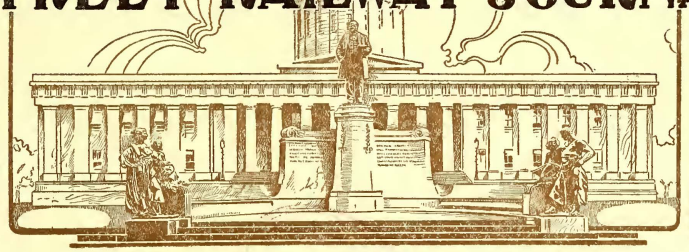
391

STREET RAILWAY JOURNAL



COLUMBUS THE CONVENTION CITY

Columbus, the capital city of Ohio, is in the geographical center of the State and practically in the center of population of the United States. The population is upwards of 150,000, and although the city has no water transportation facilities its commercial and manufacturing development has been remarkable. Its growth is due in no small measure to its electric interurban and its steam railroad connections. Eight interurban systems radiate from the city and twenty-one railroad systems now have entrance here, placing the community in direct touch with the surrounding territory in all directions. Within a night's ride are Chicago, Detroit, Buffalo, New York, Philadelphia, Washington and St. Louis, and within the range of a smaller circle are Cleveland, Pittsburg, Wheeling, Cincinnati, Indianapolis and the entire Ohio, Indiana and Southern Michigan districts.

Columbus is in close touch with the great coal fields of the Central West and is the shipping point for many of the important clay and ore fields in the district.

The excellent railroad shipping facilities have attracted many important manufacturing and industrial establishments, the city being noted for its products of heavy machinery, road scrapers, shoes, dairy products, uniforms, church and lodge room furnishings, proprietary medicines, buggies, wagons, etc.

The city is a place of level streets, the absence of grades having no little bearing on the street railway situation, as well as on the commercial development of the community, as the absence of grades materially reduces the cost of transportation and of trucking.

There are twenty-two banks in Columbus, including six national banks, and these banking institutions are regarded as among the strongest in the country. There are 1,500,000 people who make their homes within two hours' ride of Columbus.

Exclusive of public schools, the city has twenty-six educational institutions, including the Ohio State University, one of the best institutions of learning in the West.

There are seven libraries, and an elaborate Carnegie library and art gallery have just been completed.

The city cares for its feeble-minded, its sick, its poor and its malefactors in asylums, hospitals, alms houses and penitentiaries, which, in architectural features and excellent management, are not surpassed by any city of its size.

The State capitol stands in the centre of the city. Architecturally, the building is famous among the State capitols of the country. The capitol grounds are overrun with tame grey squirrels—wards of the people of Columbus.

In late years a number of "skyscraper" office buildings have been erected on High and Broad Streets.

The city is said to have more miles of well-laid brick paving than any city of its size in the country.

All the railroads entering Columbus use the Union Station, which is conveniently situated with reference to the hotel and business sections.

Columbus produces fifty newspapers and magazines.

There is an abundant supply of natural gas at low rates, and coal is cheap.

The area of public parks is 196 acres, and, in addition, there are a dozen or more private parks and recreation resorts. One of the most important amusement resorts is Olentangy Park, located on the extreme northern limit of the city. Here are a well-equipped theatre, figure-eight coaster, scenic railway, "Fair Japan," old mill, circle swing, house of mirth, refreshment booths and other attractions. Indianola Park, also in the northern section of the city, in addition to the usual park attractions, has an artificial swimming tank covering an area of 30,000 sq. ft.—a favoritie resort in summer. The interurban lines also render accessible a number of parks in the surrounding country, notable among which is Buckeye Lake, on the Columbus, Buckeye Lake & Newark Traction system.

A prominent and unique feature of the city is the method of lighting High Street, which is the main thoroughfare. A series of light steel arches have been erected from curb to curb about every 250 ft., and each arch contains fifty 16-c. p. incandescent lamps. The lamps are placed in a galvanized trough or hood attached to the under side of the arch and running the full length of the span, this hood acting as a reflector to throw the light downward. The lamps project below the edges of the reflector, and at night each individual lamp is visible from a considerable distance, the long stretch of lighted arches giving a peculiarly artistic and pleasing effect.

Columbus was the scene of some of the pioneer experiments in electric traction. In 1887 the late Sydney H. Short, who was born in Columbus and graduated from the Ohio State University, laid down and operated with considerable success an electric line about 2½ miles in length, using the overhead series system of electric traction. From a description published at the time, it appears that "On the trial road at Columbus it requires a 16-hp engine to drive two cars. Each car is 27 ft. long, and, with its load, weighs 10 tons."

THE ELECTRIC RAILWAY SYSTEMS OF COLUMBUS

Columbus in many respects is an ideal street railway city. The streets are laid out in the form of a Latin cross, the long stem being represented by High Street, which is the main business thoroughfare and runs practically north and south for a distance of 7 miles. The cross-arm is represented by Broad Street. The development of the city has been north and south and east and west along these two main lines, but the growth of the city is gradually filling up the corners made by the arms of the cross, so that eventually the city will represent a long and rather narrow rectangle.

This lay-out is conducive to short hauls, as the trends of traffic are to and from the outer ends of the main lines and the intersection at Broad and High Streets near the State capitol.

In arranging routes, it is the practice to run through cars, that is, cars start at the outer ends of the lines, carrying one load to the center of the city, where they discharge and pick up a new load, continuing on through the center of the city and out to the terminal on some other line.

From the intersection of High and Broad Streets, which is the geographical and commercial center of the city, seven parallel lines go east, four go north, two go west and two go south, thus serving the entire city and reaching every point direct. This concentration of cars on a section of High Street renders this line one of the heaviest street railway lines in the country, and, although the section of congestion is not as long as is found in other cities, High Street for several blocks north and south of the company's offices, during the rush hours, closely resembles Broadway, New York, as far as the number of cars passing in each direction is concerned. During the average day the schedule calls for about 2500 cars past this point in eighteen hours, and at peak hours cars pass at the rate of about three a minute. The traffic chart on Plate XVII. gives the distribution of cars over the system as called for by the evening hour schedule.

There are not less than six amusement grounds in the south and southeast sections, and there are two important parks in the north and northeast sections, namely, Olentangy and Indianola. The State Fair Grounds are also near these two last-mentioned parks, which makes an advantageous location for handling the large crowds during Fair Week. The company has handled to the Fair Grounds as many as 1,250,000 people in five days. Fair Week comes in the fall, after the principal parks are closed, so that the copper feeders and rolling stock which are required for handling the summer park business are utilized to good advantage during Fair Week.

The Columbus Company some years ago inaugurated a system of profit sharing with its employees, and it is believed this scheme has resulted not only in increasing the cordial relations prevailing between the men and the management, but has also tended to increase the efficiency and esprit de corps of the employees. The profit sharing dividend is paid on total amounts of wages earned at the same ratio of per cent as is paid to stockholders on the stock. The profit sharing extends to the employees of all departments of the organization. To be entitled to the dividend employees must have worked six months continuously prior to a dividend paying day, and an employee by leaving the service forfeits any further participation in the profit sharing. Both the management and the employees are enthusiastic over the results that have been achieved by this method of allowing the rank and file of the organization to participate in proportion to their wages in whatever profit the company may earn.

TRACK CONSTRUCTION

Until recently the entire street railway mileage in the city of Columbus was operated by two independent companies, namely, the Columbus Railway & Light Company and the Central Market Street Railway Company. The first named company was chartered in 1903 as a consolidation of certain prior companies, and its system includes all of the original street railway lines in the city. Practically all of these lines are 5-ft. 2-in. gage. The Central Market Street Railway Company was formerly a part of the "Appleyard System" and its tracks were laid primarily to give an entrance for the interurban lines into the city of Columbus. These tracks are 4-ft. 8½-in. gage. Since July 1 of the present year, the Columbus Railway & Light Company has been operating the Central Market system for the owners. The Columbus Railway system comprises 106½ miles, measured as single track, and the Central Market system comprises 29½ miles, giving a total of 136 miles. The accompanying table sets forth the distribution of the mileage on the wide gage lines.

STATEMENT OF MILEAGE, COLUMBUS RAILWAY & LIGHT COMPANY

	Within City Limits	Outside City Limits
Paved streets	67.086	.894
Unpaved streets	10.542	7.191
Roads	....	17.099
Park and Pr. R. of W.	1.005	2.783
Total	78.633	27.967

Total for system, 106.604 miles.

In Columbus will be found various styles of track construction, the system in this respect being somewhat out of the ordinary. The inset following page 594 illustrates graphically the different forms of track construction and the approximate quantity of each kind. The color scheme on this map illustrates the five predominating forms of track foundations, which are as follows: Concrete girder and steel angle bar tie construction; oak ties embedded in concrete, i. e., the timber has a foundation of 6 ins. of concrete, which extends upward and between the ties and is surfaced to a height to accommodate the kind of pavement to be laid; oak ties ballasted with crushed rock and a layer of cement concrete laid over the ballast to form the pavement foundation; oak ties ballasted with gravel and filled with gravel to form the pavement foundation; track construction in unimproved streets. The particular rail sections used in different locations are noted along the sides of the lines on the map.

The construction which has been followed during the last three or four years on the wide gage tracks in paved streets comprises a modified "Trilby" rail with concrete girders and steel angle-bar ties. This is now regarded as the standard track construction for city lines. The details are shown in the drawings on page 593. The procedure in laying this construction is about as follows:

After the old track work and pavement have been removed the grading is completed, in cases where brick pavement is to be laid, 11 ins. below the surface of the finished street, after which ditches or troughs are excavated under the location of each rail to a depth of 10 ins. below the bottom of the rail, the ditches being 18 ins. in width. The track work is then assembled and surfaced upon oak blocks cut from old oak ties. The

material for the concrete is then delivered by dump cars and piled along the side of the track. The dump cars travel over the rails that are supported on the oak blocks, and during this delivering of material the blocks settle into firm bearings under the track. When all the material has been delivered the track is gone over and shimmed to a true surface and line, care being taken to block the track work into line from the sides to prevent the heat of the sun from kinking the track. When all is ready for the concrete, the concrete boards are placed upon the rails, where the mixing is done by hand and the boards are pushed along upon the track as the work progresses. In connection with this work it has been found very important to leave the ends of the rails free, so that expansion will not create undue stresses while the concrete is being laid and is setting.

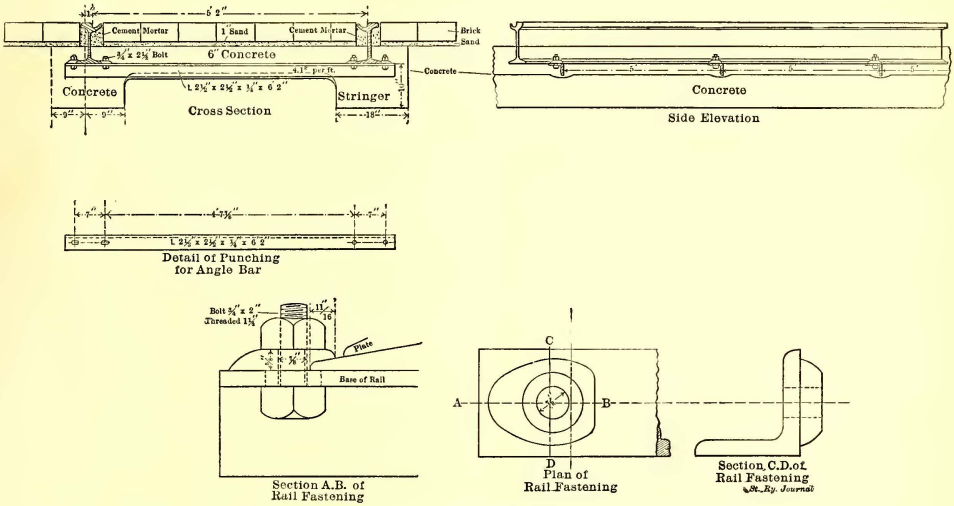
Construction similar to this was laid on State Street, from High to Fourth Streets, on the south track in 1898, and the track is in excellent condition to-day. This track was laid with ordinary six-hole standard joint plates. On more recent work the track is laid with continuous rail.

troller. The rear car has a controller of the K-10 drum type, and the motor circuits of the two cars are connected by means of jumpers between the cars.

The type M controller on the first car is the regular multiple-unit equipment for four motors. The wiring of this controller is identical with that of an ordinary four-motor equipment, with the exception that the leads for motors No. 3 and No. 4, instead of going to motors, are divided into a bus line extending the full length of the car and terminate in receptacles on each dash. On the rear car, wires leading from the receptacle on the dashes are tapped in on the motor leads, and other than this addition no changes from the usual K-10 controller wiring is made. The chief advantage of the use of the two different kinds of controllers is that the extra expense of installing a multiple-unit controller on the rear car is avoided.

SHOPS

The main repair shops for the Railway & Light Company are on Rose Avenue, about two miles east from the center of



DETAILS OF CONCRETE GIRDER TRACK CONSTRUCTION, COLUMBUS RAILWAY & LIGHT COMPANY

ROLLING STOCK

The Columbus Railway & Light Company owns about 300 cars of various designs and dimensions. The standard open car measures 40 ft. 9 in. The standard closed car measures 42 ft. over all.

All of the regular cars of the company are mounted on Brill maximum traction trucks. This type of truck has been adopted in Columbus, owing to the fact that the tracks are wide gage. The company also has a large number of single-truck cars which it uses on peak loads and during Fair Week.

It is necessary, owing to the climate in Columbus, to have a complete double equipment of open and closed cars for summer and winter service. The motor equipments are mostly G. E. 67, mounted two to the car. The company also has motors of the G. E. 52, 44 and 800, Westinghouse 49 and 12 types.

The company has recently worked out an ingenious method of running cars in trains in order to lessen the congestion on the principal streets, as well as to increase the carrying capacity during rush hours. Each car is equipped with two motors, and the first car of each train is provided with a multiple-unit con-

the city. In addition to the main shops and houses at this point, there are six operating houses scattered over the local system, in which it is the practice to do considerable inspection and light repair work. As the company has a complete equipment of open and closed cars, it is the practice to thoroughly overhaul the rolling stock once a year, during the change of seasons. All the regular repair work is done in the day time, and each car is pulled in not less than every two days for inspection and repair.

The main shop at Rose Avenue consists of a group of three buildings. The pits and truck room are located in the front wing. The machine shop occupies the ground floor of a three-story building, formerly an old horse-car barn. The second floor of this building contains the armature and field-coil rooms and the stock room. The carpenter shop is in a wing at the rear of the main building. The paint shop, foundry and blacksmith shops are in separate buildings a short distance from the main building. The plant has been developed with the growth of the system, and although all departments are now somewhat cramped, the rolling stock is kept in excellent condition. The machine shop equipment includes a wheel press, boring mill, sev-

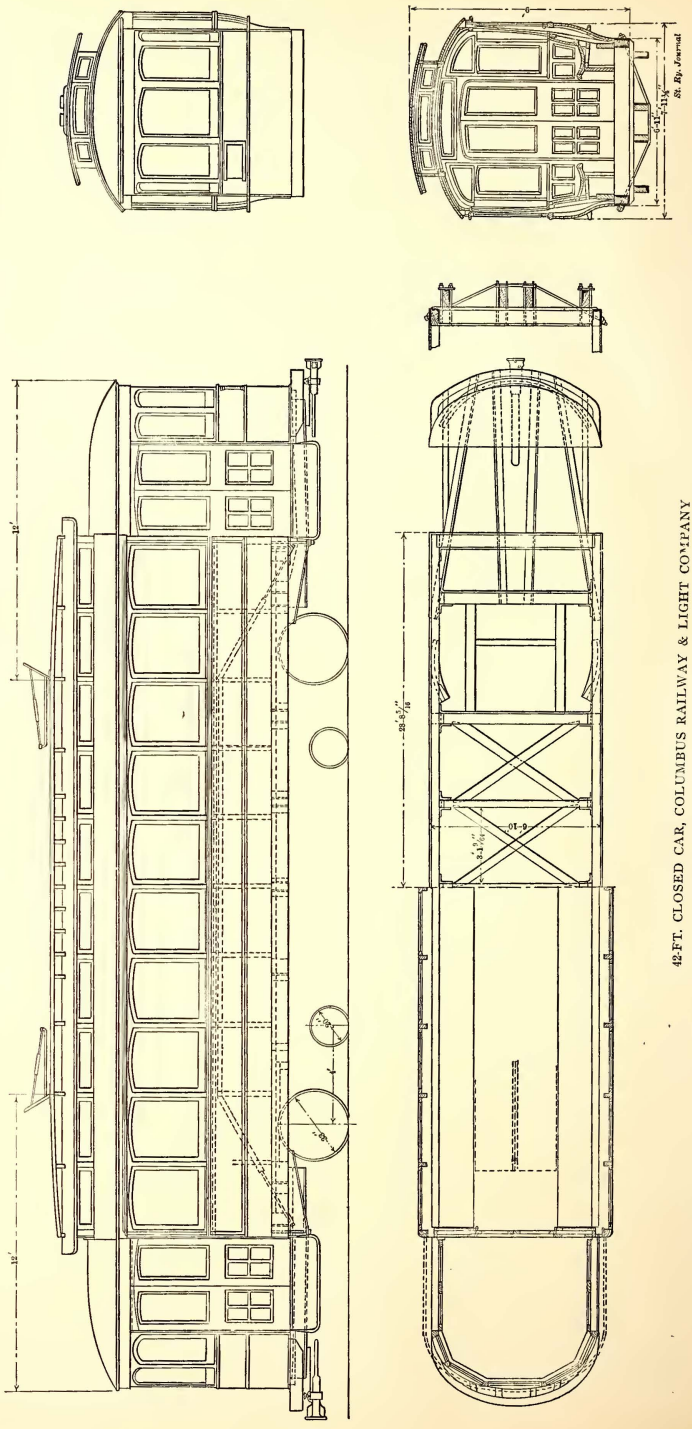
eral lathes, drills, bolt cutters, etc. In the carpenter shop are a complete set of tools, including a wood-worker, rip and cut-off saws, planer, etc. The paint shop has a capacity for only a few cars at a time, but here is done all the painting and retouching on 300 cars, and the excellent appearance of the rolling stock on the streets speaks well for the system used.

