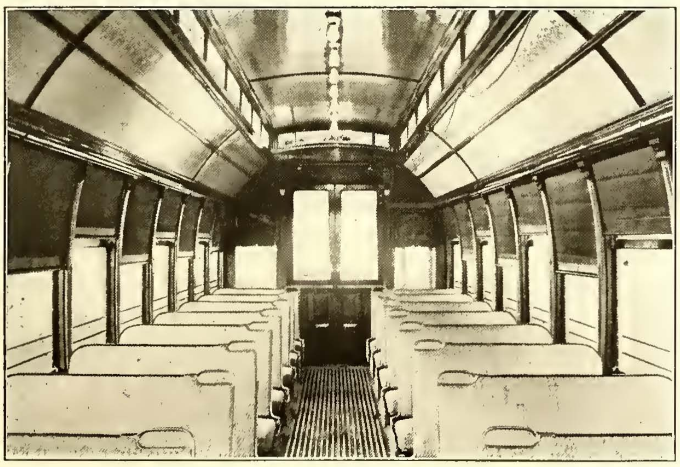


FIG. 15.—INTERIOR OF CAR SHOWN IN FIG. 14

one horizontal, gained upon the posts, glued in place and nailed. The vertical outside sheathing is also glued in place, and, when all is dry, braces are cut in between the posts and screwed fast to the inside lining. The inside finish is mahogany throughout, with inlaid decorations and carved ornaments. The leading ideas of the designer was to afford every facility and comfort for the long-distance traveler, to provide a car strong enough to be operated at from 60 miles to 70 miles an hour, and to make it so light that it could be accelerated with great rapidity and be stopped with the smallest amount of brake power.

A passing word is perhaps necessary in regard to the

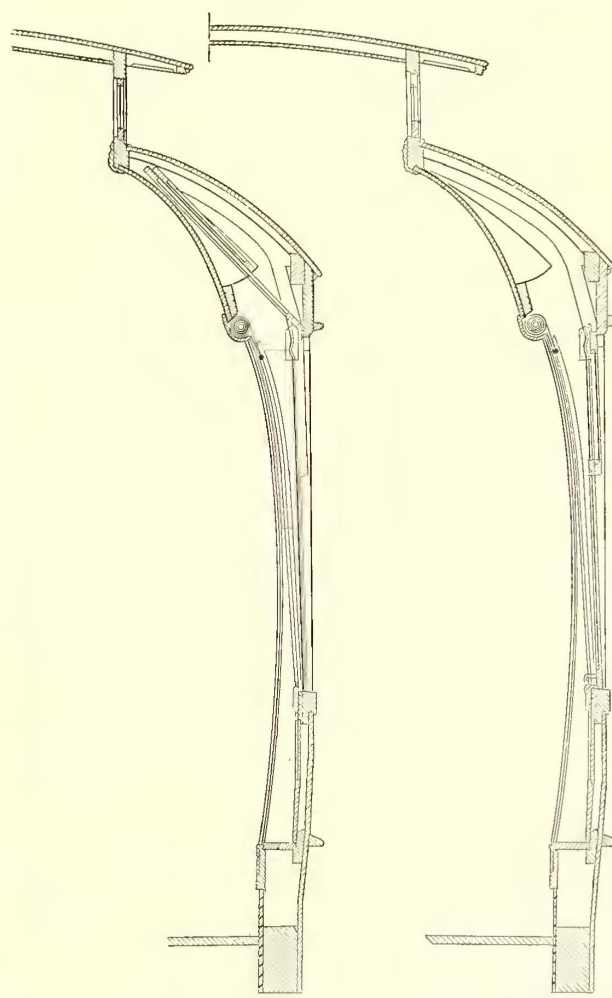


FIG. 17.—DETAILS OF ARRANGEMENT OF STORING SASH

Pullman window arrangement, to which allusion has been made. The windows are in pairs between panels. While in this car the lower sash can be raised, the design also contemplates the dropping of the sash and covering the opening with a window cap. In either case, the outside of the window is protected by guard-rails, a very necessary precaution. Either with or without the drop window, a truss-plank is introduced, which is gained and screwed upon the posts and edge bolted to the sills, the details of its fastening being modified to some extent by the arrangement of the sills and plating.

Passing now temporarily to the semi-convertible type, which the J. G. Brill Company has done so much to advance, and which it recommends so strongly for interurban service, attention is called to Figs. 14-17, which show a typical car of this pattern, one built for the Beaver Valley Traction Company. Fig. 15 shows the interior. The seating plan of the car, Fig. 16, presents no special features, being that of a straight passenger coach with a seating capacity for forty-four persons. It is of moderate length, has street car hoods, and is mounted upon the No. 27-G trucks. These are spaced 18 ft. 8 ins. from center to center. The feature upon which the company lays stress is the fact that the side of the car can be practically left wide open whenever it is desired, and the sash safely and conveniently stored in the roof. While most of the readers of the Street Railway Journal are familiar with this plan, the details shown in Fig. 17 will be of unusual interest, since they show more clearly than in any previously published sketch the method of lifting and stowing the windows. They also explain a statement frequently made that a considerable gain in the width of the car inside is secured, in this case amounting to 7½ ins. The diagram at the left in Fig. 17 shows both sash in the roof pocket, leaving the window completely opened. The second diagram shows the sash in place.

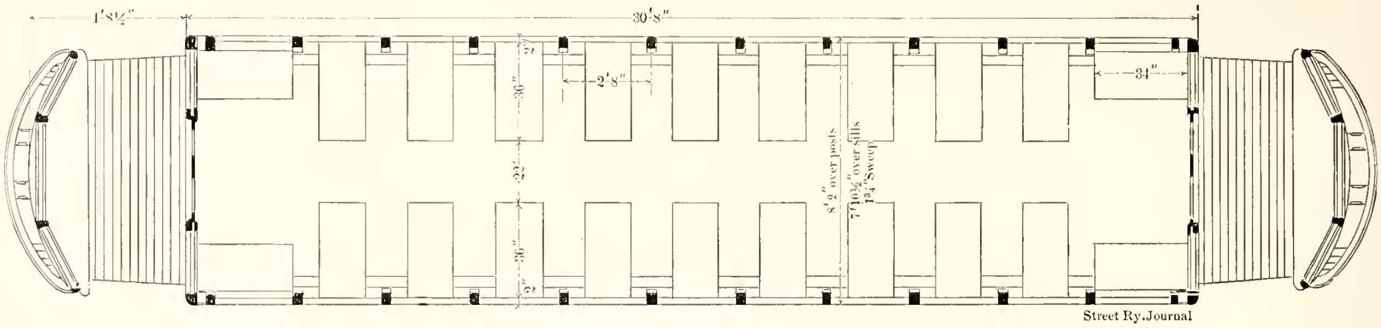


FIG. 16.—PLAN OF CAR SHOWN IN FIG. 14

The car, with its trucks, weighs about 22,000 lbs.

One of the most remarkable designs for high-speed interurban cars which has yet been put into actual service was recently brought out by the Jewett Car Company, of Newark, Ohio. The cars are 60 ft. long over the buffers, and have a seating capacity for one hundred and eight persons. Several of these cars have already been built for the Columbus, Buckeye Lake & Newark Traction Company, for the Central Market Street Railway, of Columbus, Ohio, and for the Columbus, London & Springfield Railway. These cars are of the semi-convertible type. Fig. 18 shows the car closed, and Fig. 19 as an open car, but with the curtains down. The sills are plated with steel. They are intended to run at a very high rate of speed and mounted on Peckham's M. C. B. trucks, equipped with General Electric No. 73 motors, which develop 75 hp each. A number of cars of the same type are being built for the Columbus,

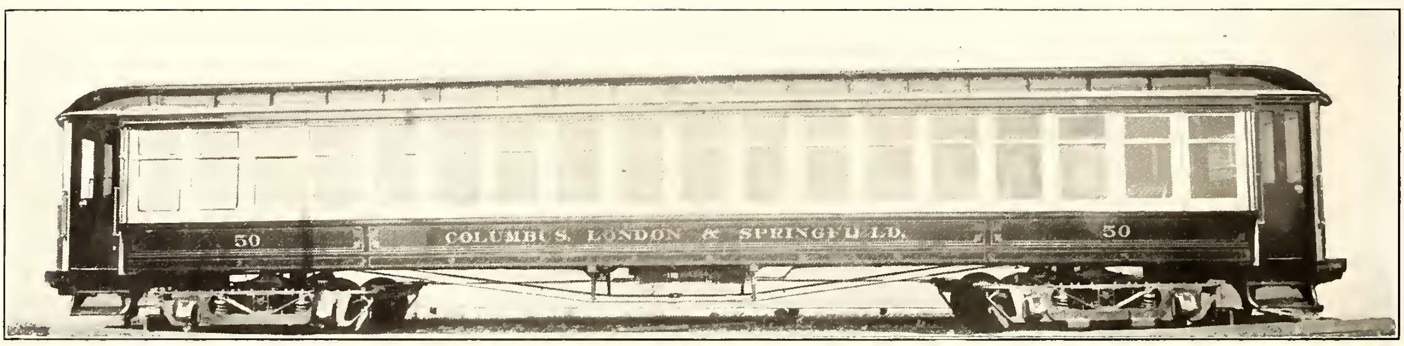


FIG. 18.—SIXTY-FOOT SEMI-CONVERTIBLE CAR, COLUMBUS, LONDON & SPRINGFIELD RAILWAY—CLOSED

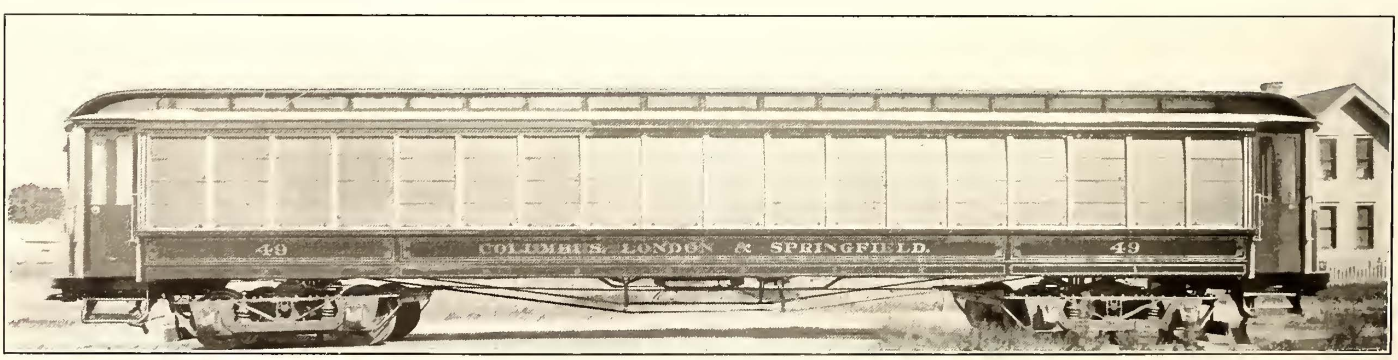


FIG. 19.—CAR SHOWN IN FIG. 18, OPEN, BUT WITH CURTAINS DOWN

Delaware & Marion Railway Company, but they differ from those just mentioned in being 66 ft. 3 ins. long over all. It is claimed that these cars are longer by 5 ft. than any interurban cars ever built, and, so far as is known, this statement is correct.

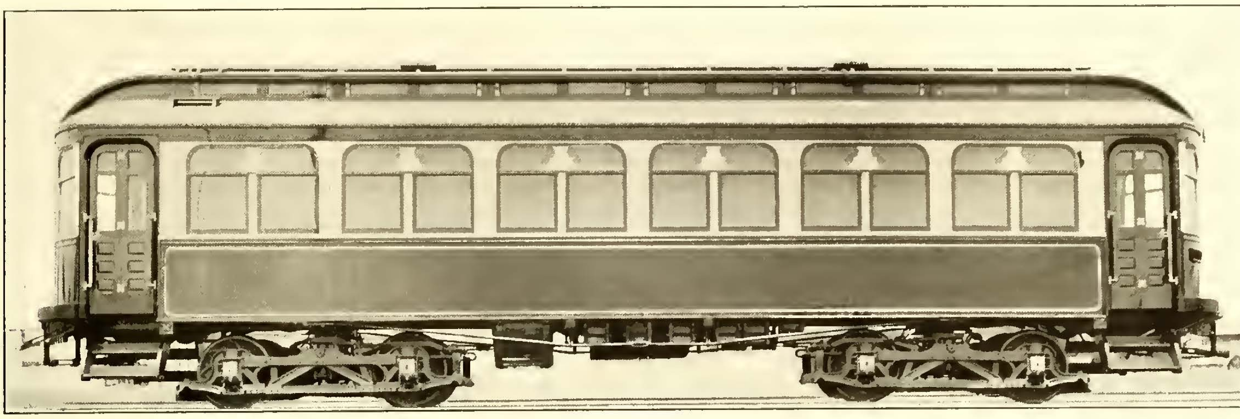


FIG. 20.—45-FOOT HIGH-SPEED INTERURBAN CAR

The standard interurban car of the Jewett Company is shown in Fig. 20. It has Pullman windows and platforms flush with the floor of the car, the center and the intermediate sills running to the ends of the vestibules. This construction, shown in Fig. 21, is of unusual strength. The sills are I-beams with yellow pine fillers. The side-sills are plated with ½-in. steel. The construction of the side with the framing of the platform, vestibule and hood, is shown in Fig. 22. Belt-rails, side-plates, deck-sills and deck-plates are of yellow pine in continuous lengths without splicing. Tie-rods are well anchored to bolster and sills. The window braces have tension-rods from the heads of the braces through the sills. This is a detail from steam-car construction, which has proved its value, but is unusual in electric railway work. In these designs we have the features of great floor strength and large seating capacity emphasized. The behavior of these designs in actual

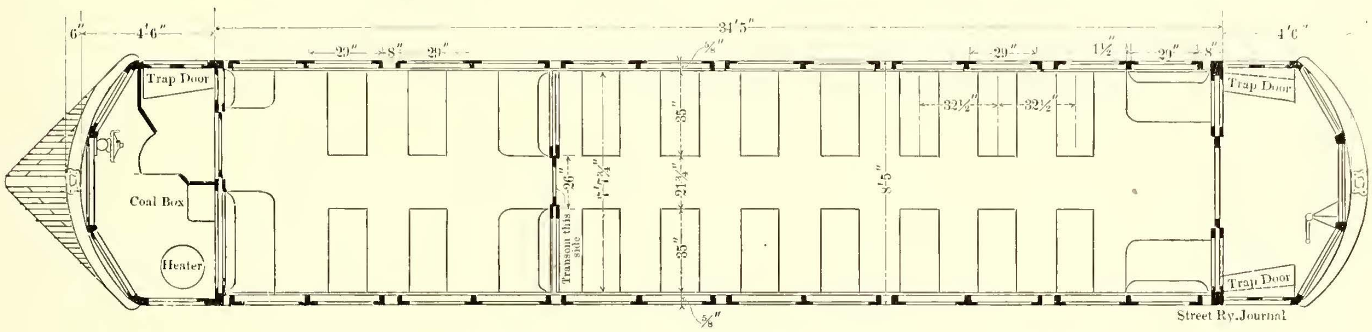


FIG. 25.—PLAN OF CAR SHOWN IN FIG. 23

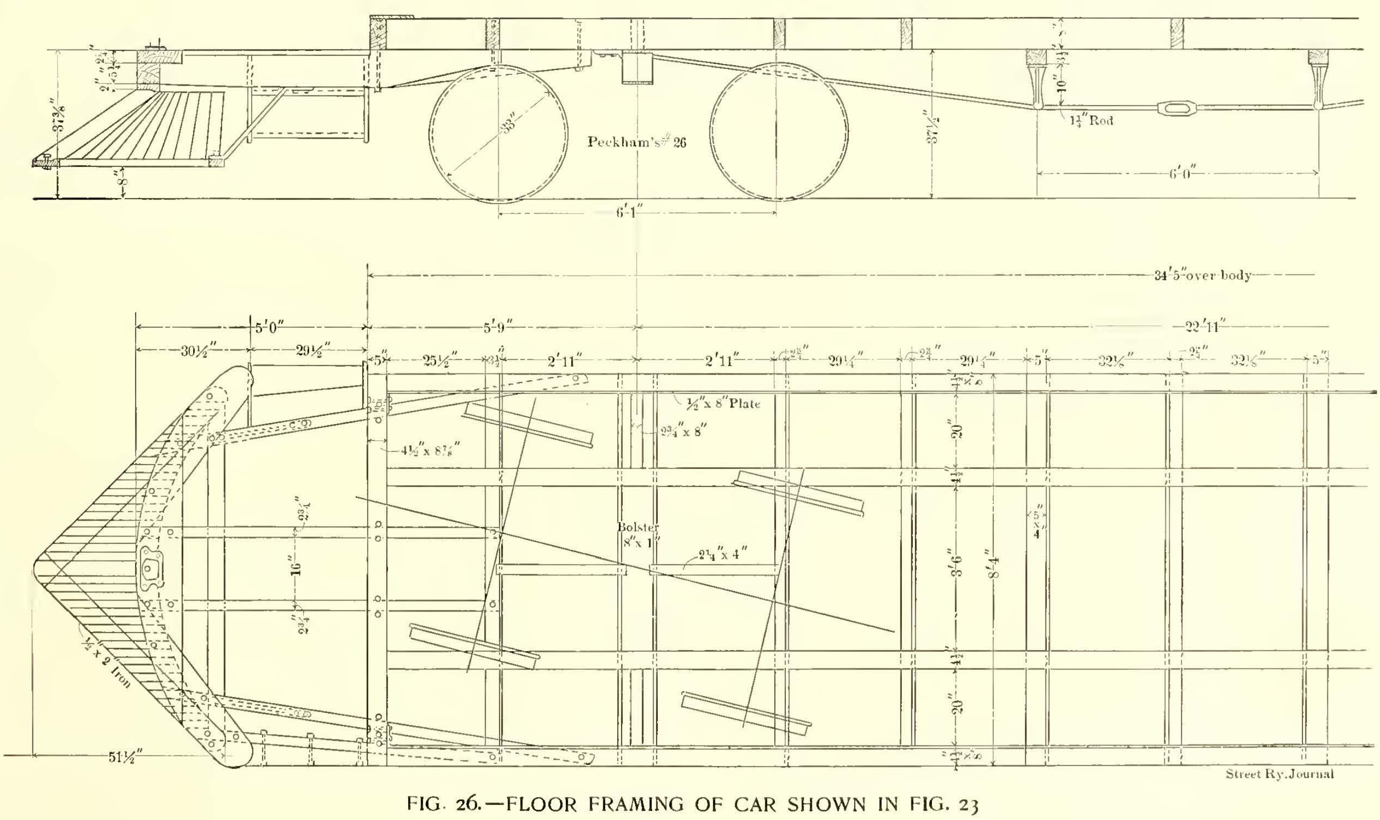


FIG. 26.—FLOOR FRAMING OF CAR SHOWN IN FIG. 23

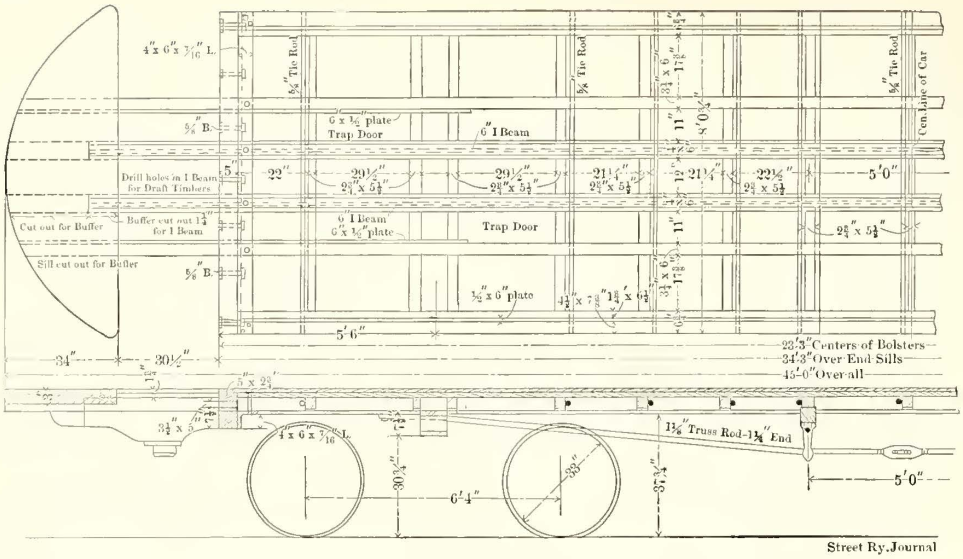


FIG. 21.—FLOOR FRAMING OF CAR SHOWN IN FIG. 20

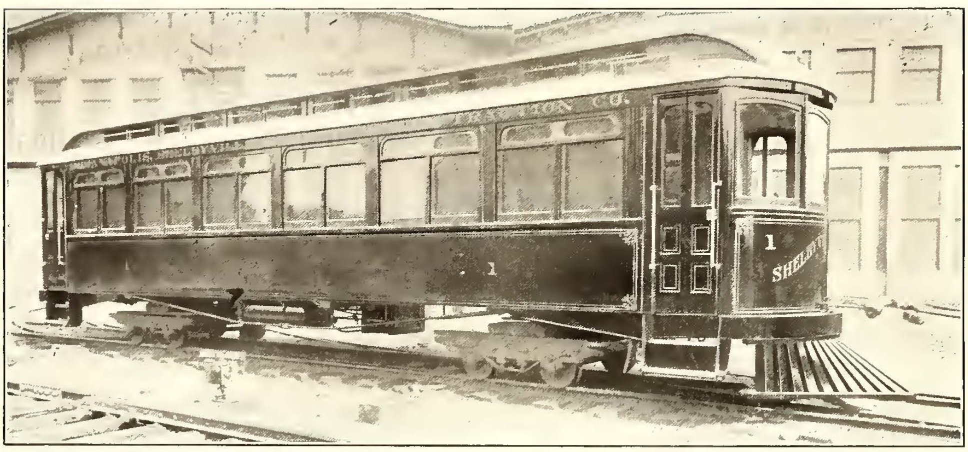


FIG. 23.—EXTERIOR OF CAR, INDIANAPOLIS, SHELBYVILLE & SOUTHEASTERN RAILWAY

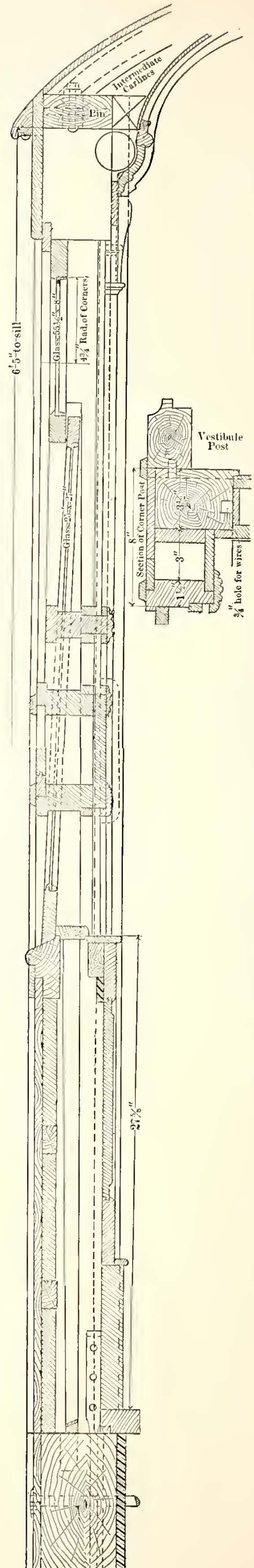


FIG. 27.—SIDE FRAMING OF CAR FIG. 23

service will be watched with great interest by railway managers. With cars of such large size, if they are to operate over any considerable distances, it will be easy to supply them with all the conveniences necessary on steam roads.

Fig. 23 illustrates a type of interurban car manufactured by the Jackson & Sharp plant of the American Car & Foundry Company, and which has proved very popular for interurban service. The interior is shown in Fig. 24. The finish, as shown in the latter engraving, is very handsome, which has long been a characteristic of the company's work. The exterior shows a car with steam road roof, Pullman windows and vestibules at each end. From the presence of a cow-catcher it will be seen that this particular car is intended to run in one direction only. Incidentally it might be said that this is an advantage which railroad men seem to be slow in appreciating. Those most advanced consider the single-end car possesses material advantages over the double-ended car. The plan shown in Fig. 25 presents a number of interesting features. The passenger compartment has

FIG. 24.—INTERIOR OF CAR SHOWN IN FIG. 23

the usual walk-over seats, with two stationary corner seats. In the smoking compartment there are four stationary seats and four walk-overs. The aisle in this compartment is diverted to one side of the center, and the entrance is made through a passage-way entirely separate from the motorman's cab. The heater is arrangement greatly increases the available space on the platform. It is a useful adaptation from steam car practice. The floor framing is of a somewhat novel character. See Fig. 26. There are four continuous sills, with the side-sills steel-plated and the plates turned up against the end-sills. In the place of intermediate timbers short stringers

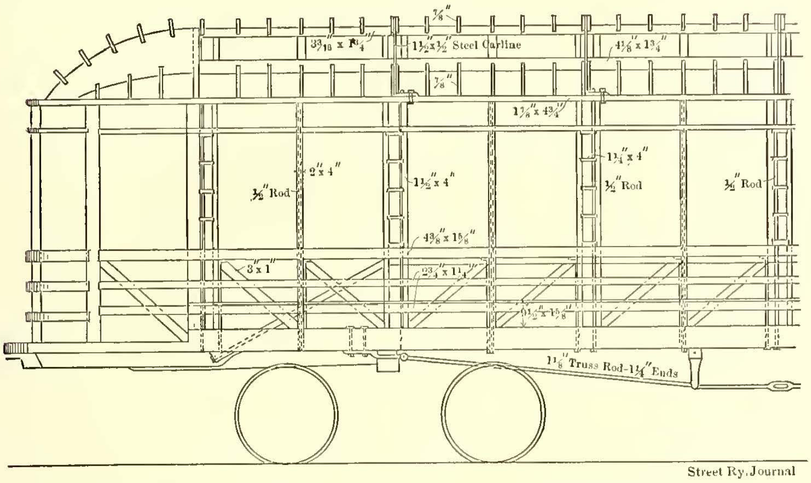
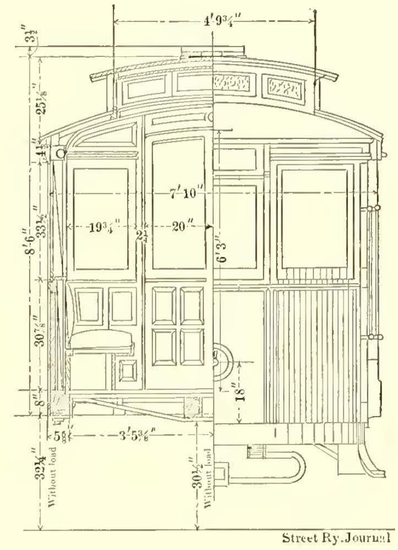


FIG. 22.—SIDE AND ROOF FRAMING OF CAR SHOWN IN FIG. 20



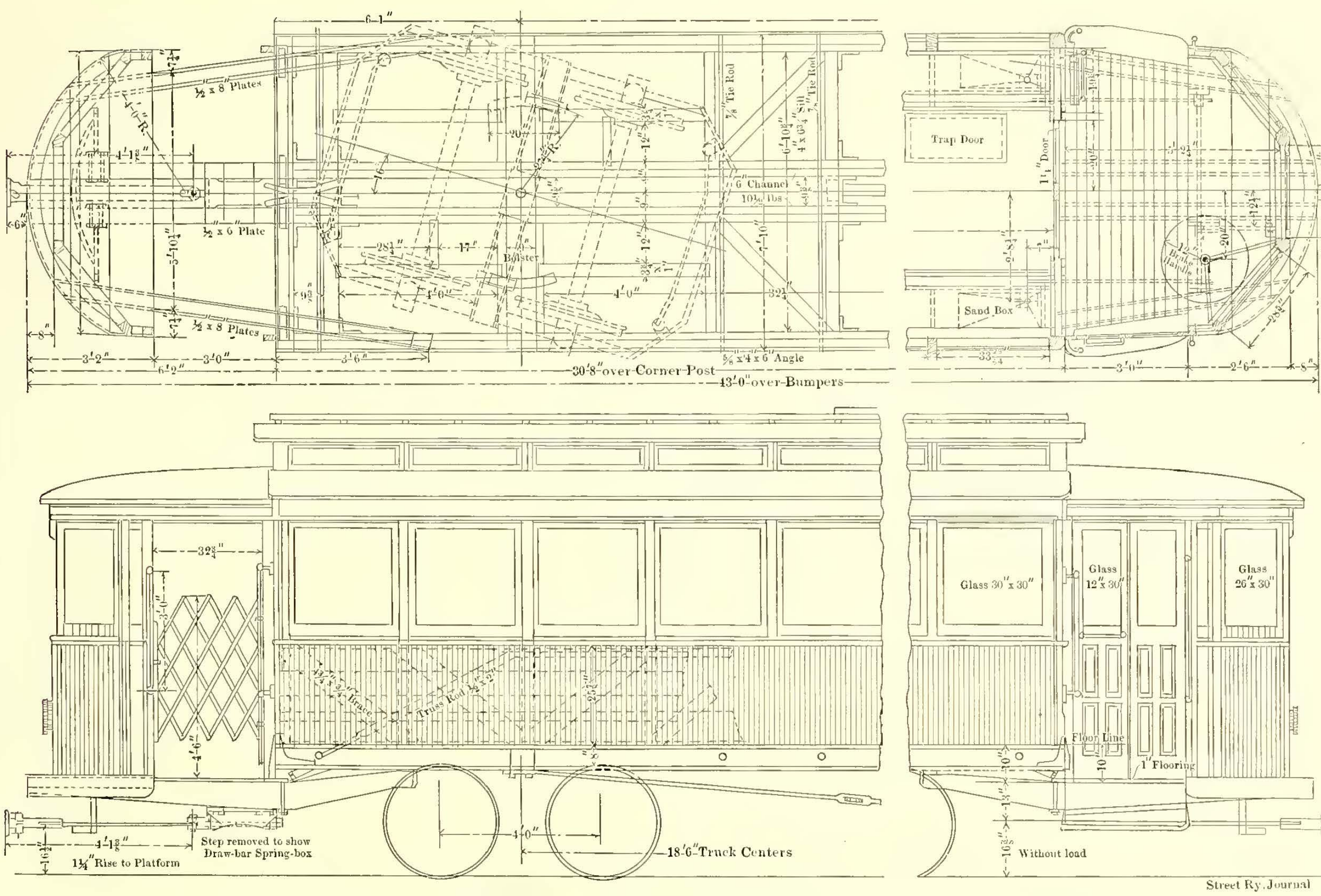


FIG. 28.—SIDE AND END ELEVATION, FLOOR FRAME AND PLAN OF 30 FT. 8 IN. INTERURBAN CAR

placed in the cab, together with coal boxes. This is a detail which has many advantages. In this particular instance a vertical hand-wheel is used, while the ordinary brake handle is employed on the rear brake. While the platforms are dropped the depth of the sills, all the entrances are provided with vestibule doors at the outer line of the car, and trap-doors, which are raised when the vestibule doors are opened and the steps are in use. This are introduced on each side of the bolster. This arrangement presents a great contrast to some of the designs which we have already given. When we consider the fact that most electric cars are run singly and the only endwise shocks to which they are subjected are those occasioned by handling in the car houses, the question arises whether any great amount of longitudinal strength is really necessary. Cars of this class appear to stand well in service, and, as their repairs are not materially different from those of other types, the only argument for or against them will have to be drawn from cases of accident. The condition of a car in case of derailment at high-speed will be the only argument for or against the design which will have any value. Certainly the saving of dead weight which is effected is one worth the most serious consideration of railway men. In Fig. 27 a detail of the side framing and posts of these cars is given. From this it will be seen that the unusually large windows are easily disposed of in the pocket, which is closed by the usual window caps. One of the trivial details, often a matter of comfort to the weary passenger which may be here mentioned, is the rounding of the interior mouldings.

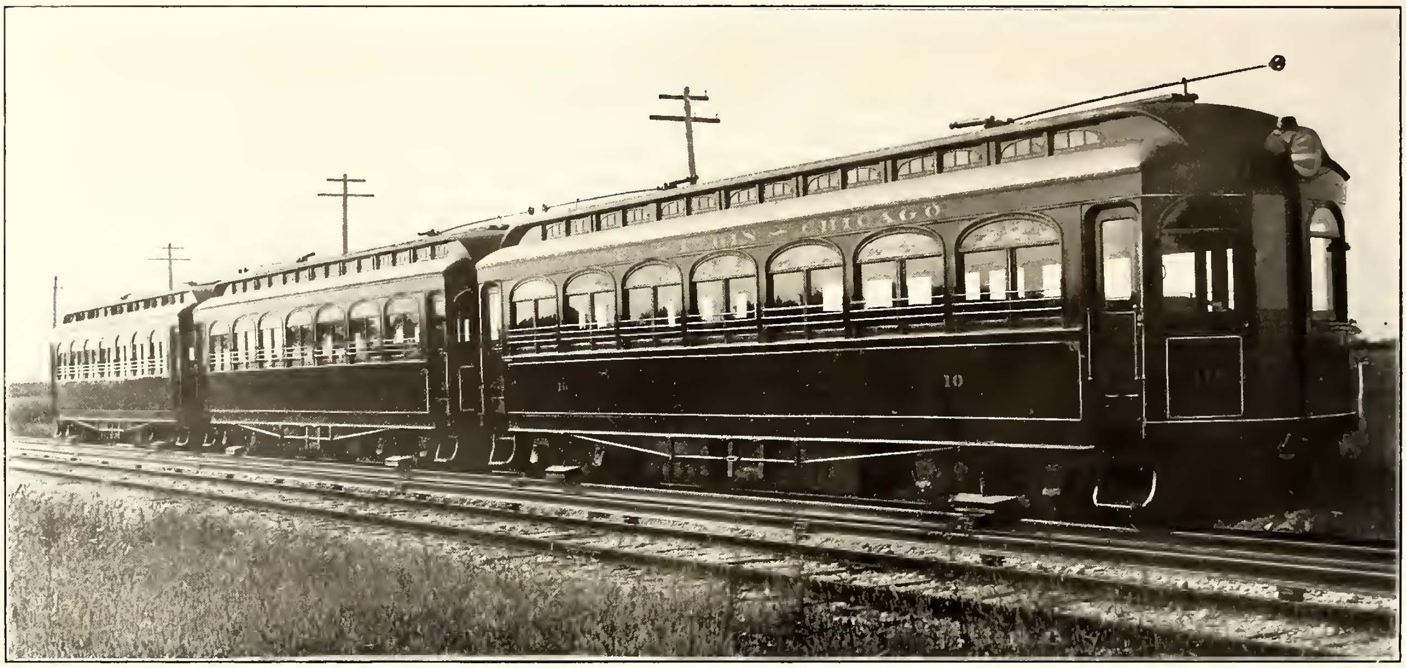


FIG. 29.—TRAIN OF CARS FOR THE AURORA, ELGIN & CHICAGO RAILWAY

The vestibules are what are sometimes called octagonal. The arrangement of these cars is unusual for the purpose, consisting of a single compartment having longitudinal seats. This, of course, gives a great standing capacity for given size. The plans are drawn in great detail, and the practical man will find them worth study. The features which deserve most attention are found in the plan of the flooring and in the cross-section. The sills are plated with angle-iron, the bottom of the iron coming underneath the sills. Wrought-iron brackets are introduced at numerous places in the frame, greatly stiffening the joints. The end-sill is plated apparently on both sides, and the unusual feature of a second sill just behind the end-sill is introduced. There are but four continuous sills. The wood center sills are but little more than fillers of their channel-iron plating. It will also be noticed that diagonals are introduced. This, with the numerous brackets, gives the frame a great amount of stiffness. The use of diagonals or their equivalents has always been insisted upon by steam railroad men as very necessary to the durability of a car bottom.

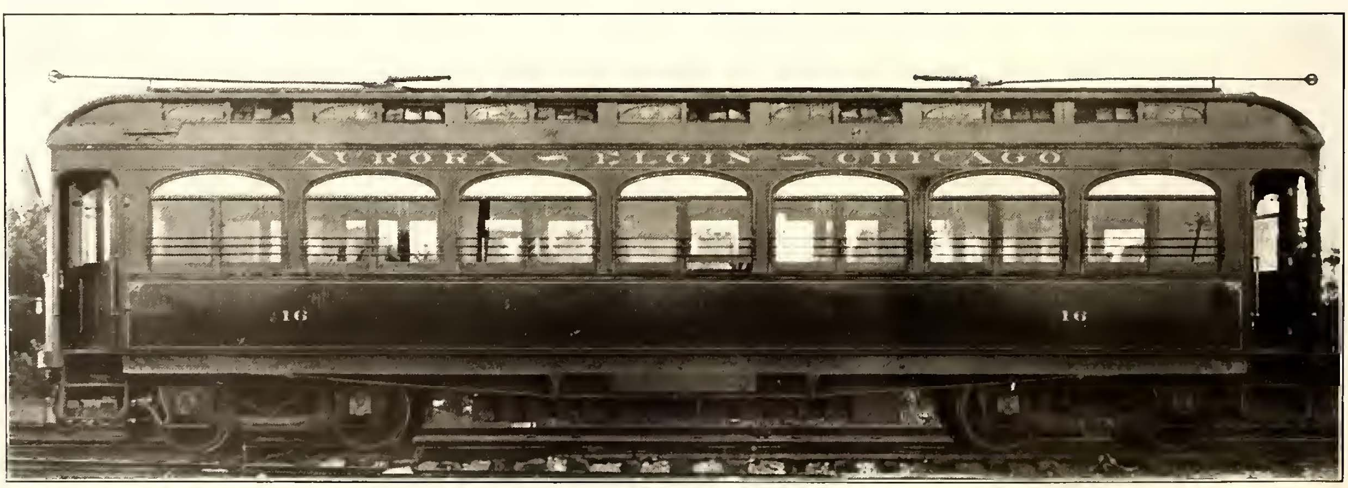


FIG. 30.—CAR FOR AURORA, ELGIN & CHICAGO RAILWAY

The Laclede Car Company, of St. Louis, Mo., has done a large amount of work in interurban cars, and one of its standard cars for this work is illustrated herewith in Fig. 28. It presents some unusual features. As will be seen it is a car of moderate length, with street-car hood and vestibule and single windows. The platforms are dropped so that the single step is brought within 16 inches of the ground.

The car, without trucks, weighs about 24,000 lbs., and the total weight, including trucks and motors, is, approximately, 40,000 lbs. This, it will be seen, for the seating capacity is a very light coach, and the plan will justify study.

The Niles Car & Manufacturing Company built the high-speed interurban car shown in Fig. 29 and Fig. 30 for the Aurora, Elgin & Chicago road. A floor plan of this car is published, in connection with the article, elsewhere in this issue, on the Aurora, Elgin & Chicago Railway. It has a flattened vestibule, with a steam hood, and from the form of the clear-story windows we judge that the interior must be of the Empire style of finish. The windows are oval-headed, of the Pullman type and protected by guard-rails. The body is carried rather lower than usual, so that only two risers are necessary to reach the platform from the ground. Two trolley poles are used. The shape of the vestibules is novel, and is intended to reduce the air resistance. These cars weigh light, including motors and all equipments, 73,000 lbs.

Fig. 31 illustrates a very handsome coach recently completed by the G. C. Kuhlman Car Company for the Columbus, Delaware & Marion Railway. It is 50 ft. over all, and is divided into two compartments, a regular passenger compartment and a smoking compartment. The former is fitted with high, corrugated back, plush seats with grab-handles, while the seats in the smoking compartment are of cane. The car is finished in solid mahogany with extra-heavy bronze trimmings and elaborate electroliers, and cost complete nearly $12,000. The seating capacity of the car is fifty-two passengers. The car is mounted on Peckham M. C. B. trucks with steel-tired wheels, and is equipped with four 75-hp Westinghouse motors. Each car is also provided with Westinghouse double-end air-brakes and an air whistle.

The subject of open cars for interurban railways has not been discussed to any extent in this article, but for completeness, a view of an open car which has given excellent satisfaction on the Northern Texas Traction Company is presented herewith. This car was also built by the Kuhlman Company. On high-speed roads the ordinary type of car with running-boards has certain objections, and this car, as will be seen, has a center aisle with end entrances. It is designed for use as a trail car only, and is hauled by either an interurban coach or a baggage car. It is 50 ft. over all, with seating capacity for fifty-five persons. The interior finish is cherry with bird's-eye maple ceiling and bronze trimmings.

An attempt has not been made in this article to cover all of the types of interurban cars which are being used in interurban work, or even to describe the products of all the prominent car-building companies in the country. Some of these builders are represented in the article on the rolling stock in Detroit, published elsewhere, and there a number in the East, like the Laconia Car Company, Jones and others, whose work is familiar to our readers through published articles in these pages. It might further be said that all the designs which are illustrated herewith are mounted upon M. C. B. standard, equalized, swing-beam trucks, or upon some modified form of it.

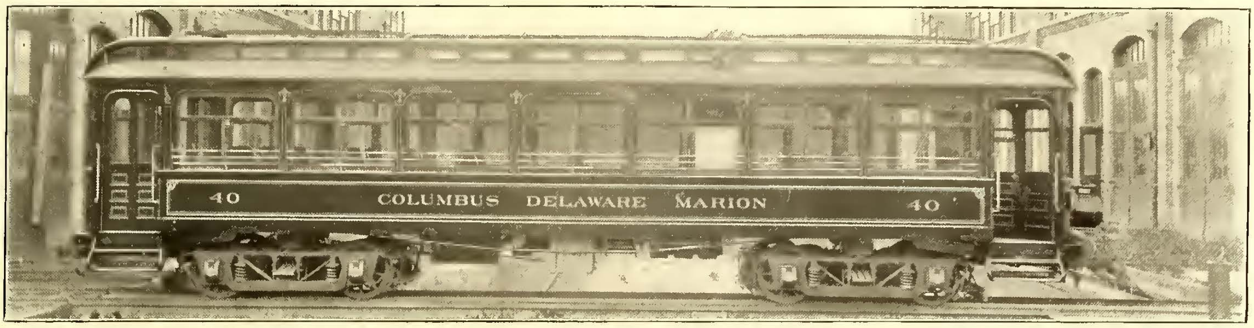


FIG. 31.—CAR FOR COLUMBUS, DELAWARE & MARION RAILWAY

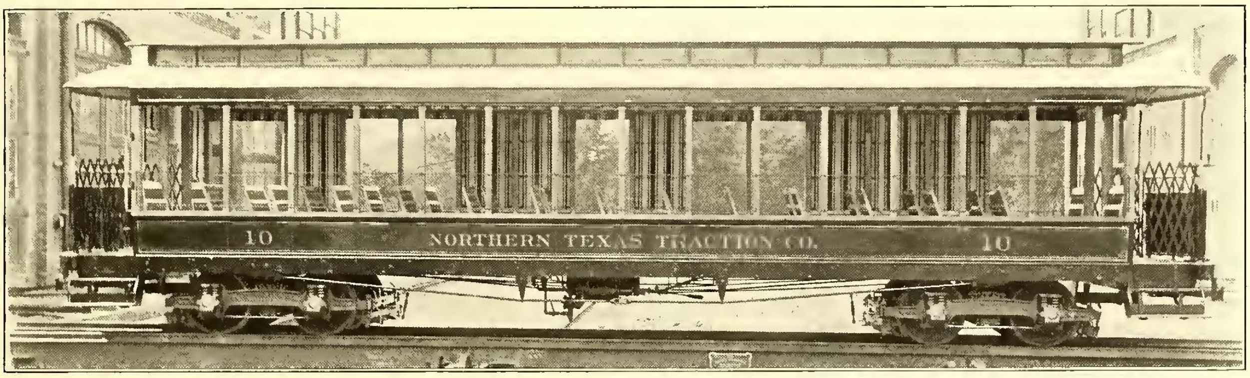
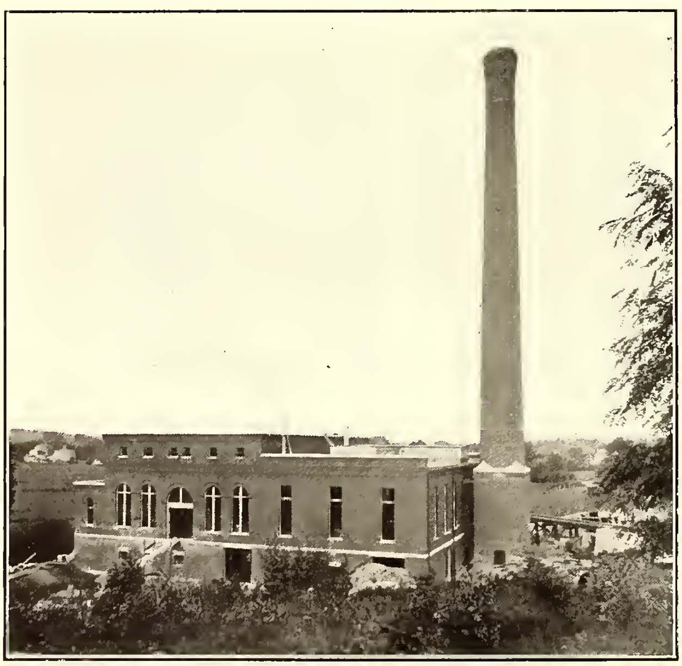


FIG. 32 —OPEN CAR FOR NORTHERN TEXAS TRACTION COMPANY

THE BOSTON & WORCESTER STREET RAILWAY

MASSACHUSETTS has been the home of the electric railway from the early days of its inception. Pioneer work of the most advanced and daring character, which has since contributed largely to the standards of practice in other States, was done in the "Old Bay State" in the strenuous years of costly experiment which laid the foundations of the mighty street railway industry of to-day. Few, if any, States can boast more splendidly equipped and finely operated local systems than the world-famous "West End," of Boston, now the "Boston Elevated," or the "Worcester Consolidated," with its far radiating branches into the country round about the "Heart of the Commonwealth." Added to these the lines of the Massachusetts Electric Companies, the Boston and Suburban Street Railway Company and those of Springfield, on the west center, gridiron the eastern and central portions of Massachusetts with a network of tracks, which goes far toward completing the total of 2309 miles of track owned at the beginning of 1902, constituting a remarkably well-served territory as regards local traffic. Up to the present time the development of the Massachusetts electric railways has been chiefly from city to town, and from town to town. The strictly high-speed interurban railway has obtained its growth chiefly in the middle or eastern portions of the West, notably in Ohio, Indiana, Illinois and Michigan. Gradually the North Atlantic States are coming to realize the need of more rapid transit between urban centers of population, and particularly is this true in Massachusetts, where the entire eastern half of the State pours an enormous daily traffic into Boston, which is constantly becoming more visibly influential in the remotest corners of the State, and still further securing its strategic position as the financial, commercial and transportation headquarters of New England.



POWER STATION AT SOUTH FRAMINGHAM

About 40 miles west of Boston, by air line, lies the city of Worcester, with a population in 1900 of nearly 120,000, noted as a manufacturing, educational and railroad center, and, strictly speaking, just without the true suburban limit. For about five years it has been possible to travel from Worcester to Boston by trolley cars, over a somewhat circuitous route about 50 miles long, the time required being in the vicinity of five hours. Some six changes of cars were required, but the fare of 55 cents against $1, as charged by the Boston & Albany Railroad, the steam line serving the two cities, frequently offset in the minds of pleasure-seekers the run of a single hour on the steam road, and created a perceptible traffic in the excursion line over the route, which offered a pleasant ride through some of the most beautiful suburbs of Boston, via either Chestnut Hill reservoir or Newton, through Auburndale, Wellesley, Natick, South Framingham, Framingham Center, Marlboro and Shrewsbury to Worcester.

BRIDGE AT NEWTON

The need of a direct line between the two cities had long been felt, however, so that in 1901 the Boston & Worcester Street Railway Company was incorporated, its object being to build and operate a high-speed through electric line between terminii, covering the distance of 40 miles in about two hours, on a fare of 35 cents. At the same time it was proposed to provide rapid transit from the suburban towns along the line into the heart of Boston, over a reserved or private right of way in the outer districts. Construction was begun in November, 1901, and it is expected that the first portion of the line, or that between Boston and Framingham, will be in operation Nov. 1, 1902, while the line from Framingham to Worcester will be opened for traffic probably in the early part of the spring of 1903.

The Boston & Worcester Company will take a passenger at Park Street Subway Station, Boston, coming from any point on the immense surface and elevated system of the Boston Elevated Railway Company, and for 35 cents carry him 40 miles west over an air line route to Worcester, there transferring him free of extra charge to any car line of the Worcester Consolidated Street Railway Company's large system. A ride of from 50 to 60 miles for

35 cents is thus possible in the plans of the new company with its connections, a large part of which is at high speed on private right of way. The cars of the Boston & Worcester on leaving the subway at Park Street will run up the Public Garden incline, going thence to Columbus Avenue, up Massachusetts Avenue to Huntington Avenue, and thence to Brookline Village, over the tracks of the Boston Elevated Railway Company, out Boylston Street, Brookline, to the end of the present line of Chestnut Hill cars, near Holyhood Cemetery. At this point the Boston & Worcester Company's own tracks begin, and run through to Framingham, over a superb boulevard road, the tracks being laid on ties in about 1 ft. of ballast in the middle of a reserved grass plot right of way at least 50 ft. wide. The line upon leaving Brookline passes through Newton, then along the old Worcester turnpike to Wellesley Hills. At Newton Highlands connections are made for Norumbega Park and Waltham, and at Wellesley Hills for Wellesley Center and Newton Lower Falls. Crossing the Boston & Albany division of the New York Central & Hudson River Railroad at Wellesley Hills, the line passes on to Natick, with a branch projected to the center of that town, then to Framingham, with connection for South Framingham, Saxonville and Marlboro to Hudson. At Felchville cars connect for Natick Center and Wayland. From Framingham the line runs largely over a private right of way, through Southboro, Westboro, Northboro and Shrewsbury to the tracks of the Worcester Consolidated Street Railway Company, at Lake Quinsigamond, Worcester, a noted pleasure resort about two miles eastward from that city. The Worcester Consolidated then takes the cars into the center of that city, to either the City Hall or Lincoln Square, the latter being the terminus of the system. At all terminals and connecting points transfers will be exchanged. The population served by the road is very large. The Boston Elevated system now serves about 1,000,000 people, and the free transfer at Park Street Subway to the Boston & Worcester cars at once throws open the new line to this vast connecting territory. According to the census of 1900 the population along the main line route of the Boston & Worcester is, as shown in the following table:

Brookline	19,935
Newton	33,587
Wellesley	5,072
Natick	9,488
Framingham	11,302
Southboro	1,921
Westboro	5,400
Northboro	2,164
Shrewsbury	1,626
Total	90,495

On the Marlboro-Hudson branch the population of Marlboro is 13,609, and Hudson 5454, making, exclusive of Boston, with Worcester's 118,421 added, a total of 227,-979. Deducting Brookline and Newton from the suburban territory already covered in the table, and adding 800,000 for passengers for or from Boston and its suburbs in touch with the new line, a conservative estimate is 1,000,000 as the population availably contiguous to the Boston & Worcester, of which about 700,000 are situated either directly along the line or inhabit the terminal cities.

The fares to be charged from any point on the Boston Elevated system are as follows:

	Electric	Steam	
Boston to Newton	$ .10	$ .13	Via B. & A. R. R.
Boston to Wellesley	.10	.30	
Boston to Natick	.15	.40	
Boston to Framingham	.20	.55	
Boston to S. Framingham	.20	.50	
Boston to Marlboro	.20	.58	N. Y., N. H. & H.
Boston to Southboro	.25	.65	
Boston to Westboro	.25	.72	
Boston to Hudson	.30	.53	B. & M.
Boston to Northboro	.30	.85	N. Y., N. H. & H.
Boston to Shrewsbury	.30	...	No R. R.
Boston to Worcester	.35	1.00	

PRIVATE RIGHT OF WAY, 50 FT WIDE, NEAR SHREWSBURY, MASS

It is planned to terminate the route of the company's large cars at Park Square, Boston. Ten other surface electric lines are crossed in the route to Worcester.

From Brookline to Framingham the line is doubled tracked. Rails are mostly 60-ft. lengths, 75-lb. T section, American Society of Civil Engineers' standard, double-bonded, and spiked to chestnut and white oak ties, 6 ins. x 6 ins. x 7 ft., if hewn, and 6 ins. x 7 ins. x 7 ft. if sawn, and laid 2640 per mile. Supporting brackets are used on curves. Weber joints with four bolts per joint are employed, and spikes are two per tie, 5¼ ins. over all.

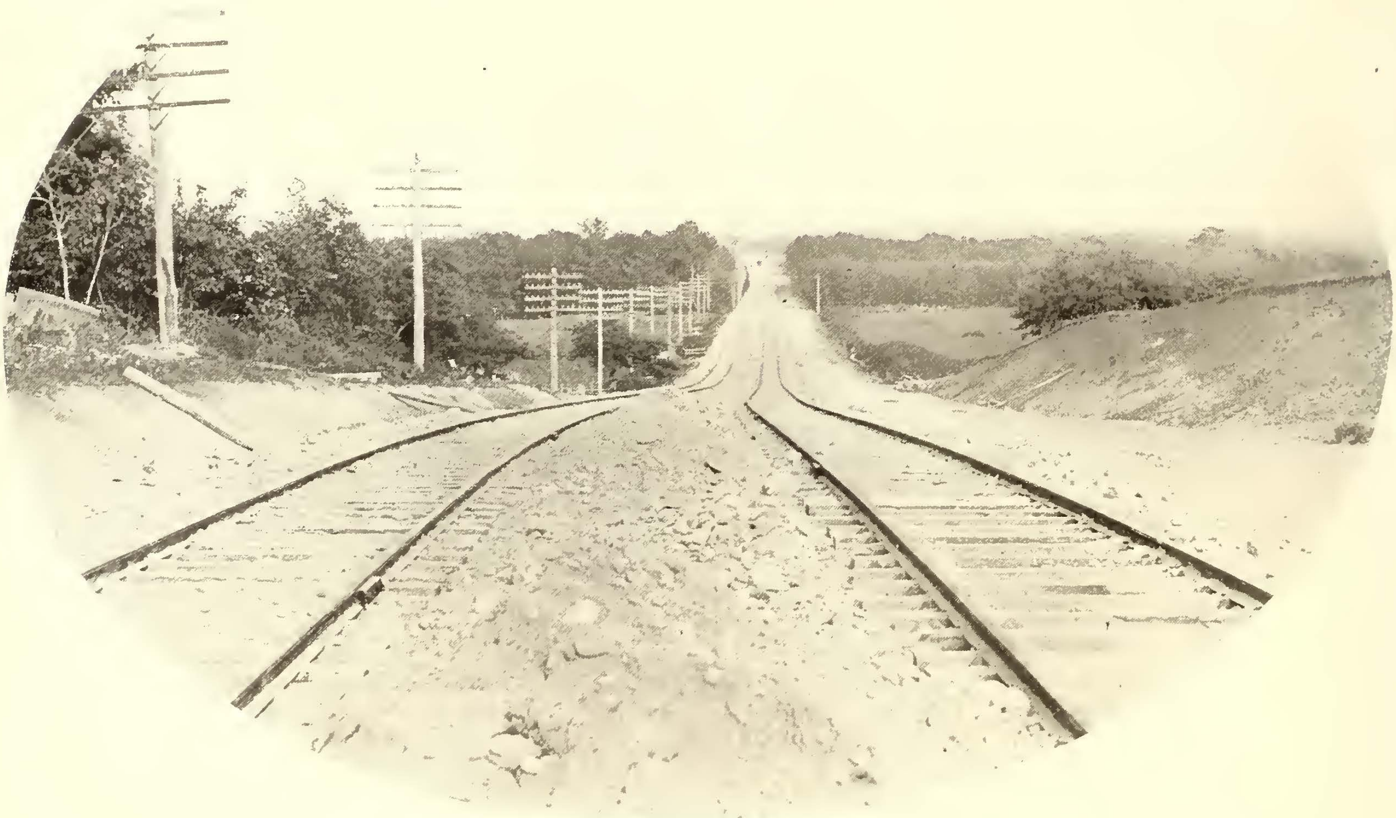
The track rails are of the Pennsylvania Steel Company's section No. 214, drilled 3 15-16 ins., and 5 ins. for 24-in. Weber joints, and with two holes 27-32 ins. in diameter, 2⅜ ins. and 6½ ins from end of each rail for bending. The bonds used are the American Steel & Wire Company's figure 8, 0000 Crown bonds, two at each joint and one on each side of the rail. These are applied by first reaming hole by tapered tool steel reamers in a Bellows Falls drilling machine, then placing terminal in hole, driving steel taper punch entirely through the terminal of the bond, then hammering the steel pin home with a machine hammer. Tracks are cross-bonded every 500 ft. with 0000 cross bonds, and are laid with broken joints, with ¼-in. clearance between the ends of the rails. The ballasting was done by using a train consisting of standard gage steam railroad dump cars, holding $7\frac{1}{4}$ cubic yards, and a standard gage railroad locomotive, excavation from pits being done by steam shovel.

Grade crossings are being abolished wherever it is possible to do so without prohibitive expense.

The trolley wire is No. 000 B. & S. Fig. 8, hard-drawn copper, with bracket suspension from center poles. No third rail will be used on the line. The trolley and feeder poles are of hard pine, and 40 ft. high, except in the Newtons, where 50-ft. poles are used. These poles are set about 6 ft. in the ground, in concrete foundations, and present a very solid appearance. The poles are about $9\frac{3}{4}$ ins. square at the top, and 15 ins. square at the top of the concrete foundations, while the butt ends are about 16 ins. square. All poles are fitted with steps, staggered on each side, so that no climbing irons will be necessary when linemen are well above ground. The brackets are of high carbon extra heavy steel tubing, and the feeder cross arms are drilled for four pins, $1\frac{1}{2}$ ins. in diameter, the hole edges covering $3\frac{3}{8}$ ins. and $19\frac{1}{8}$ ins. from the ends respectively on each side. The poles were furnished by Geo. McQuesten & Co., of Boston, and the brackets and transmission insulators by Percy Hodges, of Boston.

On the large Newton poles centers of cross arms are placed 29 ins. above the brackets, and two 30-in. braces are used. The cross arms are $3\frac{5}{8}$ ins. x $4\frac{1}{2}$ ins. x 6 ft. long. The transmission insulators are of C. S. Knowles' new pattern, type "J. G.," of emerald glass, mounted on $1\frac{1}{2}$-in. locust pins. These insulators are about $6\frac{1}{4}$ ins. in extreme diameter, and are specially designed to carry a working voltage of about 25,000, if necessary. Each insulator weighs $2\frac{3}{4}$ lbs., and is guaranteed to operate satisfactorily at considerably over the line voltage.

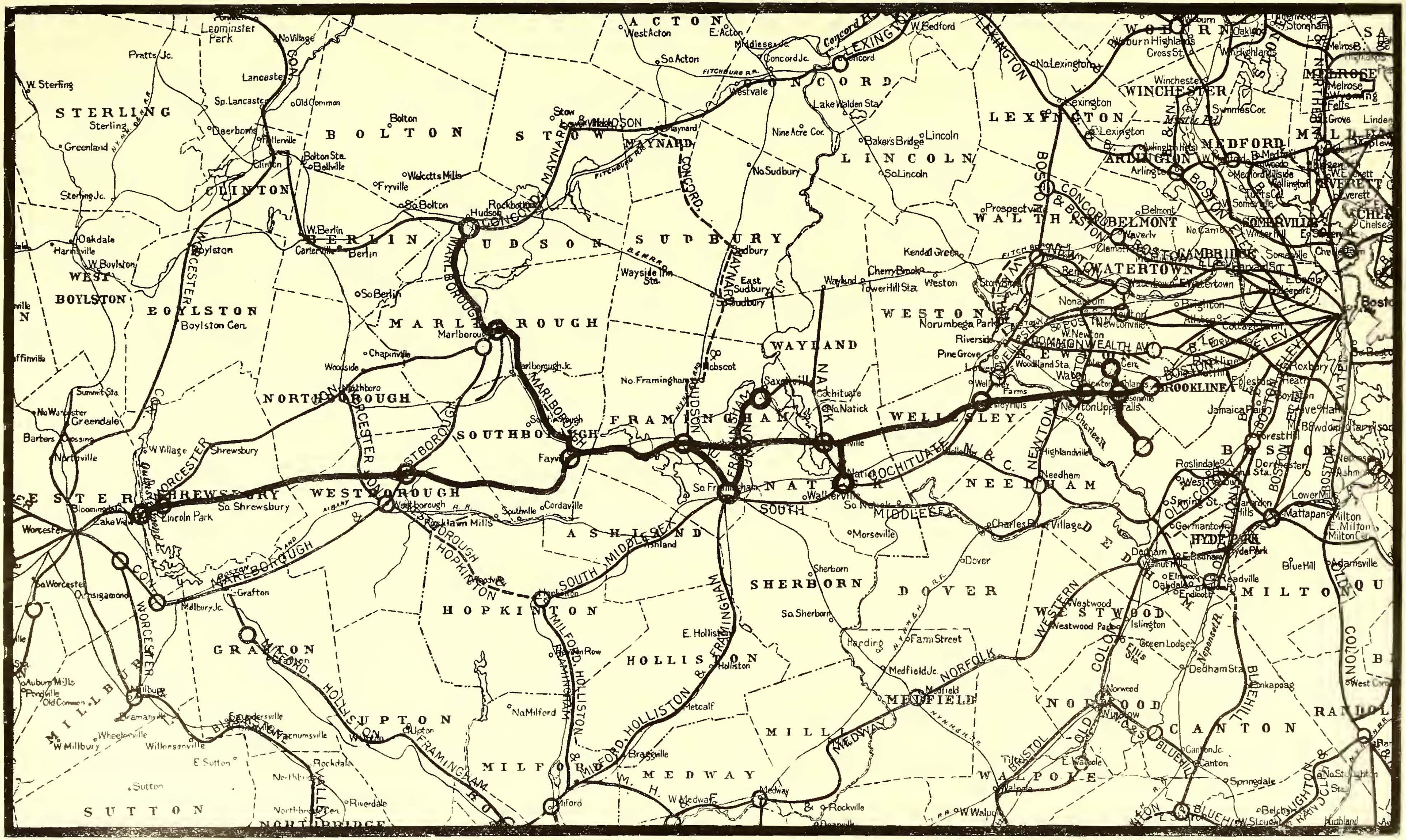
The power supply of the road is to be derived from a large power station, located in Framingham, which has sufficient extending capacity ultimately to provide all the power required by all the cars operating between Boston and Worcester. It is probable that several other lines than those directly related to the Boston & Worcester will be thus supplied with power in the near future. Sub-stations are located at Westboro, Marlboro and Wellesley Hills.



FRAMINGHAM BOULEVARD, LOOKING TOWARD BOSTON, WITH 20-FT. CARRIAGE WAY AT ONE SIDE

Current is generated in the Framingham power station at 13,200 volts, and transmitted as follows: One 3-phase circuit of No. 2 copper, 11.63 miles to Westboro, sub-station No. 1; one 3-phase circuit of No. 2 copper, 8.23 miles, to Marlboro, sub-station No. 3; one 3-phase circuit of No. 000, 9.96 miles, to Wellesley Hills, sub-station No. 2. It is also probable that the Waltham Street Railway, and possibly some of the lines of the Boston & Suburban Street Railway Company will be supplied with power generated at Framingham, so that a single 3-phase line of No. 2 copper, 7.53 miles long, will be run from the Wellesley Hills sub-station to sub-station No. 4, so-called, at Waltham.

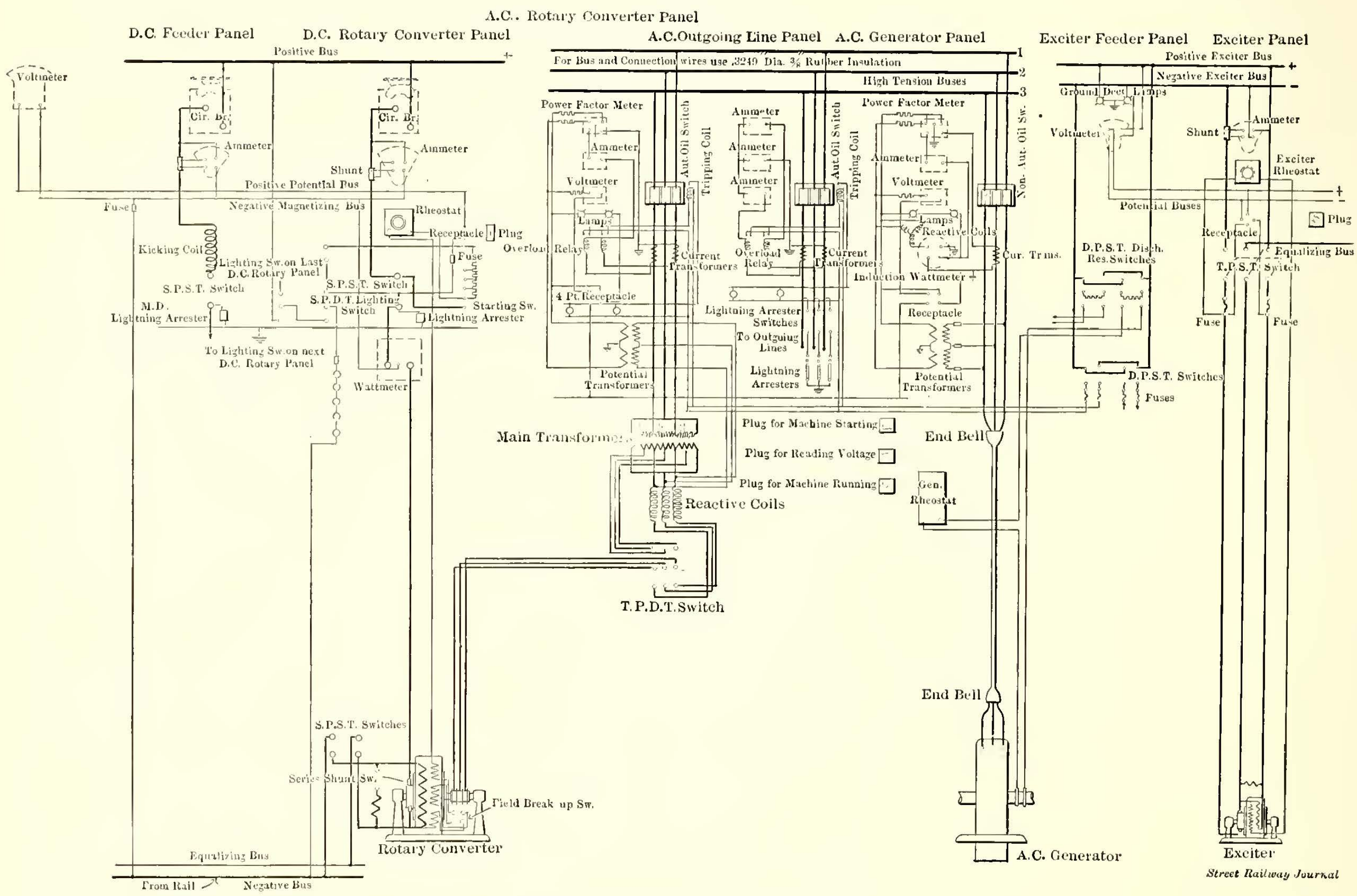
The low potential distribution is entirely made up of



MAP SHOWING ROUTE OF BOSTON & WORCESTER RAILWAY

No. 0000 B. & S. copper cable. From the power station in Framingham to the Westboro sub-station runs a feeder 11.63 miles long, supplemented near Westboro by 4 miles of No. 0000 in parallel with it. There is also a line 8.53 miles long from the Framingham power house to the Marlboro sub-station, with an additional 4 miles of No. 0000 feeder extending to Hudson.

From Westboro sub-station to Lake Quinsigamond, Worcester, runs a similar feeder, 5.81 miles long, and this is supplemented by 3.5 miles of No. 0000 feeder running west from Northboro in parallel with the first. From Framingham to Natick runs 2.5 miles of feeder, with another line, 9.96 miles long, to the Wellesley Hills sub-station. A feeder, 7.53 miles long, runs from the latter sub-station to the Waltham sub-station, which is operated by the Waltham street railway system. East of Wellesley Hills a feeder, 4.55 miles long, runs from the sub-station toward Brookline.



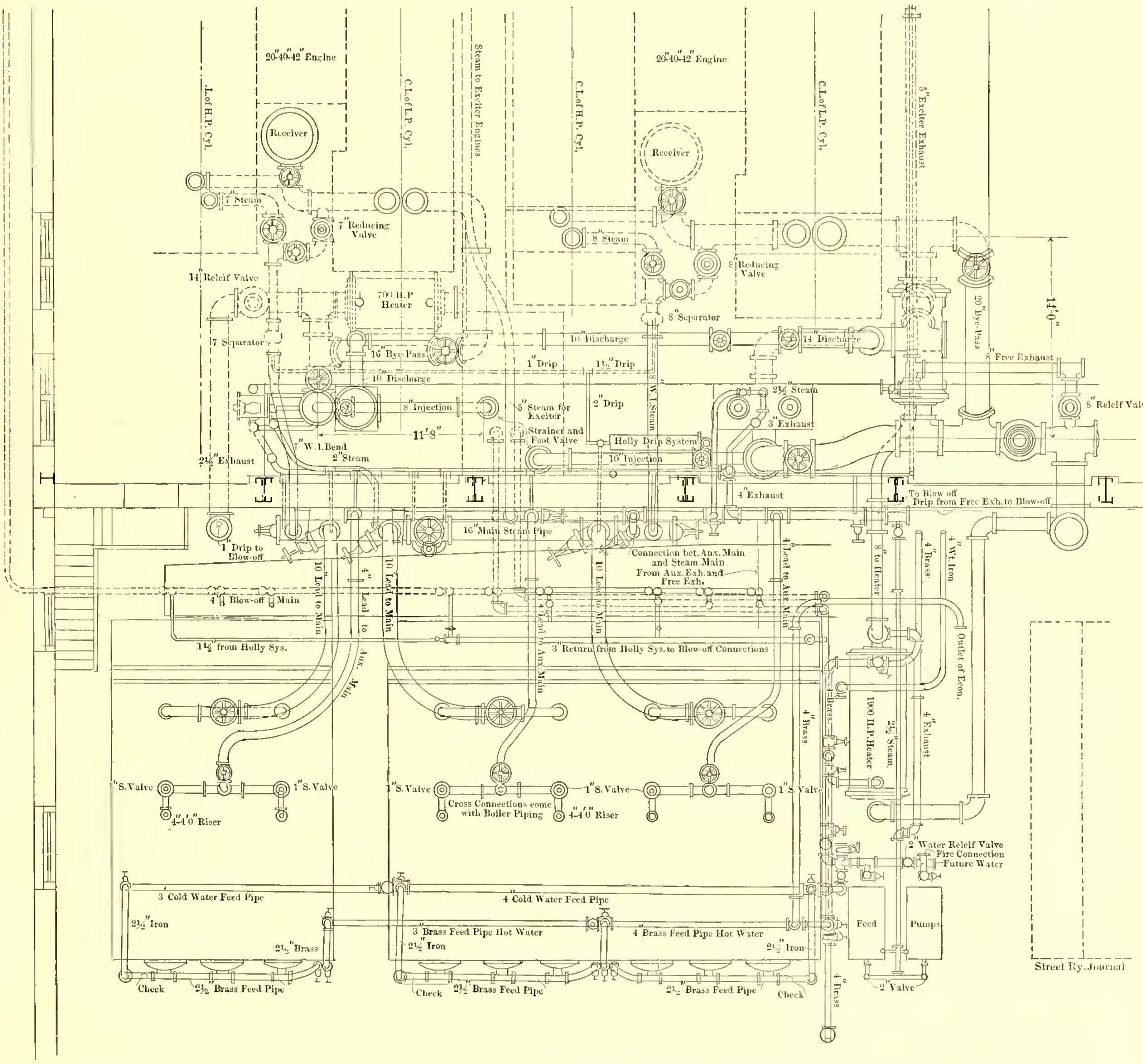
SYSTEM OF POWER DISTRIBUTION

The Framingham power station is located on the banks of the Sudbury River, where a sufficient supply of good water for feeding boilers and condensers is available, and an auxiliary supply will also be obtained from the town water service mains. The location of the station is nearly central with the line of the railway between Boston and Worcester. The plant is connected with the New York, New Haven & Hartford Railroad by a spur track leading into the property, which will enable quick and easy deliveries of coal to a bin situated directly behind the boiler room, and arranged to feed, by gravity, directly in front of the boiler room doors. The bin capacity will probably be about 1000 tons. The power station stack is of brick, and is 185 ft. high, with a core of 8 ft. in diameter through its entire height.

The station building is a handsome structure of red brick with granite trimmings, measuring 122 ft. 8 ins. long, by 106 ft. 0 ins. wide, and divided by one main wall into an engine room and basement and a boiler room. The former is a high, well-lighted and ventilated room with a basement, which is in reality the first story, being on the level of the yard outside. The distance from floor to floor is 12 ft., and in this basement are located the heaters, condensers and all large piping connecting the engines with the boiler room piping, as well as the air chambers under the transformers, the toilets, men's room, etc. In this connection it might be mentioned that no piping will be seen in the engine room above its floor line. Stairs provided with "Universal" tread connect the basement with the engine room floor, and an open well in the rear of the engines gives a view of the air pumps and condensers. Heaters were furnished by the Whitlock Coil & Pipe Company, of New Haven, Conn., and condensers by the International Steam Pump Company. Extra heavy piping is employed throughout, and no duplicate piping was installed.

In the boiler room the main features are its excellent ventilation and lighting and general accessibility. The boilers are of the horizontal style, furnished through Thayer & Co., Boston, and made by Aultman & Taylor Company. These will be 500 hp, in one battery, and 1000 hp in the second, with space for 1000 hp additional as soon as the requirements of the service demand it. Hand firing is to be employed. A Green economizer is installed, and the usual complement of pumps and heaters is to be found here. The Green economizer is situated between the present boilers and the space for the future installation, and the main smoke flues from the boilers are arranged to pass the hot gases through the economizer by a system of dampers, or by a separate by-pass into the chimney. The stack is capped with a sectional cast-iron covering and provided with a ladder and lightning rods. The section of the first 35 ft. is square capped, with a granite belt, and for the remaining 155 ft. it is round, tapering with graceful lines to a slightly spreading top. Solid red brick were used in the

no engine fly-wheel is required, the revolving field being made of sufficient diameter and weight to give all the fly-wheel effect required. In other words the generator is built on the fly-wheel instead of beside it. This does away with one hub and set of spokes, and makes a simpler, neater looking unit. The fly-wheel effect of the revolving field is 81,700 lbs., at a radius of 5.42 ft. The other unit is a similar Rice-Sargent engine, cylinders 20 ins. x 40 ins x 42 ins., rated from 800 hp to 1500 hp, according to cut-off, and operating at 107 r. p. m., direct-con-



GENERAL PLAN OF PIPING IN POWER STATION OF BOSTON & WORCESTER RAILWAY AT SOUTH FRAMINGHAM

walls, and the outer wall is separated from the inner core by an air space for its entire height. The coal bunkers are at the base of the stack.

The main generating units in the engine room at present are two in number. One of these is a Rice-Sargent horizontal cross-compound condensing engine, cylinders 24 ins. x 48 ins. x 48 ins., rated from 1500 hp to 2500 hp, according to cut-off, operating at 150 lbs. steam pressure, and direct-connected to a General Electric 1000-kw 28-pole "A T B" 3-phase 12,200-volt alternator, of the fly-wheel type, revolving at 107 r. p. m. With this type of generator

nected to a General Electric "A T B" 28-pole, 500-kw, 13,200-volt, revolving field alternator, with a fly-wheel effect of 50,000 lbs at 4.4 ft. radius. The regulation of these engines will be by a high-speed governor in connection with an approved form of Corliss valve gearing. The governors will be capable of controlling the speed so that at full load it will not vary from that at no load by more than 1 per cent, and the instantaneous variation of speed, under any conditions of loading will not exceed 3 per cent, the instantaneous variation in this case meaning the maximum departure of the speed of the engines from the speed at which they were operating when the load was changed. The governor will be adjustable while running, so that the speed of a generator without load may be made to correspond to that of the other, carrying a full or partial load, so that one or the other may be paralleled and thrown out of service at will. Ample space is provided for the installation of a larger engine in the future. In the engine room are also two steam-driven exciter sets, each consisting of a General Electric M. P., 6-pole, 35-kw, 305 r. p. m., 125-volt direct-current generator, direct-connected to a General Electric single-cylinder marine-type engine. There is also a motor-driven exciter of General Electric work, consisting of a 4-pole, 50-kw, 750 r. p. m., 125-volt direct-current generator, direct-connected to and mounted on a common base, with a 4-pole, 75-hp, 750 r. p. m., 350-volt form "K" induction motor.

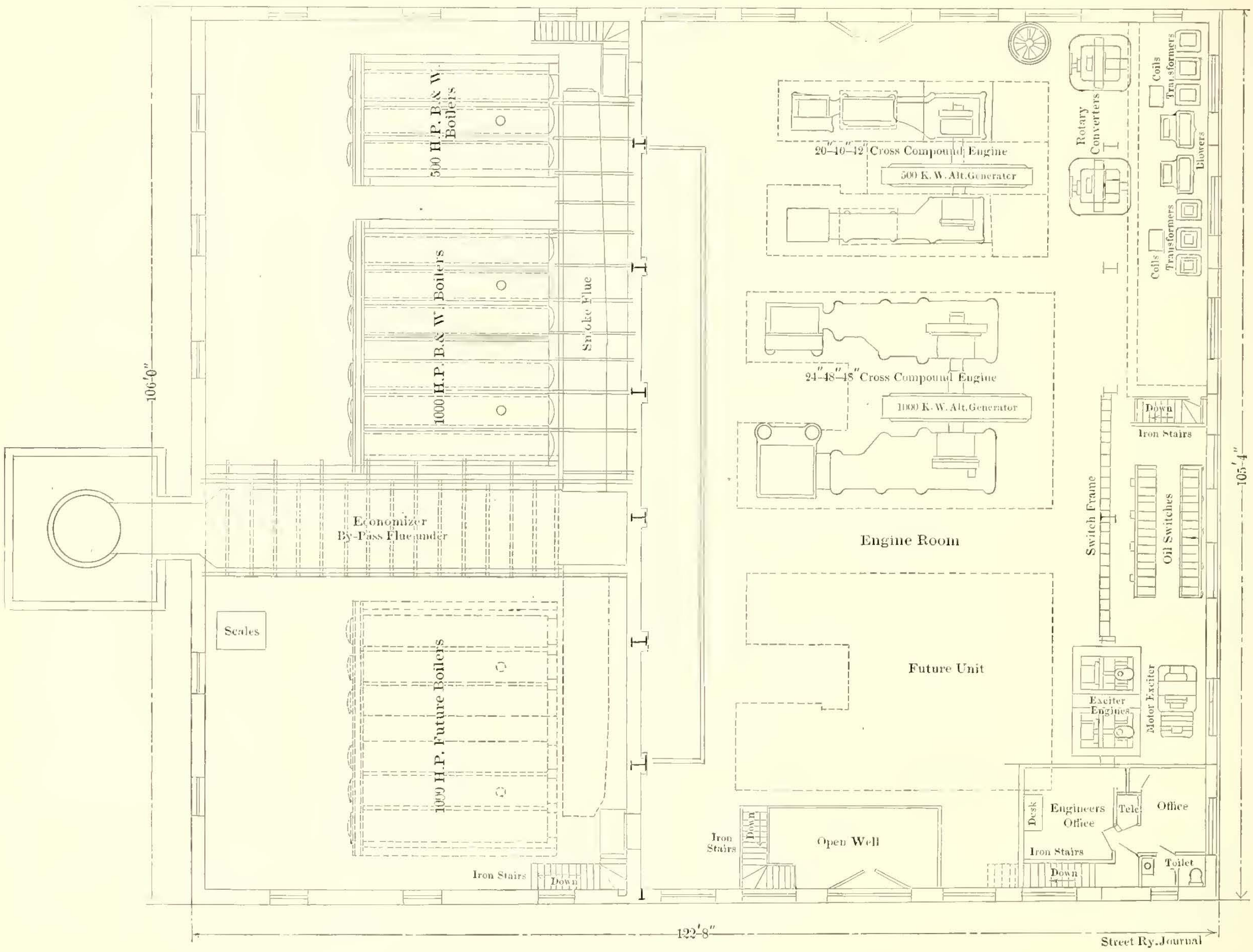
A traveling crane of 25 tons rated capacity sweeps the entire engine room floor, resting on a steel track, supported directly upon steel columns, which pass vertically to the basement floor level. This crane was furnished by the Whiting Foundry & Machine Company, of Harvey, Ill. It was necessary to excavate to a depth of 12 ft. below the basement floor level in order to provide suitable foundations for the building and its heavy machinery. The foundations were all built of Portland cement concrete.

The frame of the building is especially heavy in steel, all roof trusses and the frame of the engine room floor being of steel construction. About 150 tons were used in this work, furnished by the American Bridge Company. Brick arches with 4 ins. of concrete covered with 1 in. of Portland cement, make up the construction of the floor. The first 6 ft. of the engine room walls are of white enamelled brick, with dado above, and the remaining wall is to be treated with cold water paint.

The chief engineer's offices are located at one end of the room, and so arranged that visitors to the station will enter only through a door leading into the basement and by a staircase leading into these offices.

The entire system of steam and water piping has been developed with the greatest care for the service required in the operation of the station. Extra heavy valves and fittings are used where live steam is carried. The Holly system of gravity drip is used to return all drip water to the boilers. The feed water can be sent through or around each of the economizers or direct from the pumps to the boilers. The exhaust from the engines is arranged with a by-pass around the main heaters, so that they can be immediately removed, if required, without shutting down any part of the main operating system. Deane and Knowles condensers of ample capacity take their injection water from the Sudbury River, by means of a well connected with the latter by a canal, provided with a screen and gate at its mouth.

The steam mains are 16 ins. in diameter, and are located at the rear of the boilers, and rest upon heavy adjustable roller brackets, about 3 ft. above the floor, making the large valves especially accessible. A 6-in. auxiliary main over this one supplies steam for all pumps, etc. All leads



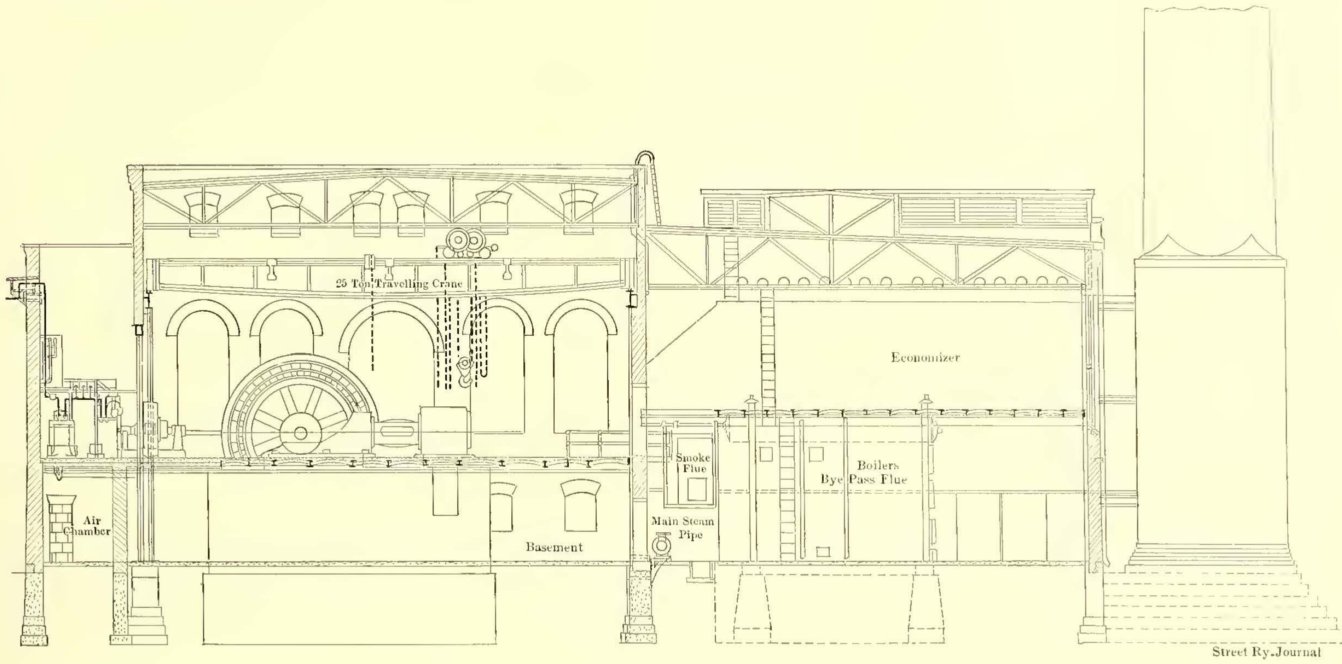
PLAN OF POWER STATION

from the boilers are of mild steel, carefully jointed with long-turn bends wherever possible. All gate valves are the Chapman Valve Manufacturing Company's make, and globe valves are of Cody make. Cochrane separators are placed in the lead pipes to each engine. The station is provided with an ample oiling and compressed air system, with fire hose. The contractors for the building were J. W. Bishop & Co., of Worcester. The power plant and sub-stations, with car houses, were designed and built under the superintendence of Engineer E. H. Kitfield, of 53 State Street, Boston, O. O. Rice representing him on the construction work.

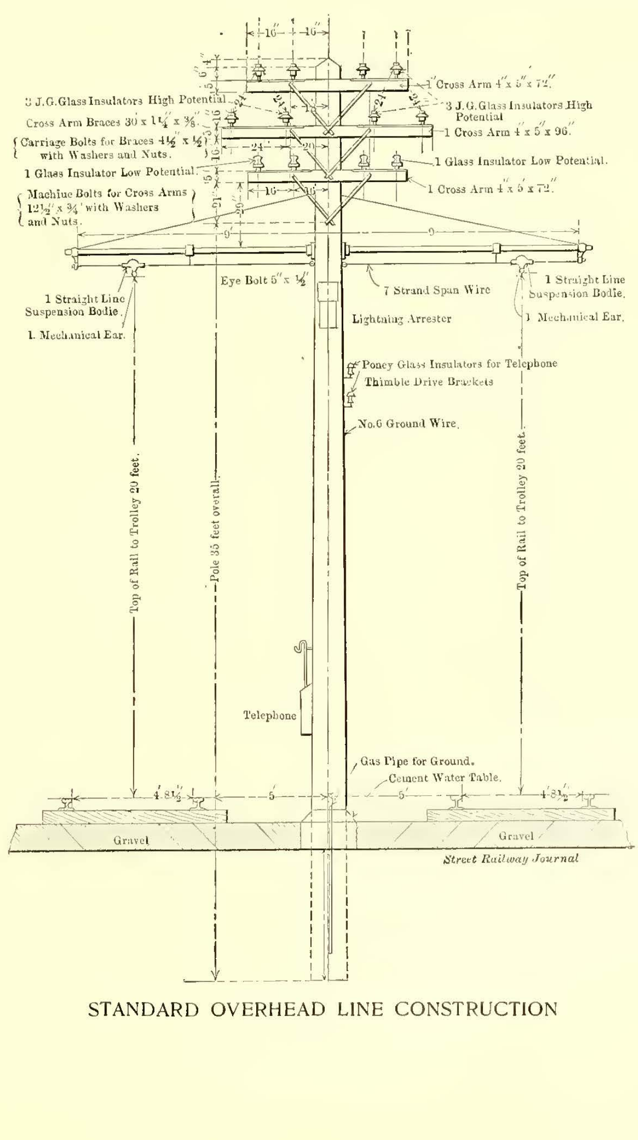
Current in the power station is reduced from 13,200 volts to 370 volts for local railway direct-current distribution, at 600 volts, through 25-cycle rotary converters. This is done by six 100-kw air-cooled step-down General Electric transformers. There are two 37.5-kw air-cooled reactive coils in connection with these, and two blower sets, each consisting of a 50-in. fan, direct-connected to an M. P. 4-pole, 1-kw, 400 r. p. m., 600-volt direct-current motor, with automatic release starting rheostat, main motor switch and magnetic cut out. There is also a single 75-kw, 3-phase oil-cooled step-down transformer in the station, for the supply of the induction motor driving the exciter. Two 3-phase, 6-pole, 250-kw, 500 r. p. m., 600-volt, 25-cycle rotary converters transform the alternating current at 370 volts to direct-current, and feed it to the trolley through the switchboard, the direct-current to alternating current ratio being 1.62.

The switchboard is of General Electric make, and contains nineteen panels, viz.: One 500-kw, 13,200-volt generator panel, one 1000-kw generator panel, two 35-kw 125-volt exciter panels, one 50-kw exciter panel, one 125-kw exciter feeder panel, one 75-kw, 3-phase induction motor panel, three 13,200-volt outgoing line panels, two 250-kw alternating current rotary converter panels, two 250-kw direct-current rotary converter 600-volt panels, two 1200-amp. form "A" feeder panels, two 600-volt direct-current blower motor panels. There are nine 13,200-volt lightning arresters, and nine Q. B. lightning arrester switches connected in the transmission lines as they begin in the station.

Each of the outgoing transmission lines is equipped with a motor-driven "Form H" oil switch, of the type used in the large Manhattan and other stations in New York City, in order to make it possible to break a line-short circuit without failure, even if the capacity of the station increases



CROSS SECTION OF POWER STATION



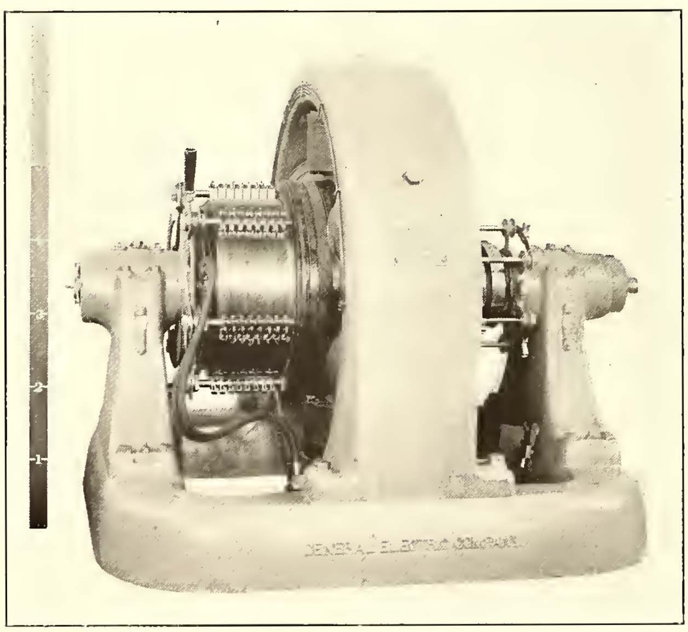
STANDARD OVERHEAD LINE CONSTRUCTION

several hundred per cent. The other switches are of a smaller breaking capacity and hand operated. All but the generator switches are fitted with instantaneous overload relays, making the switches serve as automatic circuit breakers, doing away with the use of fuses in the high-tension circuits.

The cables running from the switchboard are easily accessible, and the part of the building over the switchboard and its connections is in the form of a tower, into the top of which all feeder cables, etc., are brought and anchored to a cage before connecting with the main switchboard.

The power station is one of the largest planned in New England.

Combined car houses and sub-stations are being built at Westboro, Wellesley Hills and Waltham, and in addition the present street railway power station in Marlboro will be converted into a sub-station. These buildings are substantially built of red brick with steel trusses, furnished by Milliken Bros., of New York, and composition roofs. Ample pits for the cleaning, inspection and minor repairs of trucks and motors are provided, with wash basins for cleaning crews, repair shops, offices for superintendent, assistants, conductors and motormen's room, stock and boiler room. The buildings will be heated direct by steam.

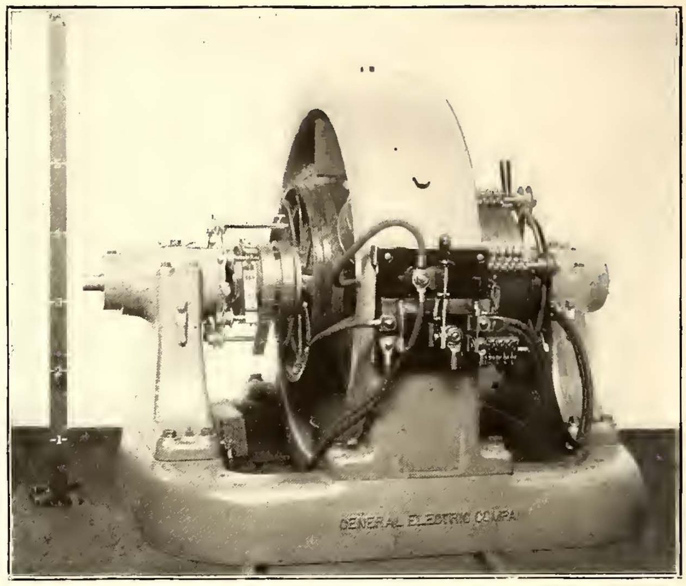


400-KW ROTARY CONVERTER

The Westboro car house has five tracks and two pits, about 128 ft. long each, with two smaller pits, 37 ft. long each. The generating, or rather the rotary room, of this sub-station is 27 ft. x 56 ft. The sand pit is about 22 ft. long.