The shops are equipped with a number of labor-saving devices, of which, perhaps, the most interesting are the air hoists and cranes over the inspection pits for handling the truck and motor parts. There are two 6-in. air hoists which travel on circular cranes. These two circular tracks cover the entire width of the shop, the diameter of each circle being 24 ft., thus making it possible to pick up parts and material and deliver them at any point in the pits or on the floor. Each crane has two arms extending from the center to the circumference, these arms being pivoted at the center, with travelers at the outer ends. On the arms are also travelers from which the air hoists are suspended. These outfits were built in the company's shops and cost $240 each complete, including air hoists and connections. The circular tracks are made from 8-in. I-beams, which are bent into proper shape on a wheel press. These circular cranes have the advantage of avoiding the necessity of posts in the center of the room. The cranes are of particular value in changing motors from one truck to another when the change from open to closed cars is being made. A direct-connected compressor supplies the hoists with air. A smaller circular crane of the same type is used in the armature room.

In addition to the circular travelers there are eight 9-in. hoists traveling on overhead tracks, for raising cars when trucks are to be changed.

A small but well-equipped brass foundry takes care of a remarkably large amount of work, and the company produces practically all of the brass castings required in the operation of the system, including rail bonds, trolley ears, trolley wheels, controller parts, etc.

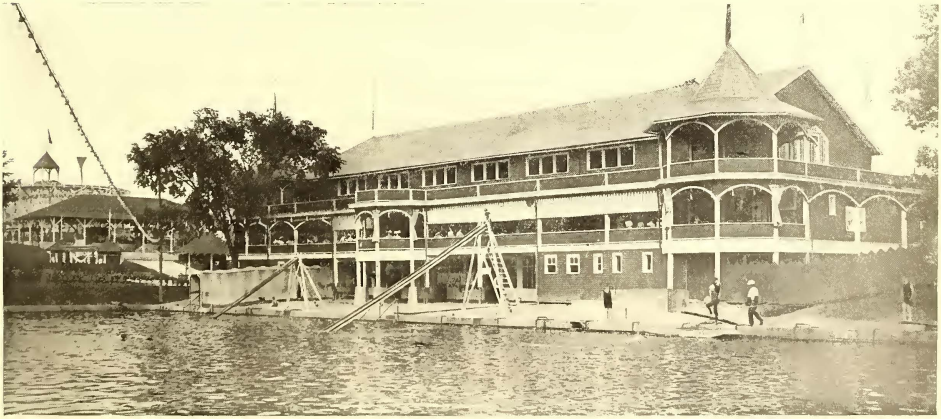
The repair shop for the Central Market system is located in



42-FT. CLOSED CAR, COLUMBUS RAILWAY & LIGHT COMPANY

THE COLONNADE AT OLENTANGY PARK, COLUMBUS

THE CASINO AT OLENTANGY PARK, COLUMBUS



THE SWIMMING POOL, BATH AND DANCING PAVILION, INDIANOLA PARK, COLUMBUS

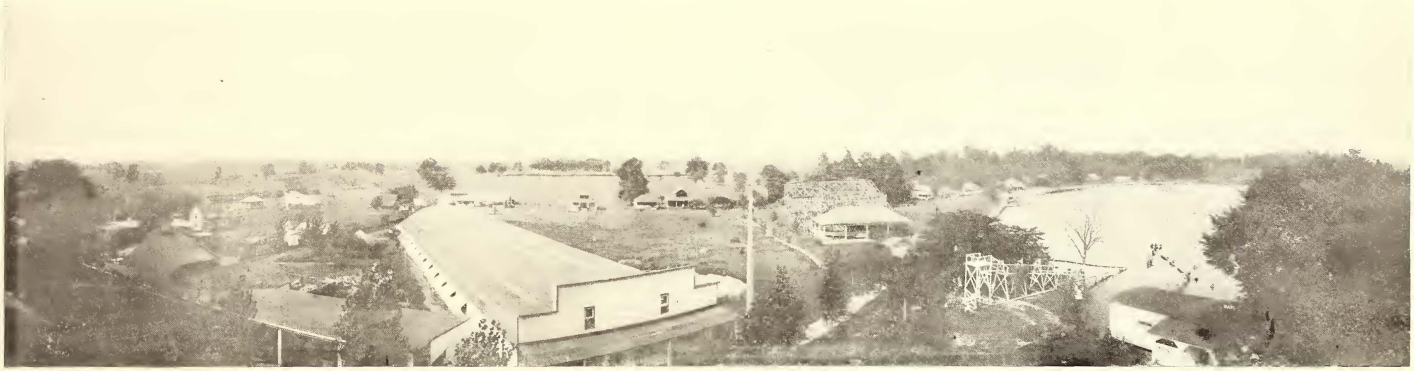
THE TUNNEL ON THE COLUMBUS, NEWARK & ZANESVILLE LINE

A PICTURESQUE SPOT ON THE COLUMBUS, NEWARK & ZANESVILLE LINE

A BIT OF NATURE CAUGHT FROM THE CAR WINDOW ON THE COLUMBUS, NEWARK & ZANESVILLE LINE

VIEW ON LINE OF THE COLUMBUS, DELAWARE & MARION

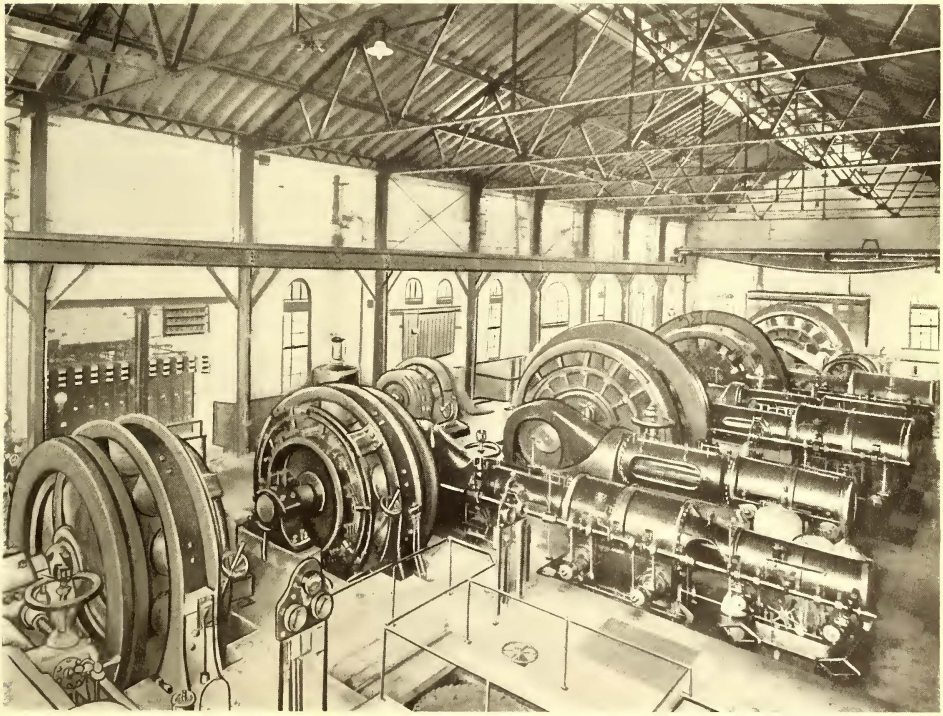
VIEW ON LINE OF THE COLUMBUS, NEWARK & ZANESVILLE



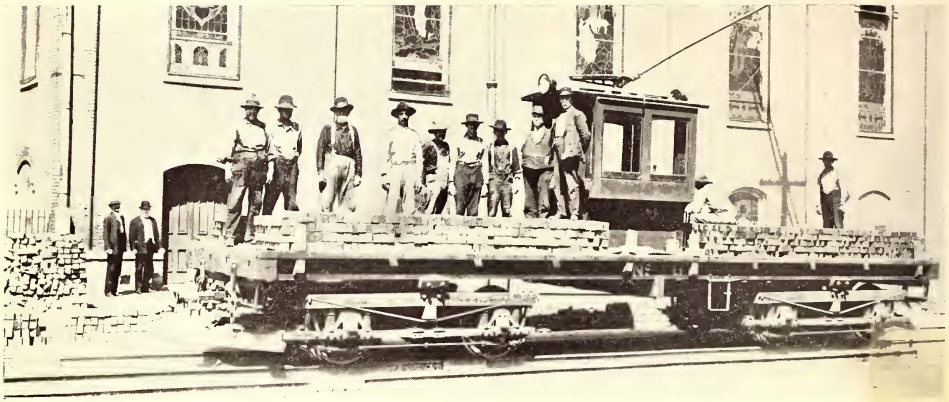
PANORAMA OF BUCKEYE LAKE, ON COLUMBUS, BUCKEYE LAKE & NEWARK

SCENE ON INTERURBAN LOOP, COI

CAR HOUSE, CENTRAL MARKET LINES, COLUMBUS



INTERIOR SPRING STREET STATION, COLUMBUS RAILWAY & LIGHT COMPANY



DELIVERING BRICK WITH RAIL CAR FOR PAVING TRACKS IN COLUMBUS

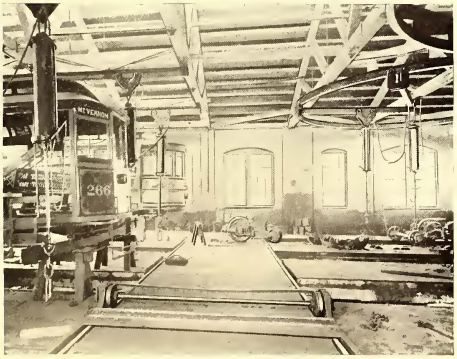
CONCRETE GIRDER CONSTRUCTION IN COLUMBUS—DELIVERING MATERIAL WITH SIDE-DUMP CARS. ONE MOTOR CAR WILL PULL TWO DUMP CARS

CONCRETE GIRDER CONSTRUCTION IN COLUMBUS READY FOR CONCRETE

CONCRETE GIRDER CONSTRUCTION IN COLUMBUS. TO BE PAVED WITH BRICK. ONE TRACK CONCRETED. MATERIAL BEING DELIVERED IN OTHER TRACK

CONCRETE GIRDER CONSTRUCTION IN COLUMBUS. ASPHALT PAVEMENT COMPLETED, EXCEPT TOP COAT IN ONE TRACK

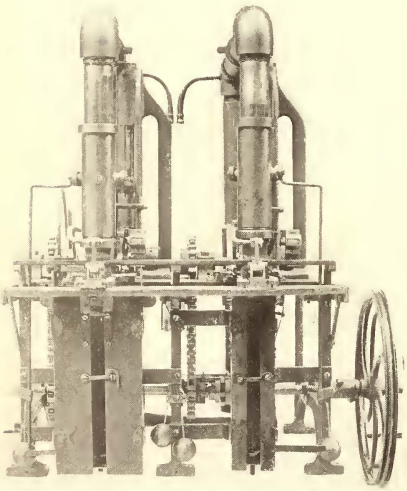
DOUBLE-GAGE TRACK IN COLUMBUS



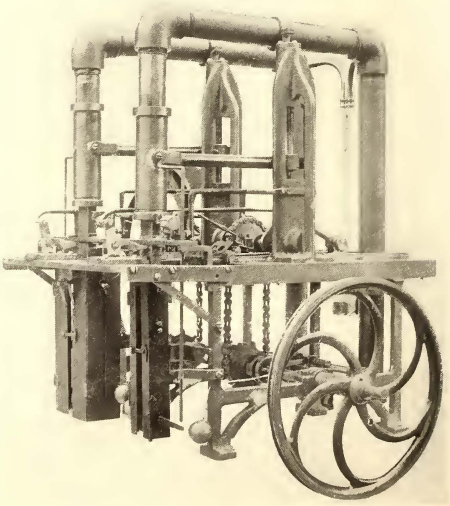
CAR SHOP, SHOWING CIRCULAR CRANES AND TRANSFER TABLE

AUTOMOBILE STORAGE BATTERY STATION MAINTAINED BY COLUMBUS RAILWAY & LIGHT COMPANY

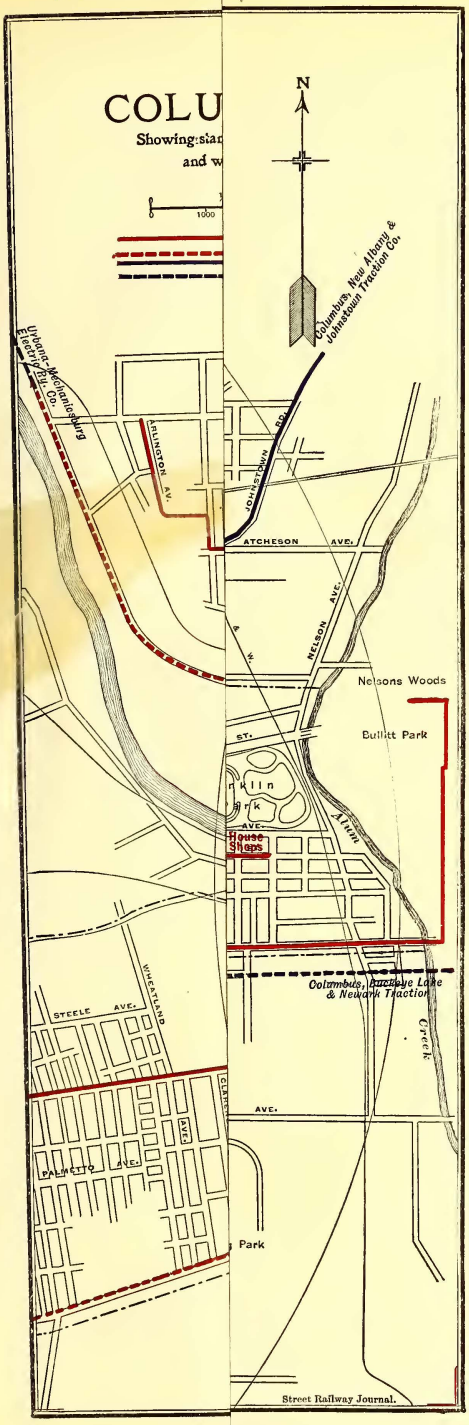
TWO-CAR TRAIN, WITH TWO MOTORS TO EACH CAR AND MULTIPLE-UNIT CONTROLLER ON FIRST CAR—USED IN CITY SERVICE BY COLUMBUS RAILWAY & LIGHT COMPANY