The electrical equipment of the Westboro and Marlboro sub-stations is the same in each case. After the high potential current of the transmission line has been brought into the sub-station building, it is reduced to 370 volts by six air-cooled General Electric 25-cycle, 100-kw step-down transformers, supplied with two 37.5-kw air-cooled reactive coils. There are two blower sets, each composed of a 50-in. fan, direct-connected to a General Electric M. P. 4-pole, 1-kw, 400 r. p. m., 600-volt motor, operated off the direct-current bus-bars of the sub-station, with automatic release-starting rheostat. Each sub-station has two General Electric 250-kw rotary converters, 6 poles, revolving at a speed of 500 r. p. m., and giving direct-current at 600 volts, to be fed to the trolley lines, as in the Framingham station.

The sub-station switchboards are composed in these two cases of eight panels each. There are two 1200-amp. form "A" General Eletric feeder panels, two 600-volt direct-



400-KW ROTARY CONVERTER, SHOWING FRAME SWITCH

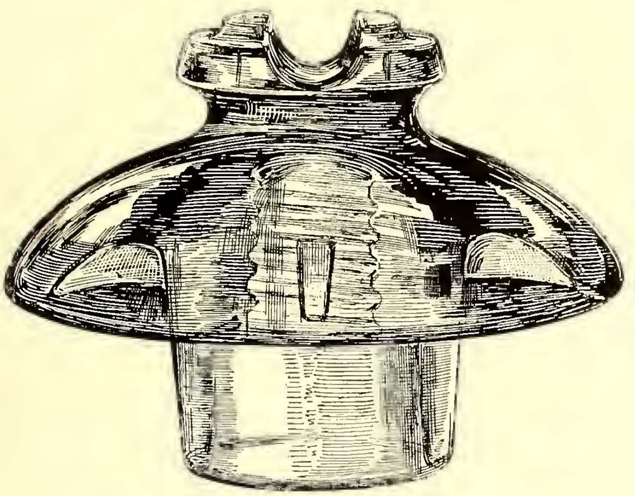
connected blower motor panels, two 300-kw alternating current rotary panels, and two 300-kw, 600-volt direct-current rotary panels. Great care was taken in all switchboards to separate sufficiently bus-bars or wires at different potentials. The material of the switchboards is black enamelled slate.

Each converter is also equipped with a triple pole, double-throw alternating current starting switch, connected in the low-tension circuits between transformers and converter, and so connected as to switch the converter onto taps in the transformer windings, by means of which the converter can be started by alternating currents at low voltage.

In the Wellesley Hill sub-station are located six 25-cycle General Electric 145-kw air-cooled step-down transformers, supplying 3-phase alternating current at 370 volts to two General Electric 400-kw, 600-volt rotary converters, speed 500 r. p. m. There are two 60-kw air-cooled reactive coils, and the blower sets are two in number, composed of Buffalo fans, driven by form K, 350-volt induction motors. The Wellesley Hills switchboard has ten panels in all, made up of two 400-kw alternating current rotary panels, two 400-kw direct-connected rotary panels, two alternating current rotary starting panels, two 1200-amp. form "A" feeder panels, and two 350-volt alternating current blower motor panels. The usual complement of lightning arresters and switches is provided.

All panels are 16 ins. wide and 7 ft. 6 ins. high. The board in the Framingham station is 26 ft. 8 ins. long. Panels are of the standard thickness of 2 ins.

The rolling stock will be composed of fifty cars, supplied by the Newburyport Car Company, of Newburyport, Mass. All closed cars will be vestibuled, and the larger cars are 42 ft. 6 ins. over all. All cars are double-trucked and equipped with General Electric "57" motors, rated at 50 hp on the one-hour basis of 75 degs. C. rise above the surrounding air. Each motor weighs 2972 lbs., its end armature bearing commutator is $6\frac{3}{8}$ ins. x $2\frac{7}{8}$ ins., pinion end $8\frac{3}{4}$ ins. x $3\frac{1}{4}$ ins., and its armature is 14 ins. in diameter. The armature cores have thirty-three slots, there are three coils per slot, and the commutator segments are $10\frac{1}{4}$ ins. in diameter, with a wearing depth of 1 in. The wheel diameter is 33 ins., bringing the clearance of $3\frac{1}{2}$ ins. between bottom of motor frame and top of rail. There are two brushes per holder, $2\frac{1}{4}$ ins. x $1\frac{3}{4}$ ins. x $\frac{5}{8}$ ins. All cars have single trolley, and open cars have special rattan seats, supplied by the Haywood Bros. & Wakefield Company. Peckham trucks, of the type No. 14 B3, extra strong, are used, with axles $4\frac{1}{2}$ ins. in diameter. General Electric ordinary series parallel hand control is used, as it is not planned to couple up cars in trains under the multiple unit



HIGH TENSION FEEDER INSULATOR

system. The seating capacity of the larger cars is seventy-five people, and the smaller cars seat sixty. These latter cars are 36 ft. over all. The cars will be equipped with Christensen air brakes.

Telephone lines will be run along the road, and some form of automatic signal will be used to prevent accidents. The double tracking of the line to Framingham will undoubtedly be as convenient in operation as is the working of similar lines, such as that between Albany, N. Y., and Schenectady, which is well known as a short high-speed line of the same class.

The beginning of operation of the Boston & Worcester road is awaited with much interest in eastern Massachusetts. Up to the present time the Boston & Albany Railroad has supplied the only real rapid transit between the two cities. A few words about this road in its relations to the suburban territory and traffic near Boston may be of interest in connection with the prospective opening of its electric competitor. It is, of course, in the passenger business that the steam road's receipts will be cut into. It is generally accepted that there has been no reduction in the steam road's fares since the middle of the last century. Last year the average passenger fare per mile on the Boston & Albany, including commutation tickets, was 1.74 cents, and the freight rate per ton mile averaged .83 cents. The gross earnings per passenger train mile were $1,569. Operating expenses were 66 per cent of gross receipts. Maintenance expenses per total train mile were: Roadbed, $.099; renewing rails, $.005; bridges, $.009; locomotives, $.078; passenger cars, $.085; freight cars, $.110; wages, $.304; fuel, $.128; total, $0.818. The cost of repairs per locomotive for the year was $2,182.12; per passenger car, $711.93, and per freight car, $62.73. The analysis of the annual reports of the Boston & Worcester will doubtless present many interesting features by way of comparison with the Boston & Albany methods of operation.

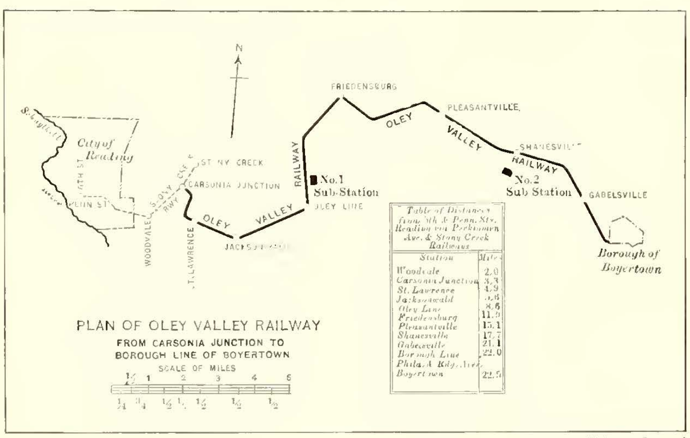
While it is true that extremely low commutation rates are in force on the Boston & Albany between Worcester and Boston, the daily fare being 19.7 cents each way for the 44 miles, it is also true that there are to be about twice as many runs daily on the electric road between the two cities as on the steam road, with the added pleasure of riding through country uninhabited by cinders, smoke and soft coal dust. Then again, the average time of steam trains between the two cities is not far from 1 hour 24 minutes, although several fast expresses make the distance easily in 55 minutes. It is probable that nearly all the pleasure traffic will be captured by the electric road unless a radical change in the Boston & Albany policy is made, until the limits of the Newton circuit loop line is reached. The circuit line of the Boston & Albany from the South Station to Riverside and return, via main line and Brookline, or vice versa, offers a most attractive field for electric equipment, and it is impossible to state how large a proportion of the present traffic will be diverted, but it is safe to assume that beyond Newton Upper Falls the electric competition will be severely felt. On the main line of the Boston & Albany, up to about 5 miles out, the electrics of the Boston Elevated have a large share of the suburban business, and the Boston & Worcester lies a little too far south of the main line to be felt seriously on this side of the circuit, but on part of the Brookline side of the circuit, and westward of Wellesley Hills on the main line, the influence of the Boston & Worcester line will be carefully studied by close observers of transportation methods and analysis in eastern Massachusetts.

The operation of the new line will be in charge of Superintendent A. C. Ralph, who is at present connected with the Shaw interests in Marlboro, and the electrical engineer will be M. V. Ayres, formerly with the General Electric Company in Schenectady. The construction of the entire line has been carried forward under the immediate supervision of James F. Shaw & Co., of Boston, who are also similarly interested in the building of lines between Boston and Providence, Worcester and Hartford, etc. The board of directors of the Boston & Worcester is composed of the following gentlemen, well known in New England street railway circles: William M. Butler, Boston, president; George A. Butman, treasurer and clerk; Charles C. Peirce, of Brookline; J. J. Whipple, Boston; H. Fisher Eldredge, Portsmouth, N. H.; P. W. Sprague, Boston; Albion R. Clapp, Wellesley; A. B. Bruce, Lawrence; W. H. Trumbull, Salem; A. E. Childs, Boston; F. C. Hinds, Boston; C. H. Shippen, Milford. Thanks are due especially to Messrs. James F. Shaw, Charles C. Peirce, B. D. Sumner and E. H. Kitfield for much of the information presented in this article. The street railway map of Massachusetts is undergoing constant changes in these times of combination of interests, and the changes of the future in the western suburban territory outside of Boston are likely to be profoundly influenced by that potent trunk line in the electric rapid transit system—the Boston & Worcester Street Railway.

THE OLEY VALLEY RAILWAY

THE Oley Valley Railway, which was lately completed and put in operation, connects the city of Reading with Boyertown, and is one of the most interesting interurban lines in Pennsylvania. The fact that it will form part of the electric system that is intended ultimately to connect Reading with Philadelphia lends importance to this undertaking at once. Another feature is the character of the construction and equipment, provision having been made for handling heavy cars or trains at high speeds over a road that is a succession of curves and grades. The transmission system is also interesting.

HORSE-SHOE CURVE AT SHANESVILLE



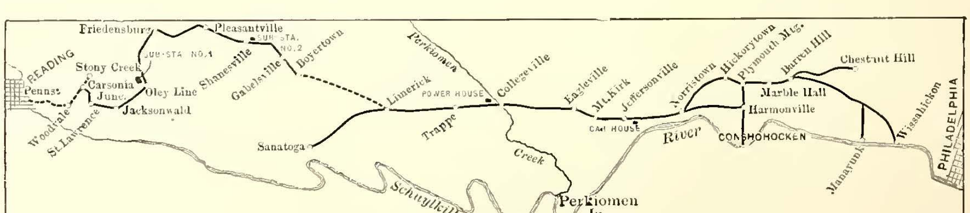
Street Railway Journal

MAP OF OLEY VALLEY LINE ENTERING READING

At the present time there are only two short gaps which have to be completed before it is possible to make the entire trip by trolley along the route indicated in the accompanying map of the proposed line between Reading and Philadelphia. One of these breaks is a short section of about three city blocks, between the present terminus of the Oley Valley line, at the border of Boyertown, and the local trolley system, over the lines of which it is proposed to pass through the town. The company has already taken steps to make this connection but has been delayed in its work by the opposition of rival interests. There still remains to be constructed a 7-mile link between Boyertown and Limerick, indicated by dotted lines on the map. When this has been finished it will join the Oley Valley and the Trappe & Limerick lines into one system, thus making a complete trolley line between Reading and Philadelphia.

The Oley Valley road passes through a mountainous country, but it is built for high speeds and is intended to carry the heaviest class of traffic. At present it is a single-track line following the winding course of the valley as closely as possible to avoid encountering any steeper grades than are absolutely necessary. There are nine side turnouts on the line, which have been located so as to enable the operation of cars at high speeds and without serious delay. At the Reading end of the line, the first six sidings encountered are $1\frac{1}{2}$ miles apart; the other three are located 3 miles apart.

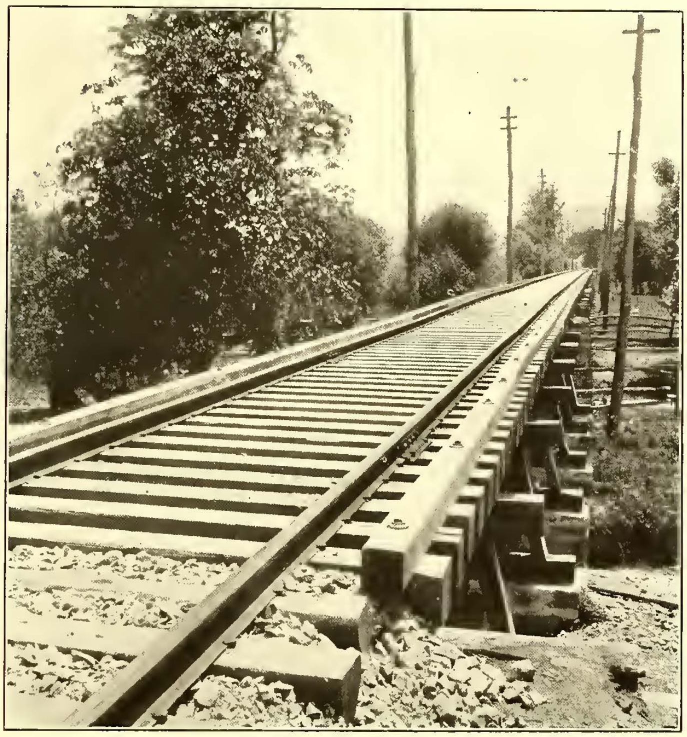
The Oley Valley line proper begins at Carsonia Park, a pleasure resort about $3\frac{3}{4}$ miles from the center of the city of Reading, but the Oley Valley cars run into town over the lines of the United Traction Company. The new road passes through a section of country that has heretofore been entirely neglected by the electric and steam railway companies, although it is one of the richest and most beautiful parts of Berks County, and has a very prosperous class of farmers and several good-sized towns. The route is traced on the map. It traverses Exeter, Earl, Oley and Coldbrookdale Townships, and touches St. Lawrence, Jacksonwald, Oley Line, Friedensburg, Pleasantville,



Street Railway Journal

MAP OF TROLLEY ROUTE BETWEEN READING AND PHILADELPHIA, INCLUDING OLEY VALLEY LINE

Shanesville, Gabelsville, Morysville, Boyertown and many smaller places. Friedensburg, which is about half-way between Carsonia Park and Boyertown, is a thriving village of 1500 inhabitants, while Boyertown, which is a station on the Philadelphia & Reading road, has 1800 population. Since the opening of the trolley line commercial travelers visiting this district generally leave the steam trains at Boyertown and take the electric cars for Reading, stopping at the villages on the way. The farming territory along the line contains about 4500 inhabitants, and a great deal of local traffic has been developed among this class. The trolley line enjoys the exclusive patronage of this district, and is utilized not only for passenger service but also for carrying mail. Provision has been made for baggage service, one car having already been fitted with a baggage compartment, and it is quite probable that freight and express will eventually be added. There is also a large excursion traffic, and as Carsonia Park is located on this line, the Oley Valley cars are utilized for handling the throngs that flock to this beautiful recreation ground. This traffic contributes largely to the support of this system, and as there are numerous other points along the line, which are very popular with the people of Reading and vicinity, the company secures considerable income from this class of business. Many visitors to these parts make



TRACK CONSTRUCTION AND BRIDGE WORK

a special trip over this road to get a view of the majestic mountains between which it passes. Entering Reading over this road one involuntarily recalls Bayard Taylor's beautiful word picture of this scene in "John Godfrey's Fortunes." On the right is Mount Penn; to the left Neversink Mountain. The glorious landscape, the stately old town stretched at full length on an incline plane, rising from the Schuylkill to the base of the mountain; the river, winding in abrupt curves; hills of superb undulations in interlinking lines, through the middle distance; Scull's Hill boldly detaching itself in front, and far to the north the Blue Ridge lifting its dim wall against the sky are all there to-day as they were in the 50's, to delight the eye and command the admiration of every lover of nature. It is not to be wondered, therefore, that this beautiful spot attracted thousands of visitors since the opening of the trolley line, which has made it readily accessible.

As already explained, the cars of this system enter the city of Reading over the lines of the United Traction Com-

ROADBED AND OVERHEAD CONSTRUCTION

pany. The starting point in Reading is at the corner of Fifth Street and Penn Street, which is the center of the business district. The line extends in a generally eastern direction through the city and suburbs to Carsonia Park, which is 3¾ miles from the starting point. Here the line of the Oley Valley Railway Company actually begins, extending 18¾ miles in a circuitous route through a very hilly country, encountering a number of sharp curves and heavy grades. One of these curves, which is of especial interest, is illustrated herewith. The cut shows a horseshoe-curve near Shanesville and a general view of the locality. It will give some idea of the difficulties which the company encountered in building this line. There is another curve a few miles from this point, which is almost an exact duplicate of the one here illustrated. The nine sidings, each 300 ft. long, are also block signal stations, equipped with the Ramsey signal system. The cars run on a regular schedule, which provides for eighteen trips each way every day at this season, beginning at 4:40 a. m., and continuing until 11:20 p. m. On special occasions, including general holidays and whenever there are any unusual attractions at Carsonia Park or other points along the line, the schedule is abandoned and the cars depend entirely on the block signal service. On Labor Day every available car was pressed into service, and the round trip of 45 miles was made in 2 hours and 10 minutes, including all stops.

There are 13.88 miles of straight track in this line and 4.87 miles of curves. There are only 550 ft. of level track throughout the entire system. The heaviest ascending grades going east are near Shanesville summit, 5.8 per cent for a distance of 1000 ft., and 4.8 per cent for a distance of 2600 ft. The total rise of the ascending grades for the entire line is 754 ft., covering a length of 7.75 miles, or an average ascending grade of 1.85 per cent. The heaviest descending grade going east is, leaving the Shanesville summit, a rate of 4.7 per cent for a distance of 2600 ft. The total fall of the descending grades for the entire line is 780 ft., covering a length of 10.9 miles or an average descending grade of 1.35 per cent. The grade of the line is undulating, owing to the nature of the country traversed; hence, there is a multiplication of rises and falls more than the difference in elevations of the highest and lowest points shows. Shanesville summit, 4 miles west of Boyertown, is 380 ft. above both the Boyertown and Carsonia Park ends of the line by actual elevation. A turnout is located at this point, and a short stop is usually made there to afford passengers an opportunity to enjoy a splendid view of the surrounding country.

The roadbed construction naturally involved numerous cuts and a great deal of bridge work. The cuts are at least 15 ft. wide, with ditches along the side of the track to keep the water from the ends of the ties. The embankments are wide enough to support the ballast under the ties and leave room on either side for working about the car, should any repairs be required for the machinery. A minimum width of 13 ft. is maintained upon all embankments. The

TRESTLEWORK NEAR READING

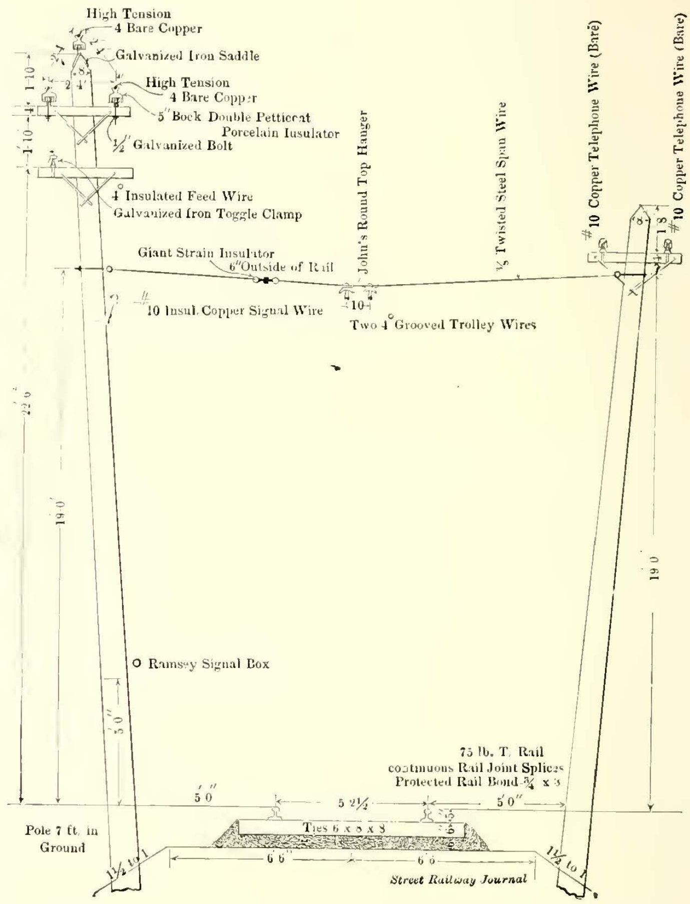
slopes of both cuts and embankments are flat enough to resist the action of the rain which washes down the mountain sides in torrents at certain seasons of the year.

There are twenty-three iron bridges on the line, twenty-two wooden bridges and three trestle works. All the bridges over 15 ft. long are of eye-beam construction with angle braces. The total length of the iron bridges is 660 ft., the longest being 45 ft. and the shortest 18 ft. The total length of the wooden bridges is 397 ft.; the longest of these is 98 ft., and is made up of eight spans, and the shortest is 10 ft. The principal trestle is 924 ft. long. This is the first one crossed after leaving Reading, and the general character of the construction may be judged from this example, which is illustrated in the accompanying cuts. The next one is 385 ft., and the third 188 ft. In all this work provision was made not alone for the weight to be carried over the bridges and trestles, but precautions were taken as well against the action of frost and the undermining caused by the severe storms which visit this locality. To reduce to a minimum the danger from roving cattle all private right of way through pasture grounds is fenced in, and cattle guards are placed at all crossings.

In building up the roadbed broken stone ballast, of a uniform depth of 6 ins., was placed under the ties to permit of sub-drainage and tamping the ties to a firm and elastic bearing. The ties were placed 2 ft. apart between centers. They have a top and bottom face of 8 ins., a depth of 6 ins., and they are 8 ft. long. They are of sound oak timber throughout. The space between ties was filled with broken stone, and also between the main track and sidings on the turnouts.

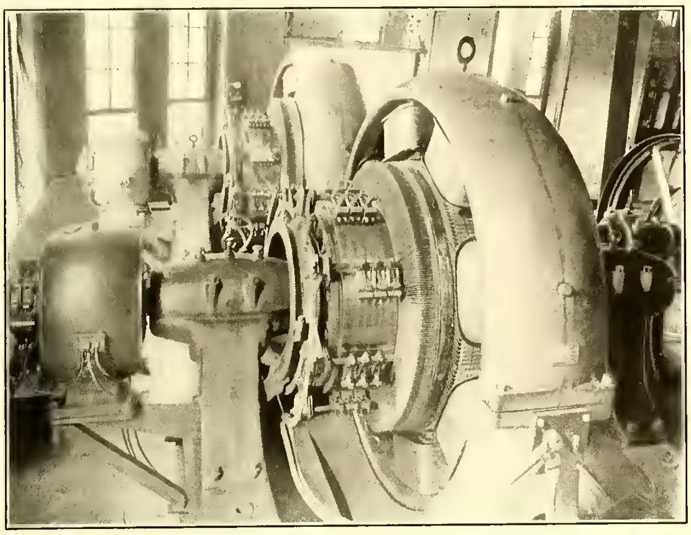
The track consists of 75-lb. T-rails, with open switches and spring frogs, continuous rail joints, and Protected rail-bonds. The rails are laid with suspended broken joints to prevent the double hammer on the joint ties from even or opposite joints, and the resulting slight downward bend to the end of each rail that eventually causes rough riding.

A cross section of the track and line construction is presented, showing complete details. There are also excellent views of a stretch of roadbed through the country, track



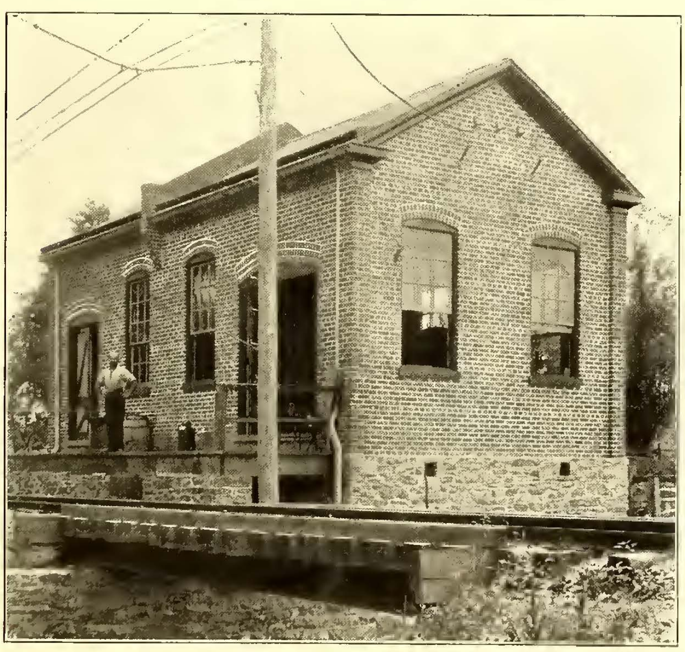
CROSS-SECTION OF TRACK AND OVERHEAD CONSTRUCTION

construction over a bridge, and overhead work. Two 0000 trolley wires are suspended by a ⅜-in. twisted steel span wire 19 ft. above the track level. The poles supporting the span wires carry the three-wire high-tension transmission lines in trianglar construction, as well as the direct-current feeder on one side of the track, and the telephone wires on the other. Poles are set 7 ft. in the ground; those carrying the transmission line being 33 ft. 6 ins., and the others 28 ft. 6 ins. above the top of the rail. They are 8 ins. in diameter at the top. There are two 4-in. cross-arms on the transmission poles, the lower one carrying a 0000 insulated feed wire. The upper arm, which is 22 ins. above the lower one, carries two of the high-tension wires, and the third wire of the alternating current system is on the top of the pole. Five-inch double petticoat porcelain insulators are used. Those on the cross-arms are set on wooden pins, through which a ½-in. galvanized bolt passes, extending down through the cross-arm, and being secured by a nut and washer on the lower end below the cross-arm. A similar insulator is placed on the top of the pole, but it is secured to a galvanized iron saddle, which sets on the top of the pole. The two insulators on the upper cross-bar, and the insulator on the top of the pole carry No. 4 bare copper wire for the high-tension current. Each of these insulators is located so that the wire it carries is 28 ins. away from the nearest high-tension conductor. The cross-arms are 3 ft. 4 ins. long, 4 ins. wide, and are placed 1 ft. 10 ins. apart. The upper cross-arm is 1 ft. 10 ins. from the top of the pole.



TWO 400-KW INVERTED ROTARIES AT READING POWER STATION

There is also a bracket carrying a No. 10 signal wire, for the block system, beneath the span wire. The signal boxes are placed on the pole at each turnout, 5 ft. above the track level, within easy reach of the train man. The telephone wires, which are carried on the opposite pole line,



SUB-STATION NO. 1 AT OLEY LINE

consist of No. 10 bare copper wire, and the construction follows the standard methods. Each car is fitted with a complete telephone set, thus enabling the crew to report promptly to headquarters any serious breakdown or the failure of any part of the system.

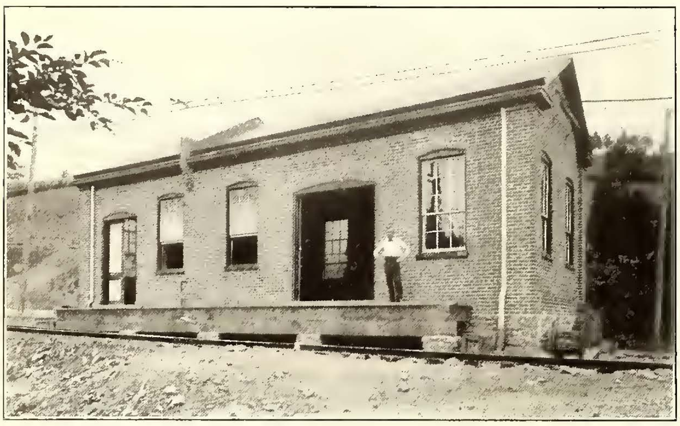
Giant strain insulators are used on the span wires. They are located 6 ins. outside of the rail, between the trolley hangers and the transmission line. The requirements of this service led to the development of a special mechanical clip and soldered ear, to carry the grooved trolley wire. The clip is about 15 ins. long, with a smooth finished channel, on each side of which is a downwardly projecting lip, having on the inside a small rib, which fits into the groove of the trolley wire. The latter is sprung into the channel and the sides of the clip are then crimped together, so that the ribs on the inside are closely fitted into the groove of the trolley wire. This would generally be considered sufficient to hold the wire, but in order to make the arrangement doubly secure, the clamped wire is soldered throughout the entire length of the clip. On the upper side of the clip, on each side of the centrally supporting hub, is a hole which communicates with the channel around the trolley wire. Solder is poured into each of these holes, thus entirely filling the interstices between the wire and the clip. When in place, the exterior of the clip conforms almost to

STATIC TRANSFORMERS IN SUB-STATIONS

the circumference of the wire, thus giving practically an even surface, with no appreciable obstruction to the movement of the trolley wheel. This device is used in conjunction with round top insulators of extremely heavy construction. The surface of the insulation inside of the round top bell, between the edges of the latter and the supporting stud, instead of being smooth, is provided with an ample petticoat molded in the insulation and about 1 in. in height from the base of the petticoat on the main surface of the insulating material to the tip. This provides almost 2 ins. of additional surface between the metal of the bell hanger and the central stud, and retains all the other advantages of a petticoat in such devices. This hanger weighs almost twice as much as one of ordinary construction. The stud projecting from the insulator into the clip hub is $\frac{3}{4}$ in. in diameter.

In feeding into the line a 00 copper insulated cable is substituted in place of the ordinary $\frac{3}{8}$-in. twisted steel span wire, insulating the ends with the same giant strain insulators just outside the eye bolts, and making a non-insulated soldered connection with the trolley wires. A short feed tap, of the same wire, is made between this wire and the feeder, just beyond the first insulator, near the pole. This construction protects the tap from being torn off by the trolley pole should the wheel jump at this point, as sometimes happens in high-speed roads. There are no switches at the turnouts, the wire on the turnout side being deflected and following the turnout. To every tenth span there is a feed span and tap, and at every twentieth span there is a lightning arrester. At about every half mile strains are run off from the trolley wires in both directions, extending to the pole at the next span, above its span wire, and from this to the next pole to which it is attached at about 8 ft. from the ground.

The spans on straight lines are 100 ft. apart, this distance being reduced on curves according to their sharpness or length of radii. The shortest span is 40 ft., on a curve

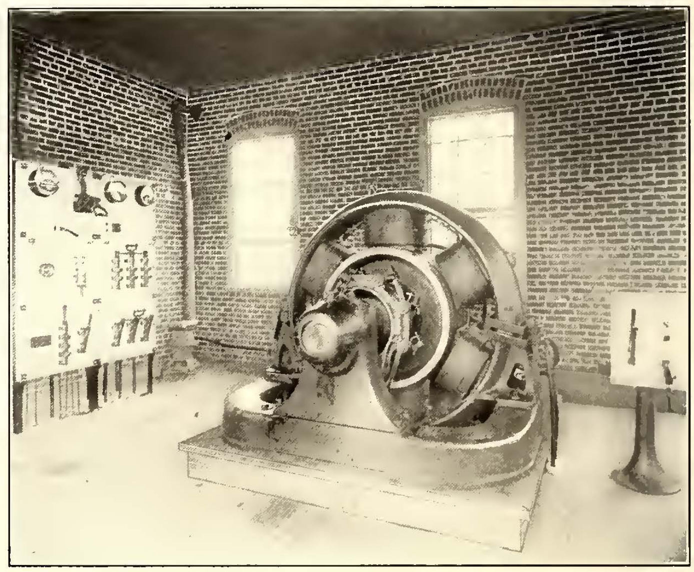


SUB-STATION NO. 2 AT SHANESVILLE

with a radius of 100 ft. In operation all turnouts are run, none skipped, and the car always keeps to the right.

Power for the operation of this line is secured from the plant of the United Traction Company, which controls all of the street railway lines of Reading and vicinity. Current is furnished by three direct-current generators, directly connected to vertical engines, two of 400-kw capacity and one of 800 kw., generating at 550 volts. The power from the direct-current switchboard is distributed through the feeders for operating the city cars, and as the Oley Valley cars operate over the regular city line for 3¾ miles, as far as Carsonia Park, this section is fed by an independent feeder of 500,000 cm, running directly from the power house and tapping in at frequent intervals. Two sub-stations have been equipped, one at Oley Line, and the other at Shanesville. Power for these sub-stations is transmitted at 16,000 volts over a high-tension line, consisting of three No. 4 hard-drawn copper wires, supported on porcelain insulators, carried on cross-arms upon the same poles as the 500-volt transmission, as already described.

From the bus-bars of the main switchboard, feeders are run to the two S. K. C. 400-kw inverted rotaries, at the city power house. On the rotary switchboard the current coming from the main switchboard passes successively through the circuit breaker and meter, starting rheostat and main switch to the commutator of the rotary. The negative current returning from the commutator passes through a negative switch mounted on a separate equalizer stand, and from there directly to the power house switchboard. By this arrangement no negative leads are on the rotary board, thus minimizing the dangers from short circuits on this board The rotary is separately excited from the small 120-volt exciter, mounted on the same shaft. The alternating current from the rotary passes through low-tension switches and instruments mounted on the low-tension board, and runs to the three 280-kw oil-filled water-cooled S. K. C. transformers, which are in a separate room. The current is here stepped up from 360 volts to 16,000 volts. In the transformer room there is also an S. K. C. lightning arrester equipment, including choke coils. The high-tension current passes to the high-tension switchboard, which is equipped with compression ball fuses and emergency switches. The current then passes

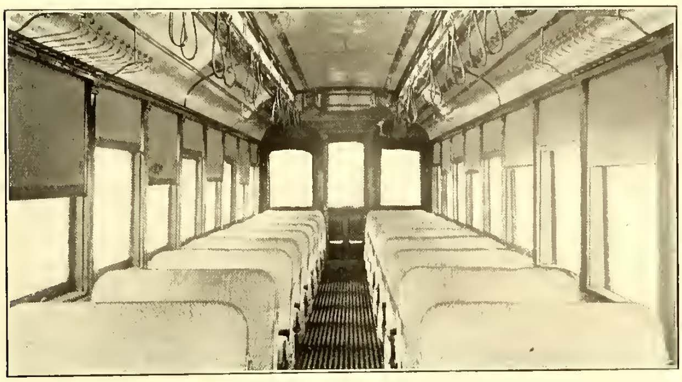


SUB-STATION ROTARY CONVERTER AND SWITCHBOARD EQUIPMENT

through 1 mile of lead-covered cable to outskirts of the town, where it terminates in a lightning arrester station, and is there connected to the three separate high-tension wires described. This lead-covered cable is said to be the highest voltage three-wire cable in the United States.

The two sub-stations are practically identical in arrangement and equipment, as shown in the illustrations. Each consists of two rooms, a transformer room and a rotary room. In the transformer room the high-tension current, having passed through the choke coils and lightning arresters, comes to the high-tension switchboard, equipped with bayonet plug switches and compression ball fuses. Thence it passes to the three 100-kw step-down transformers. In the power house the ratio of transformation is 360 to 16,000. The transformers in the sub-stations were designed for 15,000 volts on the high-tension side, stepping down to 360 volts on the other. As the drop on the line does not amount to 1000 volts, the direct current furnished by the rotaries at the sub-stations is, therefore, at a slightly higher voltage than that of the power-house bus-bars. The direct current from the low-tension side of the transformers in the sub-station passes to the low-tension switchboard equipped with instruments and switches, and then to the collector rings of the 300-kw rotary. From the positive brushes of the rotary the current goes to the direct-current feeder panel, passing through ammeter and circuit breaker, and it is then connected to the trolley line. The negative lead is connected at Oley Line, except that space has been provided for the installation of an S. K. C. frequency changer, which will enable the frequency to be changed to 60 cycles for lighting the town of Boyersville.

At the sub-stations water is circulated in the transformers by a small pump belted to the rotary, the source of water being a small stream in the vicinity. In the discharge pipes of the circulating system thermometers are placed, and the valves are so adjusted that the temperature of the water discharge is the same for all transformers. Any variation in temperature during operation indicates that the load on the transformers is unbalanced, and more water is supplied to the transformer carrying the larger load. If this does not reduce the temperature it is taken as an indication of trouble in the line. The entire power plant and transmission equipment for the Oley Valley Road was supplied by the Stanley Electric Manufacturing Company, of Pittsfield.



INTERIOR OF OLEY VALLEY CAR

Very heavy cars are operated on this line. They were built by the J. G. Brill company, of Philadelphia, and are illustrated in the accompanying cuts, which show the exterior of a combined passenger and smoking car and an interior view of the arrangement of seats, curtains, head linings and other features of interior equipment. The car bodies are 40 ft. long over the end panels and 52 ft. over all. The platforms are 5 ft. 2 ins. long, and are completely enclosed by round-end vestibules. The vestibules have folding doors, and there are double doors leading to the car body. Ratchet brake-handles, angle-iron bumpers and Brill steps are features of the equipment. The roof is of the steam-car form, with iron rafters, but is built along street-car lines of construction. The side sheath is vertical. The cars are 8 ft. 6 ins. wide, weigh 20 tons, and are mounted on No. 27 trucks with 6-ft. wheel base. The wheels weigh 425 lbs., being 33 ins. in diameter, and having $2\frac{1}{2}$-in. tread and $\frac{7}{8}$-in. flange. The gage is the Pennsylvania standard for street railways, 5 ft. $2\frac{1}{2}$ ins. There are two truss-rods with the usual needle beams. In addition to this the sides are plated with steel plates. The sash is in two parts, the top being stationary and the lower one dropping into the side of the car.

The car is divided into two compartments, one for smokers being about $11\frac{1}{2}$ ft. long. The partition between the two compartments is fitted with doors which swing into the smoking room.

The seats are of spring cane and are reversible in the passenger room, but longitudinal in the smoking room. There are parcel racks in both compartments. The interior finish of the cars is in cherry with three-ply birch veneer decorated ceilings. The windows are fitted with printed duck curtains, having pinch handle fixtures. The windows in the vestibules have drop curtains. The inside trimmings are of bronze.

In place of the regular smoking compartments fitted with longitudinal seats, the company has devoted the space at the end of one of the cars to a baggage compartment. The construction of this car is somewhat different from the ordinary cars, as the windows are eliminated. There is a side door for loading trunks and packages on each side of the baggage compartment.

HEAVY INTERURBAN CAR FOR OLEY VALLEY LINE

Two rubber-cushioned trolley boards are placed on each car, each set to one side of the center line. Each car is equipped with four G. E.-57 motors geared for a maximum speed of 55 miles an hour, the schedule speed being 20 miles an hour. Type K controllers and Christensen air brakes are used on all the cars.

The Oley Valley Company is controlled by the same interests as the United Traction Company, which operates the city lines at Reading and the mountain railways of the vicinity. A separate organization is maintained for the Oley Valley property, however, and the officers are: President, John A. Rigg; vice-president, Henry C. Moore; secretary and treasurer, William S. Bell; general manager, F. L. Fuller; superintendent, Samuel E. Rigg.

The engineering and construction on the road were done by the company's organization under the direction of James Fagan and S. S. Hoff, of the engineering department.

THE AURORA, ELGIN & CHICAGO RAILWAY

WHILE it is not always easy for those in the midst of events to judge of their relative importance, it is probably not far from a correct estimate to say that future historians of electric railway progress will note the construction of the Aurora, Elgin & Chicago Railway as one of the important mile-posts in the history of the electric railway. Many people have asked the writer what is the notable feature of this road which is attracting so much attention to it. The answer in a nutshell is: speed. That is the one characteristic which to the lay mind distinguishes the road from dozens of other electric railways. The detailed discussion of all the elements which go to make possible in a financial and engineering way this one element of speed, forms the principal object of this article.

There are two standpoints from which to consider the work on the Aurora, Elgin & Chicago Railway, that of the electric railway financier and that of the electric railway engineer. The financier sees in it a road which is expensively, though not extravagantly, built, and which has liabilities in the shape of stocks and bonds per mile of track about double the ordinary interurban road. To show for this investment he sees a road built after the manner of the heaviest steam-trunk lines, equipped with electrical apparatus and rolling stock to carry people between Chicago and three towns 40 miles west in the Fox River Valley at a speed and with a frequency to completely eclipse any service heretofore given by the steam roads between those points. He sees further preparations to carry people to intermediate and suburban points at a speed and frequency having no previous parallel in railway history. The engineer sees a third-rail electric road with alternating-current power distribution. He sees a track, over much of which 80 miles to 100 miles an hour can be made with safety. He sees cars equipped with the multiple-unit system of control, with the heaviest motor equipment ever put under an electric car for its own propulsion alone; in fact, with all provisions made for a regular maximum speed of 65 miles per hour and an acceleration at the rate of 2 miles per hour per second to attain it, a performance never before equaled in regular electric railway practice. Certainly these are matters worthy of closer investigation by both financier and manager, for they mean much to the future of the electric railway industry.

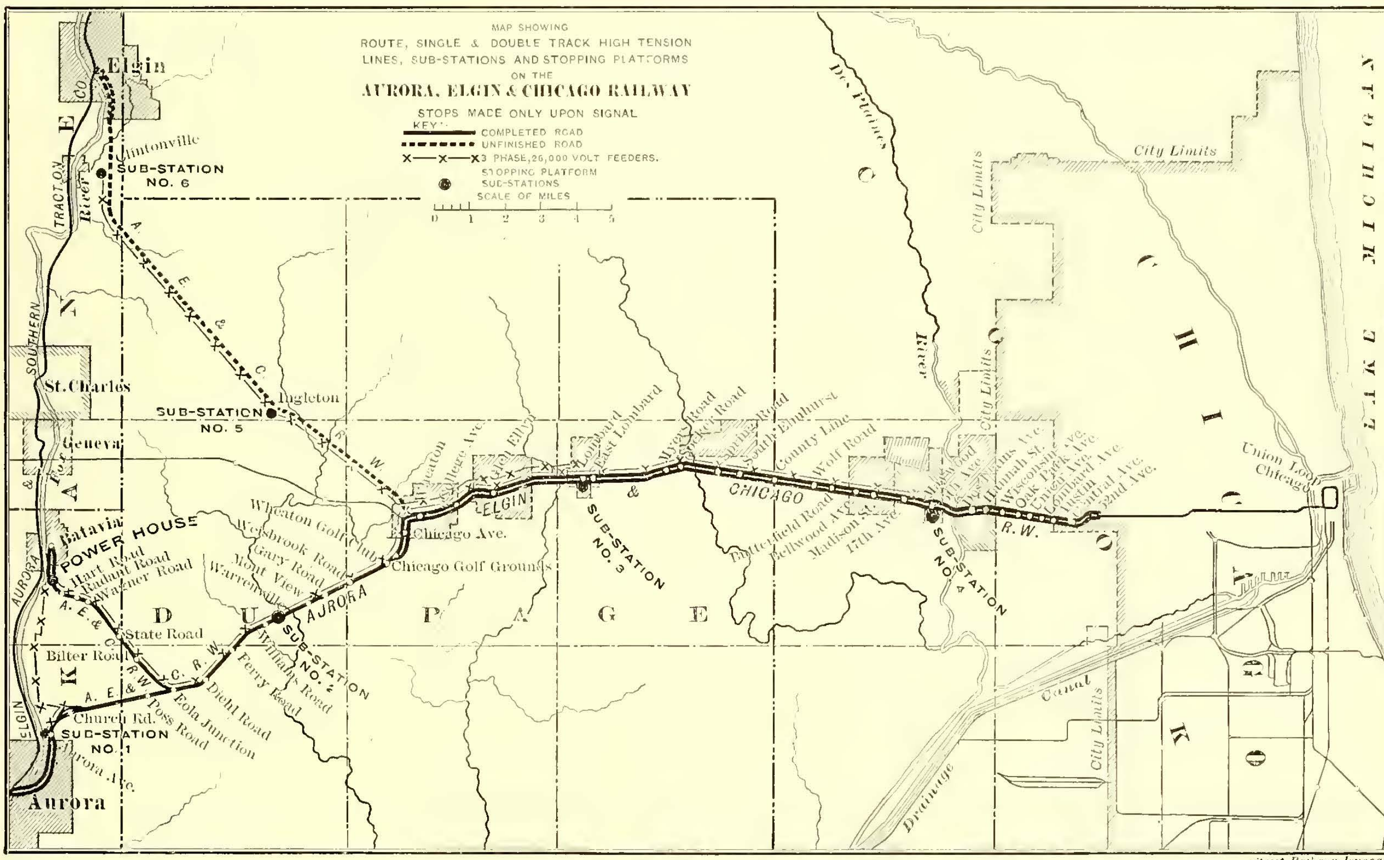
The road owes its financing and construction to a number of Cleveland gentlemen, who are by no means novices in the electric interurban railway business. L. J. Wolf, of Cleveland, is president; M. H. Wilson, vice-president; M. J. Mandelbaum, treasurer, and Warren Bicknell, of Chicago, secretary. During the construction of the road Will Christy, of Akron, Ohio, has acted as general manager, and W. E. Davis, of Cleveland, as electrical engineer. These gentlemen of the Cleveland Construction Company and their associates deserve much credit for the splendid piece of engineering afforded by the road. The other gentlemen actively connected with the construction were Charles Jones, chief engineer, who has been on the ground in charge of the construction of the road from the beginning; W. L. Morris, mechanical engineer, who designed and built the power station, and Ernest Gonzenbach, electrical engineer in active charge of electrical construction. In operation, the road is under the general supervision of Secretary Warren Bicknell, with C. E. Flenner as auditor; W. W. Crawford, superintendent of transportation; Ernest Gonzenbach, electrical and mechanical engineer in charge of power house, electric power distribution, shops and maintenance of rolling stock, and Charles Jones, engineer maintenance of way and structures.

To build the 82 miles of track which the company will have when the road is completed, a bond issue of $3,000,000 and capital stock to the amount of $4,500,000 is provided for. Of the $4,500,000 stock $1,500,000 is 6 per cent cumulative preferred. The bonds bear 5 per cent. The bond issue is therefore $36,585 per mile, and the total liabilities $91,219 per mile. As this is considerably higher than on most interurban roads up to the present time, it is natural to inquire into the conditions which have justified this expenditure in the minds of the builders of the road. That the conditions were unusual goes without saying. For a distance of 20 miles due west from the Chicago city limits is a series of suburban towns with an aggregate population according to the 1900 census of 24,065. Thirty-five miles west of Chicago is a belt of towns along the Fox River which are already interconnected by the Elgin, Aurora & Southern Traction Company lines, but which have had only infrequent steam service to Chicago. The new road, as seen by the accompanying map, touches the Fox River Valley at the three largest towns; Aurora, with a population of 21,147; Batavia, 3871, and Elgin, 22,433. The total population reached directly in the Fox River Valley by the Aurora, Elgin & Chicago Railway is 47,451, and that in the towns along the valley reached by the Elgin, Aurora & Southern Traction Company lines, which population is really tributary to the new road, is 91,224. Taking all the population in the tributary Fox River towns, together with the suburban population mentioned, gives a total of 115,289 tributary to the road, not including rural population. This is 1405 per mile of track. Now it can be seen why such an expenditure was justified. The population per mile along many good electric interurban lines running into less important centers than Chicago is frequently less than 500.

In order to make this undertaking fully successful, those responsible for it rightly figured that if the maximum possible business was to be developed fast schedules must be made. It would undoubtedly have been possible after many years of vexation to secure a franchise along the highways and to operate at the usual schedule of 15 miles to 20 miles per hour, picking up considerable local travel, as many another road has done before. But the men to whom time was valuable would have planned their trips as far as possible for the suburban steam trains, and many a person would have remained at home, where fast service at frequent intervals would have induced them to ride. It was decided, therefore, since there was population to justify it, that track and roadbed should be built on a private right of way, and of such substantial construction that over the greater portion of the route there would be nothing to hinder sustained runs at speeds as high as known to the railroad world of to-day. It was further decided to provide electrical equipment which would give the fastest schedules possible (with stops 3 miles apart on local service 40 miles per hour), 65 miles per hour maximum speed. Only the electric railway engineer familiar with schedule speeds and rates of acceleration in common use can realize what a bold step in advance of previous actual commercial practice this was. To accelerate a car from a standstill up to a rate of 50 miles per hour in 25 seconds to 30 seconds, and to sustain it at a speed of 65 miles per hour, calls for an investment in motors and power furnishing apparatus that is apt to make the engineer and manager hesitate when it comes to the actual selection of the equipment. But the step was taken, and the result is the most powerfully equipped and solidly constructed interurban electric railway in existence to-day.

The fast acceleration needed for the local service making all stops as well as the long runs at high speed practically threw out of consideration everything but the multiple-unit system. The equipment of the motor cars is four 125-hp G. E.-66 motors. The General Electric Company's type M train-control system with small master controller on each platform operating magnetic contact makers or "contactors" under each motor car was adopted. One and two-car trains will have every axle motor driven. Three-car trains will have one car without motors. The motor cars have the most powerful equipment ever put on a motor car, except on elevated roads, where the motor car acts as a locomotive to pull trailers. The type-M control permits the train or car to be operated from any car, and is practically the same as that put on the Manhattan Elevated in New York, and was described, together with the G. E.-66 motor here used, in the October (1901) STREET RAILWAY JOURNAL.

The cars upon which these motors are placed were built by the Niles Car & Manufacturing Company, and are notable for strength of sub-frame, drawings of which are shown. These cars are 47½ ft. over bumpers and 39 ft. 4 ins. over bodies. This length was selected to allow the cars to pass around the sharp curves of the Union loop in Chicago as it was the original intention to run these cars into Chicago over the tracks of the Metropolitan West Side Elevated Railway. The cars seat fifty-six people in seats disposed according to the seating plan shown. There is no waste room either on platforms or inside the car, hence the relatively high seating capacity as compared with other interurban cars of similar length. The heating is by Consolidated electric heaters placed along the side of the car. An exterior view of one of these cars is shown in the article elsewhere in this issue on "Cars for High-Speed Interurban Service." An interior view of one of these cars is given in this article and shows the location of the International register on the partition between the smoking and main compartments. The seats are rattan of the Hale & Kilburn walk-over type, 38 ins. wide. Van Dorn draw-bars are used. The trucks are Peckham's M. C. B. 30, which follows the general lines of a M. C. B. truck, but has a diamond frame and combines spiral and elliptic springs under the bolsters. In addition to the regular equalizer springs which support the frame, there are spiral springs between the frame and each journal box, which take a small part of the weight and are intended to prevent the tilting of the frame. Nichols-Lintern compressed air track sanders are mounted on the truck frames so that they will sand the track both on curves and straight line. The Christensen straight air brakes with independent motor-driven compressor and automatic motor regulator are employed. The automatic motor regulator is controlled by electric contacts on the air-pressure gage.

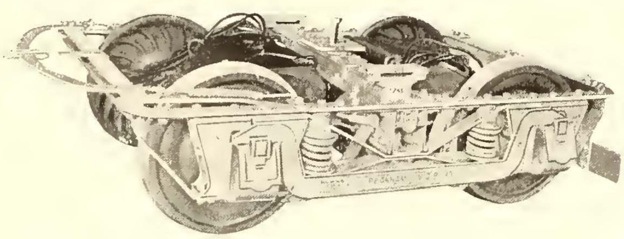


MAP SHOWING ROUTE OF AURORA, ELGIN & CHICAGO RAILWAY

The car wheels are 36 ins. in diameter, and have the standard M. C. B. tread and flange. The axles are 6½ ins. in diameter, the largest yet used under an electric motor car.

The weight of these cars is 74,325 lbs. The motors alone weigh 17,120 lbs. The gear ratio is 1.61 to 1, and the large size of the pinions and car axles and smallness of the gear wheels gives a most peculiar "fat" appearance to the equipment when apart.

Although no extensive tests have been made on the performance of the regular car equipment in service because

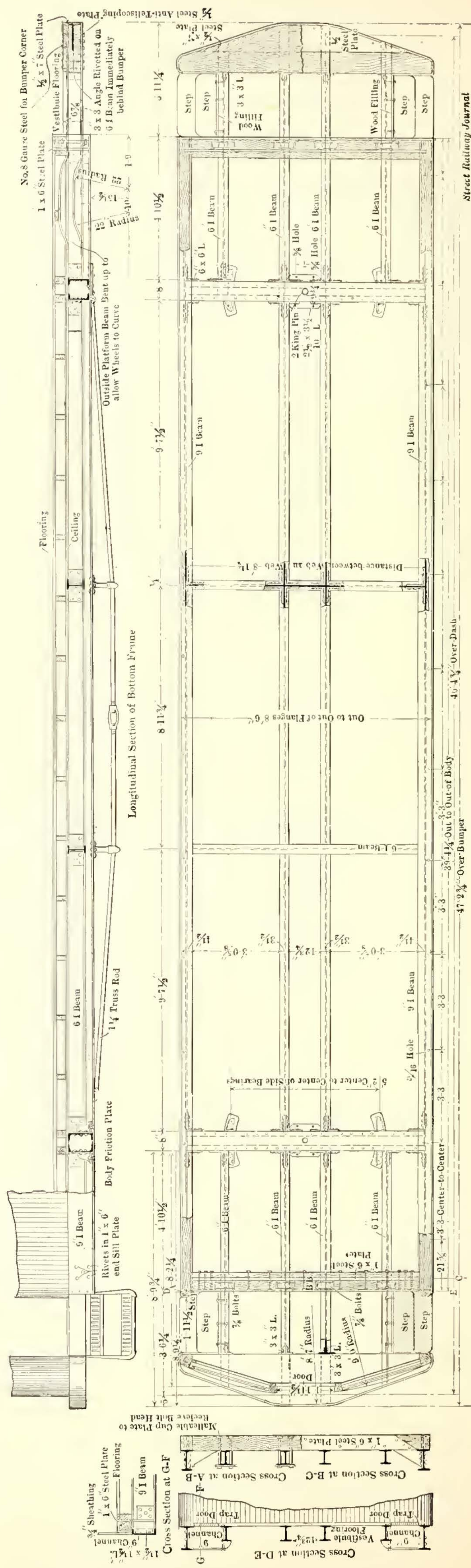


STANDARD TRUCK

of the short time the road has been operating and the many more pressing duties claiming attention, it has been found that at full speed the current required by a car on level track is 400 amps. At present line voltage, these cars run a little under 65 miles per hour maximum on a level. When accelerating at the rate of 2 miles per hour per second with motors in multiple, they require 1200 amps. or 300 amps. per motor. The present equipment consists of ten motor cars, and ten more motors and ten trailers are ordered. It is safe to say that never before in the history of electric railroading have motor cars been put through the daily mileage that some of these cars were put through the first two weeks the road was in operation, when, on account of lack of cars, some cars were run over 550 miles per day.

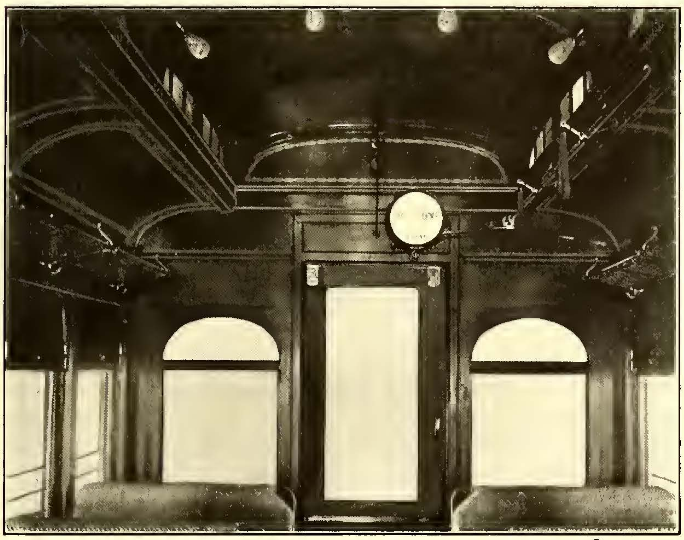
There are approximately 82 miles of main line, all on private right of way, the route of which is shown by the accompanying map. From Fifty-Second Avenue in Chicago, which is the eastern terminus, where the road connects with the Metropolitan West Side Elevated Railway, and at which point an elaborate transfer terminal depot has been erected, the line is double tracked for 21 miles to the golf grounds, 1 mile west of Wheaton. From Wheaton to Aurora is 14 miles, with a branch of 7 miles to Batavia. From Wheaton to Elgin is 16½ miles. The branches to Aurora, Batavia and Elgin are nominally single track, but have long sidings, which practically make the road double tracked for short distances, and really should be counted as short sections of road double tracked. Three miles west of Wheaton is 800 ft. of double track; 9 miles west of Wheaton is 1 mile of double track; 12 miles west of Wheaton, or about 2 miles from Aurora, is 400 ft. of double track. At Aurora there is double track for 1½ miles. On the Batavia branch is ¾ mile double track, at the main power house, and 700 ft. of double track at the Batavia terminal. On the Elgin branch there is ½ mile double track at Ingalton depot and sb-station, 1000 ft. at Wayne, ½ mile near the southern city limits of Elgin and 1500 ft. in the city of Elgin at the terminal. On the single-track portion of the line when large cuts were made they were cut sufficient width to provide for a double-track line in the future as soon as it is needed. Between Wheaton and Aurora there are 2½ miles of this double-track grading.

The roadbed for single track is 16 ft. wide, with 9 ins. of

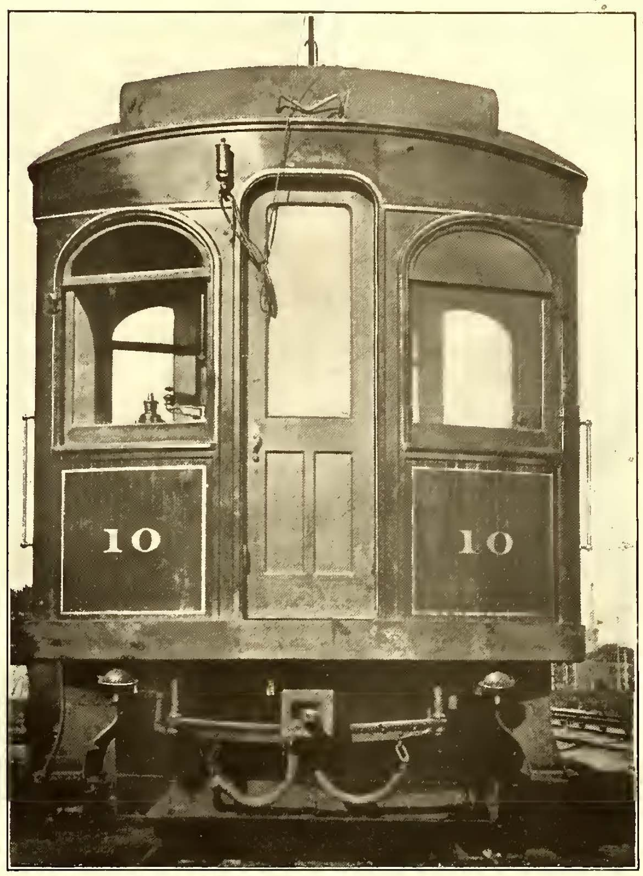


PLAN AND SIDE ELEVATION OF CAR, SHOWING STEEL SUB-FRAME gravel ballast. The double-track roadbed is 28 ft. wide, which is also the width of the single-track cuts where provision is made for double track. Double tracks are laid 15 ft. between centers. Current is supplied from a third rail which occupies the standard position relative to the track, which is in use on the elevated roads of Chicago and elsewhere. The top of the third rail is 6 3-16 inches above the top of the track rails, and it is placed 19⅛ ins. outside of the nearest track rail, the gage lines of the track and third rail being used as points of measurement in this case, and not the centers.

The track rails are standard T, 80 lbs. to the yard, in 60-ft. lengths. They are joined with four-bolt angle-bars 28 ins. long. The third rail is standard T, 100 lbs. to the yard, in 33-ft. lengths, and in order to give it better con-



INTERIOR VIEW OF CAR

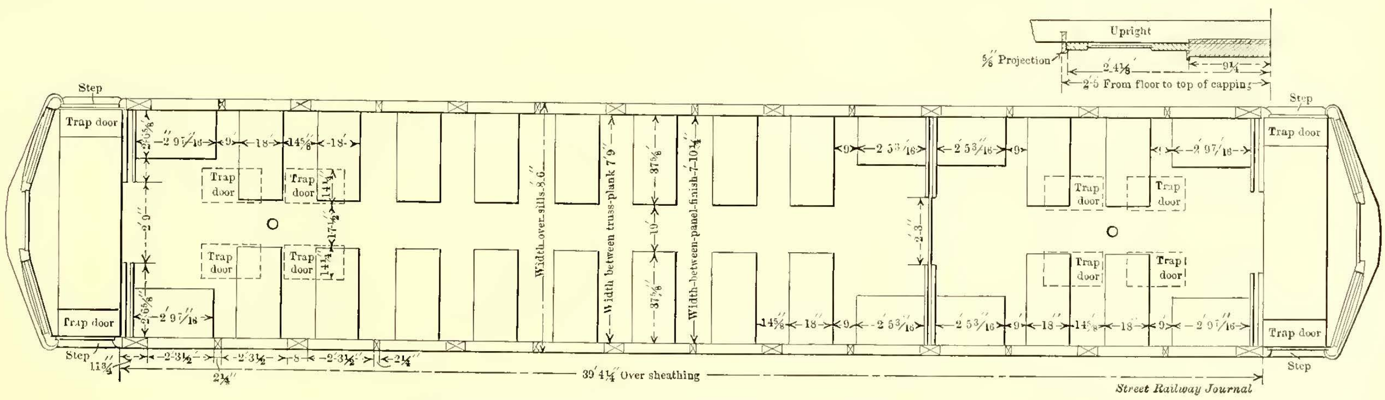


END DOOR IN VESTIBULE OF CAR

ductivity it is made of a lower percentage of carbon than the track rails, the percentage being .1. The regular ties are 6 ins. x 8 ins. x 8 ft., 2840 to the mile. Every fifth tie is 9 ft. long, and carries on one end an insulating support for the third rail. Except at two points, Wheaton and Waldheim Cemetery, where there are 16-deg. curves, the curves are limited to 1 deg., 2 degs. and 3 degs., so there is nothing to require a reduction of a speed from 70 miles per hour.

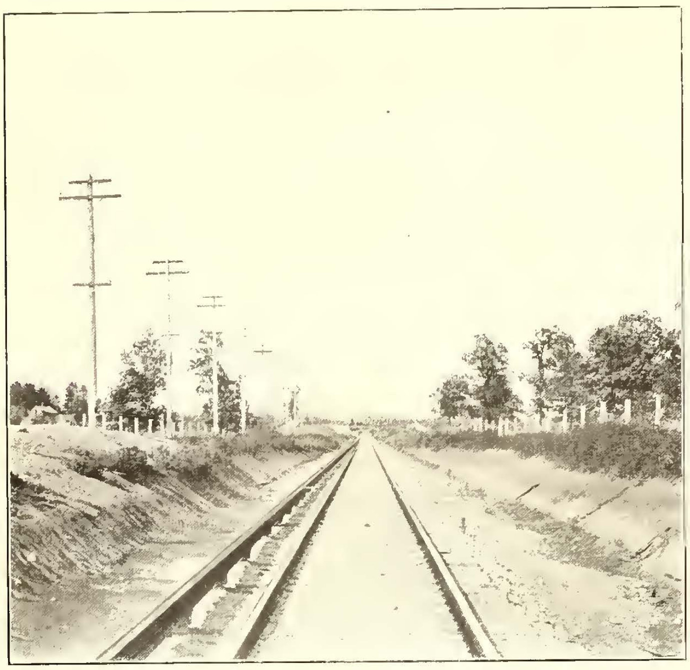
The third-rail insulators were furnished by the Ohio Brass Company. The first of these laid were wooden blocks boiled in paraffine oil, and the balance a special design of Mr. Gonzenbach, made by the same company This new design of third-rail insulator consists of a cast-iron base, over which fits a thin circular cap of "Dirigo" insulating material. On top of this is placed the cast-iron cap, upon which rests the third rail. The insulating material is not joined to the cast-iron fittings in any way, and the rail simply rests on top of the cap, as the weight of the rail is sufficient to hold the three parts of the insulator together.

The arrangement of the third rail at the cross-overs and the cable terminals connecting the third rail with the lead-covered underground cables, are clearly shown in the accompanying engravings. It will be noted that instead of omitting the third rail at the beginning of a cross-over to prevent catching of the contact-shoes on cars which are passing along the main line, the third rail has been bent downward so as to clear the contact-shoe. This is a more simple construction and does away with some underground connections which would otherwise be necessary were a separate isolated section of third rail put in for the cross-over. On the double track there is a cross-over



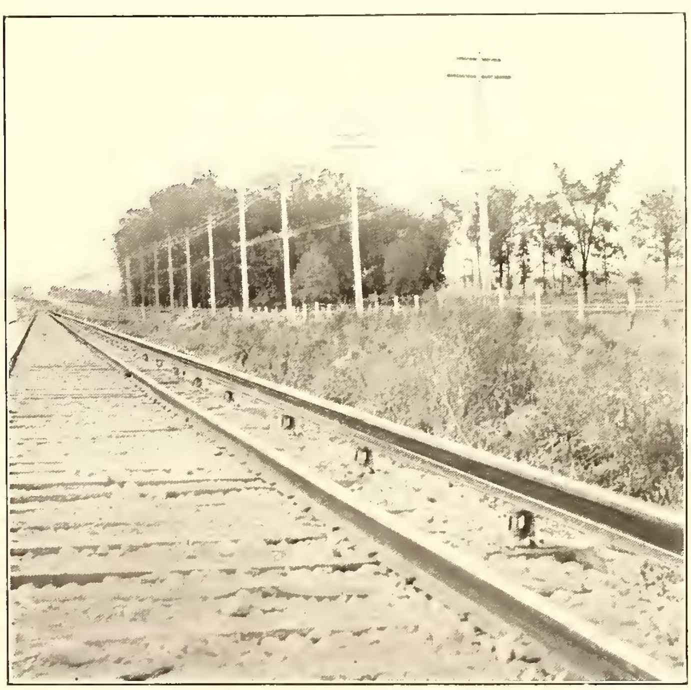
PLAN OF CAR SHOWING SEATING ARRANGEMENT

about every three miles. The switches are all of the standard steam-road pattern, with No. 10 spring frogs, furnished by the Morden Frog & Crossing Works. Interlocking signal towers, with home and distant signals so that trains



SINGLE TRACK, GOOD FOR 100 MILES AN HOUR

need not stop if the way is clear, are placed at three points where the steam roads are crossed. One of these is at Forest Home Cemetery, where the Wisconsin Central, Great Western and the Chicago Terminal Transfer Companies' tracks are crossed. Towers are also located at Chicago Junction Railway crossing, and at the crossing



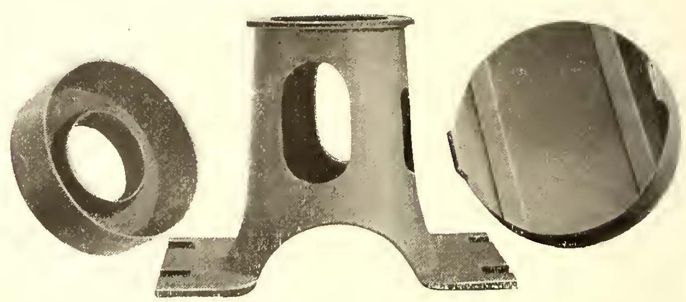
THIRD RAIL AND INSULATORS

with the Illinois Central, at South Elmhurst. As far as possible highways and steam roads have not been crossed at grade.

At highway grade crossings it is, of course, necessary to omit a short section of the third rail. At a 66-ft. highway crossing, which is the regular width of country highways, the third rail is omitted for a distance of 75 ft. For connecting across this interruption in the third rail, a lead-covered cable of 1,500,000-circ. mils cross section is placed in the ground, no protection being used for the lead sheath except a board placed over the cable. The Climax vitrified clay stock guards have been put in at all such crossings.

The bonding of the track rails is accomplished with two United States bonds of the American Steel & Wire Company at each joint. These bonds are 12 ins. long, with 1-in. terminals, and have each a cross-section of 250,000 circ. mils. Each third rail joint is bonded with two Protected Rail-Bond Company's bonds of 250,000 circ. mils. Tracks are cross-bonded ten times every mile with bonds of 300,000 circ. mils.

Experience has demonstrated the necessity for thorougly protecting the ends of the conductor and sheath of the lead-covered cable which is used for connecting across the break in the third rail at highway crossings and special work. If this is not done moisture soon works in between the lead sheath of the cable and the conductor, and as the distance between these is very short, there is certain to be trouble unless there is some means of protecting the insulations from moisture at the place where it is cut. A special terminal has been designed by Mr. Gonzenbach,



THIRD RAIL, INSULATOR APART

which has the double purpose of forming a connector and protecting the cable insulation at the end of the cable. In this terminal a bell of insulating material is clamped firmly down over the end of the lead sheath, and poured full of an insulating composition. Electrical connection is made by a cap, which is soldered over the end of the stranded cable conductor and to which a terminal lug is secured by a cap screw. This terminal lug is soldered to copper bonds connecting with the third rail.

A cast-iron tip is put on the third rail where it is interrupted, which furnishes an incline for the contact-shoe of the car. These tips can be seen in the engravings. They are 28 in. long, and in addition to the incline these afford, the third rail is dropped 2 ins. in 33 ft. approaching the tip.

Bridge work has been mainly of concrete masonry, with deck girders wherever possible, and elsewhere through girders between concrete piers. This concrete masonry is in striking contrast to some of the wooden trestle work on adjacent steam roads, and simply illustrates one of the many ways in which this company has spared no expense to get the best. Some of these bridges and culverts were illustrated in the Street Railway Journal of February, 1902.

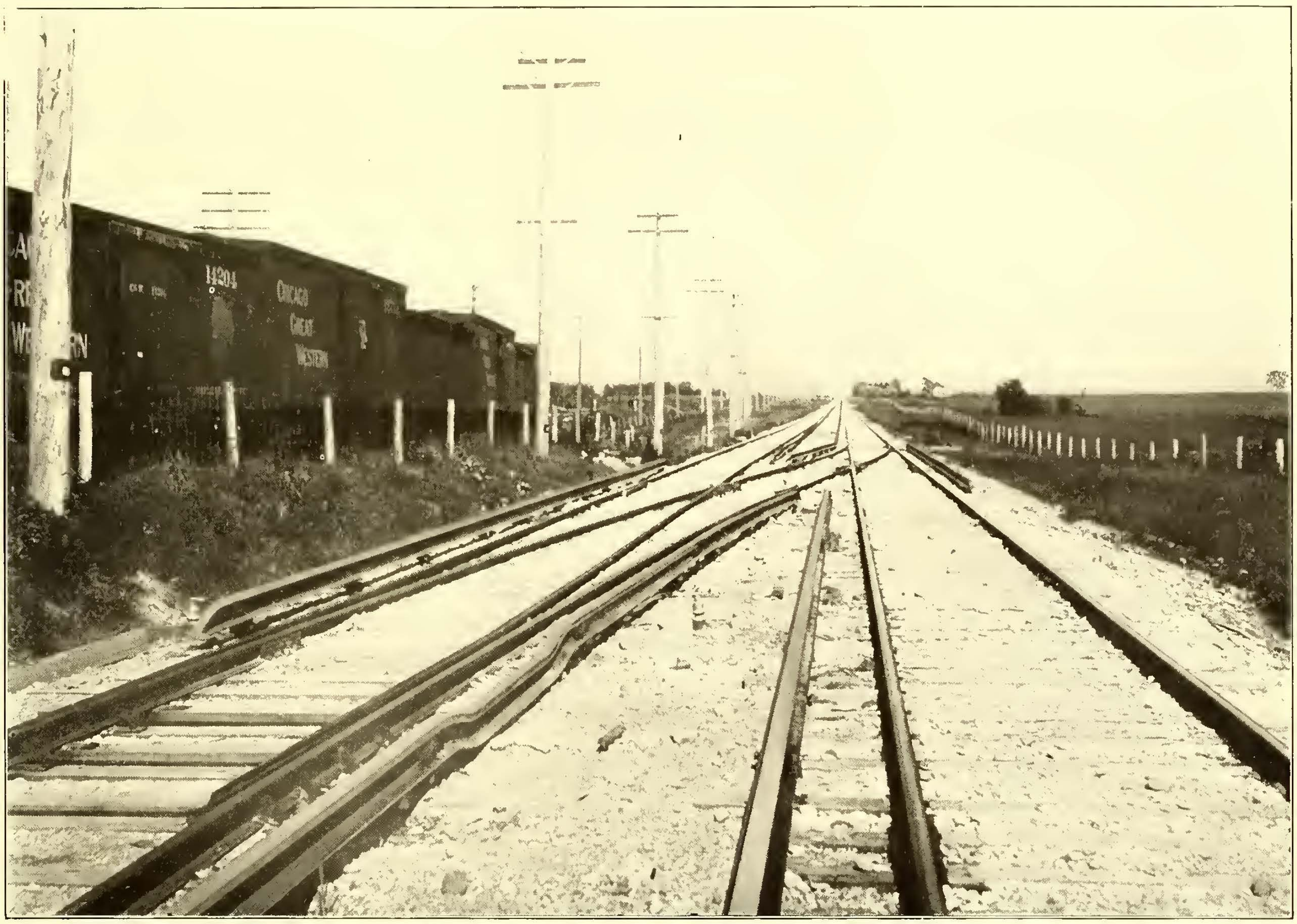
Power for the whole road is supplied from sub-stations operated by high-tension alternating current, from a power house at Batavia on the Fox River. This power house contains many interesting features, for which William L. Morris, mechanical engineer, is responsible. Drawings showing its general arrangement were given in the Street Railway Journal of February, 1902. Lack of space forbids going into a discussion of the power house until later. The present article will confine itself to the electrical distribution and matters intimately related to it.

The road is laid out for six sub-stations, the locations of which are indicated on the map. The transmission is by 26-000-volt 3-phase alternating current.

The high-tension lines are carried on cross-arms with insulators 30 ins. between centers on the cross-arms, and the cross-arms 24 ins. apart. The telephone lines are on cross-arms 7 ft. below the lower transmission cross-arm. There are two telephone circuits, one for general business and the other for despatching. The telephone lines are transposed every fourth pole, and the high-tension lines every mile, both being transposed more frequently than is

map. Three high-tension feeder lines leave the power house. From the power house to Batavia a line runs direct across country to sub-station No. 1, near Aurora. Another high-tension pole line follows the line of the railroad, supplying sub-stations Nos. 2, 3 and 4, and extending to Maywood. The third line from the lower power house is built directly across country to sub-station No. 5 on the Elgin branch, and along the right of way from this sub-station to Wheaton, at which point it joins the pole line from the Aurora branch, and the two three-phase circuits run on the same poles to sub-station No. 3, with one circuit from there to No. 4. Sub-station No. 6 is supplied by a single line running from sub-station No. 5.

Another respect in which this transmission differs from



VIEW SHOWING ARRANGEMENT OF THIRD RAIL AT CROSS OVER

common. The telephone wires are transposed by tieing both to a single wide petticoat transportation insulator every fourth pole.

No direct-current overhead feeders are needed, as the third rail has sufficient carrying capacity to conduct all the current from the sub-stations to the trains. The overhead pole line, therefore, has only to carry the 26,000-volt three-phase high-tension feeders which supply the various sub-stations and two telephone circuits. The high-tension feeders are of standard aluminum cable equivalent to No. 000 copper wire. The poles carrying these lines are 40 ft. long placed 80 ft. apart, sixty-six to the mile. In towns the poles are 60 ft. long. The system of high-tension distribution is very complete, and is arranged to secure freedom from interruptions of service due to short circuits or breakages on any one transmission line. The high-tension lines are indicated by dotted lines on the accompanying

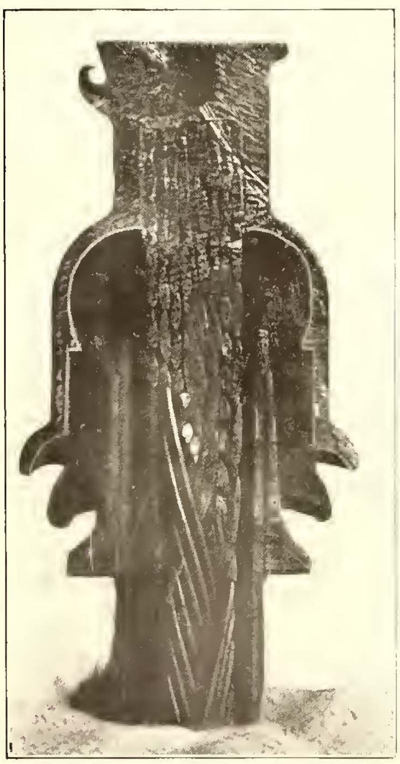
the majority is in going under, instead of over, a number of other pole lines. The usual practice is to carry the high-tension lines over every other pole line. This line goes under all unusually high telephone pole lines, and at such places guard-wires are put over the lines. The guard-wires are strung between rectangular frames surrounding the cross-arm, some of which can be seen in the background in the view taken at Wheaton.

At the crossings, which are of sufficient length so that the car must drift for a distance with no current, the annoyance to passengers from the lights going out will be obviated by putting up a short section of trolley wire at these places, with which a small sliding contact-bow trolley on the car roof will make contact. This will carry current enough for the lights on the car.

The arrangement of the direct-current feed and sectioning of the line is a matter of much importance on a high-speed road of this kind, where the fluctuations in load will be extremely violent. The arrangement employed on this road is practically the same as on all interurban roads fed by sub-stations. The third rail between any two sub-stations constitutes a continuous section fed from the sub-stations

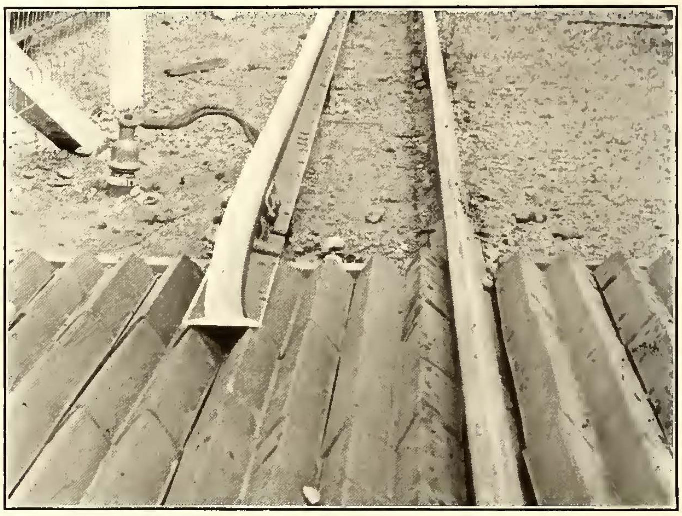
SUB-STATION AND PLATFORMS AT MAYWOOD

at each end. Sectioning of the third rail takes place only at the sub-stations. Each sub-station will, therefore, feed both ways, and as long as there is no trouble on the line, all the third-rail sections on the entire system will be connected together through the medium of the sub-station bus-bars and feeder panels, so that there will be opportunity for the sub-stations to divide the load among each other as far as the conductivity of the third rail will permit, and in case of an excessive load upon one section, the sub-station nearest will not be required to carry the total load. In case of a short circuit on any section of a third rail the circuit breakers at the two sub-stations that feed it will open, and it will be entirely disconnected. On the double track part of the road, the third rails on the two parallel tracks are not to be connected together permanently, but form two separate sections connected through the medium of the sub-station feeder panels and bus-bars, just as are any other sections.



SECTION THROUGH CABLE TERMINAL

To the specialist in high-voltage switchboards and switching arrangements the installation is of more than usual interest, because it is one of the first large high-tension alternating-current distribution plants to go into operation in which all the switching will be done on the high-voltage side of step-up and step-down transformers. Each generator in the power house has its own bank of three transformers, and each rotary converter in the sub-stations has its bank of three transformers. In each case the transformers are considered as a unit with the generator or converter. Each generator is connected with its bank of transformers directly without any switches or circuit breakers. In other words, each generator and its transformers constitute practically a 26,000-volt machine. Doing away with all low-tension switching apparatus and depending on switches in the 26,000-volt circuit alone is a proposition at first nothing short of startling to those familiar with the high-tension work that has been done in the past, and especially that in the far West, where it is the practice to do as much of the switching as possible on the low-tension circuits The manufacture of oil switches, which will with certainty open circuits of over 20,000 volts, has, however, materially changed the nature of the problem. Once a high-tension switch is introduced which is easily operated and certain in operation there are many reasons for doing way with the expense and complication of low-tension switches. The oil switch, which has made this feasible, is

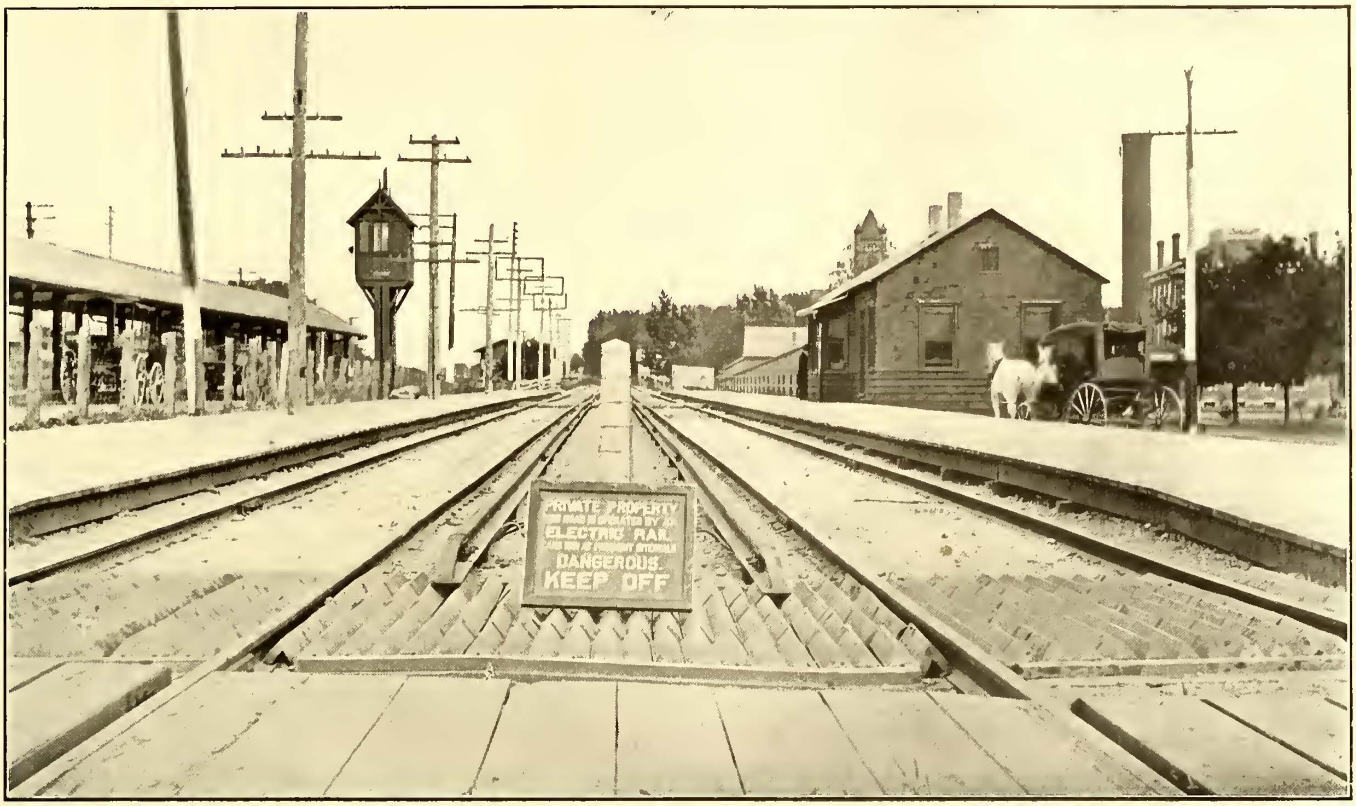


THIRD-RAIL TAP AND CABLE TERMINAL

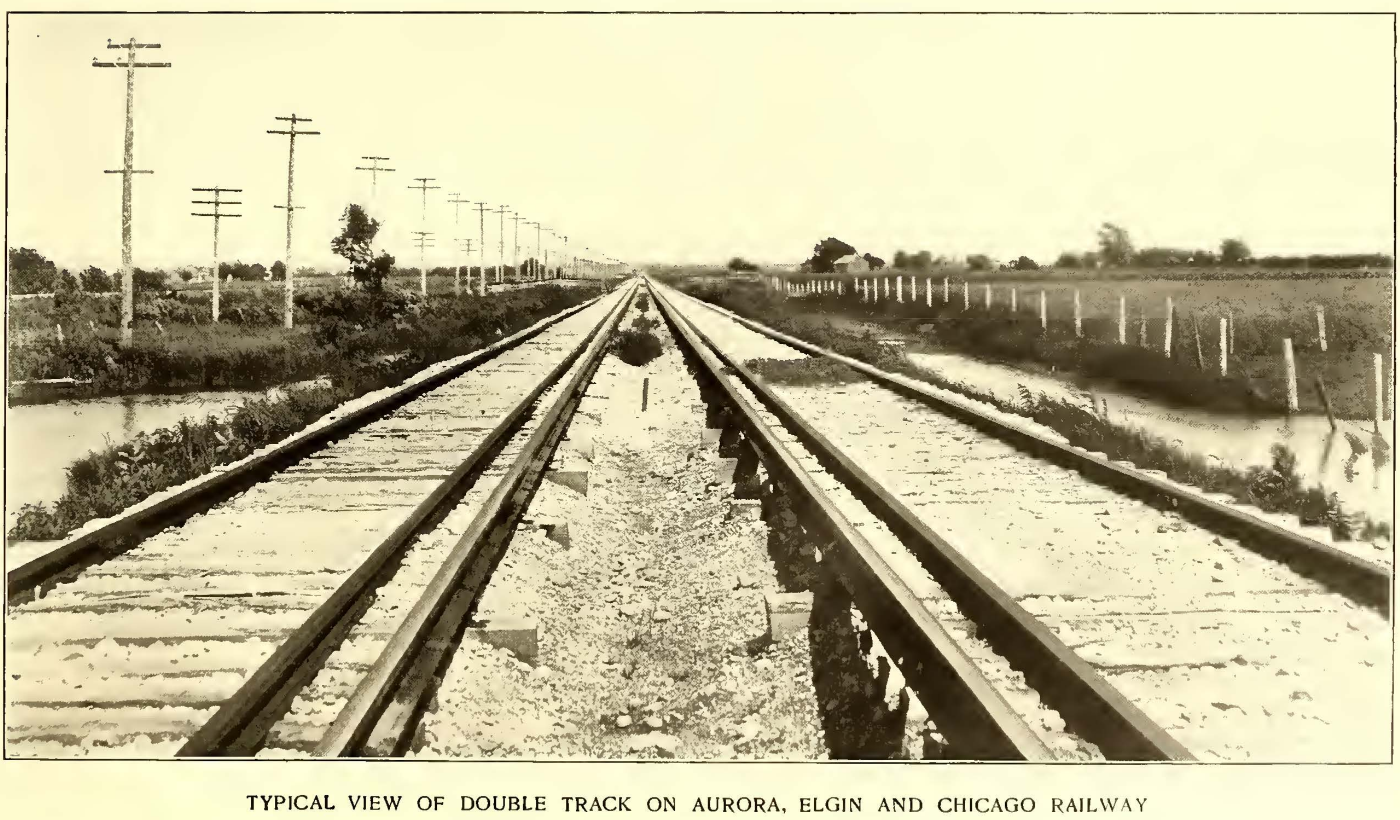
of the same general type as that made by the General Electric Company for the Manhattan Elevated power house in New York. Each leg of the switch is in an oil cylinder in a separate brick compartment. It is motor operated, a motor on each switch keeping wound up a spring which trips the switch open or shut. After each operation of the switch the motor winds up the spring to make up for the amount it unwound during the operation. The motor is operated by direct current from the exciter panel, and is entirely automatic in its action. The trip of the switch is also worked by direct current from a small switch on the generator panel. Indicating lamps on the generator panel show whether the switch is open or closed.

Taking up the circuits in their logical order, on the station-wiring diagram, the main current from the generators (2300-volt three-phase) is taken directly to the low-tension terminals of its three-delta connected transformers, taps being taken off between the generator and transformer for a potential transformer which supplies switchboard instruments on the generator panel. Taps also lead off to a three-pole, double-throw oil switch on a transfer panel, from which a panel governing an induction motor driving the exciter is run, and also blower motor and lighting circuits. On the transformer panel the three generators are so connected, as seen, to the two three-pole, double-throw oil switches as to allow any of the three generators to operate the station circuits, which are run from the transfer panels.

The lighting circuits can be supplied either by direct current from the exciters or by alternating current. The main generator current, after passing through its three step-up transformers and being raised to 26,000 volts, passes through current transformers, which are for operating the ammeter, power-factor indicator, induction wattmeter and reversal relay on the generator panel. After passing the current transformers the leads are taken to the machine-operated oil switch, from which they pass to the alternating-current 26,000-volt bus-bars. The reversal relay is a combination of current and potential coils so arranged as to trip the generator switch should current start to flow from the line toward the generators. Direct current from the exciter circuit is brought to the generator panel for controlling the main switch, which is located some distance from the switchboard. The generator and feeder



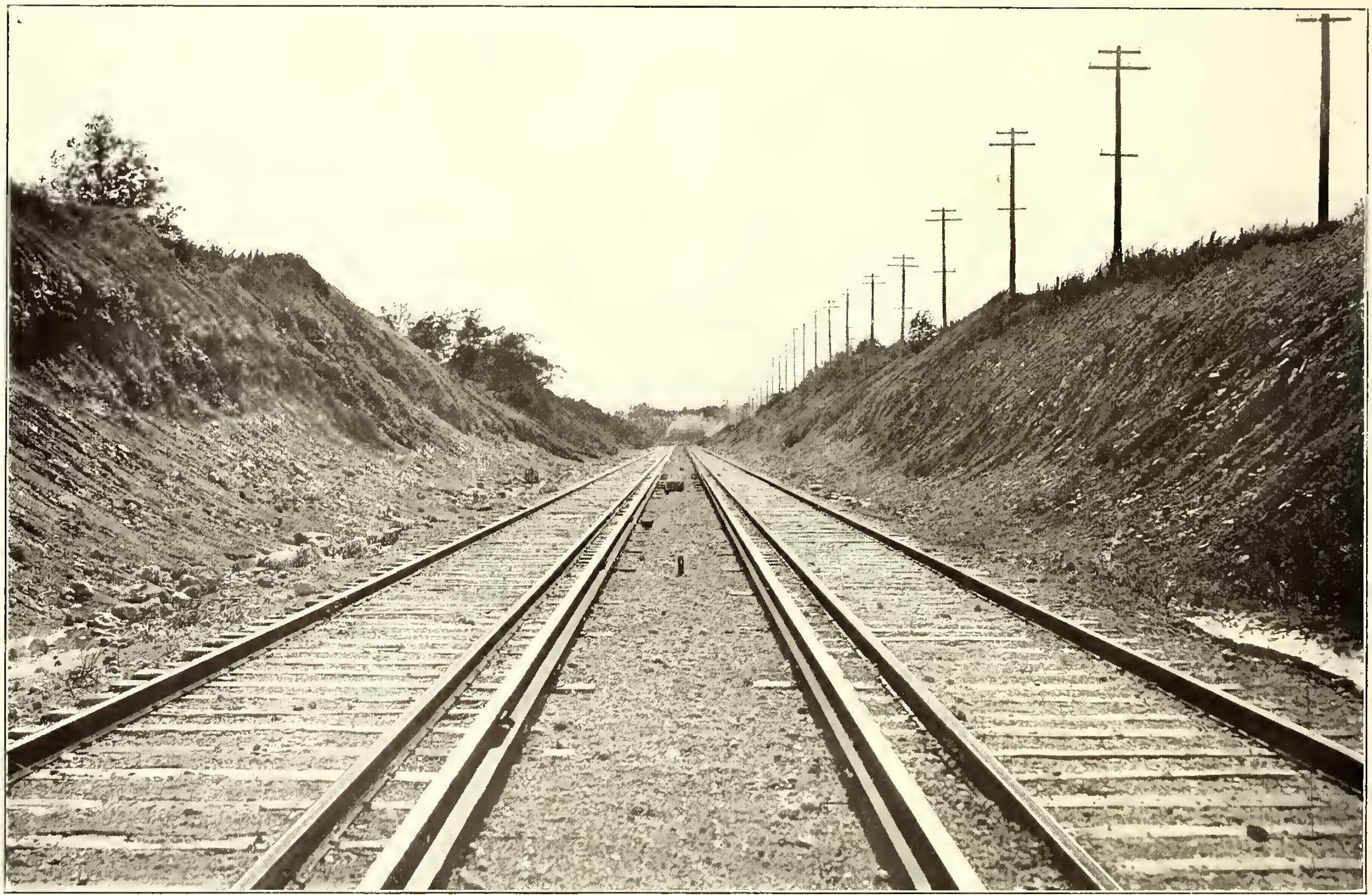
AT WHEATON, ON THE AURORA, ELGIN & CHICAGO RAILWAY, SHOWING SIDEWALK CROSSING, SIGN AND STOCK GUARD. SUPERINTENDENT'S AND DISPATCHER'S OFFICE IN DEPOT AT RIGHT. HIGH TENSION LINES WITH GUARD WIRE FRAMES AT LEFT IN DISTANCE



TYPICAL VIEW OF DOUBLE TRACK ON AURORA, ELGIN AND CHICAGO RAILWAY panels have no high-voltage wires upon them whatever.