TICKET-COUNTING MACHINE USED BY COLUMBUS, NEWARK & ZANESVILLE



SIDE VIEW OF TICKET-COUNTING MACHINE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Showing sta
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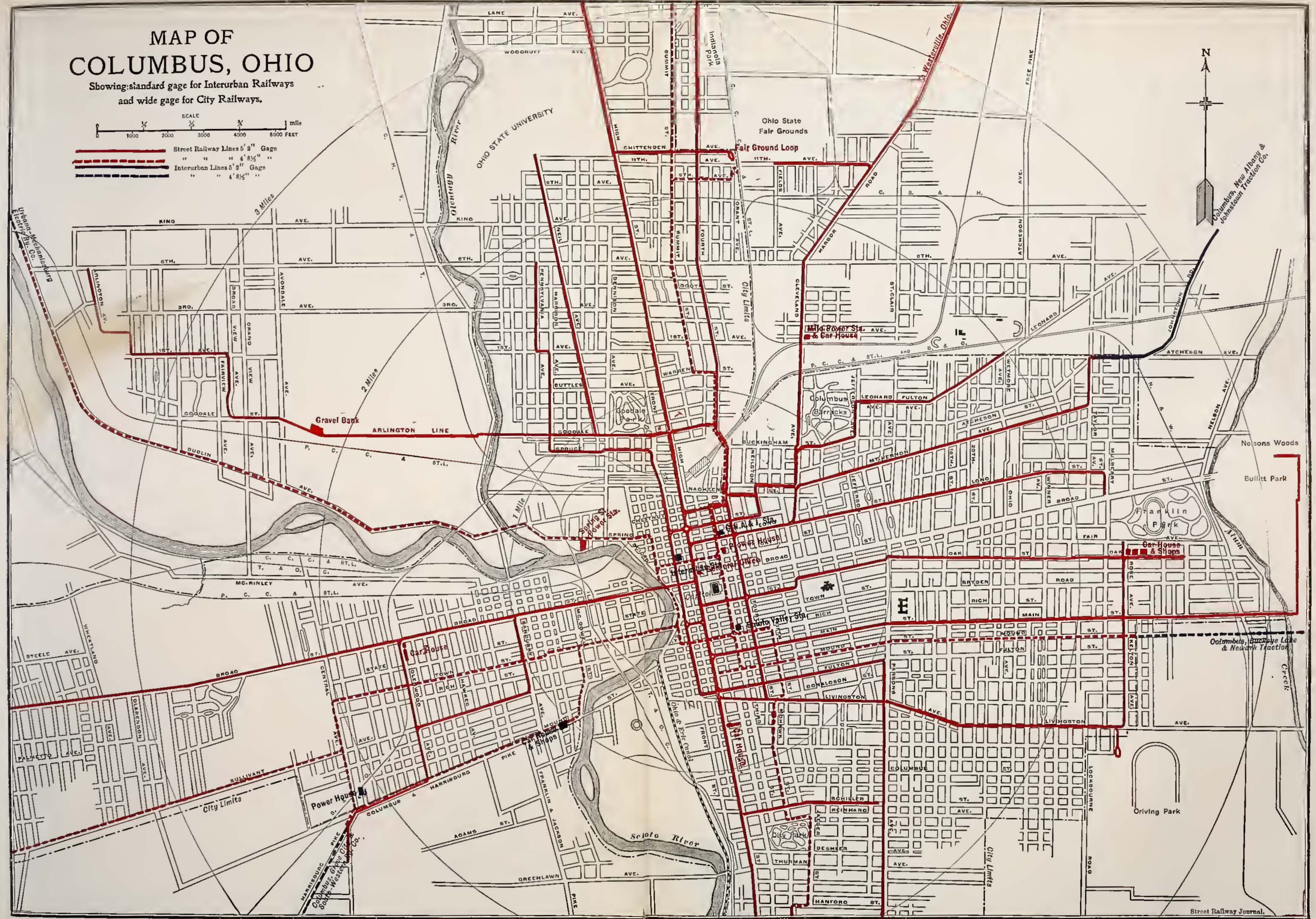
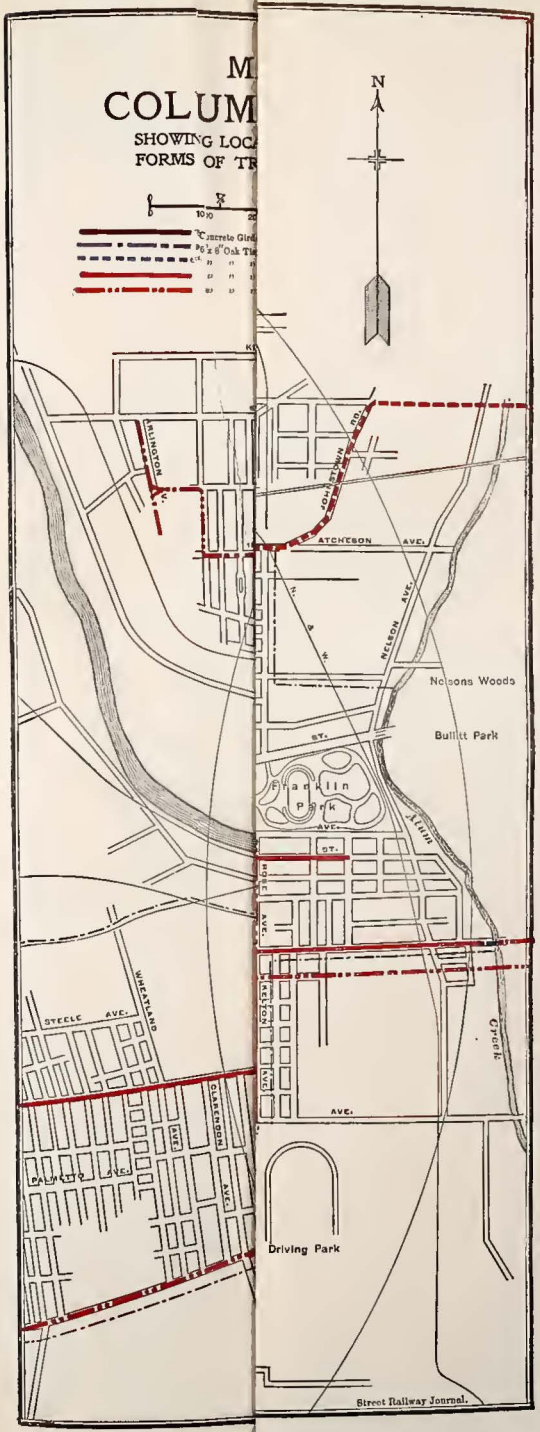
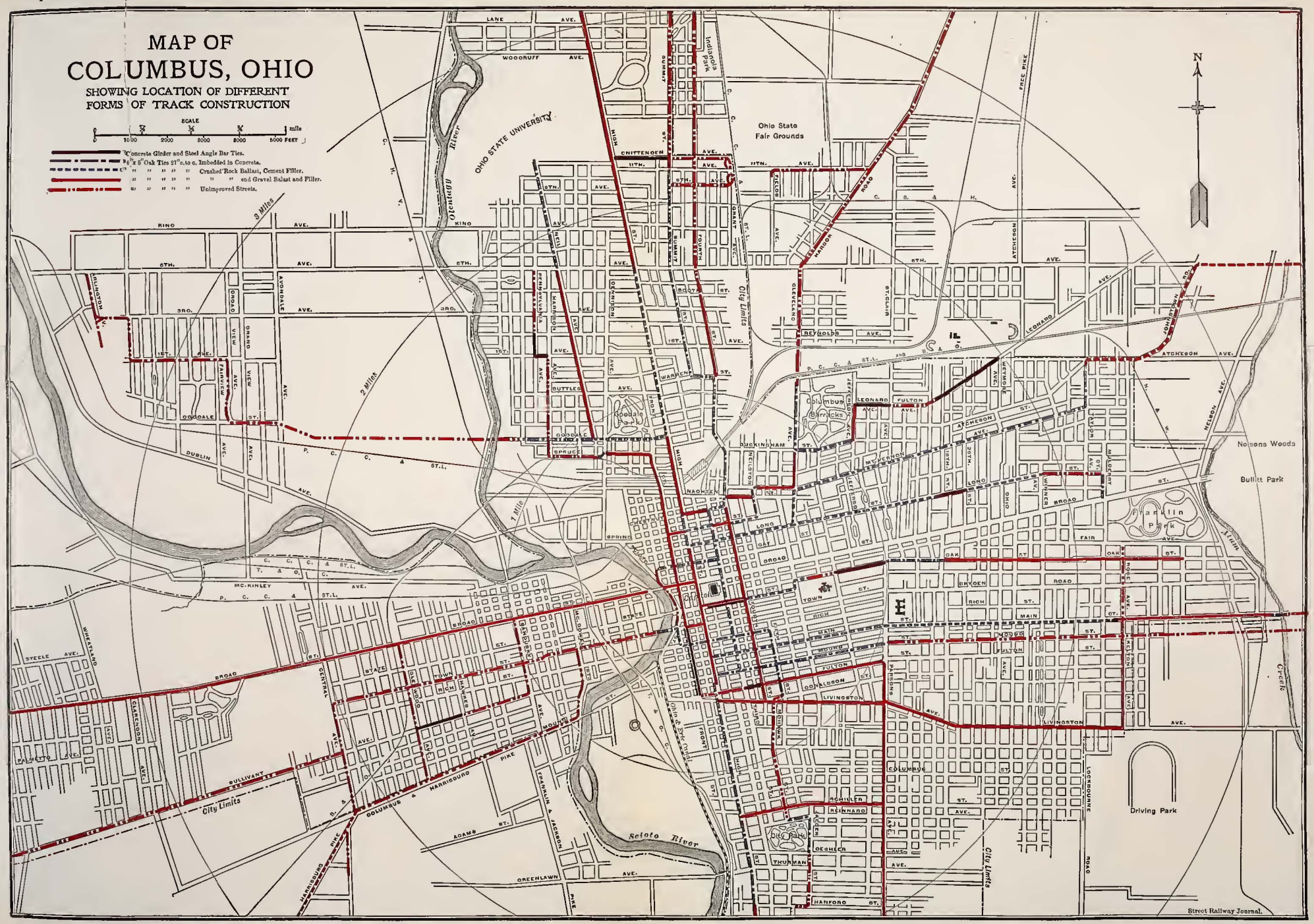
1000
N
Columbus, New Albany & Johnstown Traction Co.
Urbana-Mechanicsburg Electric Ry. Co.
ARLINGTON AV.
JOHNSTOWN RD.
ATCHESON AVE.
NELSON AVE.
A. & W.
Nelsons Woods
Bullitt Park
ST.
AVE.
House Shops
Alum
Columbus, Buckeye Lake & Newark Traction
Creek
WHITELAND
STEELE AVE.
AVE.
PALMETTO AVE.
Park
Street Railway Journal.


MAP OF
COLUMBUS, OHIO
Showing standard gage for Interurban Railways
and wide gage for City Railways.
SCALE
mile
Street Railway Lines 5' 2" Gage
" " " 4' 8½" "
Interurban Lines 5' 2" Gage
" " 4' 8½" "
N
OHIO STATE UNIVERSITY
Ohio State
Fair Grounds
Fair Ground Loop
Olentangy River
Urbana, Mechanicsburg Electric Ry. Co.
Columbus, New Albany & Johnstown Traction Co.
Gravel Bank
ARLINGTON LINE
Milo Power Sta. & Car House
Columbus Barracks
Goodale Park
Spring St. Power Sta.
C.N.A. & I. Sta.
Power House
Interurban Sta.
Capitol
Scioto Valley Sta.
Car House
Car House & Shops
Power House
Columbus, Buckeye Lake & Newark Traction
Columbus, Grove City & South Western Ry. Co.
Franklin Park
Nelsons Woods
Bullitt Park
Driving Park
City Park
City Limits
Scioto River
Alum Creek
Ohio & Erie Canal
3 Miles
2 Miles
1 Mile
Street Railway Journal.


M
COLUM
SHOWING LOC
FORMS OF TR
N
ARLINGTON AVE.
JOHNSTOWN RD.
ATCHESON AVE.
NELSON AVE.
Nelsons Woods
Bullitt Park
Franklin Park
AVE.
ST.
STEELE AVE.
WHEATLAND
CLARENDON AVE.
PALMETTO AVE.
Driving Park
Street Railway Journal.


MAP OF
COLUMBUS, OHIO
SHOWING LOCATION OF DIFFERENT
FORMS OF TRACK CONSTRUCTION
SCALE
1000 2000 4000 6000 5000 FEET
mile
Concrete Girder and Steel Angle Bar Ties.
6" x 8" Oak Ties 21" c. to c. Imbedded in Concrete.
" " " " " Crushed Rock Ballast, Cement Filler.
" " " " " " and Gravel Ballast and Filler.
Unimproved Streets.
N
Olentangy River
OHIO STATE UNIVERSITY
Ohio State Fair Grounds
City Limits
Scioto River
Nelsons Woods
Bullitt Park
Driving Park
Franklin Park
Goodale Park
Columbus Barracks
Street Railway Journal.

another part of the city and is used by some of the city cars, and by the interurbans, for such repairs as have to be made at this terminal. The shop is well equipped with tools and labor-saving devices.

The Columbus Railway & Light Company is using in its hurry-up repair service a gasoline automobile tower wagon, which has given satisfactory results for strictly city service, and is said to make better time than horse-drawn tower wagons at an expense somewhat less than for teams.

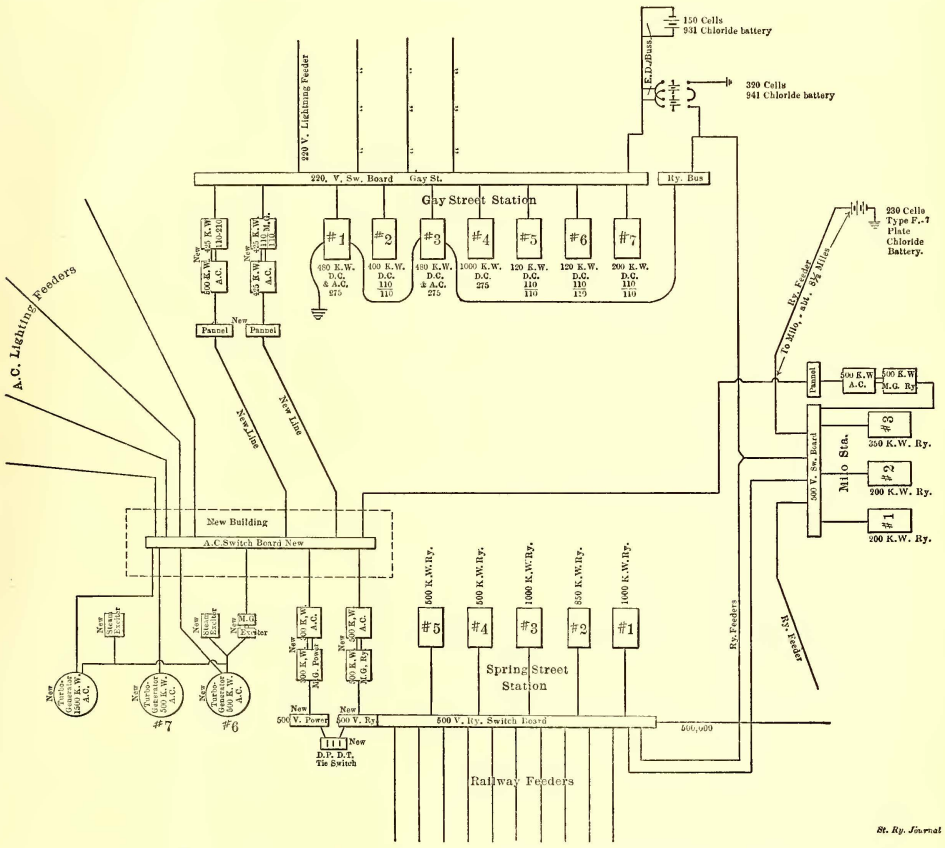


DIAGRAM SHOWING ALL TIE LINES BETWEEN POWER STATIONS, COLUMBUS RAILWAY & LIGHT COMPANY

POWER

The Columbus Railway & Light Company has four distinct power services, namely, 550-580-volt, d. c. current for railway purposes; 115-230-volt, d. c. current for Edison lighting system; 4100 a. c. current for lighting, and an independent insulated 550-volt power supply. The company owns four power houses, namely, Spring Street, known as Station No. 1; Gay Street, known as Station No. 2; Milo, known as Station No. 3, and a station formerly owned by the Central Market system, known as Station No. 4.

Most of the current for railway purposes is generated at Spring Street. Most of the current for lighting is generated at Gay Street. The generating apparatus at the Milo station is now held in reserve and is used only on peaks and in emergencies, a 500-kw National motor-generator set having been installed at this station for the purpose of taking current from the other stations and delivering direct current to the system in this district.

All of these stations are thoroughly tied together by a. c. and d. c. tie-lines, giving the greatest degree of flexibility and permitting of a number of combinations in the generation of current that assure economy and efficiency in the power supply and practically preclude the possibility of interuption to the railway, lighting or power service, through failure of lines or apparatus at any station.

The diagrammatic representation of the power lay-out given on this page, together with the map on Plate XVIII., showing the tie-lines between stations, will make clear the general power scheme.

In brief, it will be noticed that the Spring Street station contains five railway units, two of which are 500-kw, two are 1000-kw and one is a 840-kw unit. These machines handle the bulk of the railway load. There are also in this station two 500-kw Curtis turbo-generator sets which deliver alternating current at 4100 volts. There is room for an additional 1500-kw turbo-generator set. The high degree of flexibility previously

referred to is greatly increased by the use of motor-generator sets in the various stations. In the Spring Street station there is one 500-kw General Electric motor-generator set and one 300-kw General Electric motor-generator set, which can be used either to deliver railway current to the railway feeders or alternating current to the lighting system, as conditions may require. There is also one 150-kw General Electric booster-set, which can be so connected as to boost through any feeder panel at this station. This booster is used chiefly on the park lines in summer. The railway units at this station are driven by Green-Wheelock engines.

The Gay Street station contains the following generating apparatus:

Two 480-kw General Electric double-current machines, which can be used either to deliver direct or alternating current as required.

One 400-kw General Electric 110-volt, direct-current machine and one 1000-kw General Electric, 275-volt, direct-current machine for supplying the Edison lighting system.

There are also three other units, two of them consisting of two 60-kw Edison bipolar machines and one consisting of two 100-kw Edison bipolar machines for use on the Edison system.

In addition to the generating apparatus at this station there is one 500-kw, three-unit General Electric motor-generator set, the motor taking alternating current and driving the other two machines as generators, delivering 125-210 direct current to the Edison system. There is also one 500-kw General Electric two-unit motor-generator set, which is used in the same way. These sets can, of course, be reversed so as to take direct current and deliver alternating current.

To further increase the flexibility and efficiency of the power supply there have been installed at the Gay Street station two storage batteries, one comprising a 320-cell "Chloride Accumulator" battery, which may be used either to deliver 550 volts d. c. to the railway or 220 volts d. c. to the Edison lighting system. This is accomplished by operating the cells in series for railway work and in parallel sections for lighting. The battery in railway work has a capacity of 880-kw.

There is also a smaller battery, consisting of 150 cells, used on the Edison lighting system and supplied by one 50-kw, two-unit motor-generator set.

The possibilities that lie in this combination of d. c. and a. c. generating apparatus, motor-generator sets and storage batteries in securing any kind of current required, smoothing out peaks, and, at the same time, maintaining a good load factor on all machines, will be very evident.

As stated, at the Milo station, the generating apparatus, which consists of two 200-kw and one 400-kw railway generators, is held in reserve, and the station is used principally as a sub-station, there having been installed a 500-kw motor-generator set supplied by the National Brake & Electric Company. This set is of the three-bearing type, and consists of a 750-hp, three-phase, 60-cycle synchronous motor receiving current at 4100 volts and driving a 500-kw direct-current generator, which generates current at 575 volts and 870 amperes. This motor-generator set supplies the nearby territory and also feeds the line to Westerville. To improve the power situation on this Westerville line there is a 230-cell storage battery located about 8½ miles from Milo station, and which is used as a floating battery on the line.

The apparatus in the Central Market station consists of two 325-kw and one 250-kw Westinghouse railway generators. There is also at this station a 240-kw storage battery, which is fed from a motor booster set, and is used for taking care of load fluctuations at this power house.