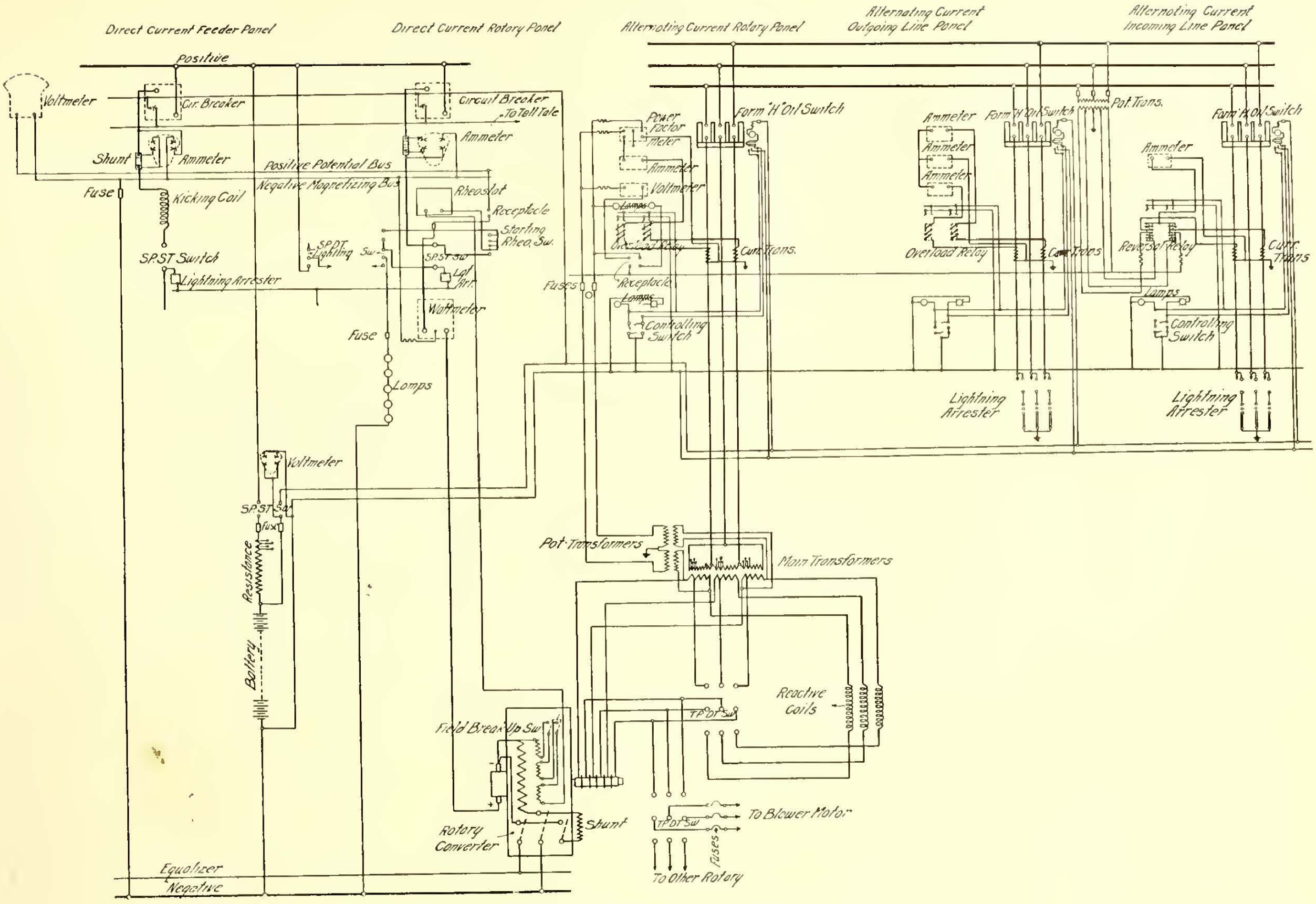
From the generator panels the 26,000-volt bus-bars pass to the high-tension feeder panels. Each feeder passes first through a machine-operated oil switch similar to those in the generator circuits. It then passes a current transformer, which operates feeder power-factor meter, ammeter and the overload relay, which closes the switch-tripping circuit whenever the current flowing exceeds the amount for which the relay is set. The main feeder switches can also be operated by a hand control switch, as well as automatically by overload. Other features of the power-house switchboards are made plain by the wiring diagram. There are three 1500-kw three-phase General Electric generators now installed. The 26,000-volt wiring in both power station and sub-stations is carried in brick flues or conduits, which isolates each circuit from adjacent circuits. The regular sub-station equipment for all the sub-stations comprises two 500-kw rotary converters with a bank of transformers for each. The sub-stations have basements which are air-tight, and in which air is kept under pressure by the blower for cooling the transformer.

Referring to the accompanying wiring diagram of a substation it is seen that one panel of the switchboard is devoted to the incoming 26,000-volt line. Where there is one or more sub-stations beyond this one there is another panel devoted to the outgoing line to the next sub-station. The principal object of this is to make it possible to cut off the line beyond in case of short circuit. After passing the lightning arresters the incoming line goes through current transformers which supply current for an indicating ammeter and the current coils of a reversal relay. This reversal relay is similar to that on the power-house generator panels, and will act to open the oil switch in the incoming feeder in case the sub-station attempts to give current to the line instead of receiving it. This might happen at any of the sub-stations on a loop circuit in case of a short circuit on the high-tension lines between the power house and the sub-station. The sub-station would then receive current from the other direction, and feed back into the short circuit. In case it were desired as a regular thing to feed back from the sub-station because of some section of the high-tension lines being cut out, it would be done by adjusting the reversal relay to allow this. After passing the current transformers, the incoming line is taken to the three-pole oil machine switch. The switch is controlled by a hand switch on the feeder panel, as well as by the reversal relay on that panel. From the oil switch the incoming feeder goes directly to the bus-bars. The panel for the outgoing line and controlling apparatus connected therewith are similar to the incoming, except that the machine switch is controlled by an overload relay, instead of a reversal relay, and there is an ammeter in each leg of the circuit. The potential transformer for the reversal relay on the incoming panel is connected directly to the bus-bars. Current for the operation of the machine switches is supplied from the 500-volt direct current ordinarily, but when the converters are not in operation and the third rail is dead, the switches can be worked by current from a small storage battery located in a cabinet in the sub-station. This is a 125-volt battery in series with a resistance.

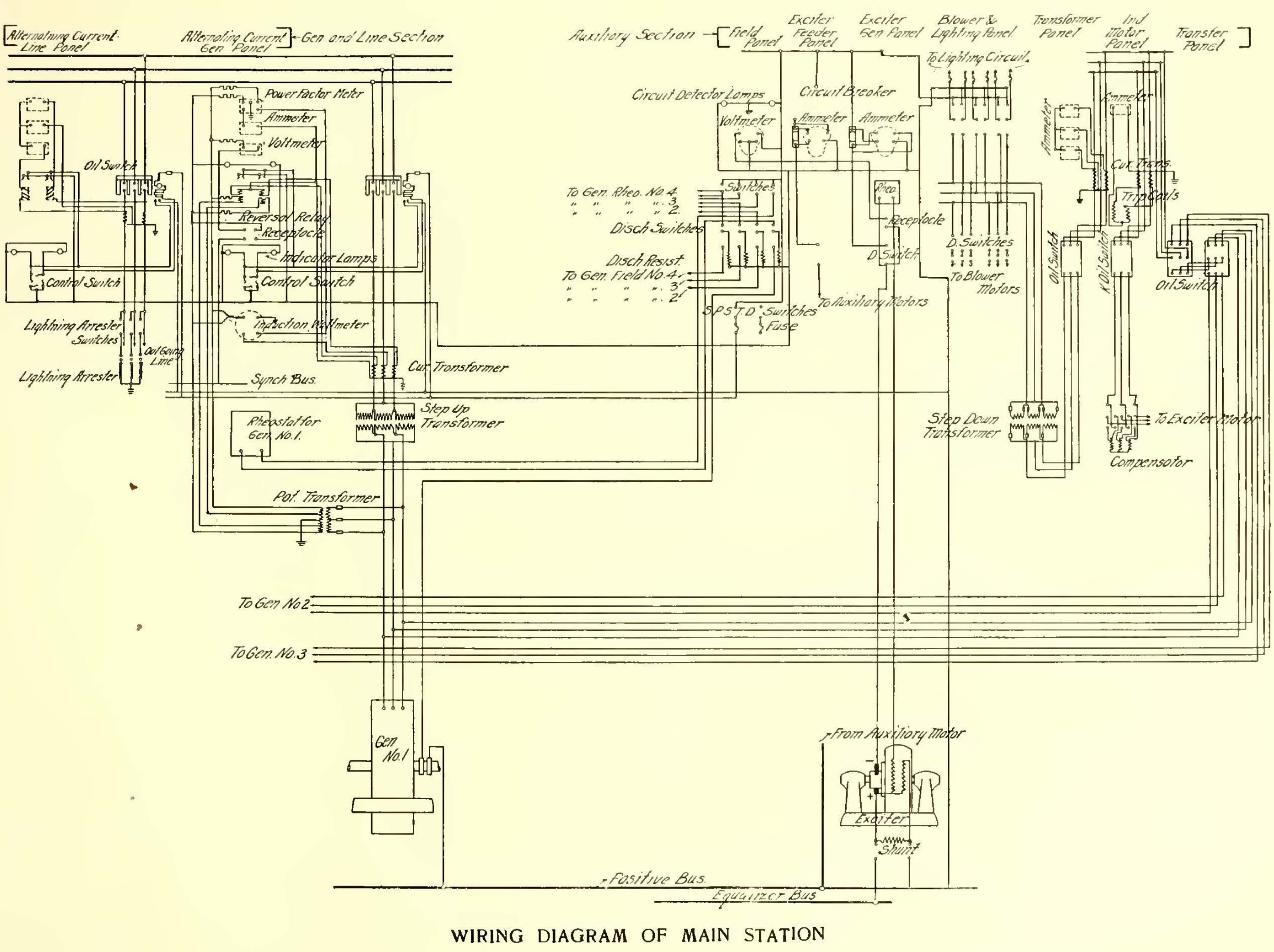


LONG CUT ON THE AURORA, ELGIN & CHICAGO RAILWAY

Each rotary converter has its bank of transformers controlled by an oil machine switch. The alternating-current panel for each converter, while having no high-voltage wires upon it, is, to all intents and purposes, a high-tension



WIRING DIAGRAM OF SUB-STATION

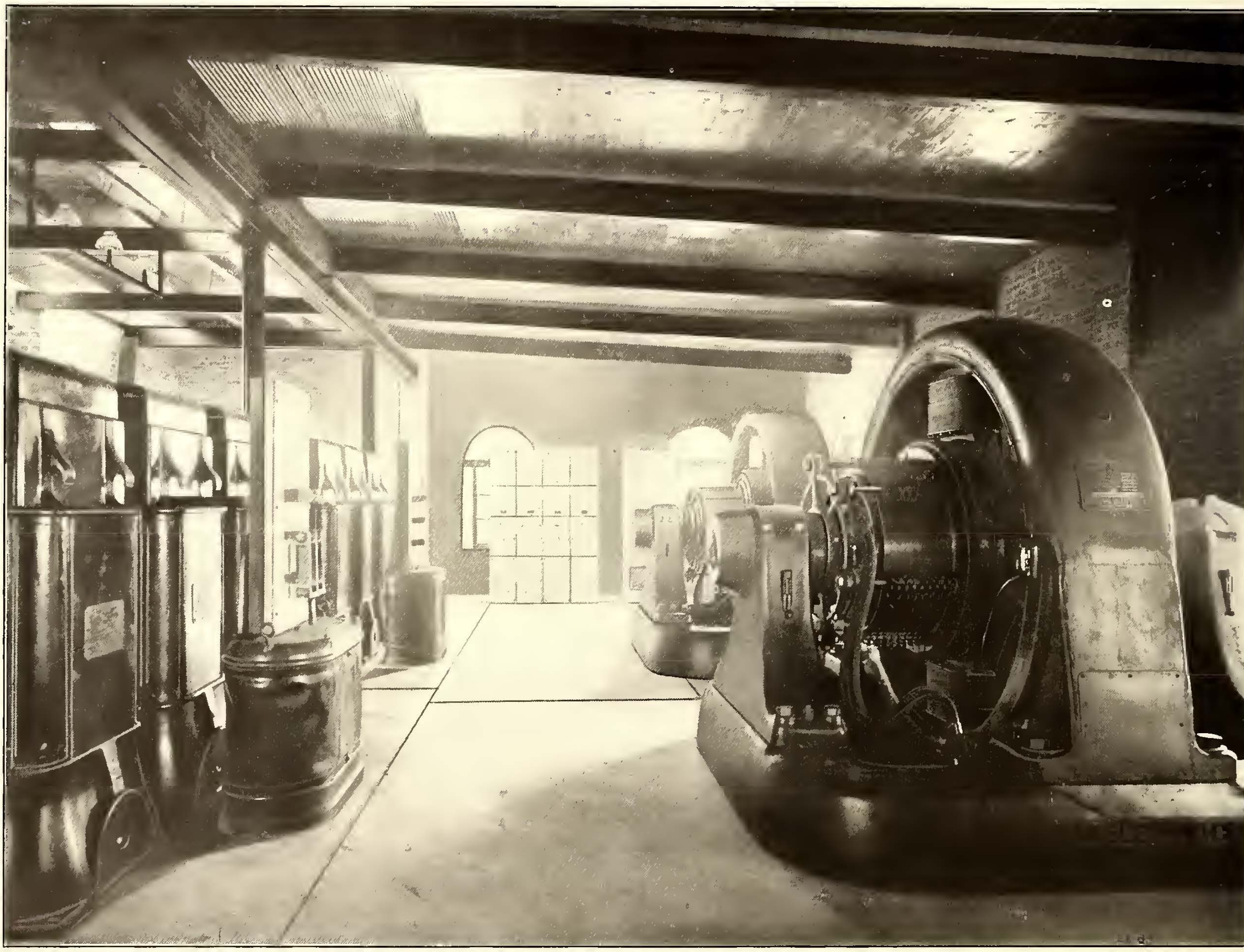


WIRING DIAGRAM OF MAIN STATION

panel, because its instruments and controlling switches all relate to the 26,000-volt line before it passes to the step-down transformers. After passing the main switch, which is operated by a hand switch or by an overload relay on the converter panel, the high-tension lines go through current transformers for the switchboard instruments, and then to the three main step-down transformers. Potential transformers for the switchboard instruments are on the low-voltage side of these. The converter panel contains a power-factor meter, ammeter, voltmeter, overload relay and controlling switch. The controlling switch on all these type-H oil switches is arranged on the principle of a faucet handle. The handle, or key, rotates to open or close the switch, standing vertical when the switch is closed, and horizontal when it is open. Indicating lamps show green when the switch is open, and red when it is closed. The rotary converters can be started either by direct current from the third rail or by alternating current. The converters are connected six-phase, as shown. When starting from the alternating-current end the three-pole double-throw switch is first put up, thereby giving only part of the full voltage until some speed has been attained, when this switch is thrown down and the converter given full alternating-current pressure through the reaction coils, the latter being for enabling the converter to make use of its compound field winding to hold up the voltage. The three-pole starting switch is mounted near the transformers on top of the reactive coils.

The road is operated under despatcher's orders given by telephone. At sub-stations train orders are received by the sub-station attendant for delivery. There are also telephone booths at all sidings and crossovers for emergency use when cars fall behind time. There are two telephone circuits the length of the line, one for despatching, the other for general business. Double-throw, double-pole knife switches at each telephone instrument make it possible to talk over either circuit from any instrument. Double-pole switches are provided at stations for cutting out sections of telephone line in case of trouble. Some device for automatically cutting out booth telephones when not in use will be installed, so that careless trainmen cannot leave a telephone bridged across the line to the detriment of the efficiency of the circuit and to fall a prey to lightning. The stationary telephones are all Stromberg-Carlson make. Each car carries a portable telephone to connect in along the line. These are made by the Garl Electric Company.

The rates of fare are approximately $1\frac{1}{2}$ cents per mile, and are about half the regular steam-road fare between the points reached. Because of the present limited equipment no attempt has been made yet to meet the steam-railroad monthly commutation rates. All 5-cent fares are registered. Tickets are sold at sub-station waiting rooms and at terminals. Cash fares are receipted for by conductors with a ticket like that used on the Orchard Lake Division of the Detroit United Railway, which is illustrated elsewhere in this issue in an article on the passenger department



INTERIOR OF SUB-STATION, AURORA, ELGIN & CHICAGO RAILWAY of that system. The car shops are being built at Wheaton, where also are the operating offices.

At present writing the road has not been in operation long enough to have made it wise management to give the fast train service ultimately intended, because the roadbed is new and subject to settling, and the trainmen need time to get used to the service. The present service is a car every half hour from the terminal at West Fifty-Second Avenue to Aurora. The Elgin line is not completed because of lack of rails, and at present writing the Batavia branch is not open, although almost ready. The run to Aurora is made in 1 hour and 15 minutes, making all stops. Cars stop at platforms along the line only to receive or discharge passengers. Stopping platforms are all shown on the map. The time to Wheaton, 20½ miles, is 42 minutes. There are twenty-four platforms in that distance, but in ordinary operation only about a quarter of these require stops. The present schedule speed is maintained with great ease, and gives the company good reason to think that with track ballast settled the local trains between Chicago and Aurora can make the distance in one hour. A through service, stopping only at Wheaton and at some points within the Chicago city limits, is contemplated, with a running time of 45 minutes. The distance is 34.6 miles. The time required to go from the Union Elevated loop in Chicago to Fifty-Second Avenue over the Garfield Park line of the Metropolitan Elevated is 30 minutes at present, and could be reduced somewhat by an express service, which may be put on. A 45-minute run from Fifty-Second Avenue to Aurora would mean that Aurora could be reached from the downtown district in Chicago in considerably less time and with less annoyance than on the steam roads, to say nothing of the greater frequency of the electric cars. The infrequency of the steam trains is one of their greatest drawbacks, as all Chicago people who have visited towns along the Fox River can testify.

However, this electric service needs no argument in its defense, because the traffic it has carried every day since it opened has demonstrated that the road is meeting a popular demand and also creating travel which did not before exist. Considering the newness of the road and the fact that some paving operations in Aurora have prevented the cars from running to the center of that city, or even leaving these out of account, the results are very gratifying. For two of the first weeks of operation the gross receipts from the half-hour local service between Chicago and Aurora were given by the management as $904.19 per day.

The service called for the operation of five cars. On Sundays the traffic has been enormous, and has sometimes swamped the ability of the company to take care of it, even with two-car trains. One Sunday, Aug. 31, with only five cars in operation, the receipts ran as high as $1,872. One gratifying thing about traffic so far has been the amount of through business between Chicago and Aurora, which constitutes the best and largest part of the business. And this is the very business which the increase in speed and operation to the center of Aurora will help. With the entire mileage of the road open for business, as it will be upon the completion of the Elgin and Batavia branches, and with fast through service inaugurated, it would not be unreasonable to expect that the gross receipts would be three times those at present. Allowing even a liberal percentage of this for operating and maintenance, as compared with other interurban roads, would leave enough for the investors in the securities to put the road on a solid financial footing. Of course, these are unusually prosperous times, and all railroad earnings are abnormally high. On the other hand, while there may be temporary declines in receipts, the general average is sure to rise as time passes, because of the increase in the riding habit and the increase of population along the line. At the present time this road touches the southern edge of a number of old, thickly settled suburban towns. There is certain to be growth in these towns along the line of the road, as well as in the villages further out. Taken altogether, it is gratifying to know that the prospects for this enterprise are so good, for it is a matter of interest to many more than the investors in this company's securities. The financial outcome of such an electric railway undertaking as this has an important bearing on future development and investment in the electric railway field; a matter in which both the public and all connected with the electric railway business are interested.

OIL SWITCH AND TRANSFORMERS IN SUB-STATION

Washington, Baltimore and Annapolis Single Phase Railway*

BY. B. G. LAMME.

The Washington, Baltimore & Annapolis Railway is the new high-speed electric line extending from the suburbs of Washington to Baltimore, a distance of 31 miles, with a branch from Annapolis Junction to Annapolis, a distance of about 15 miles. The overhead trolley will be used and schedule speeds of over 40 miles per hour are to be attained. This road is to be the scene of the first commercial operation of an entirely new system of electric traction.

The special feature of this system is the use of single-phase alternating current in generators, transmission lines, trolley car equipment and motors. It constitutes a wide departure from present types of railway apparatus, and while retaining the best characteristics of the present standard direct-current motor system the use of alternating current makes it possible to avoid many of the bad features.

The standard direct-current railway equipment possesses several characteristics which fit it especially for railway service. These characteristics have been of sufficient importance to overbalance many defects in the system. In fact, a far greater amount of effort and engineering skill has been required for overcoming or neutralizing the defects than for developing the good features possessed by the system. By far the most important characteristic possessed by the direct-current system is found in the type of motor used on the car. The direct-current railway motor is in all cases a series-wound machine. The series motor is normally a variable field machine, and it is this feature which has adapted the motor especially to railway service. Shunt-wound motors have been tried and abandoned. All manner of combinations of shunt, series and separate excitation have been devised and found wanting, and in many cases the real cause of failure was not recognized by those responsible for the various combinations. They all missed to a greater or less extent the variable field feature of the straight series motor. It is true that a variable field can be obtained with shunt or separate excitation, but not without controlling or regulating devices; and the variation is not inherently automatic, as in the series motor. Polyphase and single-phase induction motors do not possess the variable field feature at all, as they are essentially constant-field machines. They are equivalent to direct-current shunt or separately excited motors, with constant field strength, which have been unable to compete successfully with the series motor. The variable field of the series motor makes it automatically adjustable for load and speed conditions. It also enables the series motor to develop large torques without proportionately increased currents. The automatically varying field is accompanied by corresponding variations in the counter e. m. f. of the armature, until the speed can adjust itself to the new field conditions. This feature is of great assistance in reducing current fluctuations, with a small number of steps in the regulating rheostat. Any increase in current, as resistance is cut out, is accompanied by a momentary increase in the counter e. m. f., thus limiting the current increase to a less value than in the case of a constant field motor.

Next to the type of motor the greatest advantage possessed by the direct-current system lies in the use of a single current, or circuit, thus permitting the use of one trolley wire. The advantages of the single trolley are so well known that it is unnecessary to discuss them. For third-rail construction, the use of single current is of even greater importance than in the case of overhead trolley. It is seen, therefore, that it is not to the direct current that credit should be given for the great success of the present railway system, but to the series type of motor and the fact that up to the present time no suitable single-phase alternating-current motor has been presented.

Some of the undesirable features of the direct-current railway system should also be considered. The speed control is inefficient. A nominally constant voltage is supplied to the car, and speed control is obtained by applying variable voltage at the motor terminals. This variation is produced by the use of resistance in series with the motors with a loss proportional to the voltage taken up by the resistance. By means ot the series-parallel arrangement the equivalent of two voltages is obtainable at the motor terminals without the use of resistance. Therefore, with series-parallel control there are two efficient speeds with any given torque, and with multiple control there is but one efficient speed with a given torque. All other speeds are obtained through rheostatic loss, and the greater the reduction from either of the two speeds, series or parallel, the lower will be the efficiency of the equipment. At start the rheostatic losses are always relatively large, as practically all the voltage of the line is taken up in the rheostat. For heavy railroad service, where operation for long periods at other than full and half speeds may be necessary, the rheostatic loss will be a very serious matter.

The controlling devices themselves are also a source of trouble. An extraordinary amount of time and skill has been expended in perfecting this apparatus. The difficulties increase with the power to be handled. The controller is a part of the equipment which is subjected to much more than ordinary mechanical wear and tear, and it can go wrong at any one of many points. The larger the equipment to be controlled the more places are to be found in the controller which can give trouble. The best that can be said of the railway controller is that it is a necessary evil.

Another limitation of the direct-current system is the trolley voltage. Five hundred volts is common at the car and 650 volts is very unusual. By far the larger number of the railway equipments in service to-day are unsuited for operation at 600 volts, and 700 volts in normal operation would be unsafe for practically all. The maximum permissible trolley voltage is dependent upon inherent limitations in the design of motors and controllers. The disadvantages of low voltage appear in the extra cost of copper, etc., and in the difficulty of collecting current. In heavy railroad work the current to be handled becomes enormous at usual voltages. A 2400-hp electric locomotive, for example, will require between 3000 amps. and 4000 amps. at normal rated power and probably 6000 amps. to 8000 amps. at times. With the overhead trolley these currents are too heavy to be collected in the ordinary manner, and it is a serious problem with any form of trolley or third-rail system which can be used. It is evident that for heavy service, comparable with that of large steam railroads, a much higher voltage than used in our present direct-current system is essential, and the use of higher voltage is destined to come, provided it is not attended by complications which more than overbalance the benefits obtained. A further disadvantage of the direct-current system is the destructive action known as electrolysis. This may not be of great importance in interurban lines, chiefly because there is nothing to be injured by it. In city work its dangers are well known, and very expensive constructions are now used to eliminate or minimize its effects.

From the foregoing statements it is evident that an alternating-current railway system to equal the direct current should possess the two principal features of the direct current system, viz., a single supply circuit and the variable field motor, and to be an improvement upon the direct-current system the alternating current should avoid some of the more important disadvantages incident to the present direct current railway apparatus.

The system must, therefore, be single-phase. The importance of using single-phase for railway work is well known. The difficulties and complications of the trolley construction are such that several alternating current systems have been planned on the basis of single-phase supplied to the car, with converting apparatus on the car to transform to direct current, in order that the standard type of railway motors may be used. Such plans are attempts to obtain the two most valuable features of the present direct current system. The polyphase railway system, used on a few European roads, employs three currents, and therefore does not meet the above requirements. The motor for the alternating-current railway service should have the variable speed characteristics of the series-direct-current motor. The polyphase motor is not suitable, as it is essentially a constant field machine and does not possess any true variable speed characteristics. Therefore it lacks both of the good features of the direct-current railway system. A new type of motor must therefore be furnished, as none of the alternating current motors in commercial use is adapted for the speed and torque requirements of first-class railway service. Assuming that such a motor is obtainable for operation on a single-phase circuit, the next step to consider is whether the use of alternating instead of direct current on the car will allow some of the disadvantageous features of the direct-current system to be avoided. The direct-current limits of voltage are at once removed, as transformers can be used for changing from any desired trolley voltage to any convenient motor voltage. Electrolytic troubles practically disappear. As transformers can be used, variations in supply voltage are easily obtainable. As the motor is assumed to have the characteristics of the direct-current series motor, speed control without rheostatic loss is practicable when voltage control is obtained. This combination, therefore, allows the motor to operate at relatively good efficiency at any speed within the range of voltage obtained. If the voltage be varied over a sufficiently wide range the speed range may be carried from the maximum desired down to zero, and therefore down to starting conditions. With such an arrangement no rheostat need be used under any conditions, and the lower the speed at which the motor is operated the less the power required from the line.

* Read before the American Institute of Electrical Engineers, New York, Sept. 26, 1902.

The least power is required to start, as the motor is doing no work and there is no rheostatic loss. The losses at start are only those in the motor and transforming apparatus, the total being less than when running at full speed with an equal torque. Such a system, therefore, permits maximum economy in power consumed by motor and control. This economy in control is not possible with the polyphase railway motor, as this motor is the equivalent of the direct-current shunt motor, with which the rheostatic loss is even greater than with the series motor.

The use of alternating current on the car allows voltage control to be obtained in several ways. In one method a transformer is arranged with a large number of leads carried to a dial or controller drum. The Stillwell regulator is a well-known example of this type of voltage control. This method of regulation is suitable for small equipments with moderate currents to be handled. The controller will be subject to some sparking, as in the case of direct-current apparatus, and therefore becomes less satisfactory as the car equipment is increased in capacity. Another method of control available with alternating current is entirely non-sparking, there being no make-and-break contacts. This controller is the so-called "induction regulator," which is a transformer with the primary and secondary windings on separate cores. The voltage in the secondary winding is varied by shifting its angular position in relation to the primary. With this type of voltage controller very large currents can be handled, and it is especially suitable for heavy equipments, such as locomotives. It is thus seen that there is one method of control available with alternating current which avoids the inherent troubles of the direct-current controller. The induction regulator is primarily a transformer, and all wear and tear is confined to the supports which carry the rotor. Therefore the objectionable controller of the standard direct-current system can be eliminated, provided a suitable alternating-current motor can be obtained. This ideal type of controller is not applicable to the polyphase railway motor, in which speed control can be obtained only through rheostatic loss. The polyphase control system is even more complicated than the direct current, as there must be a rheostat for each motor and two or three circuits in each rheostat. It is thus apparent that by the use of single-phase alternating current with an alternating-current motor having the characteristics of the direct-current series motor the best features of the direct-current system can be obtained, and at the same time many of its disadvantages can be avoided.

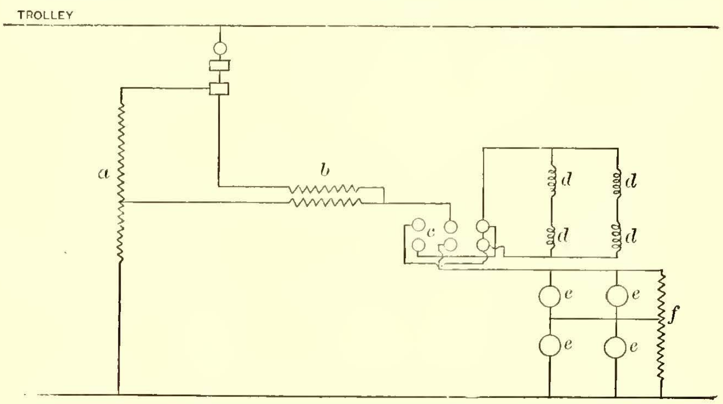
This portion of the problem therefore resolves itself into the construction of a single-phase motor having the characteristics of the direct-current series motor. There are several types of single-phase alternating-current motors which have this series characteristic. One type is similar in general construction to a direct-current motor, but with its magnetic circuit laminated throughout, and with such proportions that it can successfully commutate alternating current. Such a motor is a plain series motor and can be operated on either alternating or direct current and will have the same torque characteristics in either case. Another type of motor is similar in general construction, but the circuits are arranged in a different manner. The field is connected directly across the supply circuit, with proper control appliances in series with it. The armature is short-circuited on itself across the brushes, and the brushes are set at an angle of approximately 45 degs. from the ordinary neutral point. The first of these two types of motors is the one best adapted for operation in large units.

This is the type of motor which is to be used on the Washington, Baltimore & Annapolis Railway. Several motors have been built and tested with very satisfactory results, both on the testing stand and under a car. The results were so favorable that the system was proposed to the Cleveland Engineering Company, representing the Washington, Baltimore & Annapolis Railway, and, after investigation by their engineers, it was adopted. A description of the apparatus to be used on this road will illustrate the system to good advantage.

Single-phase alternating current will be supplied to the car at a frequency of 16 2-3 cycles per second, or 2000 alternations per minute. The current from the overhead trolley wire is normally fed in by one trolley at approximately 1000 volts. Within the limits of the District of Columbia two trolleys are employed, as by act of Congress the use of rails as conductors is prohibited in this district, presumably on account of electrolysis. In this case the trouble, of course, will not exist, but the contracting company has been unable to obtain permission for the grounded circuit.

The alternating current to the car is carried through a main switch, or circuit breaker, on the car to an auto-transformer connected between the trolley and the return circuit. At approximately 300 volts from the ground terminal a lead is brought out from the auto-transformer and passed through the regulator to one terminal of the motors. For starting and controlling the speed an induction regulator is used, with its secondary winding in series with the motors. This secondary circuit of the regulator can be made either to add to or subtract from the transformer voltage, thus raising or lowering the voltage supplied to the motors. The regulator therefore does double duty. The controller for direct-current motors merely lowers the voltage supplied to the motors, but cannot raise it; but an alternating-current regulator can be connected for an intermediate voltage and can either raise or lower the motor voltage. In this way the regulator can be made relatively small, as it handles only the variable element of the voltage, and the maximum voltage in the secondary winding is but half of the total variation required.

In the equipments in question, the range of voltage at the motor is to be varied from, approximately, 200 volts up to 400 volts, or slightly higher. The transformer on the car will supply 315 volts, and the secondary circuit of the regulator will be wound to generate slightly more than 100 volts when turned to the position of its maximum voltage. This voltage of the regulator is about one-fourth of that of the motors at full voltage. The regulator can consequently be made relatively small, in comparison with the motor capacity of the equipment. It has been found unnecessary to



a. Auto-Transformer. *b.* Induction Regulator. *c.* Reversing Switch. *d.* Field of Motors. *e.* Armature of Motors. *f.* Equalizing Transformer.

FIG. 1

use much lower than 200 volts in this installation, as this allows a comparatively low running speed, and approximately 200 volts will be necessary to start with the required torque. The greater part of this voltage is necessary to overcome the e. m. f. of self-induction in the motor windings, which is dependent upon the current through the motor and is independent of the speed of the armature.

There will be four motors of 100 hp on each car. The full rated voltage of each motor is approximately 220 volts. The motors are arranged in two pairs, each consisting of two armatures in series, and two fields in series, and the two pairs are connected in parallel. The motors are connected permanently in this manner. Since voltage control is used, there is no necessity for series-parallel operation, as with short-circuited motors. To ensure equal voltage to the armatures in series, a balancing or equalizing action is obtained by the use of a small auto-transformer connected permanently across the two armatures in series, with its middle point connected between them. The fields are arranged in two pairs, with two fields in series and two pairs in multiple. This parallels the fields independently of the armatures, which was formerly the practice with direct-current motors. It was a defective arrangement with such motors, as equal currents in the field did not ensure equal field strengths in the motors, and the armatures connected in parallel, therefore, would be operating in fields of unequal strength, with unequal armature currents as a direct result. With alternating currents in the field the case is different. The voltage across the fields is dependent upon the field strengths, and the current supplied to the fields naturally divides itself for equal magnetic strengths. The chief advantage in paralleling the fields and armatures independently is, that one reversing switch may serve for the four motors, and one balancing transformer may be used across the two pairs of armatures. The ordinary direct-current arrangement of armatures in series with their own fields can be used with a greater number of switches and connections.

The general arrangements of the auto-transformer, regulator, motors, etc., is shown in Fig. 1.

The induction regulator or controller, resembles an induction motor in general appearance and construction. The primary winding is placed on the rotor, and the secondary or low-voltage winding on the stator. The rotor also has a second winding which is permanently short-circuited on itself. The function of this short-circuited winding is to neutralize the self-induction of the secondary winding as it passes from the magnetic influence of the primary. The regulator is wound for two poles, and therefore is operated through 180 degs. in producing the full range of voltage for the motors. One end of the primary winding of the regulator is connected to the trolley, and the other to a point between the regulator and the motors. It thus receives a variable voltage as the controller is rotated. There are several advantages in this arrangement of the primary in this particular case. First, the regulator is worked at a higher induction at start, and at lower induction when running, the running position being used in these equipments for much longer periods than required for starting. Second, when the motors are operating at full voltage the current in the primary of the regulator passes through the motors, but not through the auto-transformer or the secondary of the regulator. This allows considerable redaction in the size of auto-transformer and regulator. The motors on the car are all of the straight series type. The armature and fields being connected in series, the entire current of the field passses through the armature as in ordinary series direct-current motors. The motor has eight poles, and the speed is approximately 700 revolutions at 220 volts. The general construction is similar to that of a direct-current motor, but the field core is laminated throughout, this being necessary on account of the alternating magnetic field. There are eight field coils wound with copper strap, and all connected permanently in parallel. The parallel arrangement of field coils assists in the equalizing of the field strength in the different poles, due to the balancing action of alternating circuits in parallel. This arrangement is not really necessary, but it possesses some advantages, and therefore has been used. With equal magnetic strength in the poles, the magnetic pull is equalized even with the armature out of center. The armature is similar in general construction to that of a direct-current motor. The fundamental difficulty in the operation of a commutator type of motor on single-phase alternating current lies in the sparking at the brushes. The working current passing through the motor should be practically no more difficult to commutate than an equal direct current, and it is not this current which gives trouble. The real source of trouble is found in a local or secondary current set up in any coil, the two ends of which are momentarily short-circuited by a brush. This coil encloses the alternating magnetic field, and thus becomes a secondary circuit of which the field coil forms the primary. In the motors of the Washington, Baltimore & Annapolis Railway this commutation difficulty has been overcome by so designing the motor that the secondary or short-circuit current in the armature coil is small, and the commutating conditions so nearly perfect that the combined working and secondary currents can be commutated without sparking. This condition being obtained, the motor operates like a direct-current machine, and will give no more trouble at the commutator than ordinary direct-current railway motors Experience covering a considerable period in the opration of motors of 100-hp capacity indicates that no trouble need be feared at the commutator.

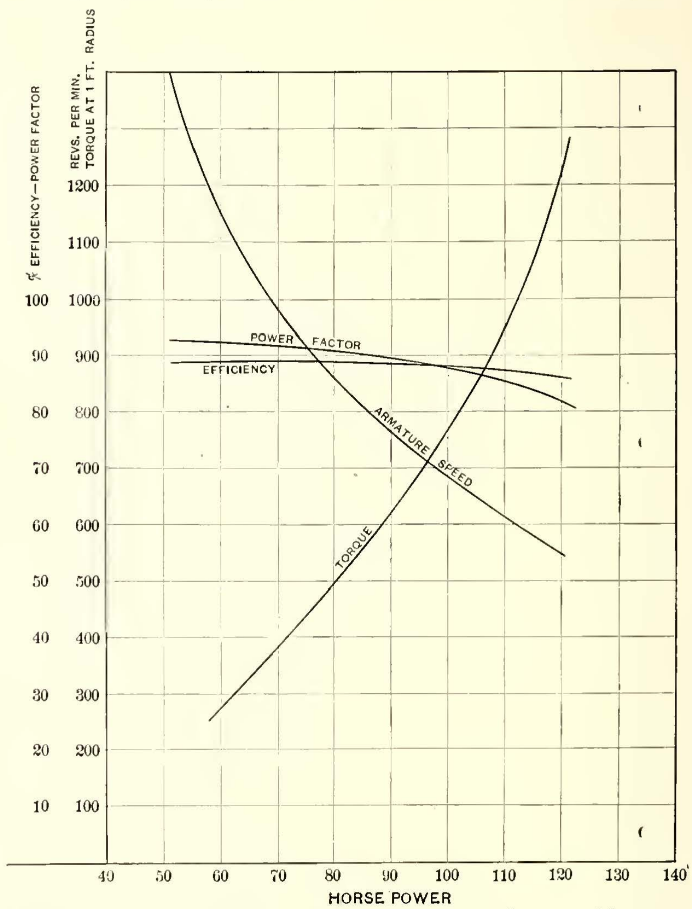
An extended series of tests were made with these motors at the Westinghouse shops at East Pittsburgh, both in the testing room and under a car. Fig. 2 shows curves of the speed, torque, efficiency and power factor plotted from data from brake tests.

It should be noted that the efficiency is good, being very nearly equal to that of high-class direct-current motors. The power factor, as shown in these curves, is highest at light loads and decreases with the load. This is due to the fact that the power developed increases approximately in proportion to the current, while the wattless component of the input increases practically as the square of the current. The curve indicates that the average power factor will be very good. The calculations for the Washington, Baltimore & Annapolis Railway show that the average power factor of the motors will be approximately 86 per cent.

The average efficiency of these equipments will be much higher during starting and accelerating than that of corresponding direct-current equipments, as rheostatic losses are avoided. When running at normal full speed, however, the efficiency will be slightly less than with direct current. This is due to the fact that the alternating-current motor efficiency is slightly lower than the direct current, and in addition there are small losses in the transformer and the regulator. The alternating-current equipments are somewhat heavier than the direct-current, thus requiring some extra power, both in accelerating and at full speed. Therefore, for infrequent stops, the direct-current car equipment is more efficient than the alternating current; but for frequent stops the alternating current shows the better efficiency. Tests on the East Pittsburgh track verified this conclusion. But the better efficiency of the direct-current equipment, with infrequent stops, is offset with the alternating current by decreased loss in the trolley wire, by reason of the higher voltage used, and by the elimination of the rotary converter losses. The resultant efficiency for the system will therefore be equal to or better than that of the direct current.

In the Washington, Baltimore & Annapolis Railway contract the guarantee given by the Westinghouse Electric & Manufacturing Company states that the efficiency of the system shall be equal to that of the direct-current system with rotary converter substations.

There is one loss in the alternating-current system which is relatively much higher than in the direct current. This is the loss in the rail return. Tests have shown that at 2000 alternations it is three to four times as great as with an equal direct current. This would be a serious matter in cases where the direct-current rail loss is high. But the higher alternating-current trolley voltage reduces the current so much, that the alternating-current rail loss is practically the same as with direct current at usual voltages. In many city railways the direct-current rail loss is made very low,



Westinghouse Alternating Current Railway Motor, No. 91.; Single-Phase; 220 Volts.

FIG. 2

not to lessen waste of power, but in order to reduce electrolysis. In such cases the alternating-current rail loss could be higher than direct current, thus decreasing the cost of return conductors. More numerous transformer sub-stations, with copper feeders, connected to the rail at short intervals will enable the rail loss to be reduced to any extent desired. As a frequency of 2000 alternations per minute is used, the lighting of the cars and the sub-stations was at first considered to be a serious difficulty, due to the very disagreeable winking of ordinary incandescent lamps at this frequency. Two methods of overcoming the winking were tried, both of which were successful. One method was by the use of split phase. A two-phase induction motor was run on a single-phase 2000 alternating circuit, and current was taken from the unconnected primary circuit of the motor. This current was, of course, at approximately 90 degs. from the current of the supply circuit. A two-phase circuit was thus obtained on the car. Currents from the two phases were put through ordinary incandescent lamps, placed close together. The resulting illumination a few feet distant from the lamps showed about the same winking as is noticed with 3000 alternations. With two filaments in one lamp the winking disappears entirely. A three-phase arrangement would work in the same way.

A much simpler method was tried, which worked equally well. This consisted in the use of very low-voltage lamps. Low voltage at the lamp terminals allows the use of a thick filament with considerable heat inertia. Tests were made on lamps of this type at a frequency of 2000 alternations, and the light appeared to be as steady as that from the ordinary high-frequency incandescent lamp. The low voltage is not objectionable in this case, as a number of lamps can be run in a series, as in ordinary street railway practice, and any voltage desired can readily be obtained, as alternating current is used on the car.

There will be an air compresser, driven by a series alternating-current motor, on each car, for supplying air to the brakes, and for operating the driving mechanism of the controller. The details of this mechanism are not sufficiently near completion to permit a description of it. The method used will be one which readily allows operation on the multiple-unit system.

The generating station contains some interesting electrical features, but there is no great departure from usual alternating-current practice. There will be three 1500-kw single-phase alternators. These are twenty-four-pole machines, operating at eighty-three revolutions and wound for 15,000 volts at the terminals. They are of the rotating field type, with laminated magnetic circuits and field coils of strap on edge. The field coils are held on the pole tips by copper supports, which serve also as dampers to assist in the parallel running. The armatures are of the usual slotted type. The armature coils are placed in partially closed slots. There are four coils per pole. The proportions of these machines are such that good inherent regulation is obtained without saturation of the magnetic circuit. The rise in potential with full non-inductive load thrown off will be approximately 4 per cent. An alternative estimate was furnished for the generators proposing 20,000 volts instead of 15,000. The simplicity of the type of winding used, and the low frequency, are both favorable for the use of very high voltage on the generator. As 15,000 volts was considered amply high for the service, the engineers for the railway considered it inadvisable to adopt a higher voltage.

There are to be two exciters, each of 100-kw capacity at 250 revolutions. The exciters are wound for 125 volts normal. The armature of each exciter has, in addition to the commutator, two collector rings so that single-phase alternating current can be delivered. It is the intention to use the exciters as alternators for supplying current to the system for lighting when the large generators are shut down at night. The main station switchboard comprises three generator panels, one load panel, and three feeder panels. High-tension oil-break switches are to be provided, operated by means of controlling apparatus on the panels. The switches, bus-bars and all high-tension apparatus will be in brick compartments, separate from the board. In each generator circuit there are two non-automatic oil-break switches in series; and on each feeder circuit there are two overload, time-limit, oil-break switches in series. The two oil-break switches in series on the same circuit, can be closed separately, and then opened to test the switches without closing the circuit. With the switches in the closed position they are both operated at the same time by the controlling apparatus, to ensure opening of the circuit, and to put less strain on the switches, although either one is capable of opening the load. There will be nine transformer sub-stations distributed along the railway line. Each station will contain two 250-kw oil-cooled lowering transformers, supplying approximately 1000 volts to the trolley system. Two transformers are used in each station so that in case of accident to one transformer the station will not be entirely crippled. It is the intention of the railway company to operate a direct-current road already equipped with the direct-current system. The present direct-current car equipments are to be retained, but the current will be supplied from a rotary converter sub-station fed from the main system of the Washington, Baltimore & Annapolis Railway. As this system is single-phase, it is necessary that single-phase rotaries be used in the sub-stations. There are to be two 200-kw 550-volt rotary converters. These are four-pole, 500-revolution machines. The general construction of these machines is very similar to that of the Westinghouse polyphase rotary converters. The armature resembles that of a polyphase rotary, except in the number of collector rings, and in certain details of the proportions made necessary by reason of the use of single-phase. The commutating proportions are so good that any reactions due to the use of single-phase will result in no injurious effect. The field construction is similar to that of a polyphase rotary. The laminated field poles are provided with dampers of the "grid" or "cage" type, a form used at present in the Westinghouse polyphase rotary converters. The dampers serve to prevent hunting, as in the polyphase machines, and also to damp out pulsations due to single-phase currents in the armature. The damper acts to a certain extent as a second phase. Each rotary converter is started and brought to synchronous speed by a small series alternating-current motor on the end of the shaft. The voltage at the motor terminals can be adjusted either by loops from the lowering transformer or by resistance in series with the motor, so that true synchronous speed can be given to the rotary converter before throwing it on the alternating-current line.