COLUMBUS AS AN INTERURBAN CENTER

Columbus is one of the principal interurban centers in the Central West. Eight lines radiate from the city in eight different directions, bringing it into intimate touch with the territory within a circle of 75 miles radius. Columbus is connected by through electric railway routes with Cincinnati and Indianapolis, and with only short links remaining to be built with Cleveland, Toledo, Detroit and Buffalo. The development of the interurban lines centering in Ohio's capital city has been so great that it is hard to realize the growth has taken place virtually within a period of four years. These lines give hourly passenger service, and are well built, well equipped and well managed. In a multiplicity of ways this frequent and close connection between the country and the city has had an enormously stimulating influence upon the development not only of the capital city itself, but also of the country districts and towns as well. The early morning cars bring in many people employed in the commer of the city, and the cars later in the day bring in retail a wholesale purchasers from all the surrounding country, whi thousands of the city people use the interurban cars in summe and in winter for pleasure and recreation, and as an importan agency in their social life. Most of the lines maintain a freight and express service, bringing to the city the farm produce and products, and in exchange carrying to the farms and the country towns the manufactured articles and supplies furnished by the larger city.

Within a circle drawn around Columbus with a radius of 75 miles there are eighteen counties wholly included and twenty others partially so. Within this area there resides an estimated population of a million and a half of people, which, through the agency of the interurban lines, might, with no great stretch of the imagination, be included as the city's population, so close and intimate is the relation established. Within the circle there are thirty country seats and more than 100 additional towns and villages.

The following are the interurban roads immediately centering in Columbus: Columbus, Delaware & Marion Railway Company; Scioto Valley Traction Company; Columbus, London & Springfield Railway Company; Columbus, Newark & Zanesville Electric Railway Company (controls the Columbus, Buckeye Lake & Newark Traction Company); Columbus, Grove City & Southwestern Railway Company (operated by the Columbus, London & Springfield Railway Company); Columbus, Urbana & Western Railway Company; Columbus, New Albany & Johnstown Traction Company; Westerville and Arlington lines of the Columbus Railway & Light Company.

Many of the construction and operating features of these systems are reviewed in the following pages.

THE DISTRICTS AND THE ROADS TREATED

In the following pages the attempt has been made to give a resume of interurban practice in the Central West. For the purpose of determining in so far as possible the latest methods and standards in interurban construction and operation in this section, a number of representative roads in Ohio, Indiana and Michigan were selected and a personal investigation of these roads was made by the editors. It is realized that the practices on roads other than those visited are well worthy of study, but owing to the lack of time and space it was impossible to include all the systems in this district, and it is believed the roads selected offer the basis for a resume of the latest and most typical practices. For the purposes of the investigation eight roads were selected in Northern Ohio, nine in Central and Southern Ohio, seven in Indiana and two in Michigan.

In the tables under each chapter are given in detail the latest practices in the various departments. In the text the attempt has been made to point out the latest standards where practices have been standardized. Where no definite standards have yet been reached the endeavor has been to indicate tendencies toward uniformity in practice, and where this could not be done the variations and differences are stated and the need for uniformity pointed out. In the pages containing the half-tone engravings, the arrangement has been to group together in so far as possible views that would show the latest and most representative practices in the matters treated.

INTERURBAN DEVELOPMENTS IN THE TERRITORY TREATED

The year 1906 will go down as an epoch-marker in the history of interurban railways in Ohio. The consolidations of many roads and the completion of new lines have made numerous changes in the interurban map of the greatest interurban State in the Union. At present there are in operation 2600 miles of strictly interurban roads in the State, of which 195 miles have been completed this year.

One of the most important incidents was the completion of the Western Ohio extension from Lima to Findlay. A golden spike presented by the STREET RAILWAY JOURNAL was the finishing touch in the line which linked together more than 4000 miles of interurban roads in the five States of New York, Pennsylvania, Ohio, Michigan and Indiana. The completion of this link was soon followed by the institution of limited service from Dayton to Toledo, 162 miles, and in connection with other roads giving limited service it rendered possible a fast trolley trip from the central part of Michigan across Ohio to all the numerous points in Indiana, or from the eastern part of Ohio to Indiana points.

The early part of this year saw the consummation of the plans of the Widener-Elkins-Schoepf syndicate for the consolidation of numerous lines in Ohio. This syndicate acquired the Columbus, Buckeye Lake & Newark and the Columbus, Newark & Zanesville. At receiver's sale it acquired the Columbus, London & Springfield; Columbus, Grove City & Southwestern; Dayton, Springfield & Urbana; Urbana, Bellefontaine & Northern and the Springfield & Western, known as the Appleyard systems. By purchase it also acquired the Dayton & Northern and the Dayton & Muncie, and by lease it secured the Dayton & Western. A steam road, known as the Columbus & Lake Michigan, was purchased, and will probably be electrified. These various properties have been grouped together under one head, known as the Indiana, Columbus & Eastern. In addition, the syndicate owns the Fort Wayne, Van Wert & Lima, the Cincinnati Northern and the Cincinnati Interurban. It has under construction a line from Lima to Toledo, part of which will be placed in operation this year and will be completed next year. In all, the syndicate has in Ohio about 510 miles of operating interurban lines, where a year ago it had less than 100. Its system of interurban and city lines in the two States of Ohio and Indiana embraces about 1300 miles. In Ohio it plans to build from Bellefontaine to Lima, which, with the Lima & Toledo, will give it a continuous line from Cincinnati to Toledo independent of any other interests. The almost entire reconstruction of the Cincinnati Northern, with double track on private right of way, a new power station and new rolling stock capable of giving very fast service between Dayton and Cincinnati, will have an important bearing on the through Cincinnati to Toledo service.

This year witnessed the complete reconstruction of the Everett-Moore system larger and stronger than it was at the time of the embarrassment four years ago. This rebuilding of a scattered system demonstrated the remarkable persistence of the Cleveland syndicate and its belief in the future of interurban traction, in that while it sold its telephone properties and one of its city properties, the Cleveland Electric, its chief aim was to get back the interurbans and enlarge the system. The first step was the repurchase of the Detroit, Monroe & Toledo Short Line, the connecting link between the Michigan and Ohio properties. This has been added to the system of the Detroit United Railways, giving it 620 miles of road, of which about 420 is interurban mileage. The syndicate then purchased the Cleveland, Painesville & Ashtabula, which it originally promoted, adding it to the Cleveland, Painesville & Eastern. Last month saw the consolidation of the Canton-Akron, Canton-New Philadelphia and the Tuscarawas Traction into the Northern Ohio Traction & Light, making the mileage of the system 205 miles. The Lake Shore Electric, another of its properties, will shortly merge under its charter the Lorain Street Railway and the Avon Beach & Southern. It is building lines from Sandusky to Fremont, from Fremont to Tiffin and from Fremont to Fostoria. This last-mentioned line will form a very direct route between Cleveland and Dayton and Cleveland and Indianapolis, and the extensions mentioned will bring the Lake Shore Electric system up to 225 miles. These extensions with city lines will give the syndicate 1300 miles of connected roads, not including some isolated properties in other sections.

The Pomeroy-Mandelbaum syndicate, owning the Western Ohio and Cleveland & Southwestern, is building an extension to Mansfield, thus connecting with the Ohio Central and giving the system about 320 miles in the State. The Columbus, Delaware & Marion is building an extension from Marion to Bucyrus, which, with the extension above mentioned, will complete a through line from Columbus to Cleveland, a result which has long been talked of. In the eastern part of the State the Youngstown & Southern and the Youngstown & Ohio River companies are working together on a line from Youngstown to East Liverpool. This line, with extensions which the Ely syndicate is building south of East Liverpool and connection with the Wheeling Traction Company, will make a continuous line from Wheeling to Youngstown. This will doubtless be placed in operation next year.

The Eastern Ohio Traction Company has practically completed its refunding plans and will extend its Garrettsville division to form a connection with a line which the Mahoning

& Shenango Valley Traction Company will build from Leavittsburg to Garrestville, and the two will be operated together, forming a high-speed line from Cleveland to Youngstown. With extensions under way in Pennsylvania, next year may see through service from Cleveland to Pittsburg over this route.

Several interests have projects well under way to connect is going on in an unprecedented manner. The interurbans are now getting a considerable share of the long-distance business, and the links which are now being forged will turn much more of this class of business in their direction.

In Indiana at the present time several new roads are being constructed, and several of the roads which have been operating

TABLE I.—GENERAL INFORMATION PERTAINING TO PROPERTIES TREATED (See also Opposite Page).

NAMES OF COMPANIES.	OPERATES BETWEEN (Main Lines).	Miles of Route.	Miles of Single Track.	Miles of Double Track.	Total Mileage.	NUMBER OF CARS. Owned.	NUMBER OF CARS. Average Operated Daily.	SYSTEM OF CONTROL. Number and Type of Motors per Car.	SYSTEM OF CONTROL. Type of Control.
NORTHERN OHIO GROUP.									
Cleveland & Southwestern Tr. Co.	Cleveland and Norwalk	56							
	Cleveland and Wooster	52	133	2	135	57	38	Four West., Nos. 112, 93, 76 and 56.	Type M, L4.
Lake Shore Electric Ry.	Cleveland and Toledo	120							
	Cleveland and Sandusky	60	160	15	175	70	42	Four West., Nos. 121 & 76, G.E. 57	Type M.
Eastern Ohio Tr. Co.	Cleveland and Garrettsville	37							
	Cleveland and Chardon	32	85	...	85	30	14	Four Lorain, No. 34.	K14.
Toledo & Indiana Ry.	Toledo and Bryan	56	56	...	56	13	9	Four West., No. 56.	K14.
Toledo & Western Ry.	Toledo and Pioneer	46							
	Toledo and Adrian, Mich.	34	80	...	80	20	8	Four West., No. 76, Lorain, No. 34.	K6, Lorain 4.
Toledo, Pt. Clinton & Lakeside Ry.	Toledo and Marblehead	52	52	...	52	13	6	Four Bullock, Nos. 50 and 75.	Bullock.
Stark Electric Ry.	Canton and Salem	35	35	1	36	11	6	Four West., Nos. 76 and 56.	K14, L4.
Canton-Akron Ry.	Akron and New Philadelphia	58	84	...	84	12	8	Four G.E., No. 73.	Type M.
CENTRAL AND SOUTHERN OHIO GROUP.									
Western Ohio Ry.	Lima and Celina	40							
	Findlay and Piqua	80	112	...	112	22	12	Four West., No. 56.	K14.
Ft. Wayne, Van Wert & Lima Tr. Co.	Lima and Ft Wayne	65	65	...	65	10	6	Four West., Nos. 85 and 121.	Type M.
Dayton & Troy Electric Ry.	Dayton and Piqua	31	21	10	31	8	4	Four West., No. 76.	L4.
Dayton, Covington & Piqua Tr. Co.	Dayton and Piqua	34	34	...	34	10	5	Four G.E., No. 67.	K14.
Scioto Valley Tr. Co.	Columbus and Lancaster	30							
	Columbus and Chillicothe	47	70	10	80	20	9	Four G.E., No. 66.	Type M.
Cincinnati & Columbus Tr. Co.	Cincinnati and Hillsboro	52	52	...	52	8	4	Four G.E., 75 h.p.	Type M.
Cincinnati, Milford & Loveland Tr. Co.	Cincinnati and Blanchester	31	24	7	31	10	7	Four Bullock, 50.	Bullock.
	Cincinnati and New Richmond	24							
Interurban Ry. & Terminal Co., Cincinnati.	Cincinnati and Bethel	32	95	6	101	36	20	Four West., Nos. 49 and 56.	K12, K14.
	Cincinnati and Lebanon	32							
Cincinnati, Georgetown & Portsmouth.	Cincinnati and Russellville	53	56	...	56	15	8	Four West., No. 56.	K14.
INDIANA GROUP.									
Indiana Union Tr. Co.	Indianapolis and Munice								
	Ind. and Logansport and Peru	...	...	...	250	...	...	Four West, No. 85	L4.
	Anderson and Marion								
Indianapolis & Northwestern Tr. Co.	Indianapolis and La Fayette								
	Lebanon and Crawfordsville	...	87	...	87	20	10	Four G.E., No. 73.	Type M.
Indianapolis & Cincinnati Tr. Co.	Indianapolis and Rushville								
	Indianapolis and Shelbyville	...	...	...	104	24	11	Four West, No. 106A	Electro-pneumatic.
Indianapolis, Columbus & Southern Tr. Co.	Indianapolis and Columbus, Ind	...	...	...	...	...	5	Four G.E., No. 57H	K14.
	Terre Haute and Clinton								
Terre Haute Tr. & Light Co.	Terre Haute and Brazil	...	...	...	*108	104	8	Four G.E., No. 73	Type M.
	Terre Haute and Sullivan								
	Terre Haute and St. Mary's.								
Kokomo, Marion & Western Tr. Co.	Kokomo and Marion	28	28	...	28	*24	3	Four West, No. 93	K10.
Ft. Wayne & Wabash Valley Tr. Co.	Ft. Wayne and Logansport								
	Ft. Wayne and Bluffton	...	101	...	101	*169	5	Four West, No. 121	Electro-pneumatic.
MICHIGAN GROUP.									
Rapid Ry. System (Detroit United)	Detroit and Pt. Huron	111	...	..	123	75	17	Four West, No. 112	Electro-pneumatic.
Detroit, Ypsilanti, Ann Arbor & Jackson Ry.	Detroit and Ypsilanti								
	Ypsilanti and Saline	...	86	...	86	43	14	Four West., Nos. 76 and 93A	L4.

*City and Interurban combined.

Marion and Findlay and Bucyrus and Fostoria, either of which would complete a very direct route from Columbus to Toledo, another long talked of through line.

The Sandusky, Norwalk & Mansfield is building from Plymouth to Shelby, which, in connection with the Mansfield-Shelby line, will give Mansfield connection with Cleveland over two routes.

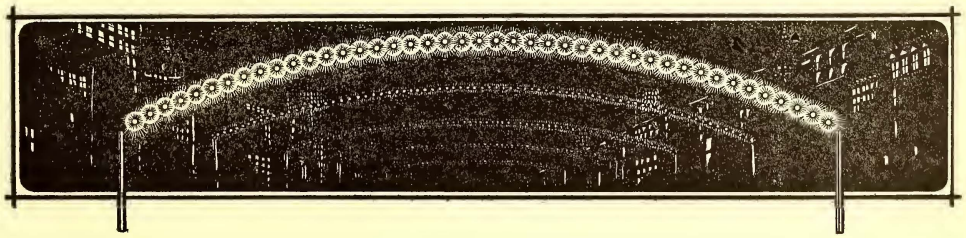
In the western portion of the State the Toledo & Indiana has surveys completed and plans ready for extending its line to Fort Wayne, thus giving another very direct route from Toledo to numerous cities in Indiana. In the southern end of the State the Cincinnati, Georgetown & Portsmouth is working to complete its line to West Union, and then it will go on to Portsmouth. The Cincinnati & Columbus and the Cincinnati, Milford & Loveland are both heading for Columbus, the former by way of Chillicothe, making connection with the Scioto Valley, and the latter by way of Washington, to make connection with the Columbus, Grove City & Southwestern.

A number of other lines which look promising are being projected, and, in a word, the completing of unconnected links for a number of years are building extensions. The Terre Haute Traction & Light Company has, within the past few months, completed an extension south from Terre Haute to Sullivan, a distance of 26 miles. In the extreme southwestern part of the State in the vicinity of Evansville two lines have recently been completed. One of these, the Evansville & Mt. Vernon Traction ompany, now operates southwest out of Evansville to Mt. Vernon, Ind., a distance of 17 miles. The Boonville extension of the Evansville Suburban & Newburgh Railway Company has been built within the last year. Its terminus is Boonville, a town of about 5000 people, lying 17 miles east of Evansville. The Winona Interurban Railway during the past summer began operation between Winona and Goshen, a distance of 28 miles. The same company is now building south from Warsaw to Peru. At about the beginning of the year the extension of the Indianapolis & Cincinnati Traction Company west from Rushville will be completed. This extension, which will eventually form part of the connecting road between Indianapolis and Cincinnati, is 19 miles long and has its eastern terminus at Connersville.

On the Shelbyville division of the Indianapolis & Cincinnati Traction Company considerable construction has been in progress during the past season. The whole line is being changed from direct current to an alternating-current system. Only a few months ago the Fort Wayne, Bluffton & Marion Traction Company was put in operation as far as Bluffton, 23 miles south of Fort Wayne. This road is operated by the Fort Wayne & Wabash Valley Traction Company. The La Fayette & Logansport Traction Company is building between La Fayette and Logansport. This company is closely identified with the Fort Wayne & Wabash Valley Traction Company. The Muncie & Portland Traction Company also began operation during the year, as did also the Indiana Northern Railway Company on its St. Joseph extension from Fort Wayne north to St. Joseph, Mich. The Marion, Bluffton & Eastern Traction Company is now operating over a portion of the line between Marion and Bluffton, and the work of extension to Bluffton will be completed within a few months. Construction work on the Indianapolis Coal Traction Company, extending west of Indianapolis towards Terre Haute, is also being pushed rapidly.

TABLE I.—GENERAL INFORMATION PERTAINING TO PROPERTIES TREATED—Concluded.

NAMES OF COMPANIES.	Power.		Average Schedule Service.	Speeds in M.P.H		
	Voltage Generated.	Voltage Transmitted.		Schedule Local Cars.	Schedule Limited Cars.	Maximum Running.
NORTHERN OHIO GROUP.						
Cleveland & Southwestern Tr. Co	390 A.C.	24,000	Hourly, 6 Ltds	19	27	50
Lake Shore Electric Ry	390 A.C., 16,500 A.C.	16,500	Hourly, 5 Ltds	20	27	60
Eastern Ohio Tr. Co	650 D.C.	13,000	Hourly, 2 Ltds	17	24	40
Toledo & Indiana Ry	13,500 A.C.	13,500	Hourly, Ltds. & Locals Alternate	24	32	55
Toledo & Western Ry	13,200 A.C.	13,200	Hourly, No Ltds	20	..	40
Toledo, Ft. Clinton & Lakeside Ry	375 A.C.	20,000	Hourly, 2 Ltds	23	26	50
Stark Electric Ry	360 A.C.	22,000	Hourly	21	..	50
Canton-Akron Ry	13,200 A.C.	13,200	Hourly, 3 Ltds	18	23	45
CENTRAL AND SOUTHERN OHIO GROUP.						
Western Ohio Ry	420 A.C.	33,000	Hourly, Ltds. & Locals Alternate	21	31	60
Ft. Wayne, Van Wert & Lima Tr. Co	Buys power	33,000	Hourly, Ltds. & Locals Alternate	24	30	62
Dayton & Troy Electric Ry	650 D.C.	650 D.C., 950 D.C.	Hourly, Ltds. every 2 hours	22	30	60
Dayton, Covington & Piqua Tr. Co	650 D.C.	650 D.C.	Hourly	19	..	45
Scioto Valley Tr. Co	375 A.C.	27,000	Hourly	28	..	60
Cincinnati & Columbus Tr. Co	380 A.C.	33,000	13 Local Cars each way daily	25	..	55
Cincinnati, Milford & Loveland Tr. Co	400 A.C.	16,500		20	..	45
Interurban Ry. & Terminal Co., Cincinnati	10,000 A.C.	10,000	Hourly	18	..	40
Cincinnati, Georgetown & Portsmouth	360 A.C.	15,000		20	..	45
INDIANA GROUP.						
Indiana Union Tr. Co	385 A.C.	15,000 and 30,000	Hourly, Ltds. & Locals Alternate	23	28	65
ndianapolis & Northwestern Tr. Co	390 A.C.	30,000	Hourly, 4 Ltds	20	28	65
Indianapolis & Cincinnati Tr. Co	2,300 A.C.	33,000	Hourly	21	27	50
Indianapolis, Columbus & Southern Tr. Co	370 A.C.	15,000	Hourly	23	..	45
Terre Haute Tr. & Light Co	2,200 A.C. and 600 D.C.	22,000 and 11,000	Hourly	27	..	52
Kokomo, Marion & Western Tr. Co	2,300 A.C.	22,000 and 11,000	Hourly	22	..	50
Ft. Wayne & Wabash Valley Tr. Co	13,200 A.C. , 16,500 A.C.	16,500 and 13,200	1½ hour, 4 Ltds	23	30	..
MICHIGAN GROUP.						
Rapid Ry. System (Detroit United)	390 A.C.	16,500	Hourly, 3 Ltds	20	28	..
Detroit, Ypsilanti, Ann Arbor & Jackson Ry	390 A.C. and 650 D.C.	22,000	Hourly and half-hourly	20	26	57



SOME PRACTICES ON THE SCIOTO VALLEY TRACTION SYSTEM

The property and operating methods of the Scioto Valley Traction Company, whose headquarters are in Columbus, form one of the most interesting subjects for study presented anywhere to builders and operators of interurban railways. Few traction lines have been so widely discussed, and perhaps so little understood, as this property. The first and only third-rail property in the great interurban district embracing the two States of Ohio and Indiana, it was built on lines which at the time were deemed by many to be too elaborate and too expensive for the territory and the character of business apparently in sight.

The system, at present embracing about 80 miles, extends from Columbus in a southerly direction with double track 6 miles to Obetz Junction, the main line continuing almost due south to Chillicothe, 48 miles, and a branch extending southeasterly from the junction to Lancaster, 25 miles. The populations of towns, exclusive of Columbus, which has a population of 160,000, according to the latest estimates, is as follows:

CHILLICOTHE DIVISION	
Chillicothe	14,000
Kingston	900
Circleville	7,500
Ashville	1,000
Intermediate	1,500
	24,900
LANCASTER DIVISION	
Lancaster	10,500
Carrol	500
Winchester	800
Groveport	750
Intermediate	1,000
	13,550
Total	38,450
Columbus	160,000

The road was built entirely on private right of way, away from the highway, through the country districts and through a number of the small towns, whereas a number of the roads in this district used pike location or were built at the side of the highway, where land was cheaper and easier to obtain. All railroad crossings at grade were eliminated by the use of expensive overgrade or undergrade crossings, a precaution not considered necessary by many. Grades were kept down to 1½ per cent, and all curves can be taken at full speed. This is true even at an overgrade crossing, where it was necessary to construct an enormous S-shaped fill to secure the desired result. The cars weigh 44 tons and are equipped with four 125 hp motors. In addition to having much heavier capacity per mile of track and per car operated than the majority of roads, the power station was equipped with a fuel and ash conveyor, fuel crusher, automatic stokers and other accessories not usually considered necessary by the majority of roads in the district. Handsome little station buildings were built in towns, and in a number of instances the sub-stations were separated from the passenger and freight stations, it being the opinion of the company that sub-station attendants should attend exclusively to the sub-station, forming another departure from accepted practice. In brief, the road in all its details was built on a broader gage and more liberal policy than was usually considered necessary for a road of this character.

It should be stated here that the enterprise was financed and built by local people, who had lived in the district all their lives and were thoroughly familiar with the conditions. Frank A. Davis, president and general manager, and E. R. Sharp, secretary and treasurer, with their associates, control the property and still hold the bonds, preferring not to market them until the property has developed its full earning power. For an operating man they selected L. C. Bradley, then superintendent of the Seattle-Tacoma Interurban Railway, in Washington. In addition to being an experienced operator under the third-rail system, Mr. Bradley was in accord with the ideas of the owners in matters of high-grade service and maintenance of equipment.

After two years of operation, the property has fully justified the policy of its builders, and the financial results have been gratifying. It may be said the road earns more per mile of track than the majority of roads in the district, which have been in operation for a longer period, and its earnings per capita of popu-

MAP SHOWING SYSTEM OF SCIOTO VALLEY TRACTION COMPANY

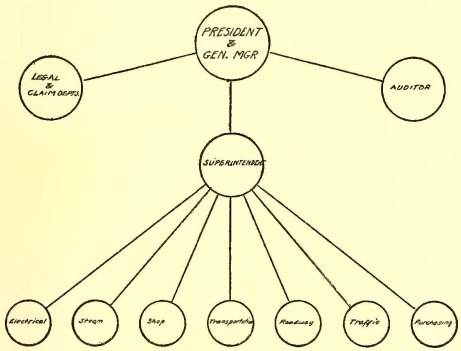
lation in the country are considerably larger than the average road in this vicinity.

It appears that, as the builders foresaw, the territory is better than the average. The valley of the Scioto is the oldest and most fertile portion of Ohio. Chillicothe was one of the first settlements in the State, and was its first capital. While both divisions of the road are closely paralleled by steam roads, the

latter have not catered to the local business and have given infrequent service, with slow and poorly equipped trains. By giving the frequent service with fine, high-speed cars, which actually make better time between terminals than the steam trains, then by giving a fast and efficient freight service at low rates, and finally by maintaining the track and equipment from the start, the company secured the bulk of the business in the territory and gained the good-will of the people.

It has not been the policy to force the operating expenses below the usually sought for 50 per cent, but rather to keep the equipment up to a high stage of efficiency and to make many needed improvements out of earnings.

Last year the company spent $216 per mile for track maintenance, including ballasting, painting bridges, fences and cattle guards, salaries of section foremen, etc. The road is divided into six sections of 12 miles each, having a force of five to eight



THE SCIOTO VALLEY TRACTION CO.
Plan of Organization – Operating Department.

PLAN OF ORGANIZATION, OPERATING DEPARTMENT, SCIOTO VALLEY

men, according to season. Each sectionman must cover his track daily. The track is kept free from weeds by cutting off the roots with scuffle hoes as often as they grow up. There are twenty iron bridges, ranging from 30 ft. to 480 ft. in length, and these have been repainted this year, although but two years old.

This year stations have been erected at all stopping points. Those in the larger towns are artistic brick buildings with concrete foundations and floors and tile roofs, with ticket office, passenger room, baggage and freight room and covered platform. It was figured that it was economy to erect buildings of this character and carry no insurance on them rather than to build frame buildings. In two or three instances the stations are combined with sub-stations, but separate attendants are provided for the two departments. In small towns there are neat frame stations of the type illustrated on one of the plates herewith, while at country stops, which average about 1 mile apart, shelter stations are provided with gravel platforms 100 ft. long and 8 ft. wide. Each station is illuminated, and is provided with a semaphore for flagging trains, displaying a green arm by day and a green light by night. One of these crossing stations, showing the semaphore and signs and the method of entering the right of way to the platform, is also shown in this issue.

For a time the company used the union waiting room in Columbus, but the inadequate facilities and the delays in passing around the interurban loop caused it to abandon this arrangement and establish a station of its own, where both freight and passengers could be handled to advantage. The station is three blocks from the State Capital, so located on the interurban loop that it is not necessary to traverse the loop, and at the same time the cars of all other lines pass the door. The building, a large two-story house, formerly used as a school, was thoroughly rebuilt, to provide ample facilities for passengers and freight, baggage room, ticket oceffi, etc., the second floor being fitted up for the executive and operating officers and train despatcher.

Superintendent Bradley differs from many operating men in the belief that the operating office should be in the large terminal city, instead of being located on the line. The greater portion of the business originates in the large city, the majority of purchases are made there, and he prefers to keep in close touch with the executive officers. While he believes in making frequent trips over the road and keeping an eye on all that is going on, he believes that better and more efficient service is secured from heads of departments where they are not under constant supervision and are taught to take their own initiative in every-day matters.

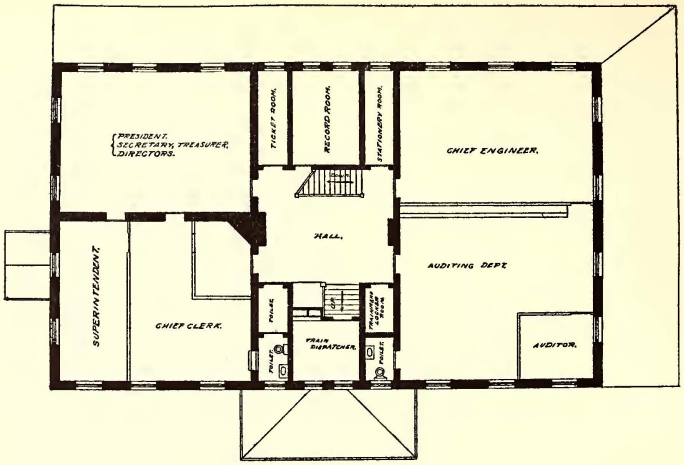
For very similar reasons, he believes that the train despatcher should not be out on the line. He reasons that a despatcher can keep closer watch of his train sheet and the position of the trains if he is at one end of the line. The superintendent aims to keep the crews away from the despatcher, rather than have him hand orders directly to the men, as is done by many roads.

In addition to handling the trains, the despatchers figure train mileages and keep a record of the number of passengers on each car, the conductor making this report each trip. In this way the despatcher can order out more cars if needed and regulate the service to better advantage.

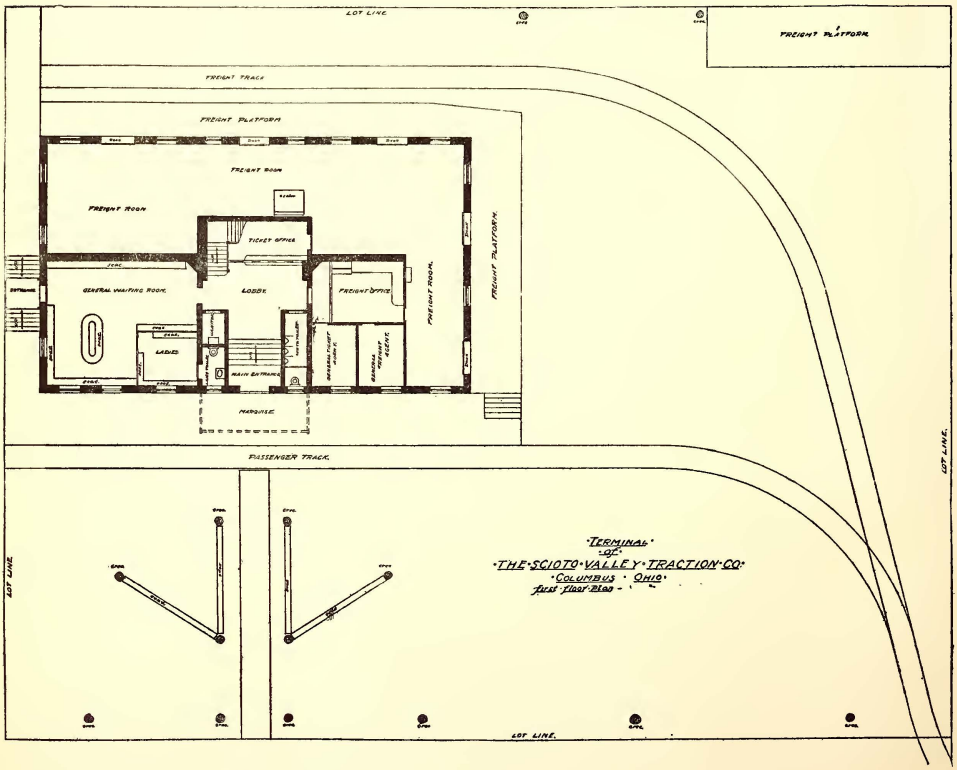
The trip reports are compiled and weekly and monthly report sheets are computed. The daily earnings are computed in two ways; by taking the actual earnings as reported for each trip and by multiplying the average earnings per passenger over a considerable period by the number of passengers handled.

The management does not believe in more frequent service than hourly headway. The two divisions are operated separately, the main line cars leaving Columbus on the hour and the Lancaster division on the half hour. It is claimed that when half-hour service is put on in the summer months people just become accustomed to the half-hour cars when the added cars are taken off. It is claimed that the half-hour cars are always lighter, for the reason that people are not familiar with the half-hour leaving time. Instead, the company runs two-car or three-car trains. Its cars are all equipped with Type M train control, and have both straight and automatic air brakes. They have a special coupler with 9-ft. beam, so that they make the right angle curves in the city without difficulty. With train operation the labor cost is, of course, reduced, although it is the practice to have a conductor on each car, which not only increases the safety of operation, but insures getting all the fares.

Freight service on this line was started on Dec. 1 of last year. The freights also operate in trains, but trailers are used in this service. The company has three motor express cars, which are fitted with the same electrical equipment as the passenger cars. There are also two trailers which were rebuilt from mail cars purchased from a steam road. The doors were made larger and the cars were fitted with automatic air brakes. They have a somewhat larger capacity than the motor cars. There are two regular trips a day in the freight service over each division, and usually a trailer is used on one of these trips. In computing the operating expenses of freight cars, it has been found that a loaded freight, with trailer, consumes 2 kw-hours per car-mile more than the passenger cars. Before the freight service was started, it was found that the consumption for passenger cars over a period of a year was 3.1 kw-hours per car-mile in summer and 3.5 kw-hours per car-mile in winter, the large power consumption in winter being due to the presence of snow and the