From the preceding description of this system and the apparatus used on it, some conclusions may be drawn as to the various fields where it can be applied to advantage. It is evident that a good field for it will be on interurban long-distance lines such as the Washington, Baltimore & Annapolis Railway. On such railways high-trolley voltage and the absence of converter sub-stations are very important factors.

For heavy railroading, also, this system possesses many ideal features. It allows efficient operation of large equipments at practically any speed and any torque, and also avoids the controller troubles which are ever present with large direct-current equipments. It also permits the use of high-trolley voltage, thus reducing the current to be collected. In this class of service the advantages of this alternating-current system are so great that it is possible that heavy railroading will prove to be its special field.

For general city work, this system may not find a field for some time to come, as the limitations in the present system are not so great that there will be any urgent necessity for making a change. It is probable that at first this system will be applied to new railways, or in changing over steam roads rather than in replacing existing city equipments. One difficulty with which the new system will have to contend is due to the fact that the alternating-current equipments cannot conveniently operate on existing city lines, as is the present practice where interurban lines run into the cities. It will be preferable for the alternating-current system to have its own lines throughout, unless very considerable complication is permitted. When the alternating-current system applied to interurban and steam railways finally becomes of predominant importance, it is probable that the existing direct-current railways will gradually be changed to alternating current, as a matter of convenience in tieing the several lines together.

As was stated, alternating-current equipments cannot conveniently be operated on direct-current lines. It does not follow, however, that the motor will not operate on direct current. On the contrary, the motor is a first-class direct-current machine, and if supplied with suitable control apparatus and proper voltage it will operate very well on the direct-current lines. This would require that the motors be connected normally in series, as the voltage per motor is low.

A complete set of direct-current control apparatus would be needed when the alternating-current equipment is to be run on direct current, and considerable switching apparatus would be necessary for disconnecting all the alternating-current control system and connecting in the direct current. The complication of such a system may be sufficient to prevent its use, at least for sometime to come.

In some cities very strict laws are in force in regard to the voltage variations in various parts of the track system. The permissible variations are so small, in some cases, that an enormous amount of copper is used for return conductors; and in some cases special boosters are used in the return circuits to avoid large differences of potential between the various parts of the track system. The object in limiting the conditions in this manner is to avoid troubles from electrolysis. The alternating-current system will, of course, remedy this.

For city work, it is probable that voltages of 500 or 600 would be employed instead of 1000 or higher. The transformers and controllers can be designed to be readily changed from full to half voltage, so that low voltage can be used on one part of the line, and high voltage on another. As the car equipments of such railways are usually of small capacity, it is probable that speed control will be obtained by means of a transformer with a large number of leads carried out to a control drum, rather than by means of the induction regulator, as the latter device is much more expensive in small units. This is chiefly a question of cost, and if the advantages of the induction regulator are found to overweigh the objection of the high first cost, then it will be used, even on small equipments.

In the Washington, Baltimore & Annapolis Railway, the generators are wound for single-phase. In the case of large power stations with many feeders, the generators may be wound for three-phase, with single-phase circuits carried out to the transformer sub-station, or three-phase transmission may be used, with the transformers connected in such a manner as will give a fairly well-balanced three-phase load.

There are many arrangements and combinations of apparatus made possible by the use of alternating current in the car equipments, which have not been mentioned, as it is impracticable to give a full description of all that can be done. But enough has been presented to outline the apparatus and to indicate the possibilities of this new system which is soon to see the test of commercial service.

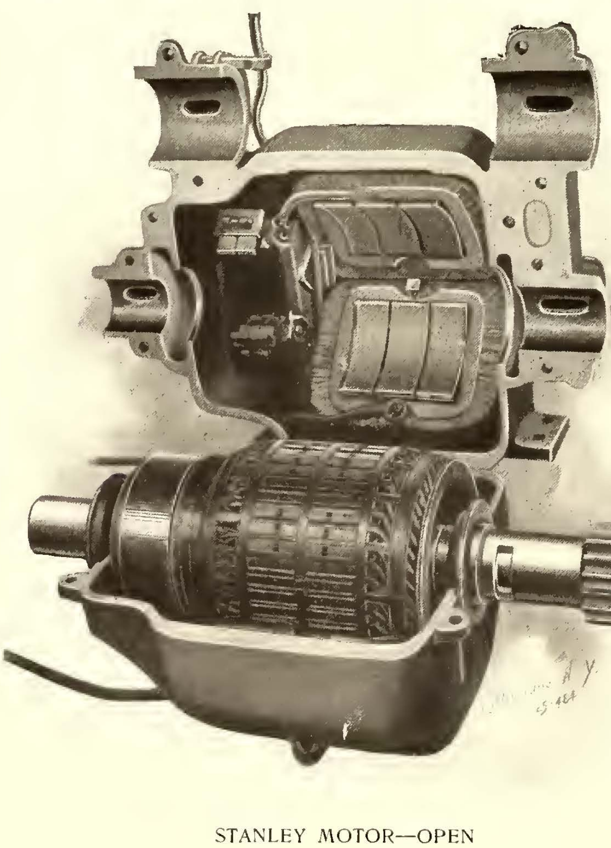
Recent Traction Apparatus

The S K C 401 Railway Motor

This motor, which has recently been brought out by the Stanley Electric Manufacturing Company, is designed for city and suburban service and has a rating of $37\frac{1}{2}$ hp, based on the usual shop test of 75 degs. F. rise at the expiration of one hour's run at full load. As a matter of fact, however, on account of the ventilation of the motor the temperatures actually reached in service are considerably below those that might be expected in view of this rating. The frame is approximately cylindrical in shape and is divided horizontally into two halves, which are held together by four bolts. On the side furthest from the axle there are two eye bolts on the lower half, which fit on hooks cast in the upper half. The lower half can be swung down by taking out the two bolts nearest the axle, leaving it hanging on the two eye bolts and their hooks. If it is desired to remove the lower half entirely all four bolts are removed and the lower frame dropped into the pit by suitable jack or tackle.

The pole pieces are made up of soft laminated steel punchings, riveted together and attached to the frame by bolts passing through the frame and tapped into a large rivet in the center of the pole piece. Each pole piece has a flare or offset at the armature end, which, besides holding the field coil in place, also effects that distribution of the magnetic flux entering the armature which results in the best commutation.

The armature bearings are babbit-lined cast-iron shells. These are of ample size, the commutator bearing being $6\frac{1}{8}$ ins. long and



STANLEY MOTOR—OPEN

the pinion bearing $7\frac{3}{4}$ ins., so that the wear of bearings, which has been such a frequent source of trouble, is reduced to a minimum. The bearings are held in place by bearing caps bolted to greased boxes cast in the upper half of the frame. The caps themselves are entirely separated from the lower half of the frame so that the lower half may be removed, leaving the armature supported by the upper half. If desired, however, the caps may be removed before the frame bolts and the armature lowered with the lower half of the frame. The caps are deep and hollow, furnishing ample oil cellars, and the bearings are kept lubricated by wicks bearing against the shaft. Grease boxes fitted with spring-closed covers are cast in the upper half of the frame and project over the bearings, furnishing an additional source of lubrication in case the oil runs out or the bearing begins to heat from other causes. A space is left between the bearing cap and the frame, through which projects the oil guard on the armature shaft. Any oil escaping from the bearing is thus thrown outside of the motor and prevented from reaching or injuring the field or armature. The axle bearings resemble the armature bearings in their general construction. The field coils are wound with square wire thoroughly insulated. By allowing ample room in the frame casting the designers have been able to use a flat coil, so that the wire is not injured by bending after being removed from the form on which it is wound.

The method of bringing out the terminals of the field coils is a feature which will be appreciated by those who have had experience in the repairing of street railway motors. The inner end of each coil is attached to a flat, flexible copper strip, which is brought out through the insulation, and the strips from the several ends are clamped together. The outer end of each coil is attached to a rubber-covered flexible wire several feet in length. These wires are brought through appropriate holes in the frame and are attached to the car wiring on the outside. This removes the danger of broken field wires at the terminals inside of the motor and makes it impossible for a repair man in replacing the coils to connect them in the wrong order. The coils after winding are dried in an oven and, while hot, are dipped in an insulating compound, which fills the spaces between the wires and prevents the entrance of oil or moisture. The coils are then wrapped in layers of rope paper, mica and tape, with leatheroid protection where there is a liability of chafing, and are finally thoroughly japanned and baked. The company's experience in insulation of high voltage coils indicates the very best results in insulation of both field and armature coils in this way.

The armature is unusually well ventilated. Large ducts, parallel to the shaft, allow the air to enter the body of the armature and ventilating ducts, perpendicular to the shaft, allow the heat to escape from the interior of the iron. The magnetic densities of armature core and teeth are so proportioned as to insure good commutation at heavy overloads, and the ample ventilation protects the insulation from injury by reason of these overloads.

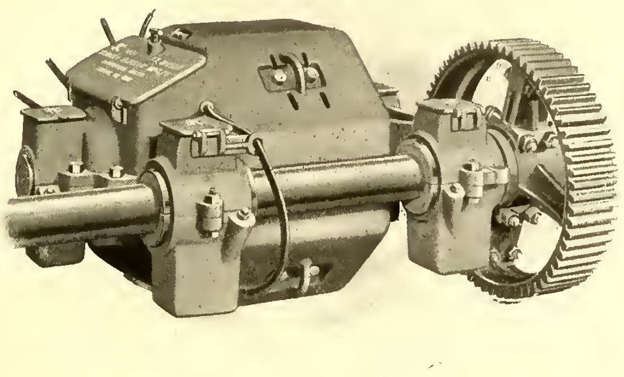
The armature end-casting projects above the level of the coils so as to protect the end-windings from injury. This casting, being well cored out and well ventilated, is light and allows ample access of air to the windings.

The armature coils are form-wound, dipped and thoroughly insulated with oiled linen and tape. The band wires holding the coils in place lie in grooves below the general surface of the armature, so that even if the bearings wear down the face of the iron protects the armature bands from injury and thereby avoids a source of trouble frequently experienced in earlier types of motors.

The commutator is carefully designed and solidly constructed. The bars are clamped together in a jig with micanite insulation between and baked to soften or remove the shellac or other cementing material. The clamping screws are then tightened and the bars drawn solidly together. The ends are then turned to gage and the insulating heads and end clamps fitted into place, after which it is again baked and the end clamps set up and locked into position.

A neat cover over the commutator permits inspection of the same and replacing of brushes. Another hand hole at the bottom of the motor allows inspection from below. This hole is fitted with a ventilated cover filled with a sponge, which prevents the entrance of dust, but allows any water in the bottom of the motor to escape.

The motor is not watertight, in the sense that the entrance of water into its interior is absolutely prevented. The object has been to design a well-ventilated motor from which the heat from the interior, as well as any water, can readily escape. There are ventilating spaces under the cover of the motor, as well as at the opposite end, through which the air can enter the armature body, to be thrown out through the perpendicular ventilating ducts in the armature. Ventilating ducts are also provided in the pole



STANLEY MOTOR—CLOSED

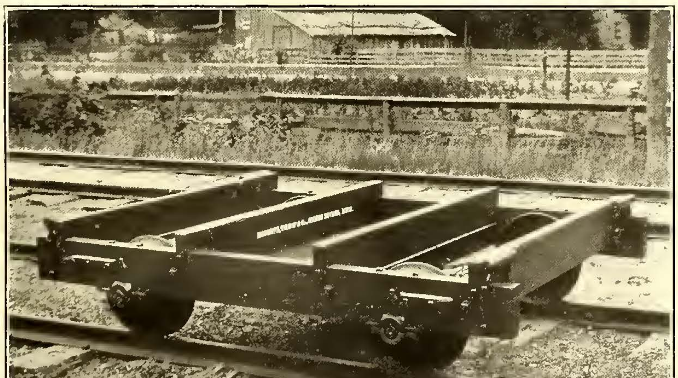
pieces, corresponding to those in the armature, an arrangement which results in a very free circulation of air in the interior of the motor. Gear and pinion for this motor are furnished with four standard ratios of reduction. The following table gives approximately the gearings ordinarily used for different kind of service:

CHARACTER OF SERVICE.

	Pinion	Gear	Ratio
Freight	15	69	4.60
Ordinary Passenger	17	67	3.94
Medium Speed	19	65	3.42
High Speed	22	62	2.82

Track-Laying Cars

The accompanying cut illustrates the track-laying car manufactured by the Roberts Car & Wheel Company, of Three Rivers, Mich. A special feature of this car is that the frame is fastened together by double blind tenons at each end of the four cross



TRACK LAYING CARS

sills and four ⅝-in. rods running full width of car; also with two diagonal truss-rods to keep it in perfect tram. For standard-gage track the measurements of the car over sills are 7 ft. 8 ins. x 6 ft. 3 in. It is equipped with cast-iron wheels 16 ins. in diameter with chilled tread 4 ins. or 6 ins. wide, as required, on steel axles 3 ins. in diameter with babbited boxes. The tool box is in the center of the car. There are steel rolls and draw-hooks at each corner, and the cross sills are plated with iron. This car is built for any gage track.

A Remarkable Specimen

The illustration herewith shows a straight line hanger and ear which were taken from the line of the Mill Creek Valley Street Railroad Company, St. Bernard, Ohio. The damaged appearance of the hanger and ear was caused by a dead short-circuit between the trolley and ground. It seems that in some way the positive trolley wire came into contact with the negative wire on one of the cars, causing a short-circuit of the line. The circuit breakers, being set at 2000 amps., would not open up until the engi-

DAMAGED HANGER AND EAR

neer opened the circuit by pulling out the breaker, and at the time that was done, he noticed that the short-circuit was carrying 150 amps.

An examination of the cut will show the extremely disastrous nature of the arc caused by the short-circuit, which was sufficient to melt entirely away the ends of the trolley ear, and also the lower part of the skirt of the hanger supporting it. The hanger in question was a type D hanger, made by the Ohio Brass Company, of Mansfield, Ohio, and the insulation was its well-known "Dirigo" make. Despite the fact that the hanger and car were so badly damaged by the arcing that the stud bolt of the hanger was partially melted away and fused on to the boss of the ear, the insulation was practically uninjured, with the exception of a slight charring of it at the lower edge of the insulated bolt. A test of 500 volts afterward applied between the hanger casting and ear showed that the insulation of the hanger was still perfect, a fact which, in itself, speaks well for the heat-resisting and insulating properties of "Dirigo" insulation.

The first electric train over the Sixth Avenue Division of the Manhattan Elevated Railroad, of New York, was run from South Ferry Station to Fifty-Eighth Street on Sept. 29. The train consisted of three cars similar in construction to those which have been in use on the Third Avenue division, and later in the afternoon a second train of six cars was sent over the same line. The test having been made successfully, the company is now prepared to open the regular Fifty-Eighth Street and South Ferry service, which was discontinued several weeks ago on account of the coal shortage. Preparations are practically complete for installing the electric service on the Ninth Avenue division, and it is probable that a trial trip will be made over this line within a few days. The company plans to start the regular schedule of electric trains over the Ninth Avenue division on Nov. 1.

Robins Belt Conveyors in Power Houses

The accompanying drawings seem to illustrate two instances of the broadening use of Robins belt conveyors in the field of coal and ash handling. These conveyors have proved themselves to be especially adapted for carrying coal under various conditions, as their use has been found to reduce the breakage of coal to a minimum. But, though they have been used for years at breakers, washeries, shipping piers, coal pockets, locomotive coaling stations and in handling the coal required at various industrial plants, the installations here described are the first cases of the use of these conveyors to take care of the entire coal supply of large stations for generating electricity. For this service their large capacity is of great importance, as is also their lightness and the small amount of space they occupy. At the shipping pier of the Dominion Coal Company at Louisburg, Cape Breton, 750 tons of coal per hour are handled on a 36-in. Robins belt conveyor.

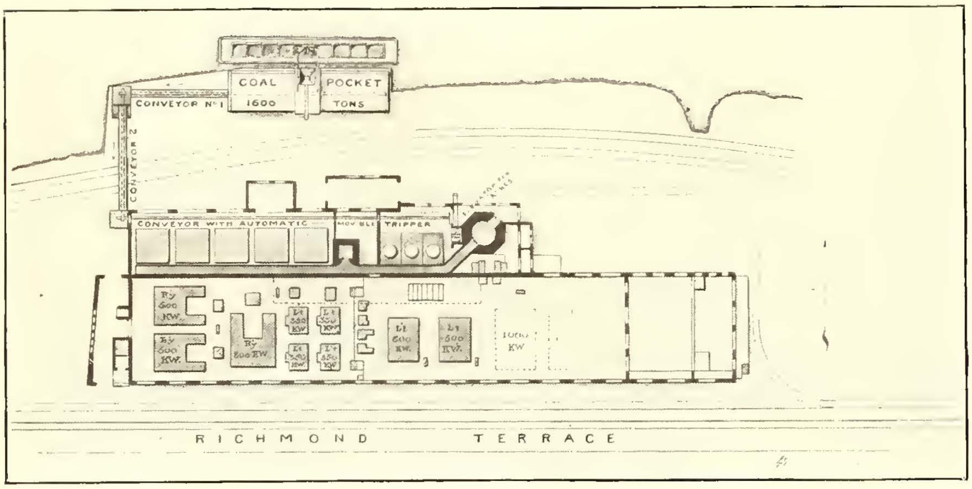


FIG. 1.—PLAN OF RICHMOND LIGHT & RAILWAY POWER EQUIPMENT

The Robins patent conveying belt is provided with a heavy rubber cover on the carrying side, thicker in the center than at the edges, the reinforcement at the center serving to prevent abrasion where the wear is heaviest, while the stiffer sides make the belt bend more easily at the center and better preserve its rough shape between the sets of idler pulleys. The latter consist of three cast-iron pulleys running on hollow steel shafts, which, in turn, are held by two cast-iron brackets. Lubrication is accomplished by forcing grease into the shafts with compression grease cups. The grease enters the bearing at the center and is constantly forced toward both ends where it forms a collar which keeps out dust and dirt. The Robins patent tripper is propelled by the motion of the conveying belt, which is connected with the driving wheels through spur gears. It reverses its direction automatically at either end of its run, thus traveling constantly back and forth, all the while distributing its load as it goes.

Figs. 1 and 2 illustrate the conveyor machinery in the station of the Richmond Light & Railroad Company at Livingston, Staten Island. The timber pocket is of 1600 tons capacity and was erected on a pile sub-structure. Coal is taken from barges moored alongside the pocket by a one-ton Hayward shovel operated by a Lidgerwood steam engine. The coal is crushed, weighed and delivered; the crusher and weighing hopper are mounted on a traveling frame, the boom being the Robins Conveying Belt Company's balanced shear leg type operated by one man. The coal is withdrawn from the storage pocket by chutes in the bottom decking, which feeds a Robins conveyor with a belt 16 ins. wide, which passes under the pocket and then rises on an incline to feed the transverse belt—conveyor No. 2, which passes over the railroad tracks. Conveyor No. 2 delivers coal to a long conveyor, which extends through the boiler rooms and delivers coal automatically into suspended steel bunkers. This is effected by means of a Robins automatic and self-reversing tripper. The conveyors have a capacity of 125 tons per hour. The coal is handled without dust or breakage and the conveyors run noiselessly. The ashes are removed by a steel tip-car, which is elevated when full on a platform elevator, to a convenient dumping point for loading cars by a chute.

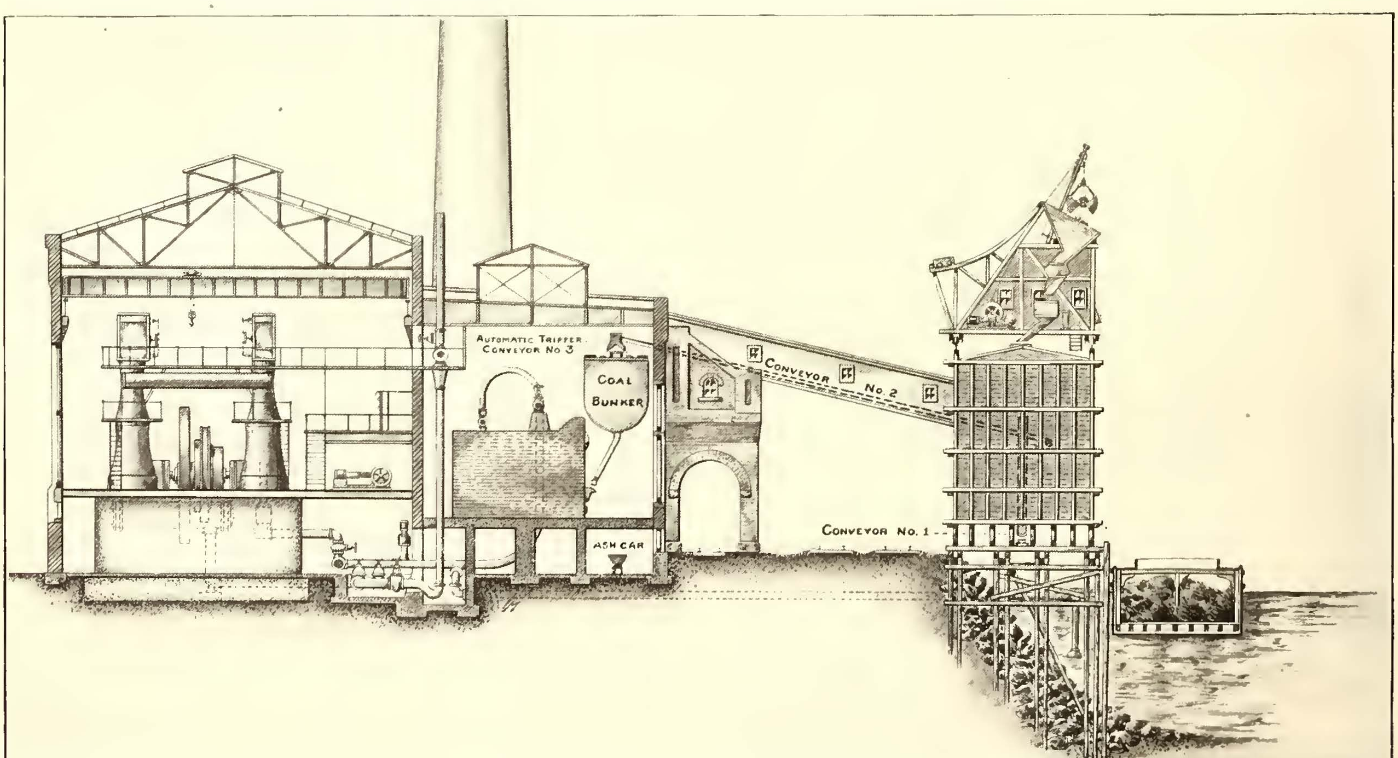


FIG. 2.—COAL AND ASH HANDLING APPARATUS AT RICHMOND LIGHT & RAILWAY PLANT, STATEN ISLAND

Fig. 3 illustrates the coal and ash handling apparatus at the Kingsbridge power station of the Third Avenue Railroad Company, now being erected by Westinghouse, Church, Kerr & Co., The coal at this station will be unloaded by a one-ton power shovel rigged on a steel "steeple" tower which is of unusually heavy construction. The engine for operating the shovel was built especially for this plant by the Lidgerwood Manufacturing Company and has cylinders 16 ins. x 24 ins. The truck is moved by a similar engine with 10 in. x 12 in. cylinders. The power shovel delivers coal to a receiving hopper which has a full-length grizzly and by-pass to deliver fine coal to the duplex weighing hoppers. Large lumps of coal pass over the grizzly to a powerful Westinghouse coal cracker, which delivers to the duplex weighing hoppers. The coal passes from the weighing hoppers to a two-way chute, which delivers the coal to either of the two belt conveyors. Each of these has a 24-in. belt and the capacity of each is 250 tons per hour. These parallel conveyors elevate the coal to conveyors in the roof of the boiler house, extending over the coal bunker. Coal is distributed in the storage bunkers, as in the Livingston installation, by automatic self-reversing trippers. The connecting inclined bridges are of extremely light construction, owing to the lightness of the belt conveyors. Ashes are drawn off into steel tip cars, which are hauled by electric locomotives to the dumping pits and chutes, which feed the ashes to a conveyor which elevates them to the pocket under the coal-hoisting towers. The ashes are distributed in the bunker by an automatic tripper. From the pocket the ashes may be chuted to barges or to carts.

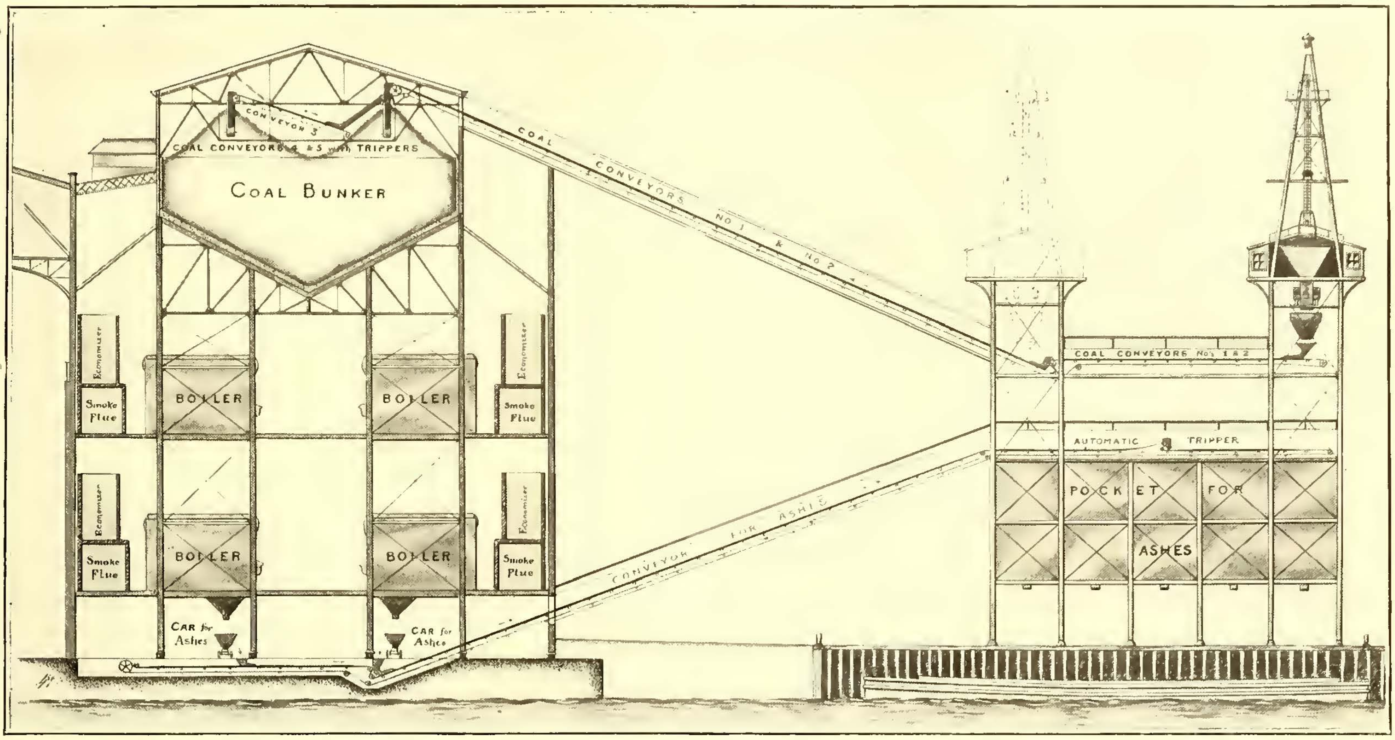
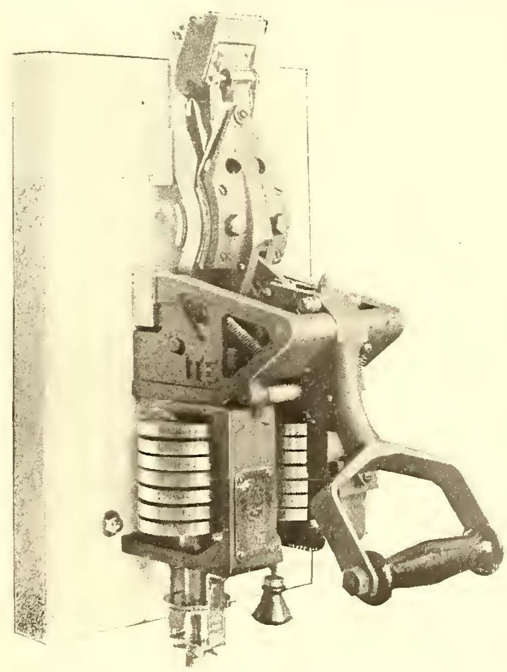


FIG. 3.—HANDLING COAL AND ASHES AT THIRD AVENUE RAILWAY PLANT, NEW YORK

The Robins belt conveyor has been in use for several years in the Ninety-Sixth Street Station of the Metropolitan Street Railway for removing ashes. Among other power plants at which they are in use for auxiliary purposes of coal and ash handling are the Boston Elevated Railroad Company, Cleveland Electric Railway Company, Chicago Edison Company and South Side Elevated Railway Company.

Single Pole I-T-E Circuit Breaker

The type of circuit breaker illustrated by the accompanying cut, originally designed for the protection of the generating side of boosters, has found a still wider field of usefulness in the protection of generators running in parallel. When used for the protection of boosters, this instrument not only opens the circuit in case of an overload or short circuit, but it also opens the instant the current tends to flow into the booster, the reversal of the current being due to a drop in the voltage of the latter below that of the line to which it is connected, in which case, unless the circuit is promptly opened the booster operates as a motor, resulting invariably in overloading the circuit and not infrequently in serious mechanical injury to the booster itself. When used for the protection of generators running in parallel, the circuit breaker prevents injury to the machines by making it impossible to connect them in parallel until their voltages are properly equalized. The breaker will also automatically cut out any generator in case of interruption of the field circuit. In either of these cases, in the absence of the protection afforded by circuit breakers of this class, the other generators would tend to run the low voltage one as a motor, often overloading and throwing out the main circuit breakers in the whole power house. Overload and reverse current circuit breakers, such as the one shown, are especially serviceable for the protection of generators operated by water-wheel. The Cutter Company

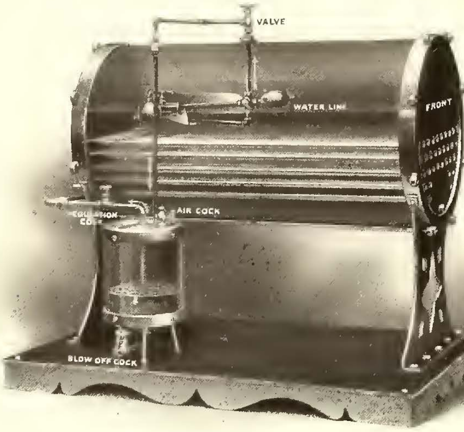


SINGLE POLE CIRCUIT BREAKER

manufactures it, also makes circuit breakers of the "plain reversal" and "overload and reversal" types, single and double pole, knife blade or laminated contacts, in any capacity for voltages up to 800 volts.

Garrigus Mechanical Boiler Cleaner

The Garrigus mechanical boiler cleaner has been before the public for four years, and in spite of the fact that many owners of steam plants have had a sad and costly experience with so-called cleaners, this invention has made many friends among practical men and is now in actual use in over 400 boilers, where it has proved very satisfactory under ordinary commercial conditions. It is strictly a mechanical device. A feature is the floating skimmer that conforms to the scum line at all times, keeping the boiler



MECHANICAL BOILER CLEANER

clean no matter what the condition of the water may be. It removes and prevents scaling, pitting, corroding and foaming, and besides the greater efficiency of the boiler, due to the absence of scale, it strengthens and preserves the iron, thus greatly increasing the life and safety of the boiler.

The impurities in water separate under ordinary working pressures and are held in suspension. The sediment thus formed, together with any earthy matter, is carried by the currents to the surface of the water and then to the rear of the boiler, where it is arrested by the trough-shaped wings; when the junction of the wings is reached the sediment is taken up by the floating skimmer (the mouth of which is always at the scum line) and discharged through the outlet pipe, with a centrifugal force, into the precipitator. The lower temperature in the precipitator and its special construction cause the sediment to settle rapidly. It then remains in the lower compartment of the precipitator until drawn off through the blow-off pipe. The circulation is completed by the return pipe, which is connected with the boiler, and takes only clear water from the precipitator. Thus the sediment is continuously and effectively removed from the boiler. The precipitator should be blown off every two or three hours. This requires very little time—about one minute at each operation.

The economical advantages of operating a perfectly clean boiler are apparent, and the fact that this cleaner removes all impurities before such foreign matter settles, or, in other words, before any damage is done, appeals to practical men. One company writes that "the mechanical floating skimmers attached to ten boilers in different plants of ours in this city are all that you claim for them. Every one is working admirably and our boilers are as clean as a bright silver dollar. We use no compounds whatever, and can cheerfully recommend the cleaner to the confidence of boiler users."

It is claimed for the cleaner that it pays for itself, that the saving on fuel alone will more than meet the cost in a short time, and the fact that the company proposes to place the cleaner on boilers entirely at its own expense, giving ample time to thoroughly try them and guaranteeing them to give satisfaction before payment is made, is certainly sufficient evidence that the company has confidence in the device.

The illustration shows the device attached to a tubular boiler It may be used on all kinds of water-tube boilers. Coe, Smith & Co., 413 Western Union Building, Chicago, are the selling agents for the Garrigus Mechanical Boiler Cleaner Company, and will be represented at the American Street Railway Convention by W. R. Mason, the Western manager.

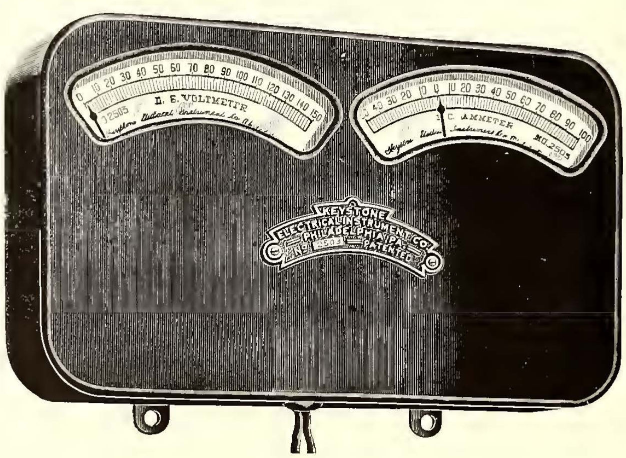
New Works for Knell Air Brakes

The Knell Air Brake Manufacturing Company, Ltd., which was organized recently at Battle Creek, Mich., for the purpose of manufacturing the Knell air brake, air compressors, air hoists and special machinery, commenced operations in its new plant on Sept. 1. The shop is equipped with the very best and latest machine tools and the company is in a position to take prompt care of all its business in the future. The company's air brakes have given excellent results in the past on a number of roads, and with the company's new manufacturing facilities an excellent business is expected.

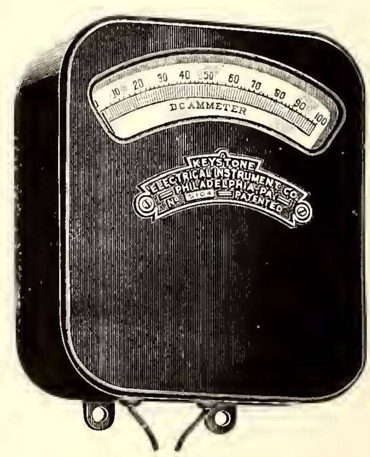
Keystone Instruments

The Cutter Company, of Philadelphia, which some months ago assumed the sales management of the Keystone Electrical Instrument Company, has given especial attention to these instruments in connection with street railway work, and the high reputation of the Cutter Company in electrical matters, together with that of the Keystone Company for electrical instrument manufacture, makes an extremely strong combination. The accompanying engraving shows the latest type of the Keystone "illuminated dial" instrument. This instrument is made in either black and copper or black and nickel, as may be desired by the customer, and this finish is also applied to the standard "round pattern" type.

A growing demand is reported for a combined ammeter and voltmeter in one case. This type was originally designed for automobile use, but its compact form has rendered it particularly



COMBINED AMMETER AND VOLTMETER



KEYSTONE ILLUMINATED DIAL

adaptable for small switchboards. The second illustration shows an instrument of this type. The case is almost square, with rounded corners, the whole covered with black enamel, which is an extremely pleasing finish and very durable. When required, either voltmeters or ammeters, separately, can be supplied in cases of this character.

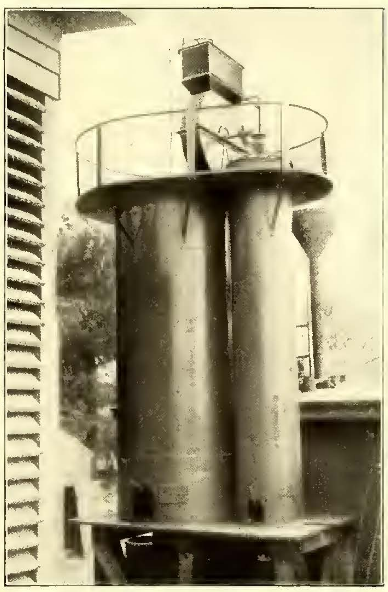
The Keystone Company also manufactures a complete line of portable testing instruments, the merits of which are fully known. All of these instruments are guaranteed by the Cutter Company.

Since his return to London, Mr. Yerkes, if the cable despatches are to be believed, has been talking very freely concerning the ruinous competition of the J. P. Morgan combination in the underground railway field. He is quoted as saying that lines other than those to be built by him are not needed, but that he is prepared to meet all competitors.

Automatic Apparatus for Feed-Water Softening

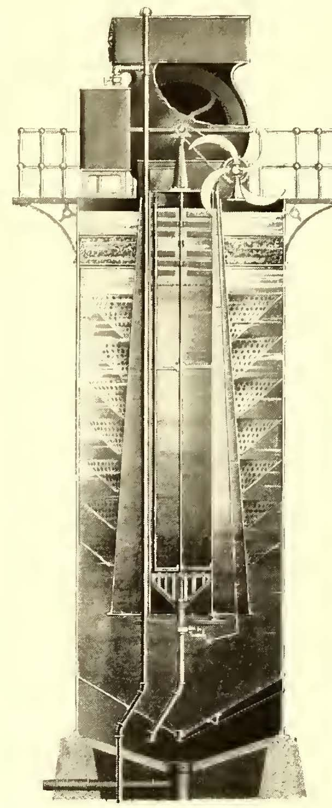
The treatment of feed-water to prevent boiler scale is now settling down to certain definite well understod lines. Many of the schemes which have been tried in the past for preventing boiler scale have been somewhat after the nature of the cure for rheumatism, which consists in carrying a potato in the pocket. Scale-forming solids in the great majority of boiler feed-waters are carbonate of lime or magnesia held in solution by carbonic acid gas and sulphate of lime or magnesia. There are many chemicals which will precipitate these salts. Carbonate of lime is precipitated by lime water, sodium phosphate, caustic soda, barium hydrate, tannin extract or common sugar. By far the cheapest of these per pound of carbonate of lime which must be precipitated from the water, is lime water obtained from common unslaked lime. Sulphate of lime is precipitated by soda ash (sodium carbonate) sal soda, barium chloride tannin extract, sugar and sodium phosphate. Of this list, soda ash is the cheapest. The use of these chemicals for the purification of water by precipitating the injurious scale-producing salts has been known for many years under the name of the Porter-Clark Process. The Clark process adds lime in the form of lime water or milk of lime to the water to be treated, thus precipitating the carbonates of lime and magnesia. The Porter process consists of adding soda to the water to be treated to precipitate the sulphates of lime and magnesia. The precipitates being settled out of the water, the resulting pure water is used for boiler feed. It is evident that to work this purification process the analysis of the water must be known so that the right amount of quicklime and soda solution can be used to completely precipitate the scale-producing salts without wasting lime or soda. Once these proportions are fixed by the analysis of the water, the whole problem lies in the apparatus for mixing the precipitating solutions and separating the precipitates. It is not desirable to have an expert chemist in charge of every steam plant to supervise the water purification. It is, on the other hand, desirable to have a water purification apparatus so simple that it will require practically no knowledge of chemistry for its operation. In fact, that it should be as nearly automatie as possible.

The water-softener plant made by the Kennicott Water Softener Company, of Chicago, has had all the details worked up with great eare, originally with the idea of offering the steam railroads softening plants which could be located at water tanks along the road and be looked after by the men operating steam pumps for these tanks. The Kennicott process is what is known as a continuous process, that is, the mixing and precipitation go on continually as long as the apparatus is in operation. It is thus distinguished from processes in which tanks are filled with a certain mixture of feed water and precipitating solutions, and then allowed to stand and settle. Such plants require considerably more room than the Kennicott apparatus of the same capacity, because of the necessity of duplicate tanks, so that one tank can settle while the other is being used. Referring to the cross-sectional view of the Kennicott water softener plant, which is shown herewith, the feed-water enters the small tank at the top of the apparatus. The water flows from this box, which is called the hard-water box, and flows over an overshot water-wheel. The wheel furnishes the small amount of power required for the agitation in the lime-water saturator and a scoop wheel, the purpose of which will be explained later. It also operates a slow hoist for lifting barrels of lime and soda ash to the top of the machine. There is a float in the hard-water box which varies at the rate of flow of the soda and lime solutions, according to the head and rate of flow from the box to the softening tank. In order to provide soft water for making the lime water solution, the scoop wheel seen revolves continuously, emptying enough purified water into an adjacent box to supply the lime-water saturator. The lime saturator is the cylinder in the middle of the apparatus. The soft water from the box supplied from the scoop wheel flows down in a pipe shown at the left and enters the lime-water saturator at the bottom at which point is the lime agitator which revolves on a vertical shaft. The caustic lime is placed in this cylinder so that the agitator keeps it constantly stirred. As water flows into the lime-water saturator at the bottom, the saturated lime water overflows at the top of the cylinder and mixes with the incoming hard water from the hard-water box. At the same time the soda ash solution from another box mixes with the hard water and this mixture settles down through the conical chamber which surrounds the lime-water saturator. On account of the shape of this chamber the velocity of the water settling constantly decreases, thereby aiding the precipitates to fall to the bottom. After reaching the bottom of the cone, the water rises past perforated baffle plates (which catch some of the finer precipitates and are self-condensing), and finally rises through a mass of excelsior to the top of the purification tank, and overflows into a storage tank which may be separate or a part of the plant. The precipitated salts are drawn off from the bottom of the purification tank, and the residue is drawn off from the bottom of the saturator. The fresh caustic lime is simply poured into the top of the lime saturator cylinder and soda ash is put in a box from which this solution is drawn according to the height of the float in the hot-water box. It is, of course, assumed in this operation that the lime and soda solutions are both full saturated solutions, the apparatus being proportioned so that there is opportunity for this complete saturation to take place in the passage of water through the solu-



KENNICOTT WATER SOFTENER—TOP OPEN

KENNICOTT WATER SOFTENING PLANT—TOP CLOSED



SECTION THROUGH KENNICOTT WATER SOFTENER tion chambers. Attention is called to the fact that the main precipitation takes place as the water is falling, and hence is in the direction of the flow of the water and not against it. The heavier particles of the precipitate tend to carry down the lighter particles. The final filtration is through common excelsior, which is renewed once in six months, since it catches only the smallest particles not heavy enough to precipitate. When desired, the storage tank is placed surrounding the purifying apparatus tank. This form is compact, requiring but one foundation for storage and purifying tanks, and is probably the most economical of space of any of the forms yet designed.

The Thomas Rail-Bond

The rail-bond illustrated by the accompanying engravings consists of a series of flat strips of soft rolled copper, soldered to one another at the ends, but having a central flexible portion where the strips are unattached, the ends forming flat feet which are soldered to the rails, while the flexible part is bent into a loop that projects through an opening punched in the rails at the point of meeting, as shown in Fig. 1. A soft copper strip is placed under the ends of the bond and extends to the head and foot of the rail, giving a very large contact area between the bond and the rail. For convenience in installing the bond, and as an additional element of strength in its attachment to the rail, a small cap screw is put through the web of the rail and tapped into the foot of the bond, serving to draw the bond into close contact with the rail, and relieving the solder of much of the stress which comes upon it in service. Since the cap screw is soldered both to the rail and bond in the process of attaching the bond, it is impossible for it to become loose. The construction of the bond and its application to the rail are shown in Fig. 2. The punching of the necessary

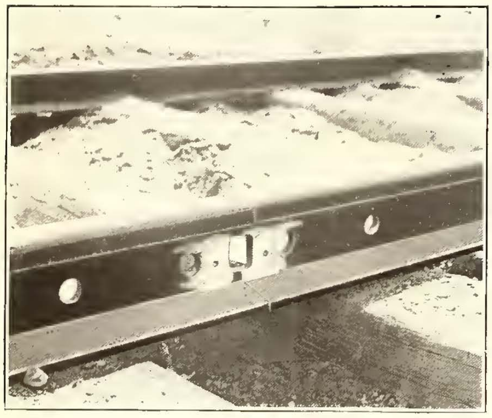


FIG. 1.—RAILS PREPARED TO RECEIVE BOND

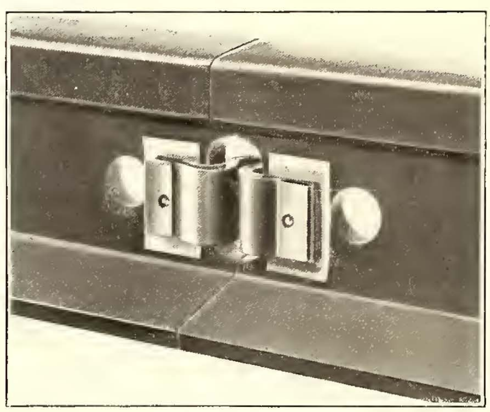


FIG. 2.—CONSTRUCTION AND APPLICATION OF BOND

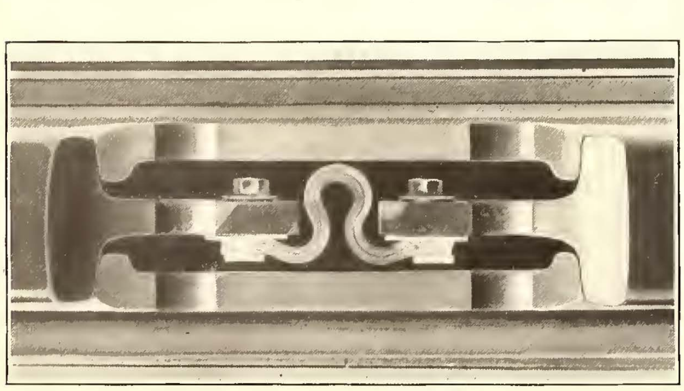


FIG. 3.—HORIZONTAL SECTION OF BOND APPLIED TO 90 -LB. RAIL

opening at the ends of the rails may be accomplished at the rail mills, or at the point of use, but the work will preferably be done by a hydraulic punch of sufficient power to punch both rails at one time after the rails are laid and the track is surfaced. The rails are then drilled for the cap screws and ground with an emery wheel where the bond is to be attached, until the surface is bright. The work of brightening the surface is done rapidly and well by means of a grinding equipment consisting of a portably mounted gasoline engine driving a flexible shaft fitted to a small emery wheel in the manner illustrated in Fig. 4. Fig. 1 shows a rail ready for the application of the bond, which is held in position by the cap screws, while the rail and bond are being brought to a soldering heat by a powerful gasoline heater. When the solder in the feet of the bond is thoroughly melted, enough is added with acid to ensure the complete filling of the space under the foot of the bond, and the cap screws are turned up hard, drawing the layers of the bond together and pulling the bond as a whole into intimate contact with the rail. The rail and bond are then allowed to cool slowly, the result being a perfectly secure, permanent joint, which cannot be broken execpt with use of tools.

One of the features of the Thomas bond is its extremely short length, being but 4½ ins. in length between the centers of the attaching surfaces. The manufacturer states that by thus employing in the circuit a greater length of rail and a shorter length of bond, the resistance of the joint is less, by 25 per cent to 40 per cent, than that of a joint bonded in the ordinary way with the same section of copper in bonds of the riveted terminal type. He says further that the rail is weakened far less by the punching necessary for this bond than by the drilling of the two holes needed for ordinary double bonding, since the metal removed from the rail is taken from a point where it has little value in supporting the rail-head, and where entire dependence is placed on the rail-joint to hold up the rail. To double-bond with riveted terminals requires drilling two ⅞-in. holes in the line of shear through the bolt holes, while the horizontal dimension of the punching for this bond, added to the width of the hole for the cap screw, is less than the diameter of a single ⅞-in. hole. Fig. 3 is a horizontal section through the bolt holes and angle-bars, showing the application of the bond to the 90-lb. T-rail.

Shop tests of these bonds indicate great life, both under horizontal bending, such as would be produced by the expansion and contraction of the rails, and under vertical deflection of one end, such as would be due to a loose joint. Under expansion and con-

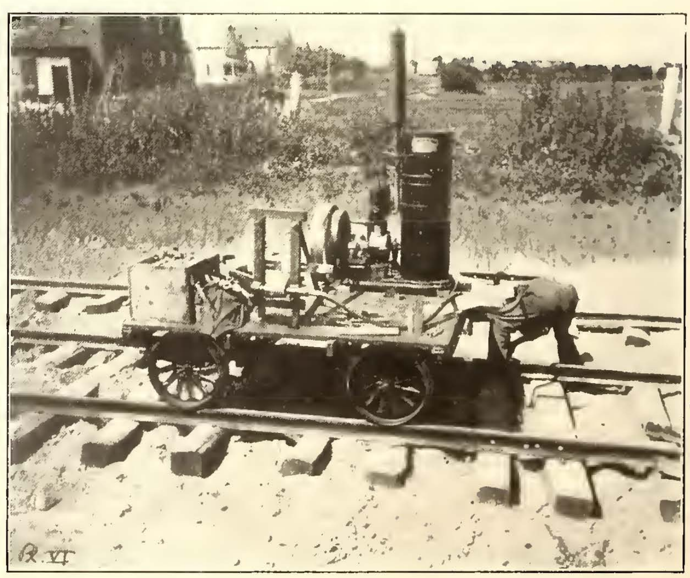


FIG. 4.—PORTABLE GRINDING EQUIPMENT FOR BRIGHTENING CONTACT POINTS

traction of ½ in. at the rate of 100 per minute, these bonds last from 12,000 to 20,000 complete movements, and at no time did the soldered joint break. Under a vertical deflection of ⅛ in. at the same rate, which could be caused only by an extremely loose joint, a bond was tested for 360,000 movements without any signs of breaking, either in the copper strands or in the soldered joint. Under these tests the bonds retained their shape perfectly, showing that in ordinary use no deformation can occur which will bring the bond into contact with either rail or joint plate. These bonds can be installed under any fish-plate or rail-joint that provides for any bonding whatever between the plate and the rail. The manufacturer, Edward G. Thomas, 4 State Street, Boston, Mass., is prepared to undertake the installation of these bonds under contract for the complete work, and can also furnish and install soldered bonds under the rail for open work, cross bonds, and feeder connections.

New Quarters of the Mayer & Englund Company

The new quarters occupied by the Mayer & Englund Company in the modern eight-story, fireproof building at 1020-1024 Filbert Street, Philadelphia, are admirably adapted to meet the requirements of this enterprising establishment. The location, in the heart of the business district of the city, conveniently near all of the depots, affords every facility for the economical handling of a large business.

BASEMENT STOREROOM FOR WIRE AND HEAVY MATERIAL

A fine suite of offices for the accounting and executive departments have been fitted up on the second floor of the building. The general shipping and store rooms occupy the first floor. The basement is utilized for heavy material, and extensive overflow storage capacity has been provided on the seventh floor. Each of the floors is 60 ft. x 80 ft., so that the company uses a total of nearly 20,000 sq. ft. of floor space, which is nearly four times the room formerly occupied in the old building on South Tenth Street. A glance at the accompanying illustrations affords conclusive evidence that this increase in space was secured none too soon.

The growth of this company's business has been in keeping with the development of the industry. Having been so closely identified with the street railway supply business for a number of years, it will undoubtedly be of interest to trace the progress of this house from its inception in 1893 by Charles J. Mayer, who acted as a commission agent for several makers of street railway supplies. When A. H. Englund became associated with Mr. Mayer during the latter part of 1895 the firm name became Mayer & Englund, and at that time the business was carried on in a single office in the Betz building, where one stenographer, one bookkeeper and a clerk to look after orders and shipments constituted the office force, the selling department being represented by Mr. Mayer and Mr. Englund. Gradually the business developed until it was necessary, in January, 1897, to move to 10 South Tenth Street, where the firm occupied the first floor and basement, the latter being used as a store room. In order to meet the requirements of an increasing trade, however, it was deemed advisable in March, 1900, to incorporate a company to transact the business as the Mayer & Englund Company, the second floor of the building on Tenth Street being engaged to meet the demand for more room, but again, in 1901, it was necessary to secure enlarged facilities, and at this time the company secured the whole building in which it was then located, comprising five floors and basement. The latest move, by which the company takes possession of the Filbert Street building, is the most important change that has yet been made, as it enables the company to handle a much larger business than could possibly be taken in the old quarters.

During the firm's early history the line of goods handled by Mayer & Englund consisted almost entirely of the gears, pinions and trolleys made by the R. D. Nuttall Company; the fare registers and fixtures made by the International Register Company, and a line of overhead insulation made by the W. T. C. Macallen Company, of Boston. To this line have been added from time to time specialties and standard street railway material, so that at the

TWO VIEWS OF SHIPPING DEPARTMENT AND STOCK ROOM ON MAIN FLOOR present time the company is furnishing a complete line of electrical and mechanical supplies required for street railway construction, maintenance, and operation, as well as supplies required by large industrial plants and factories. It was this constant growth of the business that brought about the company's last move to the commodious quarters now occupied in the new building on Filbert Street, where every up-to-date convenience is to be found.

Among many noticeable features of the new offices attention is attracted to the equipment of the clerical department, in which the loose-leaf system of bookkeeping is in use, except in the case of the general ledger. The system used is known as columnar bookkeeping, in which separate accounts are kept with each general line of specialties for the purpose of ascertaining the relative profit on different lines at the end of the year, the entire cost of conducting the business being charged pro rata to each of the different lines, according to the volume of gross sales. All the company's correspondence is kept by the vertical file and index system, under which each particular subject is given an index number, and all papers relating to the same subject are filed under the same number. All letters are duplicated in carbon, the duplicate being filed with the answer. All orders, job tickets, bills, shipping blanks, etc., are written on book typewriters. The general office and other departments are also provided with the latest labor-saving office devices and appliances.

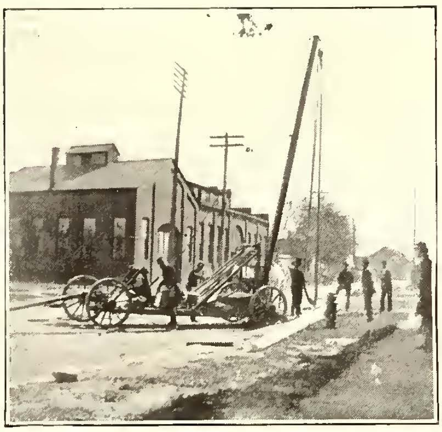
During the last two or three years the firm has acquired a large number of patents, covering "Protected" rail-bonds, as well as tools and machines for installing such bonds. All of these patents are owned by the Protected Rail-Bond Company, which is controlled by Mr. Mayer and Mr. Englund, and for which the Mayer & Englund Company acts as general selling agent. The growth of the company's bond business has been phenomenal, "Protected" bonds having been installed on 515 electric railways, bonding a total of 9000 miles of track, which of course comprises a large part of the electric street railway mileage in the United States. The overhead construction material handled by the firm is of the best quality, being of heavy, substantial design. The company is in a position to give prompt attention to the shipment of orders at short notice. For the convenience of its patrons a 580-page catalogue is issued, covering a list of over 5000 separate and distinct articles. For the purpose of saving its customers unnecessary expense when ordering goods by cable or telegram the catalogue is provided with a code formulated by the company.

One of the pronounced indications of growth is the fact that the company now employs thirty-two persons, including nine in the sales department; eleven in the purchasing, accounting, order and general office department, and twelve in the shipping department and store room. Branch offices are maintained in charge of the following agents: W. A. Cockley, 85 Liberty Street, New York City; George W. Provost, Park Building, Pittsburgh; J. M. Gallagher, 135 Adams Street, Chicago; H. M. Lofton, Equitable Building, Atlanta, Ga. Mr. Lofton also maintains a branch office in the Hennen Building, New Orleans, La., which is under his supervision. The company contemplates establishing an office in Cleveland. No regular foreign agencies have been established, but the company now enjoys a very large foreign business.

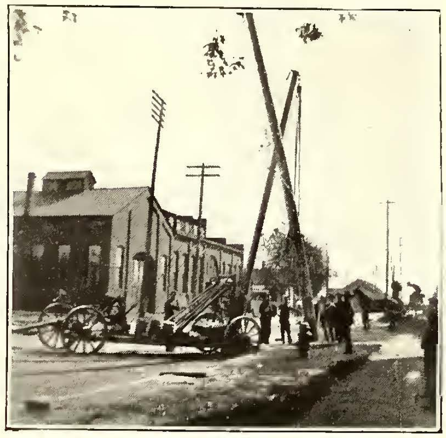
The following is a list of the principal manufacturers represented by the Mayer & Englund Company: R. D. Nuttall Company, Pittsburgh, Pa.; the International Register Company, Chicago, Ill.; the Protected Rail-Bond Company, Philadelphia, Pa.; W. T. C. Macallen Company, Boston, Mass.; William Hall & Company, Boston, Mass.; Speer Carbon Company, St. Mary's, Pa.; Simplex Electrical Heating Company, Boston, Mass.; Garton-Daniels Company, Keokuk, Iowa; Strieby & Foote Company, Newark, N. J.; Sterling Varnish Company, Pittsburgh, Pa.; Pittsburgh Insulating Company, Pittsburgh Pa.; Universal Safety Tread Company, Providence, R. I.; Trolley Vestibule Shade Company, Bridgeport, Conn.

Labor-Saving Tools

Although the cost of pole-raising in electric railway construction is likely to be very high, many companies do not seem to have appreciated the possibilities of saving labor in this work. A few electric railway companies have built special wagons or derricks, but it remained for W. H. Anderson & Sons, of Detroit, Mich., manufacturers of contractors' tools, to appreciate the desirability of a staple article of this kind and to manufacture it so that it is within the reach of all. This wagon is fixed with an adjustable boom or derrick, by which the lifting of the poles into position is greatly facilitated. The wagon has been made for several years, and many improvements in details, as the result of this experience, have been made. The wagon and its method of operation are shown by the accompanying engravings, taken from photographs. The boom is made of steel tubing, with a hardwood spar inserted, which allows it to be extended to any desired length to lift poles from 35 ft. to 70 ft. in length. On the front end of the wagon is a hoisting winch which operates the guy lines. The boom can be moved to any angle, even with the load in suspension. The tackle on the boom is arranged to be worked with the team which operates the wagon. It is not necessary for the team to be hitched to the wagon to move from pole to pole, as they can pull the wagon with one of the crew steering it by the tongue. The companies not using these wagons usually employ eighteen men, as a pole-raising crew, with a team of horses, and the average day's work is to set twenty to thirty-two poles. With the Anderson pole-raising derrick wagon, from eight to twelve men are used, setting forty-five to sixty-five poles per day. The saving in labor is easy to figure. This company makes many other devices which

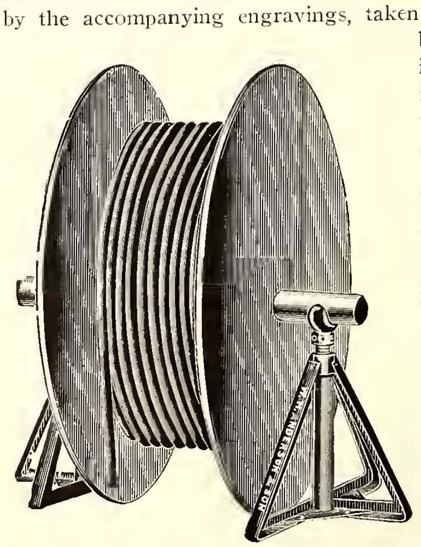


WAGON READY TO LIFT



POLE PARTLY RAISED

POLE READY TO BE LOWERED

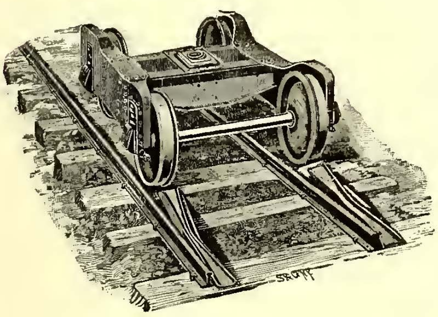


CABLE REEL JACK

are popular with contractors. A cable reel jack, which is proving very popular, is shown herewith. Instead of supporting cable reels on blocks or rollers, which are cumbersome to carry around and slow to operate, this device is a neat support made with angle-iron frame, and with height adjustable as any other jack-screw. This company makes railroad picks all steel, which can be used when worn much shorter than ordinary steel-pointed picks. The Anderson man-hole cable hanger for supporting cables in man-holes, permits any number of cables to the capacity of the man-hole, to be put neatly in to one side, without requiring any room for hangers until the cables are put in. This company makes many other tools for the use of electric railway contractors and track maintenance departments, which are too numerous to mention here.

Car Replacers

The car replacer is a small but very essential part of the equipment of an electric railway, and any improvement in a device of this kind means much to the car crew or "man about the barn." This has been accomplished by the Heitzman Tool & Supply Company, of Hoboken, N. J., which has recently brought out a pressed steel car replacer which is claimed to answer the requirements of a light, strong and thoroughly reliable wrecking frog for modern heavy equipment.

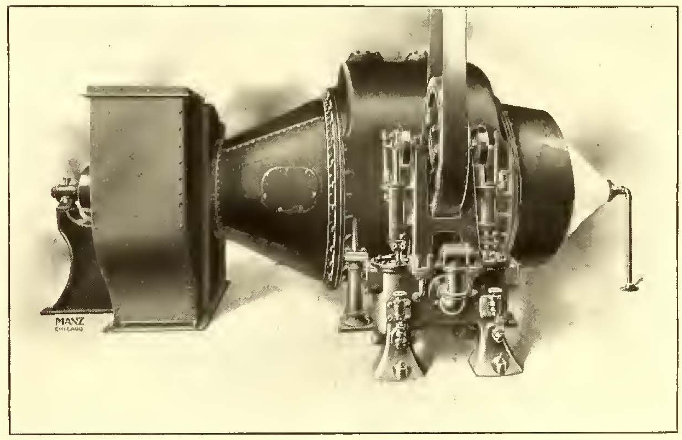


PRESSED STEEL CAR REPLACER

These replacers are pressed in the form of a truss and are guaranteed to hold up 150 tons without flattening or breaking. They weigh 115 lbs. to the set, so that one man can easily carry and place them in the most difficult places. They bind the rail without the use of clamps, and will put all four wheels of a truck on the rails, even when they are some distance removed, and roll the car on without a jolt. Another advantage is that but one size of replacer is required for all patterns of rail.

Condensing by Evaporation

The great heat absorbing capacity of evaporating water has been known for years, but it is only recently that condensing apparatus in commercial form has been worked out to employ the heat absorbed by the evaporation of water for condensation. In ordinary practice cooling for condensation is accomplished by conducting away the necessary amount of heat by passing a large body of water through the condensers. To condense a pound of steam from atmospheric pressure or near it takes the absorption of about 1000 heat units. In the ordinary condenser this heat is conducted away by water which is raised, say 50 degs., in the process, so that each pound of the water used in condensation absorbs 50 heat units, and 20 lbs. of condensing water are required in a condenser per pound of steam. If water could be sprayed upon the steam-heated pipes of a closed condenser so that the water in evaporating would absorb the heat to condense the steam, it would take only a pound of water to condense a pound of steam. The condenser made by the Cosmopolitan Power Company, of Chicago, which has recently been put on the market, makes use of the evaporation principle with the practical result that plants not on a natural body of water, which have heretofore run non-condensing because of the great amount of water required for condensing purposes, and the room and expense required for artificial cooling towers, can now operate condensers in connection with their engines at a cost for condensing water which will certainly not exceed that required at present for boiler feed-water, and will probably be considerably less; this, too, with a compact apparatus taking up but little more room than any closed or surface condenser. The apparatus consists essentially of a closed or surface condenser with pump, the cooling in which is accomplished by water sprayed from a nozzle and blown through the condenser tubes. A condenser complete, with spraying apparatus, is illustrated herewith. The condenser cylinder into which the exhaust from the engine passes is filled with copper tubes, expanded into one head like the flues in a boiler, and provided with a packed slip joint at the other to allow for the contraction and expansion of the copper tubes, which is, of course, not the same as that of the iron. At the left-hand end of the apparatus is a nozzle which sprays water into the copper tubes, and at the right is an exhaust fan which draws a continuous current of air and spray through the tubes. The water from the nozzle is broken up into very finely divided particles, and the current of air evaporates the water to make the cooling effect required for condensation. Combined with this there is the conducting away of heat from the steam by the water. After being drawn through by the fan the water not evaporated into the air falls, and is piped back to be used again at the nozzle. No cooling of this water is needed, as it is so broken up in its passage through the condenser that it remains at a workable temperature, water being added continuously by a float valve in the hot well to supply that taken by evaporation. The company installs its apparatus with the guarantee that it will not take more than one pound of fresh water per pound of steam condensed. This would bring the cost for condensing water practically down to that for boiler feed-water, were the plant non-condensing. As a matter of fact some tests have been made under rather unfavorable conditions, where but six-tenths of a pound of water per pound of steam condensed was required, the balance of the cooling being accomplished by conduction to the air drawn through the apparatus. A 300-hp condenser cylinder now under construction at the works is 5 ft. long and 72 ins. in diameter. A 1000-hp condenser cylinder, also under way, is 8 ft. in diameter and 5 ft. long.



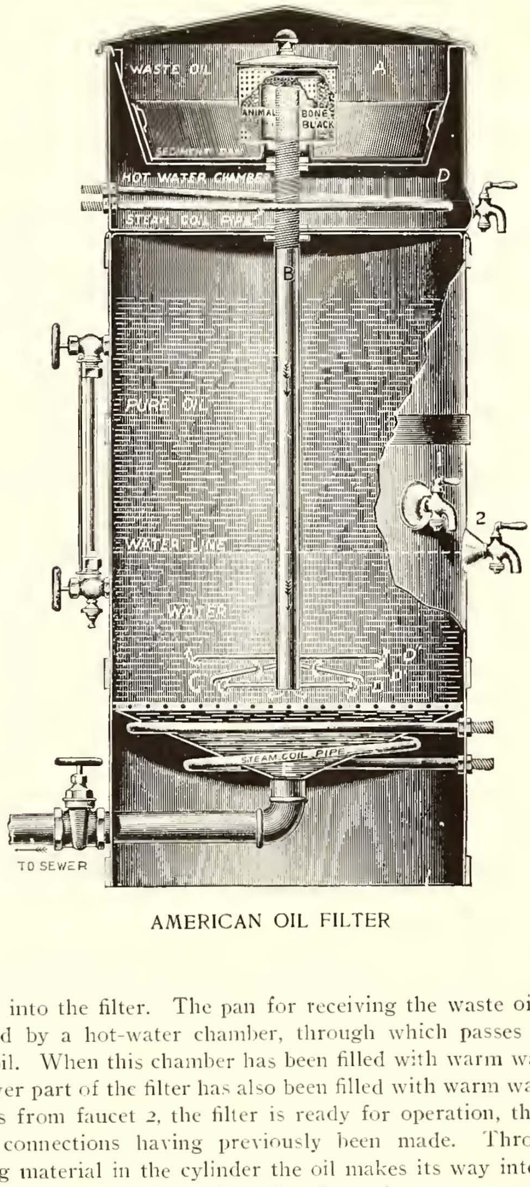
CONDENSER WITH SPRAYING APPARATUS

The H. W. Johns-Manville Company, of New York, has issued a small sixteen-page pocket catalogue telling about the Manville fire extinguisher, which is simply a dry powered chemical, put up in nicely decorated tubes that may be hung in any convenient place in the home, office or shop. The powder should be thrown at the base of the flame, which is thereupon extinguished by the generation of carbon dioxide, which will not support combustion. The powder will not freeze or cake in the tubes; is not affected by dampness, and does not deteriorate with age. It is perfectly safe, and will not injuriously affect the finest fabrics.

The business of the Burt Manufacturing Company, Akron, Ohio, has grown to large proportions, over 12,000 of the company's oil filters having been sold during the past twelve years throughout the world. They are used in twenty-eight different countries and have been adopted by ten governments. These facts in themselves would seem to be an ample guarantee of satisfaction, but rather than allow any opportunity for dissatisfaction upon the part of the buyer, the company is glad to allow a thirty-days' trial of its filter to prove the claim that it will reduce lubricating oil bills at least 50 per cent and satisfy in every way.

The American Oil Filter

The oil filter illustrated by the cut presented herewith was designed by the Burt Manufacturing Company, Akron, Ohio, for filtering very heavy grades of oil, which cannot be successfully cleaned in an ordinary filter because of the liability to clog up easily. The claim is made that such oils are readily purified by this filter, the oil being heated and thereby thinned immediately upon being



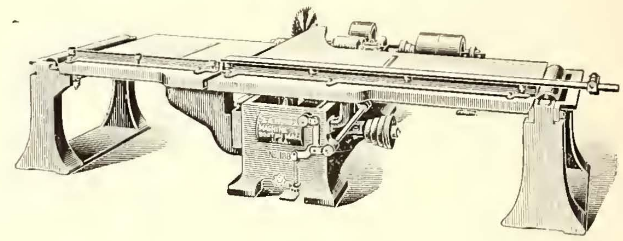
AMERICAN OIL FILTER

poured into the filter. The pan for receiving the waste oil is surrounded by a hot-water chamber, through which passes a steam pipe coil. When this chamber has been filled with warm water, and the lower part of the filter has also been filled with warm water until it flows from faucet 2, the filter is ready for operation, the proper steam connections having previously been made. Through the filtering material in the cylinder the oil makes its way into tube *B* and down onto the filter plate *D*, where the pressure of the oil above overcomes the resistance offered by the weight of the water, and the oil spreads out in a very thin film, becoming thinner and thinner as it travels from the center to the circumference of the plate. Every particle of the oil is thus exposed to the action of the water. This process is repeated as the oil flows upon plates D_1 and D_2, the separation of foreign ingredients from the oil thus being made, the remaining impurities then settling by force of gravity to the bottom of chamber *E*, from which they are drawn off by simply opening the valve. The purified oil is drawn from faucet 1.

Attention is called to the minimum of care required by this filter to keep it in operative order. Any kind of filtering material may be used, or none at all, and the filtering material may be removed without interrupting the oil service. The method of cleaning the filter is very simple, requiring only that the cylinder at the top be unscrewed, the filtering substance removed, and the sediment pan lifted out and emptied of the large quantity of dirt and grit which has collected in it through force of gravity. In nearly all other oil filters the bulk of the dirt is collected at the bottom, while in the American oil filter it is collected at the top, greatly increasing the ease with which the latter may be cleaned.

New Automatic Railway Cut-off Saw

The heavy power feed railway cut-off saw illustrated herewith was recently designed to meet the requirements of car shop work in large steam and electric railway plants, where it has been installed with satisfactory results. This machine is manufactured by the S. A. Woods Machine Company, South Boston, Mass., for cutting up lumber or timber into accurate lengths, taking heavy stock up to 14 ins. by 16 ins., or boards 30 ins. wide and carries saws up



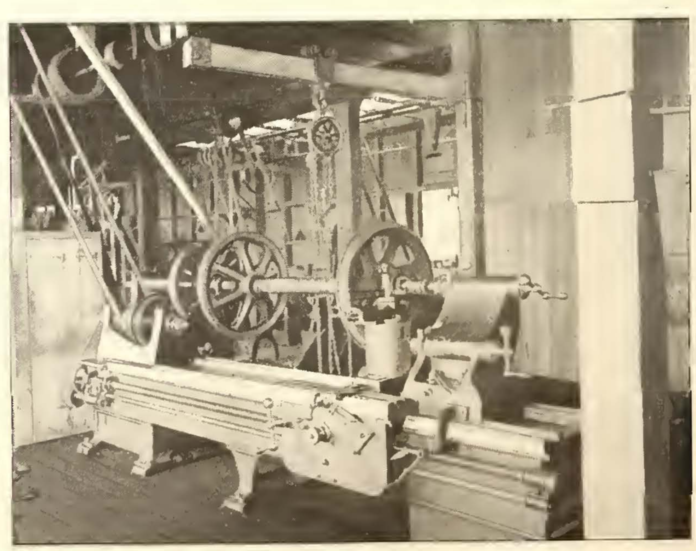
RAILWAY CUT-OFF SAW

to 40 ins. in diameter. The saw carriage is operated by power, and three rates of speed may be obtained by friction cone pullies. The travel of the carriage is controlled by a treadle, pressure upon which brings it forward at the rate intended. The return is automatic, and such jar as would ordinarily result by the fall of the carriage as it returns is eliminated by a pneumatic attachment which acts as a cushion at any point. A tension device for the driving belt keeps it tight as it moves with the carriage. The saw arbor can be made long enough to enable the use of a gaining head. The table is built in sections, so that it may be extended at any time, and rolls located at suitable intervals facilitate handling of the lumber. The fence or gage which is provided is extra heavy, and adjustable stops are furnished for duplication of work and convenience in locating the lumber. The stop bar is interchangeable with fences on both sides of the saw. The pulley on the arbor is of a patent pneumatic type, so constructed as to save about 30 per cent of the power which is usually lost. The loose pulley on the countershaft is also of a patented self-oiling type. Where much heavy cutting is done this machine is indespensable. It is quick-acting, self-contained, and is capable of doing the work of several old-style machines where the saw is brought forward by hand. It weighs about 4000 lbs.

The manufacturers have also lately produced a new vertical cut-off saw and will be glad to furnish full details on application..

Double-Spindle Repair Shop Lathe

The accompanying illustration, representing a portion of the repair equipment of the Brooklyn Heights Rapid Transit Company



DOUBLE-SPINDLE LATHE FOR RAILWAY REPAIR SHOPS

on Fifty-Second Street, Brooklyn, shows, in actual operation, a double-spindle lathe built by J. J. McCabe, 14 Dey Street, New York. This lathe is particularly well-adapted for general repair work, combining the capacity of a 26-in. and 48-in. swing in the one machine, and thus making it possible to conveniently handle large work as well as medium and small size jobs. On the lower spindle, which is back-geared, the ordinary range of work may be done, while on the upper spindle an axle, to which 33-in. wheels are attached, may be swung, as indicated by the illustration presented herewith, and all the necessary turning of the shaft accomplished without removing the wheels, which may be trued up, if necessary, at the same time that the shaft for which they are mounted is being turned.

Car House Doors at Oldham, England

The accompanying illustration is from a photograph of the principal opening in the tram car house of the Oldham Corporation Tramways, Oldham, England. The doors, which were supplied by the Kinnear Manufacturing Company, Columbus, Ohio, are made in a series of three, being unequal in size and separated

STEEL ROLLING CAR HOUSE DOORS

by very substantial intermediate posts. These posts, being hinged at the top, can, after the doors are open, be readily raised to the ceiling, maintaining the opening perfectly clear without obstruction. In the rolling door at the right-hand end will be noted a small wicket or hinged door which is utilized for a passageway by employees when the rolling doors are closed. Two of the doors are equipped with "Kinnear" trolley wire arms.

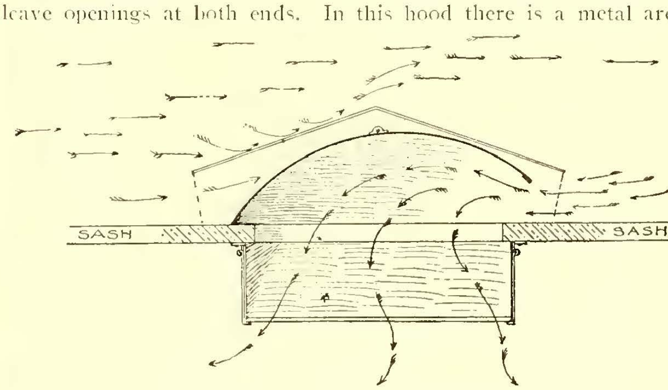
New Cars for Allentown & Reading Traction Company

The accompanying illustration shows one of a recent shipment of handsome cars to the Allentown & Reading Traction Company by the J. G. Brill Company, of Philadelphia. The cars are of the Brill semi-convertible type, particularly suited to the interurban service for which they are intended. The advantages of the transverse seating arrangement is enhanced materially by the addition of 7¼ ins. to width of aisle and length of seats by doing away with the necessity of wall pockets and bringing the seat ends within the posts. The roof storage of the windows is described in detail elsewhere in this issue.

The measurements are frequently adopted for this form of service, viz., length over vestibule, 37 ft. 5 ins.; width over sills, 7 ft. 10½ ins., and over post at belt, 8 ft. 2 ins. The interiors are done in natural cherry, handsomely inlaid. The ceilings are of decorated birch. Among the fittings are Brill sand-boxes, "Dedenda" gongs, angle-iron bumpers, radial draw-bars and ratchet brake handles. The speed capacity of these cars is practically equal to steam service, as they are mounted on Brill No. 27 high-speed trucks.

Pullman Automatic Car Ventilator

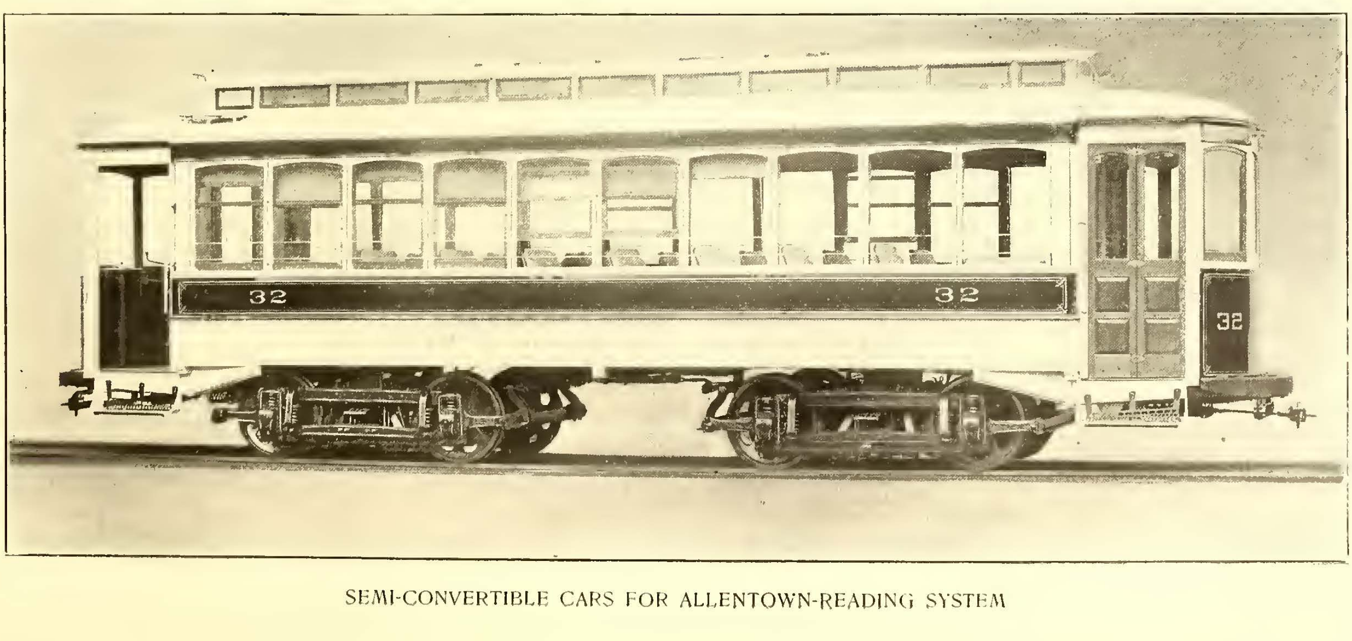
The ventilator shown by the accompanying cut consists of two parts, the hood and a diffusion box. The hood is so shaped as to leave openings at both ends. In this hood there is a metal arc-



AN AUTOMATIC CAR VENTILATOR

shaped valve poised on a perpendicular pin, and of the same length and width as the shutter-frame opening into the car. The hood-side of the device, with its enclosed valve, is projected on the outside of the car window by being placed in the lower part of the sash. Thus adjusted, the hood receives and breaks the direct blast of the wind admitting air on the breathing line of the passengers in the car in sufficient quantities to make each passenger comfortable, and at the same time it is claimed that the vitiated air within the car is exhausted. The air admitted is free from dust and dirt, and without draught, and the passengers do not suffer any inconvenience. In the transom at the top of the car, a 5-in. ventilator is installed inverted, which acts both as an intake and exhaust, and by making this installation in connection with the sash installation, makes an even temperature throughout the car.

The valve in the hood is so acted upon by the wind pressure cre-

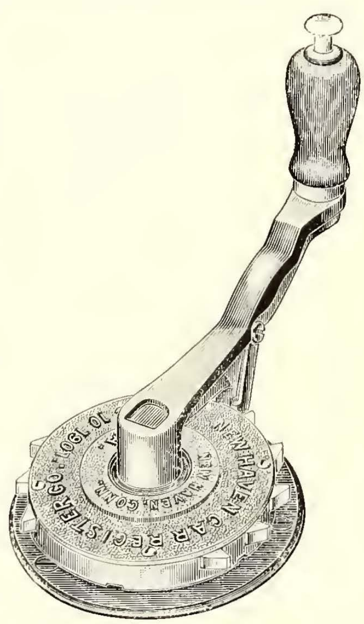


SEMI-CONVERTIBLE CARS FOR ALLENTOWN-READING SYSTEM ated by the forward movement of the car that it closes the end to the wind, and at the same time opens the end opposite to the direction from which the blowing wind is coming, thus shutting out the direct blast, with its dust, rain, or snow, and admitting the fresh air gently to the car through the open rear end of the hood.

The diffusion box which projects into the car is of galvanized iron, handsomely finished, covered with a lid or shutter, which can be raised or lowered according to the amount of air that is needed. Below this is a strip of perforated metal, which distributes the air as it enters the car. The total amount of air admitted through the ventilators is sufficient to change the air in the car four times an hour, and at all times, even if the car is overcrowded, it is stated that the air will be pure and fresh. This ventilator is made by the Pullman Ventilator Company, Washington, D. C.

New Haven Controller Regulator

The New Haven Car Register Company has perfected a controller regulator to prevent a motorman from throwing on at once more current than is indicated by one point of contact on the controller top and necessitates the pressing down of a thumbpiece arranged on the top of controller handle at each succeeding contact point. This forces the motorman to give full value to each notch of the controller as intended by the manufacturers, and prevents the shock to both controller and motor which the throwing on at once of a full current causes. This produces a material saving to both controller and motor and results in a saving of current. The operation of throwing off the current is not changed, being performed by a backward motion of the handle in the regular manner without operating the thumbpiece. The controller regulator will fit on any of the "K" type of controllers manufactured by the General Electric Company without alteration.



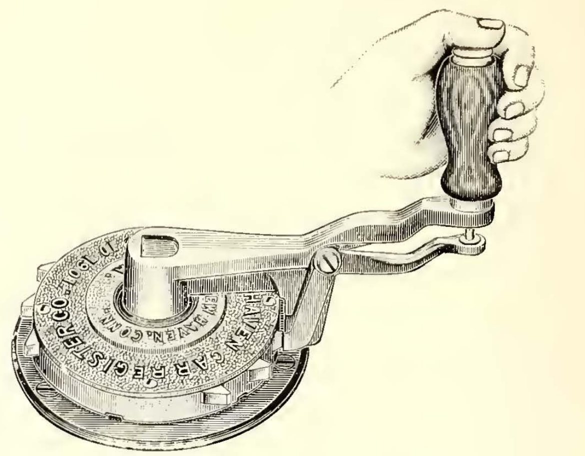
CONTROLLER HANDLE

The New Haven Car Register Company will have on exhibition a sample of this controller regulator at the Detroit convention. The use of this new device will eliminate the annoyance caused by the sudden jolting so common in the starting of electric cars.

Register Test in Brooklyn

An interesting test of a number of different types of registers was recently completed in the Fifty-Second Street shops of the Brooklyn Heights Railroad Company, the object of which was to determine the ability of the different machines to register 1,000,000 fares. Two registers of several different makes were taken and were rung by machinery. If any register gave out before the end of the test, the defective part was repaired or replaced and the machine was put into service again. The test was held in the presence of the representatives of each of the register companies and the railway company.

An upright frame was built 14 ft. 4 ins. long and 6 ft. 1 in. high, and consisting chiefly of five uprights of 4-in. x 4 in. stuff spaced 3 ft. 4 ins. center to center and braced at the top and bottom. At the top of each upright were fastened two 18-in. x 24-in. boards, to which were attached the registers. To the back of the frame and running its entire length was a 1-in. longitudinal shaft placed 13 ins. below the top of the register boards, and having bearings on the five uprights. At the middle of this shaft was clamped a horizontal wrought-iron driving lever 10 ins. long, which, by means of a 1½-in. x ½-in. connecting rod, was connected with a crank having a distance of 2 ins. between the center of its shaft and the center of the the crank run, this shaft being fastened rigidly to the shaft of a pulley driven by power from the mill room. This mechanism gave the longitudinal shaft an oscillating motion, which was transmitted to each register by means of a vertical slotted lever clamped rigidly to the shaft and a spring connecting



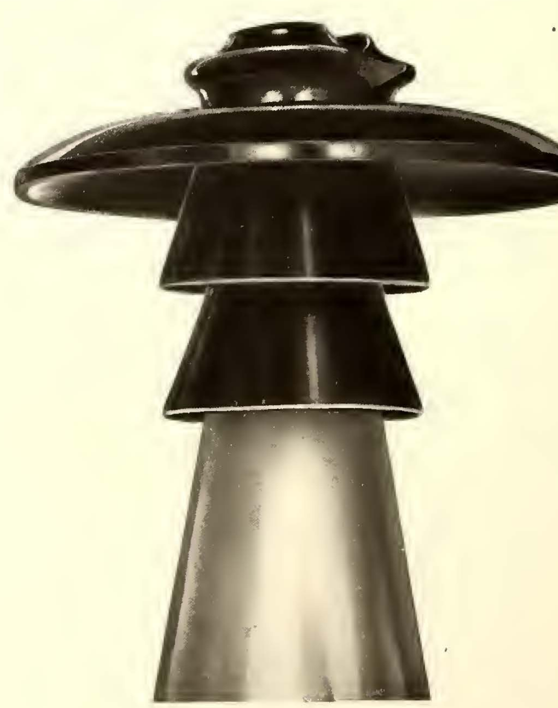
CONTROLLER HANDLE IN OPERATION

rod. The purpose of the spring connecting rod was to avoid damaging the register in case its mechanism became locked.

The rate of speed agreed upon was 300 registrations per minute, and the test was conducted twenty hours daily from 5 a. m. to 1 a. m., during which time, however, certain hours were allowed for repairs. As a result of the test, which was commenced Sept. 15 and ended Sept. 20, the St. Louis register made the best showing.

New High-Voltage Insulator

Fred M. Locke, of Victor, N. Y., whose work in the direction of improved insulators for high-voltage transmission is well known, has recently brought out a modified type of insulator, illus-



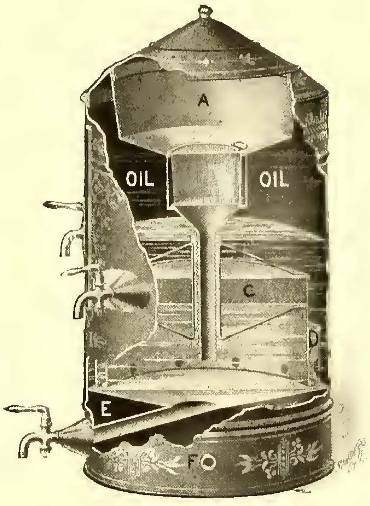
HIGH VOLTAGE INSULATOR

trated herewith. This insulator is somewhat similar to that shown in a recent issue, but is slightly higher, and is provided with three petticoats, as shown in the illustration. It is 14 ins. across the hood. This insulator has been tested up to 160,000 volts, and is made for any voltage up to 100,000 line pressure.

Acme Oil Filter

The accompanying engraving shows a section of the Acme oil filter, manufactured by Walter L. Flower & Co., of St. Louis. The large amount of oil used in street railway power stations makes a filter of this kind, which is simple in construction, easy of operation and of effective filtering capacity, of interest.

The filter is built of heavy galvanized iron and the filtering materials employed are animal bone-black or charcoal, recognized by the oil refiners as the best oil filtering medium extant. Five sizes are built. The four largest are fitted with steam connections, inducing greater and more effective filtering capacity.



OIL FILTER

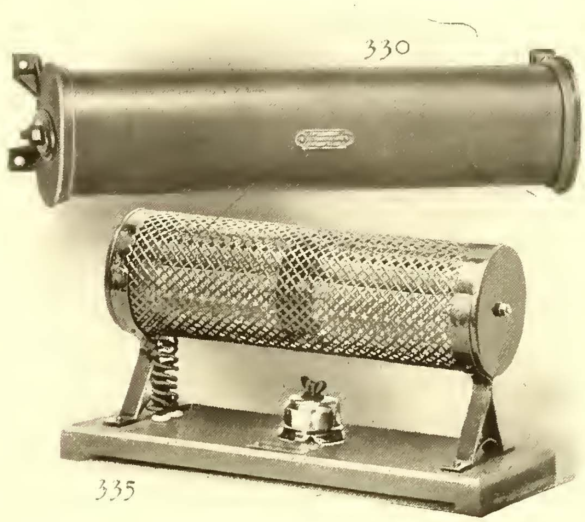
In the engraving, which shows the arrangement of one of the intermediate sizes, "A" is the receptacle for the oil to be filtered. The oil falls by its own weight then rises by gravity through the water and filtering material, which is immersed in water, and is finally drawn off from faucets, as shown. "C" indicates filtering material and its location. "D" is a pan that catches dirt precipitated by oil coming in contact with water. "E" is the double bottom or steam chamber for heating the water in the three sizes of filters mentioned. The larger size is equipped with a steam coil in the bottom. "F" is the inlet. The outlet is on the reverse side for steam for heating the filter. The steam connection increases the filtering capacity about 10 per cent.

The Prometheus Electric Heater

There has recently been placed on the American market a new type of car heater, which, on account of its success abroad, and the number of advantages claimed for it, has attracted the attention of street railway officials in this country. It is known as the "Prometheus" heater, and it is equipped with the "Prometheus" wireless heating units which are also used in numerous types of heating and cooking apparatus.