SECOND FLOOR PLAN, TERMINAL AT COLUMBUS, SCIOTO VALLEY



GROUND-FLOOR PLAN, TERMINAL AT COLUMBUS, SCIOTO VALLEY

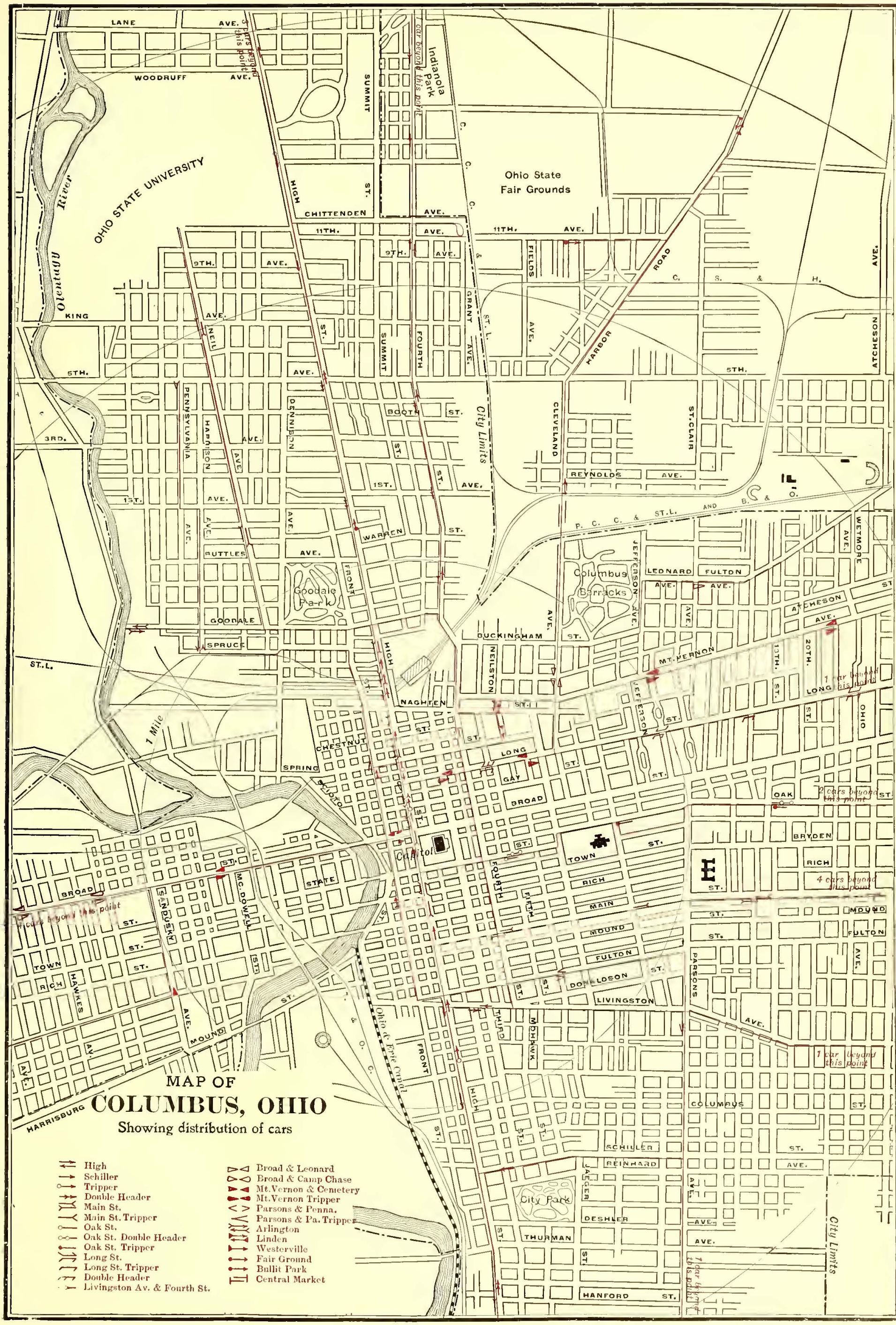
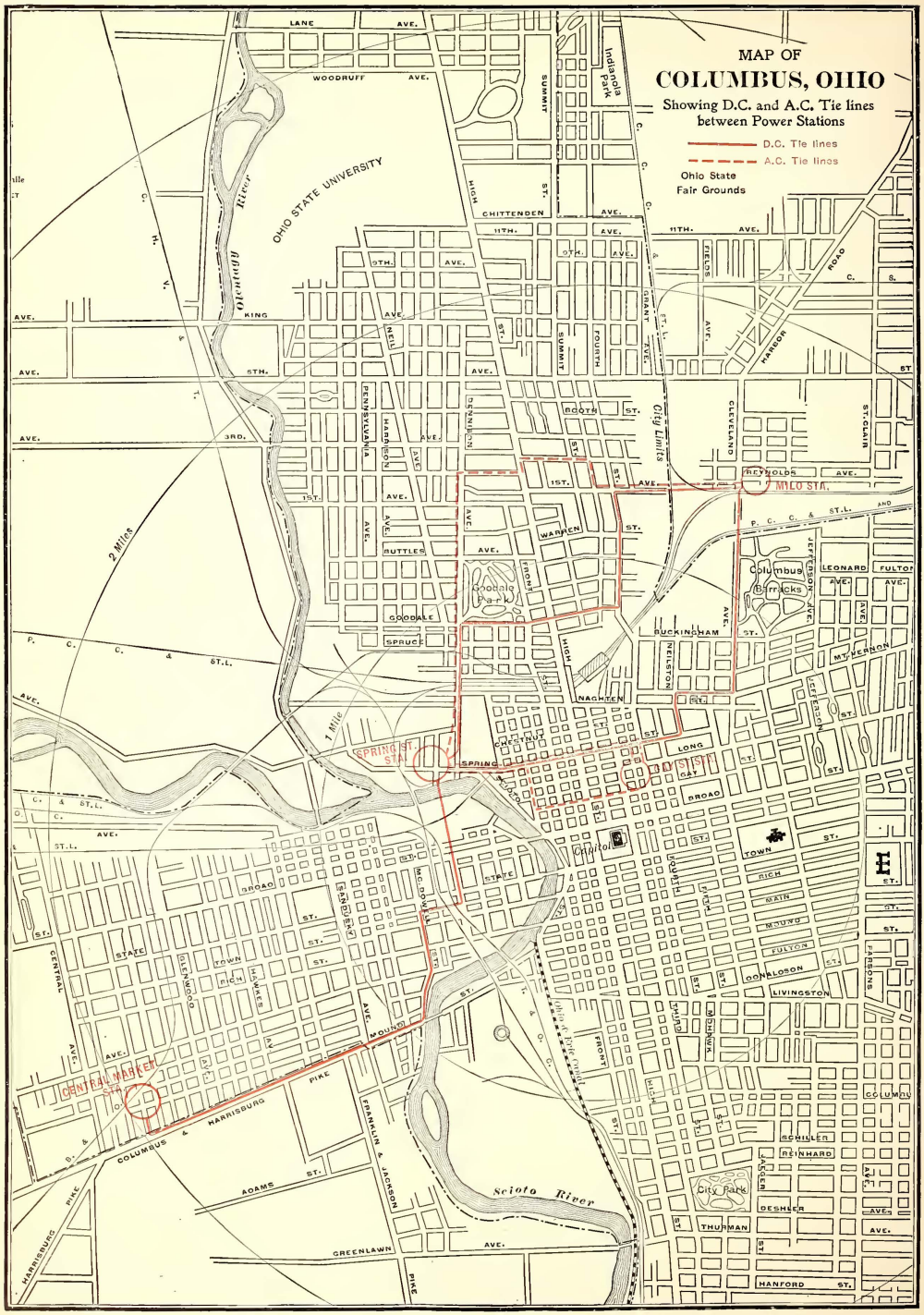
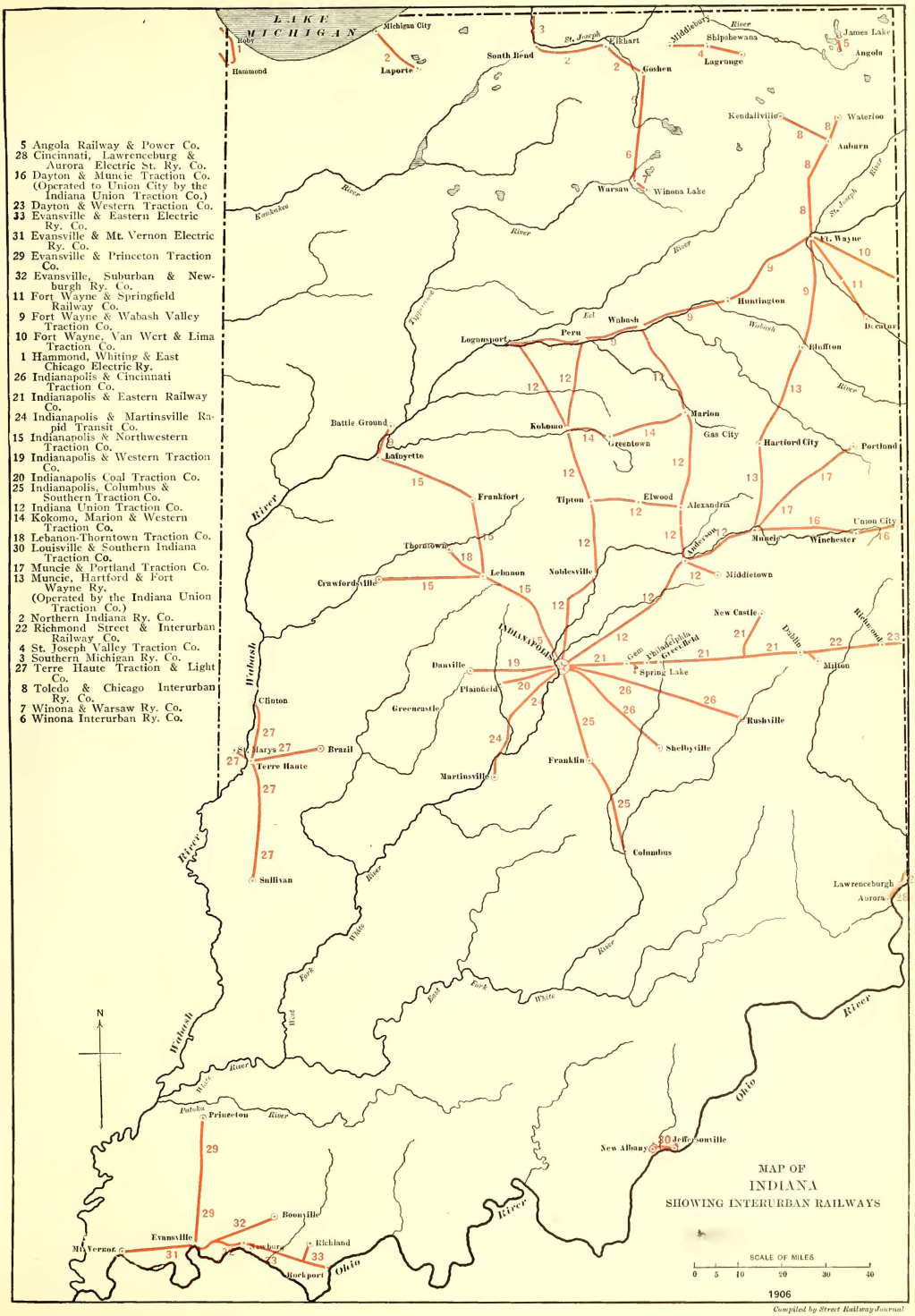
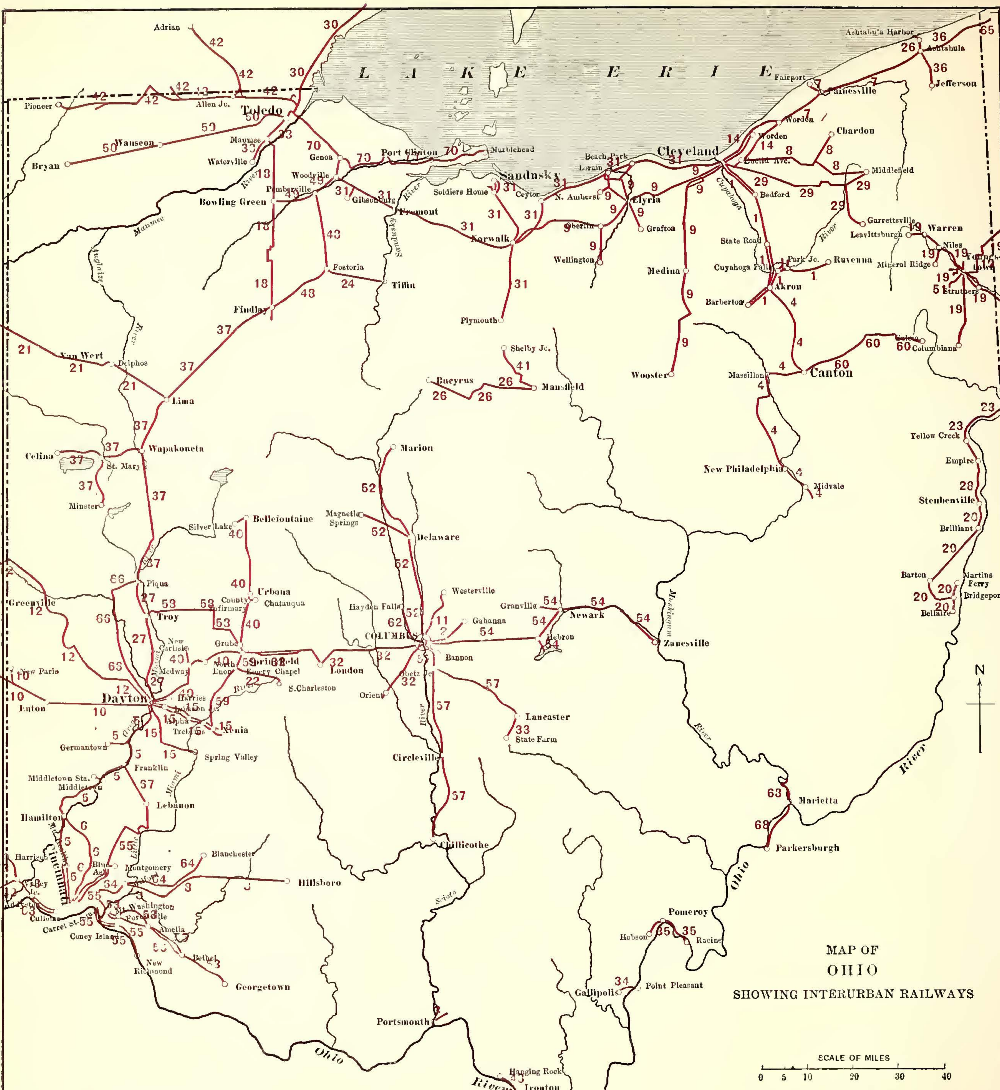

MAP OF
COLUMBUS, OHIO
Showing distribution of cars
High
Schiller
Tripper
Double Header
Main St.
Main St. Tripper
Oak St.
Oak St. Double Header
Oak St. Tripper
Long St.
Long St. Tripper
Double Header
Livingston Av. & Fourth St.
Broad & Leonard
Broad & Camp Chase
Mt.Vernon & Cemetery
Mt.Vernon Tripper
Parsons & Penna.
Parsons & Pa. Tripper
Arlington
Linden
Westerville
Fair Ground
Bullit Park
Central Market
OHIO STATE UNIVERSITY
Olentagy River
Ohio State Fair Grounds
Indianola Park
City Limits
Columbus Barracks
Goodale Park
Capitol
City Park
Ohio & Erie Canal
1 Mile
LANE AVE.
WOODRUFF AVE.
CHITTENDEN AVE.
11TH. AVE.
9TH. AVE.
KING AVE.
5TH. AVE.
3RD.
1ST. AVE.
HIGH ST.
SUMMIT ST.
FOURTH ST.
GRANT AVE.
CLEVELAND AVE.
HARBOR ROAD
ST. CLAIR
REYNOLDS AVE.
BUTTLES AVE.
GOODALE
SPRUCE
BUCKINGHAM ST.
NAGHTEN ST.
MT. VERNON AVE.
LONG ST.
GAY ST.
BROAD ST.
TOWN ST.
RICH ST.
MAIN ST.
MOUND ST.
FULTON ST.
LIVINGSTON AVE.
PARSONS AVE.
COLUMBUS ST.
SCHILLER ST.
REINHARD AVE.
DESHLER AVE.
THURMAN AVE.
HANFORD ST.
HARRISBURG
SANDUSKY
MC. DOWELL
STATE
SPRING
CHESTNUT
ATCHESON
LEONARD AVE.
FULTON AVE.
OAK ST.
BRYDEN
WETMORE
OHIO AVE.
JEFFERSON AVE.
NEILSTON ST.
FRONT ST.
THIRD ST.
MOHAWK ST.
JAEGER ST.
P. C. C. & ST.L. AND B. & O.
C. S. & H.
1 car beyond this point
2 cars beyond this point
4 cars beyond this point
3 cars beyond this point

Plate XVIII


MAP OF
COLUMBUS, OHIO
Showing D.C. and A.C. Tie lines
between Power Stations
D.C. Tie lines
A.C. Tie lines
Ohio State
Fair Grounds
Scioto River
Olentangy River
OHIO STATE UNIVERSITY
City Limits
Goodale Park
City Park
Capitol
Columbus Barracks
MILO STA.
SPRING ST. STA.
CENTRAL WORKER STA.
2 Miles
1 Mile
LANE AVE.
WOODRUFF AVE.
CHITTENDEN AVE.
11TH. AVE.
9TH. AVE.
6TH. AVE.
5TH. AVE.
3RD. AVE.
1ST. AVE.
KING AVE.
BUTTLES AVE.
GOODALE
SPRUCE
NAGHTEN
WARREN ST.
BUCKINGHAM ST.
LONG ST.
SPRING ST.
BROAD ST.
STATE ST.
MOUND ST.
FRONT ST.
ADAMS ST.
GREENLAWN AVE.
HANFORD ST.
THURMAN
DESHLER
SCHILLER
REINHARD
JAEGER
LIVINGSTON
GONDELOSON
FULTON
MAIN
RICH
TOWN
LENGYEL
SUMMIT ST.
HIGH ST.
NEIL AVE.
PENNSYLVANIA AVE.
HARRISON AVE.
DENNISON
BOOTH ST.
GRANT AVE.
FOURTH
CLEVELAND
ST. CLAIR
REYNOLDS AVE.
HARBOR ROAD
LEONARD AVE.
FULTON AVE.
MYRTLE AVE.
JEFFERSON AVE.
NELSON ST.
CENTRAL AVE.
COLUMBUS & MARRISBURG PIKE
FRANKLIN & JACKSON
HARRISBURG PIKE
P. C. C. & St. L.
C. H. V.
Indianola Park
SUMMIT