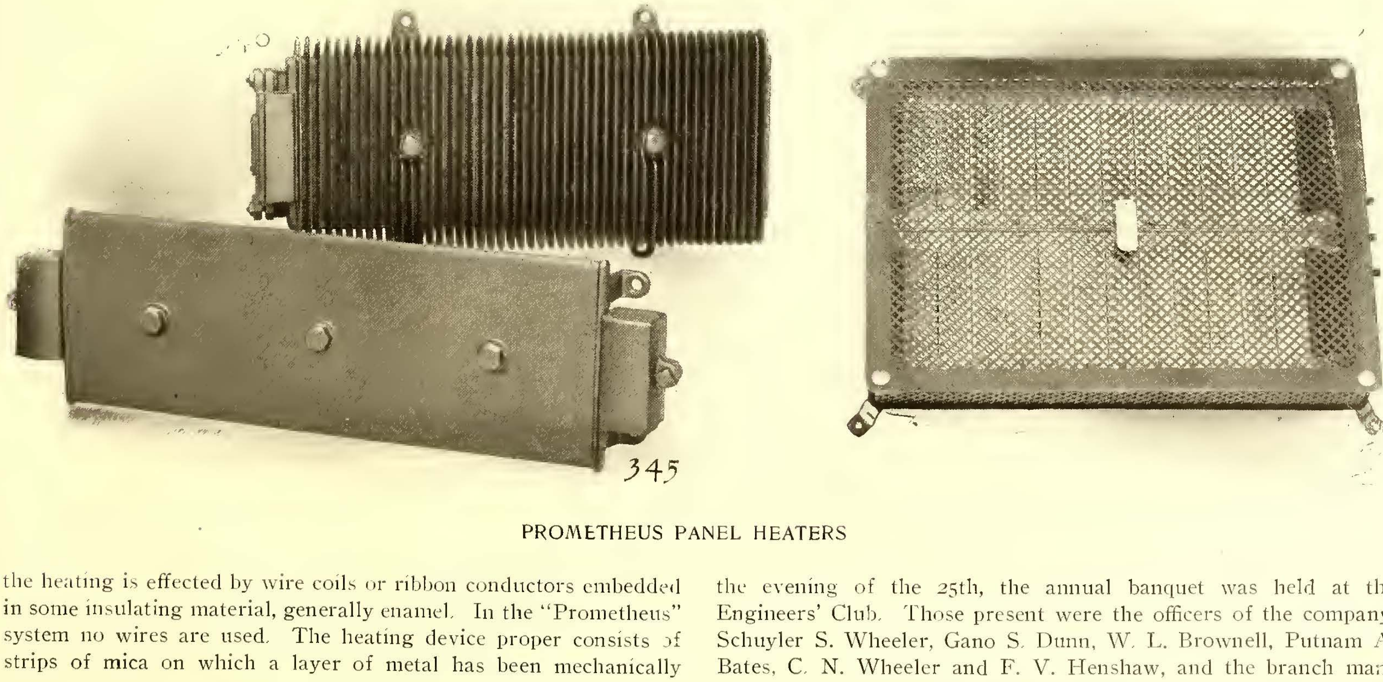
The system differs materially from all other systems in which the heating is effected by wire coils or ribbon conductors embedded in some insulating material, generally enamel. In the "Prometheus" system no wires are used. The heating device proper consists of strips of mica on which a layer of metal has been mechanically deposited, or more correctly speaking "fired," the layer consisting of metals which do not oxidize and do not appreciably expand or contract with the rise or fall of temperature.

These "heating elements," as they are called, which can be made of any desired resistance or shape, are so attached to the apparatus themselves, whether they be pots, stoves, irons, radiators, etc., that they can be removed with the greatest ease and replaced by a new element in case of a breakdown, which, however, does not often occur, on account of the mechanical construction of the elements and their great carrying capacity. A new element costs but a few cents, and can be inserted into the apparatus by the most unskilled person.


PROMETHEUS ROUND AND ELLIPTICAL HEATERS

Besides this very desirable feature, ease of repair, the "Prometheus" elements possess the great advantage of a large radiating surface, and on account of this and their large carrying capacity, the heaters may be made very much smaller than existing heaters, and have the same heating capacity. The great flexibility of the system permits heaters to be constructed of any desired shape, and the circular, elliptical and panel types are especially attractive and commendable.

These heaters are now being placed on the market by The Prometheus Electric Company, of 60 Reade Street, New York.

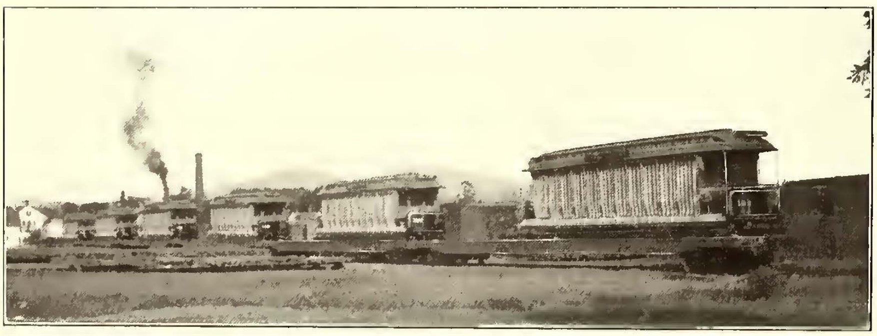

PROMETHEUS PANEL HEATERS

Crocker-Wheeler Branch Office Managers' Convention

The Crocker-Wheeler Company held at its works at Ampere, N. J., on Sept. 25 and 26, its annual managers' convention. On the evening of the 25th, the annual banquet was held at the Engineers' Club. Those present were the officers of the company, Schuyler S. Wheeler, Gano S. Dunn, W. L. Brownell, Putnam A. Bates, C. N. Wheeler and F. V. Henshaw, and the branch managers, Samuel Russell, Jr., Julian Roe, J. Hally Craig, Louis P. Hall, W. H. Wissing, Francis B. De Gress, Henry J. Sage, William A. Doble and Harold Lomas. At this dinner many interesting speeches were made by the branch office managers, and Francis B. DeGress, of the New York office, who has been in the service of the company longer than any of the other managers, presented to the general sales manager, Putnam A. Bates, in the name of the managers, a token of their esteem and an acknowledgement of his efforts in their behalf. Mr. Bates responded in his usual happy manner. The purpose of the convention is to bring all of the men closer together and give them an opportunity of comparing notes and planning methods for handling the largely increased business of the company.

New Open Cars for New Hampshire

The accompanying illustration represents a small shipment of open cars to the Massachusetts Construction Company, which is operating extensively in the State of New Hampshire. The cars were built at the Laconia Car Company Works, which have built several hundred cars for this concern. This particular lot represents some of the fourteen-bench open cars, with enclosed ends, having three sashes in each end, arranged to drop into pockets. The cars are finished in white ash, with seats of white maple; ceilings of white birch, and fitted with curtains of Crown pattern running to floor of car. The cars are also equipped with double running boards the full length of car, and a lower step arranged to fold; also drop side guards and chains, and solid bronze trimmings throughout. The trucks used are the improved No. 9-B high-speed Laconia trucks with cushioned swing bolsters, and heavy double plate wheels.



OPEN CARS FOR NEW HAMPSHIRE

The Characteristics of Good Paint for Iron Work

There is perhaps no manufacturing material in these days which is subject to more adulteration, and when adulterated is as worthless, as paint for iron work. Adulterated paint is cheap in first cost, but railroad companies having in view the cost of maintenance of outdoor iron work for a term of years are not searching for the cheapest paint at first cost, but that which will give them the best results in the long run. It is to this class of work that Detroit Graphite Manufacturing Company caters. The basis for the graphite paint made by this company is a peculiar graphite obtained from a mine in Northern Michigan. This graphite ore contains about one-third pure graphite, the balance being silicates. When this graphite was first discovered attempts were made by the company owning the mine to use it for the various purposes to which graphite is usually put and to separate the graphite from the other matter. The mixture, however, was too complete to admit of this being done, but it was discovered afterward that it was remarkably well adapted for use as a paint. The percentage of graphite and various other minerals in this ore, when ground and mixed with oil, gives a paint of an extremely uniform composition. The company takes care to use none but the best boiled oil and maintains its own plant for boiling oil, as well as for grinding graphite ore and pigments for use in paint, and it is claimed that this ore mixture of silica and graphite, when ground to an extremely fine powder, makes a pigment for paint superior to pure graphite, which has not as great mechanical toughness. Perhaps the best recommendation for the wearing qualities of this paint is its use by companies desiring the best service obtainable from paint. The United States Government uses this paint for covering its warships. The first important order received by this company when starting in business ten years ago was from the Waldorf-Astoria Hotel for covering steel structural work. The architect for this hotel had orders to obtain the best material the markets of the world afforded, and, after investigation, selected this graphite paint as being not only durable, but uniform in composition and of honest manufacture.

Large Gift to the Library of the American Institute of Electrical Engineers

At the meeting last week of the American Institute of Electrical Engineers, President Scott announced a large gift to the library from C. O. Mailloux, stating that Mr. Mailloux had presented his check for $1,028.23 to pay for the cost and for rebinding, when necessary, of a number of valuable sets of French scientific *Transactions* and other books. This donation is in addition to a full set of *Comptes Rendus* from 1835 to 1897 (130 volumes) which Mr. Mailloux presented to the library about eighteen months ago, the cost of which, including new half-morocco binding, was $317. President Scott also announced that Mr. Mailloux will donate a sum of money, the annual proceeds of which will be sufficient to pay the future cost of subscription to such of the periodical publications that he has presented to the library that are yet current, and also to defray the cost of binding the same.

The books presented include the *Transactions* of the French Academy of Sciences from 1666 to 1900 (247 volumes) lacking the years from 1778 to 1816. It is understood that Mr. Mailloux has authorized the library committee to complete the set at his cost. The *Annales de Chimie et Physique,* a complete set from 1789 to 1900 (312 volumes). *Journal de Physique* a complete set from 1872 to 1900 (29 volumes). The *Transactions* of the Austrian Society of Engineers and Architects, complete from 1855 to 1901, including both the weekly and monthly editions. A complete set of *Zeitschrift fur Instrumentenkunde*, 1881 to 1901 (21 volumes). The gift also includes an abridgement in French, in 13 volumes, of memoires read before the leading European societies previous to 1770; an English abridgement of the Memoires of the French Academy of Sciences from 1699 to 1720 (5 volumes); a French abridgement of the transactions of the same society from 1666 to 1718, and a history of the French Academy of Sciences.

The Seattle-Renton line of the Seattle Electric Company, which follows the route of the Seattle-Tacoma Interurban Railway as far as Renton Junction, 10½ miles from Seattle, branching off to Renton, has been placed in operation, thus completing the company's suburban lines. The company is building two new car houses, one 55 ft. x 120 ft., and the other 120 ft. x 240 ft., and a paint shop 65 ft x 120 ft. For the present the framework will be of wood, but the foundations will be built of sufficient strength to hold brick walls, the plan being to replace the wooden ones in the spring. The roofs will be permanent. The rush necessitating the subsequent change of walls is due to a shortage of space. Many of the cars recently received have been left on side tracks, and it is the desire of the company to get them under cover before the severe winter weather. The company has recently issued a neat little booklet entitled "Seattle Street Railways; How to Use Them." It tells where every line goes, how transfers are issued, and contains exactly the information that is most valuable to residents of the city, as well as to visitors.

Mr. William Wampler, formerly representative in New York of the Stuart-Howland Company, of Boston, has severed his connection with that company and has accepted one as sales agent of the Peckham Manufacturing Company, with which he was previously connected. Mr. Wampler has just started on an extensive trip through the far West and to the Pacific Coast in the interest of the Peckham Company.

Street Railway Apparatus in Detroit

While the type and manufacturers of a great deal of the street railway apparatus used in Detroit are mentioned in the articles on the different systems elsewhere in this issue, it was not found practicable to give credit in every case in these longer articles. It has been considered advisable, therefore, to publish below a list of some of the more important installations in Detroit not mentioned elsewhere, so that the visitor to that city can select what particular apparatus he desires to inspect, and for this purpose, as well as to give proper credit to the different manufacturers, classification has been made under the names of the different supply houses.

The Crane Company, of Chicago, furnished the complete equipment of valves for the Detroit Citizens' Railway, also for the Detroit Rapid Railway Company.

The Billings & Spencer Company, Hartford, Conn., has furnished a large quantity of pure lake copper, drop-forged commutator segments to the Detroit street railway companies.

The R. Bliss Manufacturing Company, Pawtucket, R. I., has supplied many of its patent platform gates for Detroit street cars.

The Lehigh Car, Wheel & Axle Works, Catasauqua, Pa., have supplied wheels to some of the roads in Detroit and vicinity.

The power plant of the Detroit, Rochester, Romeo & Lake Orion Railway Company, at Rochester, Mich., which forms a part of the Detroit United Railways system, is equipped with engines made by the Ball & Wood Company, of Elizabeth, N. J.

The American Car Seat Company, Brooklyn, N. Y., has installed quite a number of its pushover seats, also longitudinal rattan seating, in the cars of many of the roads in and around Detroit.

Sand-boxes made by the Ham Sand-Box Company, Troy, N. Y., are in use on the cars of the Detroit & Pontiac Railway, the Detroit City Street Railway, and the Detroit, Rochester, Romeo & Lake Orion Railway.

Insulating material has been supplied to the Detroit railways by the American Vulcanized Fibre Company, Wilmington, Del., manufacturer of hard and vulcanized fibre.

The J. G. Brill Company, Philadelphia, Pa., has equipped 100 of the cars of the Detroit United Railways with its No. 27-F trucks, one of the cars of the Rapid Railway of Detroit being fitted with the company's No. 27 heavy, high-speed trucks.

Green fuel economizers, manufactured by the Green Fuel Economizer Company, Matteawan, N. Y., are in use in the plants of United Railways and Rapid Railway, Detroit.

Bristol recording voltmeters, supplied by the Bristol Company, Waterbury, Conn., are used by the Detroit United Railways.

The Van Dorn & Dutton Company, Cleveland, Ohio, has furnished almost all of the gears and pinions used on the cars of the Detroit United Railways system, and most of the cars of the suburban lines have been equipped with the company's track cleaners.

The Standard Traction Brake Company, New York, N. Y., has furnished brakes to the Rapid Railway system and the Detroit, Ypsilanti, Ann Arbor & Jackson Railway.

Track rails and fastenings have been supplied to the Detroit railways by the Pennsylvania Steel Company, Philadelphia, Pa.

The Star Brass Works, Kalamazoo, Mich., has supplied trolley wheels and harps to nearly all of the city and suburban lines in and around Detroit.

The Bullock Electric Manufacturing Company, Cincinnati, Ohio, has a contract for electrical machinery foi the Detroit, Rochester, Romeo & Lake Orion Railway.

The Heywood Brothers & Wakefield Company, New York City, has equipped some of the cars of the Rapid Railway system of Detroit with Wheeler walkover seats, and in Toledo, Ohio, the cars of Toledo & Monroe Electric Railway, the Toledo & Maumee Valley Railway, the Toledo & Western, and the Toledo Railways & Light Company, are equipped with the company's seats.

The Curtain Supply Company, Chicago, Ill., has equipped the open cars in and around Detroit with its special open-car duck curtains with rod at bottom, and the closed cars, B-43 Crown; Forsyth roller tip pantasote and Acme Cl. C. pantasote.

Transfer ticket punches made by the R. Woodman Manufacturing & Supply Company, Boston, Mass., have for the last seven years been in use on the Detroit United Railway throughout their system, where they have given satisfaction.

The Hoppes Manufacturing Company, Springfield, Ohio, has eight of its 300-hp live steam feed-water purifiers in service in the Detroit City Water Works, where they are used as separate units on boilers of the same power. Six of them, of 500-hp capacity, are also in use in the plant of the Detroit United Railways.

Many of the cars of steam roads entering Detroit have been equipped with heaters made by the Gold Car Heating & Lighting Company, New York, N. Y. Among these roads may be mentioned the Pere Marquette, Michigan Central, Cincinnati, Hamilton & Dayton, Lake Shore & Michigan Southern, Wabash and Grand Trunk.

The John Stephenson Company, Elizabeth, N. J., furnished some of the open cars used in Detroit.

That part of the Michigan Traction Company's system between Kalamazoo and Battle Creek, Mich., about 27 miles of complete road, was built by Smethurst & Allen, electrical engineers and railway contractors, Philadelphia, Pa.

Several trolley wagons supplied several years ago by J. R. McCardell & Company, Trenton, N. J., to the street railway companies of Detroit, are still in use, giving pronounced satisfaction.

J. G. White & Company, engineers and contractors, of New York, were interested in the construction of the Toledo & Monroe Railway, and in the Detroit, Rochester, Romeo & Lake Orion Railway, the former being described in the Street Railway Journal of Aug. 3, 1901, and the latter in the issue of April 7, 1900.

The Pittsburgh (Pa.) Insulating Company has supplied to the Detroit railways several grades of insulated cloth and paper.

The feed-water heaters and separators manufactured by the Harrison Safety Boiler Works, Philadelphia, Pa., are in use in several plants in and around Detroit.

Ties for the Lake Shore Electric Railway between Cleveland and Toledo, Ohio, were supplied by the Advance Lumber Company, of Cleveland.

At the power house of the Detroit United Railways Company there are four large tandem compound direct-coupled engines having cylinders 28 ins. and 52 ins. x 48 ins., each driving an 800-kw generator. They were installed by the Allis-Chalmers Company, Milwaukee, Wis., by whom, aside from street railway equipments, engines have been supplied to a large number of factories in Detroit; in fact, the company has supplied more engines to Detroit than to any other city of equal size.

To the city and interurban railway companies in and around Detroit, the American Steel & Wire Company, Chicago, has furnished large quantities of "Crown" rail-bonds, which are said to have been adopted as the standard for roads in that vicinity. Trolley wire, span wire, weatherproof electrical cables, and other portions of the wire equipment in use on these roads have also been supplied by this company.

Last season the Simplex Electric Heating Company, Cambridge, Mass., equipped the Toledo & Monroe Railway cars with about 200 of its enamel type car heaters, which are efficient, durable, and sanitary, being light, extremely compact, with a minimum number of parts. There are no receptacles for dirt, consequently no expense whatever for cleaning and overhauling.

The Hope Webbing Company, Providence, R. I., has supplied the Detroit, Ypsilanti, Ann Arbor & Jackson Railway Company with tapes and webbings, and the company's goods are used by other Detroit street railway companies, the material being purchased from dealers who handle such lines of goods.

The Duff Manufacturing Company, Allegheny, Pa., has supplied the Detroit street railway system with Barrett track and car jacks, which are used extensively and are said to be regarded as the standard in that section of the country.

Christensen independent motor-driven air brake equipments, made by the Christensen Engineering Company, Milwaukee, Wis., are in use on a considerable number of cars of the Detroit & Toledo Shore Line Railway Company, the Detroit, Lake Shore & Mount Clemens Railway Company, and the Rapid Railway Company, of Detroit.

The Morris Electric Company, with headquarters in New York, has supplied its rail-bonds to the following roads in Michigan in the vicinity of Detroit: Jackson & Suburban Traction Company, Jackson, Mich.; Wolverine Construction Company, Detroit, Mich.; Michigan Traction Company, Kalamazoo, Mich.; Detroit, Lake Shore & Mount Clemens Railway, Detroit, Mich. A large number of iron poles and brackets have also been sold by the company to roads in Detroit and vicinity.

The G. C. Kuhlman Car Company, Collinwood, Ohio, built most of the cars for the interurban roads controlled by the United Railways Company, of Detroit, and also some of the cars used in the city.

The Peter Smith Heater Company, Detroit, Mich., has installed car-heating equipments as follows: Fifty to the Rapid Railway system, the Detroit and Port Huron line; twelve to Detroit & Flint Railway Company; twelve to Detroit, Rochester & Romeo Railway Company; fourteen to Detroit & Pontiac Railway Company; twelve to Detroit & Northwestern Railway Company; ten to Detroit, Wyandotte & Trenton Railway Company; twelve to Detroit Shore line.

The Ohmer Car Register Company, Dayton, Ohio, has its registers in service on all the cars of both the Detroit & Wyandotte and the Detroit & Pontiac lines of the Detroit United Railways Company.

Nearly all of the line material used by the Detroit railways was supplied by the Ohio Brass Company, Mansfield, Ohio. The pole brackets supplied to the Detroit & Northwestern Railway Company, the Rapid Railway system and the Detroit & Toledo Shore Line Railway, are the company's well-known "Richmond" flexible pole brackets. The Detroit United Railways have also a number of these brackets in use, as well as the "Detroit" type of brackets, which, as their name implies, were designed especially to meet the requirements of the Detroit United Railways Company.

In the power plant of the Detroit, Rochester, Romeo & Lake Orion Railway, at Rochester, Mich., there are three engine-type railway generators, two of 200 kw and one of 400-kw capacity, made by the Crocker-Wheeler Company, Ampere, N. J. There is also a Crocker-Wheeler booster set of 400-amp. capacity at 150 volts.

The apparatus installed by the Electric Storage Battery Company, of Philadelphia, Pa., in Detroit for street railway purposes, consists of the three batteries for the Detroit United Railway. One battery, consisting of 276 elements, with a capacity of 2500 amps. for one hour is located opposite the power house; another battery, located at the Third Street sub-station, consists of 250 elements, having a capacity of 2000 amps. for one hour, and the third battery, located at the Ecorce power house, on the Wyandotte division, consists of 276 cells, having a capacity of 280 amps. for one hour. These batteries are all chloride accumulators, installed in lead-lined tanks, and are used for regulating the fluctuations and maintaining voltage on the line.

The Maltby Lumber Company, Bay City, Mich., states that every electric road centering in Detroit has been furnished with its cedar ties or poles, some of the roads every year since they began building, and others at various times in their history. A list of some of the roads are given below. Since the consolidation of the Detroit railways the company has furnished the Detroit United and the Rapid Railway system both poles and ties. Also the roads connecting Toledo with Detroit, viz., the Detroit & Toledo Shore Line and the Toledo & Monroe, the first-named with poles only, and the latter with both ties and poles. The company has a yard in one of the suburbs of Detroit, River Rouge. The following railways use material supplied by the Maltby Company: Detroit, Lake Shore & Mount Clemens Railway; Detroit & Pontiac Railway Company; Detroit, Plymouth & Northville Railway Company; Detroit, Rochester, Romeo & Lake Orion Railway; Detroit & Grand River Elevated Railway Company; Detroit United Railway Company; Port Huron, St. Clair & Marine City Railway Company; Wyandotte & Detroit River Railway Company; Toledo & Monroe Railway Company; Detroit Citizens' Street Railway Company; Detroit Construction Company; Detroit, Ypsilanti & Ann Arbor Railway Company.

The Babcock & Wilcox Company, New York, has installed water-tube boilers in the following plants in and around Detroit: United Railways, 12 boilers of 250-hp capacity each; Rapid Railway Company, 4 boilers of 300 hp; Detroit, Ypsilanti & Ann Arbor Railway, 8 boilers of 230 hp; Detroit & Pontiac Railway, 2 boilers of 230 hp; Toledo & Monroe Railway Company, 2 boilers of 230 hp each.

Brakes manufactured by the G. P. Magann Air Brake Company, Detroit, Mich., are being used on all the double-truck cars of the Detroit United Railway, Detroit & Wyandotte, Detroit & Northwestern, Detroit & Pontiac, and Detroit, Rochester, Romeo & Flint roads.

Large quantities of insulating varnish is supplied by the Sterling Varnish Company, Pittsburgh, Pa., to the railway and electrical trade in Detroit and vicinity, comprising the Sterling extra insulating varnish for the insulation of armatures, field coils, etc.; the Sterling extra black finishing varnish for the finishing coat to be applied to electrical apparatus to bring it up to a jet black, handsome, glossy appearance; the Sterling black air drying varnish for making quick repairs where there is not sufficient time to bake the coils before and after insulating, and the Sterling black core plate varnish for the insulation of armature discs.

The Wheel-Truing Brake-Shoe Company, Detroit, Mich., manufactures a wheel-truing brake-shoe which in a short period of three and one-half years is said to have found favor with upwards of 400 different electric railways in this and other countries, besides being adopted by steam roads. The roads in and about Detroit are using the device, of which shipments were recently made to Australia, South America, Portugal, India, Africa, Netherlands, Ireland, Scotland, England, and other foreign points.

Trolleys, gears and pinions made by the R. D. Nuttall Company, Pittsburgh, Pa., are in use on the following lines in and around Detroit: Detroit Citizens' Street Railway; Detroit, Lake Shore & Mount Clemens Railway; Detroit, Plymouth & Northville Railway; Detroit United Railway Company; Detroit & Toledo Shore Line Railway; Detroit, Ypsilanti & Ann Arbor Railway; Rapid Railway Company; Toledo & Monroe Railway Company; Wyandotte & Detroit River Railway Company; Detroit & Pontiac Railway; Detroit, Rochester, Romeo & Lake Orion Railway; Detroit Railway Company.

The Consolidated Engine Stop Company, New York, has installed its safety engine stop system in Detroit at the plants of Nelson, Baker & Company, manufacturing chemists; Ireland & Matthews Manufacturing Company, stove trimmings and sheet metal goods, and Stephen Pratt, manufacturer of steam boilers.

Practically all of the railways in and about Detroit use lightning arresters made by the Garton-Daniels Company, Keokuk, Ia. The Detroit, Ypsilanti, Ann Arbor and Jackson Railway Company use them throughout, while nearly all of the roads composing the Detroit United Railways system have a large number of the company's lightning arresters in use.

Merritt & Company, Philadelphia, Pa., has supplied to the railway companies in Detroit and vicinity a system of lockers which may be seen at the plant of the Detroit, Ypsilanti, Ann Arbor & Jackson Street Railway Company, and the Grand Rapids, Grand Haven & Muskegon Railway Company. Among other places in Detroit, the company's locker construction can be seen at the Lloyd Construction Company, Solvay Process Company and Detroit City Gas Company.

The 25-ton hand traveling crane in the plant of the Detroit Citizens' Railway was built by the Brown Hoisting Machinery Company, Cleveland, Ohio. The crane has a span of 60 ft., and its operations, including hoisting, trolley traveling and crane traveling, are performed by means of hand cranks from a platform attached to the under side of one end of the crane.

The Lorain (Ohio) Steel Company is said to have furnished practically all of the rails and special work in use in the Detroit Railways system, except that part of it which was built by the Pack-Everett syndicate.

In electric cars in and around Detroit three types of the cross-seats made by the Hale & Kilburn Manufacturing Company, Philadelphia, Pa., are used, viz., stationary seat No. 2, about 66 ins. long, with spring cushion and back, upholstered in plush, and also some upholstered in rattan. These are for cars having the aisle at one side, the arrangement of seats being practically the same as in open summer cars, the car, however, being closed at the inner end or side; stationary seat, No. 3, about 34 ins. long, of the same general style, but for use in cars having the aisle in the center, and always "running head on;" walkover seats, patterns Nos. 80½ and 99-E, with spring cushion and back, upholstered in plush, also some upholstered in rattan. These three types are used on the cars of the Detroit United Railway, Detroit & Pontiac Railway, Detroit & Northwestern Railway, Detroit, Rochester, Romeo & Lake Orion Railway, Rapid Railway, of Detroit, and Detroit & Toledo Shore Line Railway.

The advertising privileges in the electric cars of Detroit and vicinity are controlled by the Mulford & Petry Company, which has established an enviable reputation in the efficient handling of street car advertising. The executive offices of the company are located in Detroit, together with the designing department and printing plant, where advertisments are prepared under the direct supervision of the company's officers. The Mulford & Petry Company has branch offices in New York, Chicago, Philadelphia, Cleveland, Toledo, Dayton, Indianapolis, Grand Rapids, Youngstown, Toronto and Montreal. It now controls the advertising privileges on a large percentage of the roads in Michigan, Ohio and Indiana, and is prepared to handle business in any part of the country.

The Le Valley-Vitæ Carbon Brush Company, of New York, is furnishing Le Valley-Vitæ carbon brushes to the Detroit & Lake Saint Clair Railway Company, Detroit United Railways Company, Detroit & Pontiac Railway Company, Detroit, Rochester, Romeo & Lake Orion Railway Company, Detroit, Ypsilanti, Ann Arbor & Jackson Railway Company, Rapid Railway System, Toledo & Monroe Railway Company.

William C. Baker, inventor of the Baker hot-water, non-freezing car heater, of New York, has furnished hot-water heaters for the cars of Detroit, Lake Shore & Mount Clemens Railway, Detroit, Ypsilanti & Ann Arbor Railway, and Rapid Railway Company.

Sand-boxes manufactured by the De Witt Sand-Box Company, Troy, N. Y., are in use on the Mount Clemens (Mich.) & Belle Isle electric roads.

AMONG THE MANUFACTURERS

THE STANDARD POLE & TIE COMPANY, New York, are delivering a large number of poles at Toledo, Ohio.

W. G. A. MILLAR, formerly manager of the ornamental department of the American Bridge Company, has been appointed purchasing agent of that company, with offices at 259 South Fourth Street, Philadelphia, Pa.

C. H. BROWN & COMPANY, Fitchburg, Mass., manufacturers of the Brown engines, has furnished a 22 in. and 40 in. x 48 in. cross-compound condensing direct-connected engine for the Houghton County Street Railway Company, of Hancock, Mich.

ROBINS' BELT CONVEYORS for handling salt are illustrated and described in an attractive four-page folder issued by the Robins Belt Company, of New York. Several views of conveyors in actual operation are shown. Copies will be mailed free upon application.

THE CRANE COMPANY, of Chicago, has just issued a new pocket catalogue of 164 pages. This book covers the company's complete line, including standard, medium, low-pressure; extra-heavy and hydraulic goods in brass and iron, engineers' supplies, tools and pipe. Copies may be obtained by writing the home office or to any branch house.

SEVERAL YEARS AGO Herschell, Spillman & Company, North Tonawanda, N. Y., amusement outfitters, installed a number of outfits in Michigan, and as they report that these have all gradually worked West and South, except a few that were taken to Canada, it would seem that Detroit and vicinity ought to be a good place to locate a merry-go-round.

THE NEW HAVEN CAR REGISTER COMPANY states that it is expecting to make an especially large exhibit of registers and its other specialties at the Detroit convention, and will probably also exhibit at that time a new device for electric railway work. The company has not yet disclosed the nature of this apparatus, but it is understood that it is something of great value in railway work.

THE DETROIT GRAPHITE MANUFACTURING COMPANY, of Detroit, is doing an excellent foreign and domestic business in graphite. For instance, a recent mail brought two very large orders for graphite paint from Manila, P. I., and from San Juan, Porto Rico. The company has a force of machinists working constantly putting up new machinery and reports that its factory is working to its fullest capacity and overtime in taking care of current orders.

THE VALENTINE CLARK COMPANY, Chicago, Ill., carrying an extensive line of white cedar poles, of which a specialty is made, operates large yards and is prepared to execute orders promptly. An immense stock is carried in the yards, which are located at Pinconning, Mich., Green Bay, Wis., New London, Wis. and Prentice, Wis., all conveniently situated directly on railroad lines. The company issues an interesting eight-page illustrated folder that will be mailed free upon application.

THE PECKHAM MANUFACTURING COMPANY has just received an order from the new Washington & Baltimore Railway for all the trucks to be used on that line. This is the new through line which has been referred to in several recent issues of the JOURNAL and is controlled by the same capitalists who own the Aurora, Elgin & Chicago Railway, on which line the Peckham trucks are also in use. The trucks will be of the same style as those employed on the latter railway, which is the largest high-speed line in the country.

SOME OF THE RECENT ENGINE INSTALLATIONS made by the Baker Engine & Machine Company, Philadelphia, Pa., are as follows: J. B. MacAfee, for the Augusta & Aiken road, Augusta, Ga., two 600-hp tandem compound condensing Corliss engines, running at 150 r. p. m.; M. P. McGrath, Lansdale and Norristown, two 400 hp automatic engines, running at 200 r. p. m.; Tennis Construction Company, West Chester, Downingtown & Coatesville Railway, two 600-hp Corliss and one 400-hp automatic engines; Pennsylvania State Construction Company, Cumberland & Frostburg Railway, two 400-hp automatic engines.

JAMES W. COPELAND, of Denver, has been appointed sole agent for the State of Colorado for the Scaife and We-Fu-Go Water Softening & Purifying Systems, manufactured only by William B. Scaife & Sons' Company, Pittsburgh, Pa. Mr. Copeland was formerly located at St. Paul, where for a number of years he was one of the most successful manufacturers' agents of the city. He has recently opened an office in Denver to further the interests which he represents, and is well known throughout the West in mechanical and engineering circles. Mr. Copeland has always given the subject of water purification considerable attention, and is particularly well versed in this line.

THE OTIS ELEVATOR COMPANY has recently closed a contract with the Subway Construction Company for an escalator, or moving stairway, to be installed at the Manhattan Street station of the new rapid transit road. At this point the subway crosses the Manhattan Valley on a viaduct, the tracks being about forty feet above the level of the street. The escalator will carry passengers both up and down, the two tracks being arranged in the same vertical plane. The guaranteed carrying capacity of the device is 20,000 people per hour—10,000 in each direction. A motor of 35 hp will be sufficient to operate the mechanism when working at its maximum capacity.

THE STILWELL-BIERCE & SMITH-VAILE COMPANY, Dayton, Ohio, recently supplied to the Muskegon (Mich.) Traction Company a special cast-iron heater in connection with outside packed feed pumps and circulating pumps. This company also furnished the Chicago Edison Company, of Chicago, Ill., a 10,000-hp heater and is constructing for the Canton-Akron Company two vertical feed pumps. Some time ago the company supplied the Northern Ohio Traction Company with a combined jet condenser and vacuum pump and the Dayton & Covington Traction Company, West Milton, Ohio, condensing apparatus, feed and circulating pumps, heater and triplex electric pump.

JAMES B. CLOW & SONS, of Chicago, have just issued their new catalogue of supplies for water and gas works, railways, contractors, plumbers, steam and gas fixtures. Although comprising 840 pages, it is of a convenient size and will no doubt be one of the standard reference works on the desks of all who have anything to do with steam and sanitary matters. This company is thoroughly up to date in its business methods, as was recently outlined in these columns at the time a description appeared of this firm's new building in Chicago. This catalogue, and the many other attractive advertising schemes which emanate from this company, are due to Miss Helen Mar Shaw, advertising manager.

C. J. HUEBEL & COMPANY, dealers in cedar posts and poles, were incorporated twelve years ago. Their main concentration yard is at Menominee, Mich, from which orders of any ordinary magnitude can be shipped within twenty-four hours from their receipt. The firm has had the benefit of twelve years' experience and can naturally meet the wants of large customers, such as electric railway companies, in a very satisfactory way. It buys its own stumpage, and the customers are given the advantage of the fact that they do not need to deal through middlemen. In addition to the main concentration yards at Menominee, Mich., the company has seven branch yards from which to supply local demands.

THE JOHNSON COMPOUND & SUPPLY COMPANY, of Rochester, N. Y., is placing on the market the sumac elastic paint. This paint has been tested under the most severe conditions and found to give excellent results. It is especially adapted to give a durable and elastic coating to all metal surfaces, such as boilers, trucks, poles, bridges, etc. The manufacturers claim, among other points, that excessive heat, smoke, dampness, water or acid have very little effect on this paint. It never scales or falls off, no matter what the conditions may be. This is largely due to the fact that no coal tar or benzine are used in its composition. Right materials, compounded in the most careful manner, characterizes the sumac elastic paint.

JAMES G. CONNER & COMPANY, Philadelphia, Pa., manufacturers of varnishes and japans, has issued a bright red folder to which attention is attracted by a statement on the first fold which would lead one to think that the company was "doing a hell" of a business, but the second fold reveals the missing "o" of hello, so that the sentence reads "We are doing a hello business now in 'battery paint black,' " a compound which has given satisfaction in painting work in storage battery rooms and on all kinds of electrical and structural iron work, the manufacturers claiming it to be the best insulating and anti-rust paint made. The company is also sending out some attractively printed blotters, calling attention to some of the advantages in using battery black paint.

THE JOHN A. MEADE MANUFACTURING COMPANY, of New York, has just issued an extremely neat, attractively illustrated twenty-four-page catalogue descriptive of "something new" in the shape of belt conveyors. The catalogue not only shows the construction of the conveyor and its application, but it clearly defines the advantages which are inseparable from their use. Illustrations of the company's patent trolley and traction system and automatic radiating truck are also shown. This company's line of machinery covers automatic, steam shovels, unloading towers, automatic, shuttle and industrial cable railways, gravity bucket, scraping and belt conveyors, bucket and case marine elevators, etc., comprising a complete line of labor-saving machinery for unloading, storing, reloading and economically handling any type of material in bulk or package.

"MODERN WOOD PAVEMENTS" is the title of a forty-two-page cloth-bound book issued by the United States Wood Preserving Company, of New York City, describing the company's creo-resinate process of preserving timber and including a paper on "Recent Experiences with Wood Pavements," by B. T. Wheeler, superintendent of streets of Boston, Mass. The author of the book, Fred. H. Kummer, C. E., Jun. A. S. C. E., has also prepared a pamphlet in which similar data is presented, and in a paper on "A Proposed Method for the Preservation of Timber," read by him before the American Society of Civil Engineers, together with the discussion elicited thereby, much interesting information is brought to light, nearly a score of the members having talked on the subject. A reprint of the last-named paper is issued by the United States Wood Preserving Company, from whom any of the publications mentioned may be secured.

"THAT REGISTER WILL LAST AS LONG AS THE CAR" is what a candid street railway man said after examining the new Sterling No. 5, made by the Sterling-Meeker Company, Newark, N. J. There is some foundation for such exuberant praise. A register is a complex machine, and if it keeps a true record, with all the banging it gets, it should not be expected to last forever, yet every expert who looks into the No. 5 is impressed with the strength of every part and the obvious preparation for great and unusual durability.

THE STUART-HOWLAND COMPANY, of Boston, Mass., reports a very prosperous season in electric railway supplies. This company represents what can be accomplished in a few years by a thoroughly active and up-to-date business policy. It has salesmen and representatives in every section in this country, and has recently arranged with Theodore May to represent them in Paris. Mr. May is well known in electrical circles in England and on the continent. With salesmen and representatives in all parts of the world the Stuart-Howland Company keeps itself thoroughly posted on what is going on, and very few contracts for any kind of construction work are awarded without the knowledge of its managers. Since the first of January over 700 miles of road has been equipped with the Stuart-Howland overhead material. This material is meeting with favor among engineers and managers on account of its improved design, as well as the important features of strength and durability.

AMONG RECENT SALES of plows made by the Taunton Locomotive Manufacturing Company, Taunton, Mass, are the following: One heavy nose plow, Chicago, Harvard & Geneva Lake Railroad Company, Walworth, Wis.; one heavy nose, Citizens' Electric Railway, Light & Power Company, Mansfield, Ohio; one heavy nose, Pennsylvania & Ohio Railway Company, Ashtabula, Ohio; one Boston share, Chicago & Joliet Railway, Joliet, Ill.; two heavy nose, Houghton City Street Railway Company, Hancock, Mich.; one heavy nose, Illinois Interurban Construction Company, Rockford, Ill.; one snow sweeper, Cleveland, Painesville & Eastern Railroad Company; two heavy nose, Indiana Railway Company, South Bend, Ind.; one heavy nose plow and one snow sweeper, Cleveland, Berea, Elyria & Oberlin Railway Company; one heavy nose plow and one snow sweeper, Cleveland & Eastern Railway Company, Chardon, Ohio; one heavy nose plow and one share, Chicago Consolidated Traction Company.

ROBERT BELLAMY, the inventor and patentee of the Bellamy vestlette for conductors, which was formerly manufactured by the A. B. C. Manufacturing Company, of Cleveland, has incorporated a new company with paid-in capital stock of $20,000, to be known as the Bellamy Vestlette Manufacturing Company, and will continue the manufacture of this article, which is widely used by conductors on leading street railways of this country and abroad. The new company has a large factory especially designed for its work, and is now in position to fill orders in quantities. The vestlette is now being made from a new material which is so durable that, it is claimed, the garment will outwear six or seven uniforms. It contains nine large and convenient pockets, which are so designed that it is impossible for money or tickets to be stolen by pickpockets or in running to switches or jumping on and off cars. Since the organization of the new company it has been flooded with orders and inquiries, and the vestlette has been adopted by several leading roads as part of the regular uniform.

THE H. W. JOHNS-MANVILLE COMPANY'S exhibit at the Detroit convention will include a full line of overhead line material, comprising a number of newly designed devices, a working display of electric car heaters and Sach's "Noark" fuse protective devices. In this part of the exhibit an especially interesting feature will be a line of newly designed insulated and metallic crossings and section insulators, which embody a number of new features and which are claimed to eliminate the trouble experienced with other devices used for similar purposes. The line of subway fuse boxes to be shown represents the largest and most complete line of work ever built of this description and will be very interesting, together with the other new features in the fuse business that are also exhibited. Those present at the convention will be: J. W. Perry and J. E. Meek, of the New York office; D. T. Dickson, of the Philadelphia branch; S. H. Finney, of the Chicago branch; William A. Buddecke, of the St. Louis branch; also E. B. Hatch and Mr. White, representing the Johns-Pratt Company.

THE CHRISTENSEN ENGINEERING COMPANY, of Milwaukee, will distribute at the convention a booklet containing the names of the roads upon which its air brake apparatus is installed, together with the number of equipments on each road. This is in accordance with the Christensen Company's well-established policy of publishing the names of its patrons, so that any one who desires to consider the merits of the Christensen air brakes may know where to see the equipments in use under the severe conditions of actual service, which is the only satisfactory test for mechanical appliances. The company has also arranged an interesting exhibit at the convention, including a complete air brake equipment in operation. That the apparatus of this company continues to hold its high popularity is shown by the continual growth of its factory, made necessary to fill the demands for brakes. It was only recently that the company completed a very large plant in Milwaukee, but the demand for apparatus has already outstripped its manufacturing facilities, and the company is now engaged on a 250-ft. extension to its present machine shop, which is 186 ft. in width. This extension, when completed, will therefore cover 46,500 square feet of ground space. In addition to the ground floor, 41,500 square feet more floor space will be provided by the galleries on each side and in the center of the building, which is three stories in height.

THE NEAL DUPLEX BRAKE is illustrated and described in a handsomely printed twenty-four-page catalogue issued by the United States Steel Company, Everett, Mass. A number of line drawings, together with several high-grade half-tone engravings, are given to show the application of the brake and the arrangement of the mechanism, of which there are two parts, viz., an axle-driven pump of ordinary construction and a cylinder holding about three gallons of a non-freezable oil. The cylinder, which is fastened to the sills of the car, contains two pistons that are connected directly to the regular brake levers. When the brake is not in use the oil is forced by the pump through one piece of a flexible hose, returning to the pump through another. The valve through which the oil leaves the cylinder can be closed by the motorman with one-quarter of a revolution of the ordinary hand brake, after which the brake remains on and the hand brake may be wound up as far as desired. Release of the brake is instantaneous. The brake cylinder valve is provided with graduated ports, thereby enabling the motorman to make either an emergency or a service stop, as occasion may require. This brake is the invention of J. H. Neal, who was for a long time associated with the Boston Elevated Railway Company. A copy of the catalogue, with further information, will be furnished free upon application.

C. J. HARRINGTON, 15 Cortlandt Street, New York, has just issued a very complete 128-page catalogue that will be of interest to every one connected with street railway, lighting and telephone companies. The catalogue is copiously illustrated, and a full stock of everything shown therein is carried, so that hurry orders may be filled promptly, the material being of first quality as regards metal, insulation and workmanship, none but experienced workmen familiar with the requirements of line work being employed in the manufacture of the goods. Mr. Harrington's personal experience in the electrical supply business has without question placed him in a position to understand the requirements of the trade at large. An instance of this is shown in his purchase of the well-known Medbury insulating plant, which has been dismantled and removed to the Harrington factory at Newark, N. J., where the same high grade of insulated material will be manufactured under the Harrington standard trade-mark, "Empire," instead of the Medbury name. In addition to the line of material manufactured, Mr. Harrington is the sole Eastern representative of several concerns that are well known in the railway and electrical trade, among them being the Banner Electric Company, Youngstown, Ohio; Heil Rail-joint Welding Company, Milwaukee, Wis., and the Scranton Fire Brick & Conduit Company, of Scranton, Pa. The Harrington exhibit occupied space No. 6 at the Detroit convention, also parlor E at the Hotel Cadillac, where friends were entertained.

THE GROWTH OF AN IMPORTANT COMPANY.—Few persons realize the magnitude of the gear, pinion and trolley business of the R. D. Nuttall Company. A dozen years ago, when this company first began the manufacture of gears and pinions for street railway service, the demand for this class of material required the use of but one gear-cutting machine. Soon it was found necessary to add another machine and later advisable to increase the equipment by two additional machines. Since then new and improved machinery has been added from time to time, until at the present upward of seventy gear-cutting machines (the largest gear-cutting equipment in the world) are taxed to their utmost to supply the demand for the well-known "Nuttall make" of gears and pinions. Within the past few years foreign agencies have been established in many of the larger European cities, and the number and size of orders received through this source has exceeded all expectations. The almost universal adoption of heavy cars and powerful motors for high speed and interurban service has made it necessary to correspondingly increase the weight and improve the design of motor gearing, and this company, fully alive to these requirements, has placed in the market a very complete line of heavy design gearing for this particular service. A complete motor-bearing department has recently been added and a full line of all standard bearings will be carried in stock. Last, but by no means least, is the trolley department, in which are manufactured trolleys and trolley repair parts for every conceivable trolley service. Under the able management of F. A. Estep this company has attained an enviable position in the street railway supply business, and the reputable business methods to which the company's past success may be accredited are sure to be adhered to in the future.

THE ST. LOUIS CAR COMPANY has been very busy recently, having within the last few days shipped fifteen single-truck cars to the Dallas Consolidated Street Railway Company, ten double-truck cars to the Dallas Rapid Transit Company, both of Dallas, Tex.; ten single-truck convertible cars to the South Covington & Cincinnati Street Railway Company, at Covington, Ky., and twenty-seven single-truck cars to Birmingham, Ala. A shipment of six cars, completing an order of sixty, was sent to the Northwestern Elevated Railway and the Lake Street Elevated Railroad, of Chicago. The company has also recently shipped four long interurban channel-steel convertible cars to the Interurban Railway, of Des Moines, Ia., and the same number and same type cars to the Richmond Interurban Company, of Richmond, Ind. In addition to this, ten cars have been shipped to the Louisville (Ky.) Railway Company, completing an order for seventy-five cars, and the work of shipping fifty cars to Los Angeles, Cal., for service on the Pacific Electric Railway has been begun. Of the cars for the Pacific Electric Railway thirty are to be of the combination type and twenty will be high-speed cars for interurban service, geared to be run at a speed of 60 miles an hour. The company is also completing a shipment of cars to Akron, Ohio, for interurban service on the Canton & Akron Railroad. These cars, which are 60 ft. long, have three compartments, a regular passenger compartment, beautifully fitted up; a smoking compartment and a baggage compartment. An order of twelve cars for use on the East St. Louis & Suburban Railway Company, running between East St. Louis and Belleville, is being completed, as is also an order of ten cars of the same type for the Cincinnati, Georgetown & Portsmouth Railway, of Cincinnati. The company has secured from the St. Louis & Suburban Railway a large order for convertible cars. In these cars the windows, both upper and lower, can be lowered to a line with the seats, giving an unbroken view from the inside of the cars. These cars will be built and completed at once, and will be painted an olive green, the new color that the St. Louis & Suburban Railway has adopted, in order to distinguish them from the cars of the St. Louis Transit Company. Contracts are being let for the erection of the largest street car electric truck and blacksmith shop in the country, by the St. Louis Car Company. The buildings will be 600 ft. long and 375 ft. wide, and will be built of brick.