5 Angola Railway & Power Co.
28 Cincinnati, Lawrenceburg & Aurora Electric St. Ry. Co.
16 Dayton & Muncie Traction Co. (Opcrated to Union City by the Indiana Union Traction Co.)
23 Dayton & Western Traction Co.
33 Evansville & Eastern Electric Ry. Co.
31 Evansville & Mt. Vernon Electric Ry. Co.
29 Evansville & Princeton Traction Co.
32 Evansville, Suburban & Newburgh Ry. Co.
11 Fort Wayne & Springfield Railway Co.
9 Fort Wayne & Wabash Valley Traction Co.
10 Fort Wayne, Van Wert & Lima Traction Co.
1 Hammond, Whiting & East Chicago Electric Ry.
26 Indianapolis & Cincinnati Traction Co.
21 Indianapolis & Eastern Railway Co.
24 Indianapolis & Martinsville Rapid Transit Co.
15 Indianapolis & Northwestern Traction Co.
19 Indianapolis & Western Traction Co.
20 Indianapolis Coal Traction Co.
25 Indianapolis, Columbus & Southern Traction Co.
12 Indiana Union Traction Co.
14 Kokomo, Marion & Western Traction Co.
18 Lebanon-Thorntown Traction Co.
30 Louisville & Southern Indiana Traction Co.
17 Muncie & Portland Traction Co.
13 Muncie, Hartford & Fort Wayne Ry. (Operated by the Indiana Union Traction Co.)
2 Northern Indiana Ry. Co.
22 Richmond Street & Interurban Railway Co.
4 St. Joseph Valley Traction Co.
3 Southern Michigan Ry. Co.
27 Terre Haute Traction & Light Co.
8 Toledo & Chicago Interurban Ry. Co.
7 Winona & Warsaw Ry. Co.
6 Winona Interurban Ry. Co.
LAKE MICHIGAN
Michigan City
Hammond
Laporte
South Bend
St. Joseph River
Elkhart
Middlebury
Shipshewana
Lagrange
Goshen
James Lake
Angola
Kendallville
Waterloo
Auburn
Warsaw
Winona Lake
Kankakee River
Tippecanoe River
Eel River
Wabash River
St. Joseph River
Ft. Wayne
Huntington
Decatur
Peru
Wabash
Logansport
Bluffton
Marion
Kokomo
Gas City
Hartford City
Portland
Battle Ground
Lafayette
Greentown
Frankfort
Tipton
Elwood
Alexandria
Muncie
Winchester
Union City
Anderson
Thorntown
Lebanon
Noblesville
Middletown
Crawfordsville
Wabash River
New Castle
Richmond
Dublin
Milton
Danville
Plainfield
Greenfield
Spring Lake
Clinton
Greencastle
Rushville
Shelbyville
St. Marys
Brazil
Terre Haute
Martinsville
Franklin
Columbus
Sullivan
Lawrenceburg
Aurora
White River
East Fork White River
West Fork White River
Patoka River
Princeton
Boonville
Evansville
Mt. Vernon
Newburgh
Richland
Rockport
Ohio River
New Albany
Jeffersonville
N
MAP OF
INDIANA
SHOWING INTERURBAN RAILWAYS
SCALE OF MILES
0 5 10 20 30 40
1906
Compiled by Street Railway Journal



26 Ashtabula Rapid Transit Co.
43 Camden Interstate Ry. Co.
4 Canton-Akron Ry. Co.
8 Cincinnati & Columbus Traction Co.
53 Cincinnati, Georgetown & Portsmouth R. R. Co.
63 Cincinnati, Lawrenceburg & Aurora Electric St. Ry. Co.
64 Cincinnati, Milford & Loveland Traction Co.
5 Cincinnati Northern Traction Co.
7 Cleveland, Painesville & Ashtabula R. R. Co.
14 Cleveland, Painesville & Eastern Ry. Co.
9 Cleveland & Southwestern Traction Co.
52 Columbus, Delaware & Marion Ry. Co.
32 Columbus, London & Springfield Ry. Co.
2 Columbus, New Albany & Johnstown Ry. Co.
54 Columbus, Newark & Zanesville Electric Ry. Co.
11 Columbus Ry. & Light Co.
62 Columbus, Urbana & Western Ry. Co.
65 Conneaut & Erie Traction Co.
66 Dayton, Covington & Piqua Traction Co.
12 Dayton & Muncie Traction Co.
40 Dayton, Springfield & Urbana Electric Ry. Co.
27 Dayton & Troy Electric Ry. Co.
10 Dayton & Western Traction Co.
15 Dayton & Xenia Transit Co.
30 Detroit, Monroe & Toledo Short Line Ry. Co.
23 East Liverpool Light & Traction Co.
29 Eastern Ohio Traction Co.
33 Fairfield Traction Co.
55 Inter-Urban Ry. & Terminal Co.
49 Lake Erie, Bowling Green & Napoleon Ry. Co.
31 Lake Shore Electric Ry. Co.
67 Lebanon & Franklin Traction Co.
21 Lima & Toledo Traction Co.
19 Mahoning & Shenango Ry. & Light Co.
41 Mansfield Ry. Light & Power Co.
38 Maumee Valley Rys. & Light Co.
1 Northern Ohio Traction & Light Co.
26 Ohio Central Traction Co.
35 Ohio River Electric Ry. & Power Co.
6 Ohio Traction Co.
68 Parkersburg, Marietta & Interurban Electric Ry. Co.
36 Pennsylvania & Ohio R. R. Co.
3 Portsmouth St. R. R. & Light Co.
57 Scioto Valley Traction Co.
59 Springfield & Xenia Ry. Co.
22 Springfield, Charleston, Washington & Chillicothe Ry. Co.
58 Springfield, Troy & Piqua Railway Co.
60 Stark Electric Ry.
28 Steubenville Traction & Light Co.
24 Tiffin, Fostoria & Eastern Electric Ry. Co.
50 Toledo & Indiana Ry. Co.
42 Toledo & Western Ry.
48 Toledo, Fostoria & Findlay Electric Ry. Co.
70 Toledo, Port Clinton & Lakeside Ry. Co.
18 Toledo Urban & Interurban Ry. Co.
37 Western Ohio Ry. Co.
20 Wheeling Traction Co.

Compiled by Street Railway Journal


LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
GEORGIAN BAY
LAKE ERIE
MINNESOTA
WISCONSIN
MICHIGAN
IOWA
ILLINOIS
INDIANA
OHIO
KANSAS
MISSOURI
KENTUCKY
WEST VIRGINIA
ONT.
ST. PAUL
MINNEAPOLIS
DES MOINES
MADISON
SPRINGFIELD
INDIANAPOLIS
COLUMBUS
LANSING
TOPEKA
JEFFERSON
MAP
SHOWING
ELECTRIC INTERURBAN RAILWAYS
IN THE
CENTRAL STATES
COMPILED BY
THE ARNOLD COMPANY
ENGINEERS - CONSTRUCTORS
ELECTRICAL - CIVIL - MECHANICAL
111 LA SALLE ST.
CHICAGO
IN OPERATION
UNDER CONSTRUCTION
PROPOSED
SCALE OF MILES
0 5 10 15 20 30 40 50 60 70 80 90 100

STEEL BRIDGE OVER SCIOTO RIVER AT ENTRANCE TO CHILLICOTHE, SCIOTO VALLEY TRACTION COMPANY

VIEW AT BIG WALNUT CREEK, SHOWING STANDARD BRIDGE CONSTRUCTION.
POWER HOUSE IN BACKGROUND—SCIOTO VALLEY

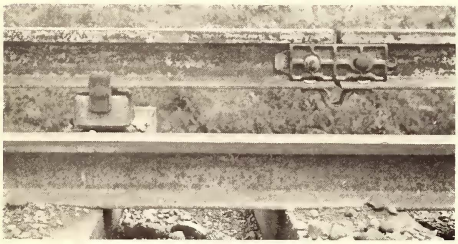
UNDERCROSSING WITH THE N. & W. RAILWAY AT KINNIKINNICK, SCIOTO VALLEY

THE "BIG FILL" AT OVERCROSSING WITH H. V. RAILWAY, SCIOTO VALLEY

TYPICAL CROSSING, SHOWING CROSSING SIGNS AND GUARDS, SCIOTO VALLEY

JOINT AND METHOD OF APPLYING SOLDERED BOND, SCIOTO VALLEY

OBETZ JUNCTION, THE JUNCTION POINT OF LANCASTER AND CHILLICOTHE DIVISIONS. THE PASSENGER STATION PLATFORM EXTENDS OVER THIRD RAIL—SCIOTO VALLEY



THIRD-RAIL INSULATOR, JOINT AND BOND, SCIOTO VALLEY

STANDARD OPEN WAITING STATION AND TRAIN-SIGNALING DEVICE, SCIOTO VALLEY

STANDARD TURNOUT, SHOWING SWITCH STAND, TELEPHONE BOOTH AND THIRD-RAIL CONSTRUCTION AND CONNECTIONS, SCIOTO VALLEY

FREIGHT AND PASSENGER STATION AT LANCASTER, SCIOTO VALLEY

FREIGHT AND PASSENGER STATION AT LOCKBOURNE, SCIOTO VALLEY

SUB-STATION AND TEMPORARY FREIGHT AND PASSENGER STATION AT CHILLICOTHE, SCIOTO VALLEY

COMBINATION FREIGHT, PASSENGER AND SUB-STATION AT KINGSTON, SCIOTO VALLEY

REMODELED STORE BUILDING USED AS FREIGHT AND PASSENGER STATION AT CIRCLEVILLE, SCIOTO VALLEY

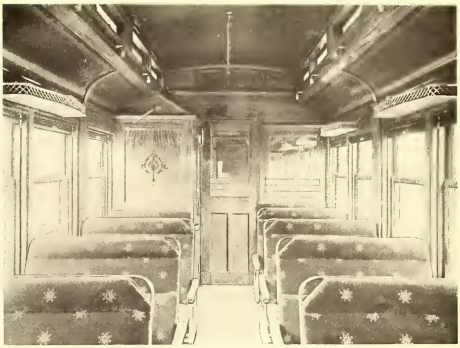
FREIGHT AND PASSENGER STATION AT CANAL WINCHESTER, SCIOTO VALLEY

FREIGHT AND PASSENGER STATION AT GROVEPORT, SCIOTO VALLEY

SUB-STATION BUILDING, SCIOTO VALLEY

FREIGHT AND PASSENGER STATION AT ASHEVILLE, SCIOTO VALLEY

INTERIOR BAGGAGE CAR, SCIOTO VALLEY

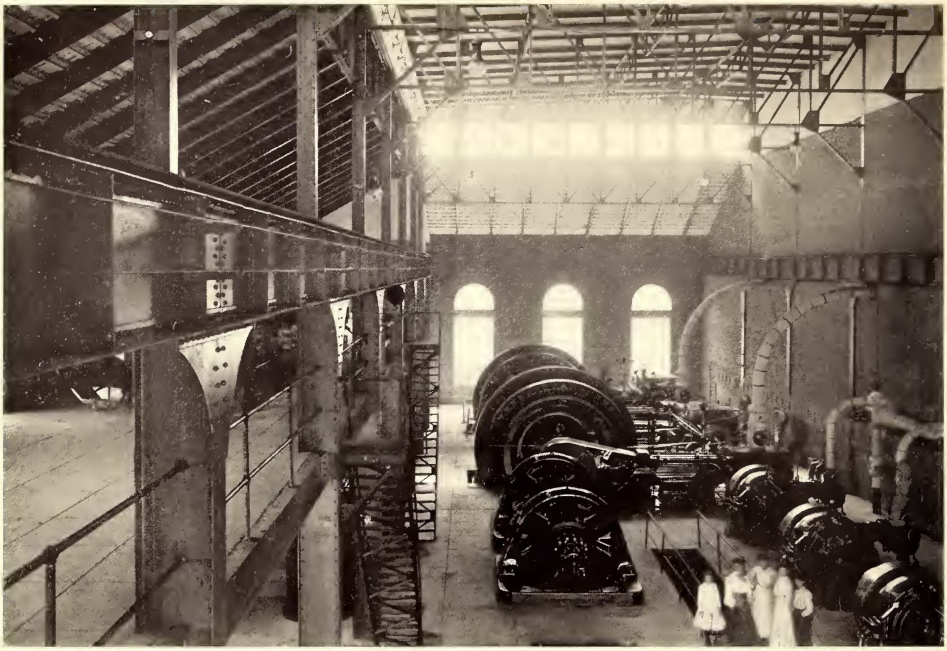


INTERIOR PASSENGER CAR, SCIOTO VALLEY

STANDARD CAR, SCIOTO VALLEY

BAGGAGE CAR, SCIOTO VALLEY

THREE-CAR TRAIN USED FOR HANDLING HEAVY TRAFFIC, SCIOTO VALLEY. THIS TRAIN HAS SEATING CAPACITY OF 210 PASSENGERS



INTERIOR POWER STATION, SCIOTO VALLEY

EXTERIOR POWER STATION, SCIOTO VALLEY

use of heaters. Thus the company is enabled to make a very close estimate of the cost of freight operation, which is something the majority of roads have not been able to do.

Although the freight service has been operated but a short time, it has exceeded the expectations of the management. The freight cars have averaged 36.5 cents receipts per car-mile for several months, which is considerably better than the passenger car earnings. Rates are in strict competition with the parallel steam roads, the official classifications being used. Of course, the cheaper classes of heavy freight are not handled, nor are standard steam freight cars hauled. About 25 per cent of the business is in small packages, with a minimum charge of 25 cents. The average rate on all freight is about 11 cents per hundred pounds, so that a train with 10 or 15 tons makes a very good showing. The average mileage of each freight car year. These, with individual 30-day commuter books giving a rate of 1 1-5 cents per mile, are sold largely to the country people, and as tickets are sold in all towns there are comparatively few cash fares on the trains.

In computing daily earnings on ticket sales, only the actual earnings are considered; that is, only such portions of round-trip tickets, coupon books, etc., as are actually collected on that day are considered in the earnings for the day, and the tickets sold and not redeemed are carried on a balance sheet as a liability. This liability is not computed each day, but in the monthly balance sheets the liability for outstanding tickets is taken into consideration. It is believed that this is the only method to keep a uniform record of earnings per car-mile and per month.

This is illustrated by a condition existing on this road recently.

THE SCIOTO VALLEY TRACTION COMPANY

DAILY REPORT OF EARNINGS.

Date ..... 190...

	LANCASTER DIVISION				CHILLICOTHE DIVISION				TOTAL BOTH DIVISIONS			
	PASSENGER	FREIGHT	MISCEL.	TOTAL	PASSENGER	FREIGHT	MISCEL.	TOTAL	PASSENGER	FREIGHT	MISCEL.	TOTAL
Earnings this day												
Earnings same day last year												
Increase or decrease												
Previous days this month												
Total from first of month												
Same period last year												
Increase or decrease												
Per cent of increase or decrease												
Receipts per car mile this day.												

OPERATING DATA.

Number of regular cars operated												
Number of regular trips												
Car mileage (regular cars)												
Special cars run												
Special car mileage												
Number of paid passengers carried												
Number of free passengers carried												
Average number of miles per car												
Aver. No. of paid passengers per car.												
Aver. No. of paid passengers per trip.												

Weather this day — Events this day

Weather same day last year — Events same day last year

FORM USED FOR MAKING DAILY REPORT OF EARNINGS, SCIOTO VALLEY

is 121 miles, as compared with 407 miles a day for passenger cars. The advantage of the service is that it is practically express service at freight rates, and the cars are unloaded in the business district convenient for the commission houses, who receive and originate a considerable portion of the business. The traffic is about equally divided between goods shipped from Columbus to the country merchants and produce and manufactured articles originating in the towns along the lines. There is considerable interchange with other interurban roads, and foreign cars frequently run into the company's yard to make transfers.

All agents are on a salaried basis. The company has a freight solicitor, and agents solicit business in the towns. All blanks, records and claim adjustments follow closely those used on steam roads.

Passenger rates are 2 cents a mile, but they are usually about 5 cents under the steam road rate at each point, because the steam road mileage is longer to reach the same points. The interurban gives a reduction of 10 per cent from double the one-way rate for round trips, which is not done by the steam roads. Baggage to the extent of 150 pounds is carried free. Mileage books with a reduction of 16 2-3 per cent are sold with practically no restrictions, except that they must be used within a

During August the round-trip ticket sales were very heavy, due to county fairs, for which special rates were made with a return limit of 15 days. The round-trip ticket sales may be stated as approximately $40,000, of which about $4,000 worth of tickets were used both going and coming that month. Of the remainder, $36,000, the going coupon was used in August and the returning in September. Assuming that the service and operating expenses were equal both months, and with only the average number of round-trip sales in September, the crediting of the whole of the $40,000 for the round-trip sales above mentioned to August would show an enormous gain in earnings for that month and probably a deficit for September, and the car mileage earnings would go to opposite extremes, although the mileage and traffic were practically the same.

TRAIN SERVICE

As the operating conditions on this road are practically equivalent to those on steam roads, it was considered necessary to adopt equivalent precautions for the safe and prompt handling of trains, and to that end the train service rules in effect upon steam roads were adopted and are strictly adhered to.

This made it necessary to employ trainmen familiar with such rules, and the company adopted the policy of securing locomo-

tive engineers as far as possible. About 90 per cent of the motormen are experienced locomotive engineers and the balance are experienced conductors, any one of whom is competent to handle a train in any district on any steam railway in this country.

In the preparation of this article, Mr. Bradley was asked if it was possible to secure the better class of locomotive engineers, or if, as has often been intimated by other traction operators who do not favor the employment of steam men, the engineers that can be obtained for the wages paid are the off-scourings of the steam service, who cannot secure a job because of incompetence.

Mr. Bradley stated emphatically that this was not the case. In the first place, his company pays the highest wages in the district, motormen receiving 25 cents an hour, and the runs are arranged so that they work ten hours. A number of the men came from the competing steam roads, and were anxious to secure the positions because they were enabled to be home with their families every night and did not have to pay for lodgings at distant terminal points.

Mr. Bradley does not consider that because a man is discharged for carelessness by a steam road, he will not make a safe man for an interurban road. A man is frequently discharged for the good of the service and the incident proves a warning to him, so that he is not likely to repeat the act on some other road. In matters of discipline, he has no fixed rule for demerits or layoffs. Usually in cases of carelessness the attention of the man is called to the incident, and only after the second or third offense is he given a layoff for five to ten days. It is not considered desirable to give a longer layoff than this, as the loss of pay usually falls on the innocent family and it makes the man unfriendly against the company. Only for continued carelessness or for an error on the rights of a train is a man discharged. The smell of liquor on the breath or visiting a saloon or taking a drink while on duty are also causes for instant dismissal, and a man guilty of these offenses or of dishonesty will not be recommended to another road.

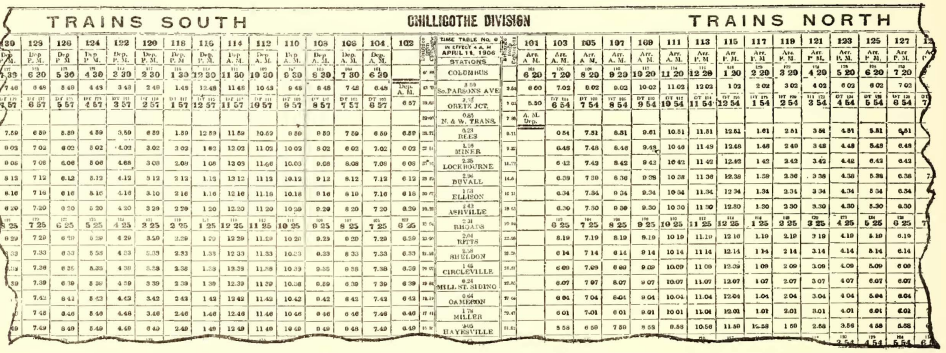
To secure positions, motormen are required to pass written examinations on train service rules, and must show an absolutely clear understanding of all the rules. The examination includes some seventy-five questions, which are designed to develop the man's knowledge as to the import and meaning of the company's rules and regulations. The questions are not reproduced here, owing to lack of space, but they are well worth the attention of interurban operators.

After having successfully passed the required train service and physical examinations, the applicant is put on the road to "break in" with regular motormen, until he is judged competent to handle trains. He is then assigned to the shop department for a period usually ranging from seven to ten days, where he is given thorough and practical instruction upon the equipment and its care and maintenance. After having been given a certificate of competency by this department, he is then assigned to regular service. As a rule, four weeks are required in this train-and "breaking in" before his application is formally accepted and he is assigned to regular service.

The requirements for employment of conductors are not so strict, although great care is used to select men thoroughly competent for this work. Conductors are in line for promotion as motormen, when they prove themselves competent to pass the examinations and fill the requirements of the more responsible position, and this will probably require from two to three years' experience.

Reproductions of train orders, forms "19" and "31," clearance cards and registering tickets, are shown in this connection. A portion of the time card is also shown.

Columbus, Obetz Junction, Lancaster and Chillicothe are registering stations, at which points all trains, regular and extra, are registered in a book provided for the purpose, showing num-



SECTION OF TIME-TABLE FOR GOVERNMENT OF EMPLOYEES, SCIOTO VALLEY

ber of train, direction, number of car, name of conductor and motorman, time of arrival and departure, and whether carrying signals for sections or not. The crews of all trains consult this register for the purpose of ascertaining if all trains due have arrived and departed. No train may leave or pass a registering station except upon clearance from despatcher.

From Columbus to Obetz Junction, a distance of 7 miles, is double track. The latter station is the junction point of the Lancaster and Chillicothe divisions.

Yard limits extend from Obetz Junction to Rees, at which point the repair shops and storage yards are located. Between these points extra cars in switching, etc., are moved by clearance from despatcher.

Train order signal boards are located at all points where agents are assigned and are used for stopping trains for orders. No train may pass a train order board, which is displayed against them, without obtaining orders or clearance stating that there are no orders for that train.

To illustrate the movement of regular or time-card trains, reference may be made to illustration of time card and to the following explanation:

Take, for example, train No. 106, from Columbus, southbound for Chillicothe. This train is given clearance at Columbus, upon which it proceeds on its time card rights to Obetz Junction, the first registering station and end of double track. At or north of this point this train is due to meet No. 105,

north-bound. All trains are required to register at this station, by "registering ticket." After registering his own train and consulting the register to ascertain that all trains due on his division have arrived and departed, the motorman calls the despatcher and obtains a clearance for his train.

This train may then proceed on its time card rights to Rhoads, which is the next meeting point.

All crews are required by rule to call despatcher by telephone immediately upon arrival at meeting points, if opposing train has not arrived.

Another rule requires that when a train becomes five minutes late the crew must notify despatcher from first telephone station. These telephone stations are located at each passing track, with permanent wall telephone in each booth.

After having met train No. 107 at Rhoads, No. 106 proceeds on its rights to next meeting point, and so on to destination.

Upon arrival at Chillicothe, the motorman of this train notifies despatcher by telephone of his arrival, and also registers his train in train register provided for this purpose. Before proceeding north under another train number, he is again required to obtain clearance from despatcher.

All train orders given to crews upon the road are transmitted to motormen, who make two copies at one impression, and upon repeating the written order to despatcher and obtaining "Complete" for same, he retains the original copy, giving carbon copy to his conductor, who repeats it aloud in his presence.

When orders are transmitted to operators, motormen and conductors are both furnished copies of the order, or orders, together with clearance giving the numbers of all orders for their train.

All freight trains are operated as "Extras"; that is to say, by train order only, and are not represented on time card.

For example, a freight train leaving Columbus for Lancaster would be given an order, "Motor No. 14 will run extra, Columbus to Lancaster." The same rules regarding clearances and registering apply to extras as to regular trains. All extra trains are required to clear time of regular trains five minutes, both in following them out of switches and also in making meeting points, unless meeting point is fixed by train order. Ordinarily an extra train proceeds as far as possible to clear a regular train five minutes at a siding, and, after the train to be met has arrived, proceeds again in the same manner.

The following extracts are made from the "Book of Rules" of this company:

TRANSPORTATION RULES

DEFINITIONS

84. Train: A motor, with or without trailers, equipped with train signals.

Regular Train: A train represented on time-table. It may consist of sections.

Section of a Train: A portion of a regular train which either carries signals or for which signals are carried, as per rule 105.

Extra Train: A train not represented on the time-table, designated as:

Extra: For freight or passenger-train extra.

Work Extra: For work train.

Superior Train: A train having precedence over other trains. A train may be superior to another train either by right or by class.

Right is superior to class.

Train of Superior Right: A train given precedence by train order.

Train of Superior Class: A train given precedence by time-table.

Schedule: That part of a time-table which prescribes the movement of a regular train, its direction, class, number, days when run, times at stations, stopping, meeting and passing points.

Single Track: A track upon which trains are operated in both directions by time-table or by train orders.

Siding: An auxiliary track for meeting or passing trains.

Yard: A system of tracks within defined limits, provided for the making up of trains, storing of cars and other purposes, over which movement not authorized by time-table or by train order may be made, subject to prescribed signals and regulations.

Pilot: A person assigned to a train when, in the judgment of the proper authority, motorman or conductor, or both, are unacquainted with the physical characteristics or running rules of the road, or portion of road, over which the train is to be moved.

The responsibility of a pilot is the same as that of the motorman or conductor, or both, whom he pilots.

Station: An assigned location at which times for trains are stated on the time-table.

STANDARD TIME.

85. Central standard time, obtained from Western Union Telegraph Company, will regulate clocks hourly.

86. Watches that have been examined and certified to by a designated inspector must be used by conductors and motormen. The certificate in prescribed form must be filed with the superintendent before assignment for duty, and must be renewed and filed on the first of each quarter. Watches must be submitted to inspector monthly for comparison.

TIME-TABLES

88. Each time-table, from the moment it takes effect, supersedes the preceding time-table. A train of the preceding time-table shall retain its train orders, and take the schedule of the train of the same number of the new time-table.

A train of the new time-table, which has no corresponding number on the preceding time-table shall not run on any district until it is due to start from its initial point, on that district, after the time-table takes effect.

Trains in each district date from their initial point on such district.

89. Not more than two times are given for a train at any point; where one is given it is, unless otherwise indicated, the leaving time; where two, the arriving and the leaving time are given.

90. Regular meeting or passing points are indicated on the time-table by figures in full-faced type.

Both the arriving and leaving time of a train are in full-faced type when both are meeting or passing times, or when one or more trains are to meet or pass it between those times.

When there are more trains than one to meet or pass a train at any point, attention is called to it by special note.

In all cases trains are required to clear and follow as per rules 118, 120 and 121.

Special rules published on a time-table, at variance with those rules and regulations, are effective only during the continuance of such time-table.

SIGNAL RULES

91. Signals must be used strictly in accordance with the rules, and trainmen and all concerned must keep a constant lookout for signals. Those giving signals must locate themselves so as to be plainly seen, and make them so as to be plainly understood.

The utmost care must be exercised by trainmen to avoid taking signals that may be intended for other trains. Unless conductor and motorman are positive that signals given are for them, they will not move their trains until communication is made by words. In backing a train, the disappearance from view of trainmen, or lamp by which signals are given, will be construed as a stop signal.

Employees whose duties may require them to give signals must provide themselves with the proper appliances, keep them in good order and ready for use.

92. Flags of the prescribed color must be used by day, and lamps of the prescribed color by night.

93. Night signals are to be displayed from sunset to sunrise. When weather or other conditions obscure day signals, night signals must be used in addition.

VISIBLE SIGNALS

94. Color Signals:

Color	Indication
(a) Red	Stop.
(b) White	Proceed, and for other uses prescribed by the rules.
(c) Green	Proceed with caution, and for other uses prescribed by the rules.
(d) Blue	See rule No. 108.

95. A fusee on or near the track burning red must not be passed until burned out.

95a. Fuses must not be thrown off on or near bridges or trestles.

96. HAND, FLAG AND LAMP SIGNALS

Manner of Using	Indication
(a) Swung across the track	Stop.
(b) Raised and lowered vertically	Proceed.
(c) Swung vertically in a circle across the track, when the train is standing	Back.
(d) Swung vertically in a circle at arm's length across the track, when the train is running	Train has parted.
(e) Swung horizontally in a circle, when the train is standing	Apply air-brakes.
(f) Held at arm's length above the head when train is standing	Release air-brakes.

97. Any object waved violently by anyone on or near the track is a signal to stop.

AUDIBLE SIGNALS

98. Air-whistle signals.

Note.—The signals prescribed are illustrated by "O" for short sounds; "——" for longer sounds. The sound of the whistle should be distinct,

with intensity and duration proportionate to the distance the signal is to be conveyed.

Sound	Indication.
(a) O	Stop. Apply brakes.
(b) —— ——	Release brakes.
(c) —— —— —— ——	Flagman return from south.
(d) —— —— —— —— ——	Flagman return from north.
(e) O O O O O O	Flagman go back and protect rear of train.
(f) O O	Answer to any signal not otherwise provided for.
(g) O O O	When train is standing, back. Answer to signal to back.
(h) O O O O	Call for signals.
(i) —— O O	To call attention to signals carried for a following train.
(j) —— —— O O	Approaching highway crossings and obscure places.
(k) ——	Approaching stations, railroad crossings and junctions.
(l) —— —— ——	Train parted, when running.
(m)	A succession of short sounds of whistles is an alarm for danger ahead.

99. A torpedo, placed on the rail, is a signal in addition to the usual signals. The explosion of one torpedo is a signal to stop immediately; the explosion of two not more than 200 ft. apart is a signal to reduce speed immediately, and look out for a stop signal. See rule No. 133 (H).

100. BELL-CORD SIGNALS

Sound	Indication
(a) One	When train is running, stop at once.
(b) Two	When train is standing, go ahead.
(c) Three	When train is running, stop at next station.
(d) Three	When train is standing, back the train.
(e) Four	Next siding is meeting point.

TRAIN SIGNALS

103. The headlight will be displayed to the front of every train by night, but must be concealed when the train turns out to meet another and has stopped clear of main track, or is standing to meet trains at the end of double track or at junction points.

104. Two (2) red-marker lamps must be displayed at the rear of every train by night.

105. Two (2) green flags by day, and two (2) green lights by night, displayed in the places provided for that purpose on the front of a train, denote that the train is followed by another train, under the same schedule. All sections except the last must display these signals.

Motormen, when carrying green signals, should invariably call attention to conductors and motormen of trains met or passed, as per rule 98 (i), which must be acknowledged, as per rule 98 (f). When the response is not given, the train giving the signal must stop and give notice.

105. Motormen will similarly call attention of section men and bridgemen to signals carried. When trains being met or passed also have signals, they will acknowledge signals called, and then call attention to their own signals, which will be acknowledged by the opposing train. The train being met or passed is not relieved from responsibility for not noticing signals or passing trains.

106. Two (2) white flags by day, and two (2) white lights by night, displayed in the places provided for that purpose on the front of a train, denote that the train is an extra. These signals must be displayed by extra trains of all kinds.

107. One flag or light displayed as provided in rules 105 and 106 indicates the same as two; but the proper display of all train signals is required.

109. A signal imperfectly displayed or the absence of a signal at the place where a signal is usually shown, must be regarded as a stop signal and the fact reported to the superintendent.

Where lights are not used at night on day office telephone signals, all trains will positively ascertain position of signal before passing.

111. When a signal (except a fixed signal) is given to stop a train or reduce speed, it must be acknowledged, as provided for in rule 98 (f).

CLASSIFICATION OF TRAINS

113. Trains of the first class are superior to those of the second; trains of the second class are superior to those of the third, and so on. Extra trains are of inferior class to regular trains of whatever class.

On single track, all southbound trains have the absolute right of track over all northbound trains of the same class.

For time-table purposes the direction of trains is made arbitrary, either north or south, such direction being specified on time-table.

Note.—See rule 127.

MOVEMENT OF TRAINS

114. A train must not leave its initial station on any division or junction, or pass from double to single track, until it has ascertained that all trains due, which are superior to it, have arrived or left.

115. A train leaving its initial station on each division, or leaving a junction, when a train of the same class running in the same direction is overdue, will proceed on its own schedule, and the overdue train will run as provided in rule 121.

116. A train must not start until the proper signal is given.

117. An inferior train must keep out of the way of a superior train.

118. At meeting points between trains of the same class, the inferior trains must clear the main track before the leaving time of the opposing train, and must pull into the siding when practicable. If necessary to back in, the trains must first be protected as per rule 121, unless otherwise provided.

119. Trains must stop at schedule meeting or passing points, if the train to be met or passed is of the same class, unless the switches are right, the track clear and trains are positively identified to each other.

120. The place at which a train should stop is the switch used by the train to be met or passed in going on the siding. If the expected train of the same class is not found at the schedule meeting or passing point, the superior train may proceed on its rights, the inferior train thereafter clearing the superior train at least five minutes.

At meeting points between trains of different classes, the inferior train must take the siding and clear the superior train at least five minutes, and must pull into the siding when practicable. If necessary to back in, the train must first be protected as per rule 133 (a) unless otherwise provided.

An inferior train must keep at least five minutes off the time of a superior train moving in the same direction.

121. Trains moving in the same direction must keep at least five minutes apart, except in closing up at stations or at meeting and passing points.

122. A train failing to clear the main track by the itme required by rule must be protected as provided in rule 133 (a).

123. A train must not arrive at a station in advance of its scheduled arriving time.

A train must not leave a station in advance of its leaving time.

124. A regular train which is delayed, and falls back on the time of another train of the same class, will proceed on its own schedule.

125. A train which overtakes a superior train or a train of the same class so disabled that it cannot move, will pass it if practicable, and, if necessary in order to proceed, will assume the schedule and take the train orders of the disabled train, proceed to the next open telephone office, and there report to the superintendent. The disabled train will assume the schedule and take the train orders of the last train with which it has exchanged, and will, when able, proceed to, and report from, the next open telephone station.

126. Should a train be held by another between telephone stations, the conductor of the train thus delayed may require the first train passing him to carry signals or a flagman on the train to the next telephone station, if an important train will not thereby be delayed. Precautions must be taken to stop in such manner as to block the switch until the opposing trains are notified that they are flagged and held for following trains.

127. Regular trains, two hours or more behind their schedule time, lose both right and class.

128. A train must not display signals for a following train, nor an extra train be run, except as per rule 126, without orders from the superintendent.

129. When signals displayed for a following train are taken down at any point before the following train arrives, the motorman must inform the operator, if there be one at that point, unless there be some other provision to that end. The operator—or, if there be no operator, the switchtender; or, in the absence of both, a flagman left there for the purpose—must, unless otherwise directed by the superintendent, notify all opposing trains of the same or inferior class leaving such point that the train for which the signals were carried has not arrived.

130. Work extras will be assigned working limits. When protected as provided by rule 133 (a) they may occupy main track until arrival of second class and inferior trains, clearing them after arrival with the least delay.

131. All trains must approach terminals, the ends of double tracks, junctions, railroad crossings at grade and drawbridges, prepared to stop, and must not proceed until switches or signals are seen to be right, or the track seen to be clear. Where required by law, all trains must stop.

(b) Speed of all trains over junction switches, railroad crossings at grade, drawbridges and trestles must be under such control as to insure safety.

(c) Trains must not stop on grade crossings of other railroads except to prevent accident.

(d) Unless protected by interlocking signals and derails, all trains before passing over railroad crossings or drawbridges will come to a full stop, and in all cases the flagman or conductor will precede the train to the crossing or bridge.

132. (a) Cars will not be left on main track at night without placing lights on them or taking other precautions to make them conspicuous to other yardmen, motormen and trainmen. (b) When a train is occupying the main track between switches at stations, no signal will be sent out except where delay is unusual, view is obstructed or when weather is such as to prevent seeing far enough ahead to avoid accident, in which case both trains are equally responsible in case of rear collision. Inferior-class trains must protect against superior-class trains.

It must be understood as a general rule that responsibility for rear collisions at stations rests with the approaching train.

(c) Trains doing work at commercial spur located at other than regular stations must be protected as per rule 133 (a).

(d) Extra trains, unless running on schedule order or definitely advised of position of preceding trains by telephone train orders, will look out for fully rated freight trains ahead.

Speed of all trains will conform to special rules; will be so reduced depending on braking power and distance of vision at all points where slides or obstructions may be expected as to insure absolute safety, and at no place exceed a rate which, in the judgment of motorman, is safe and proper.

133. (a) When a train stops or is delayed under circumstances in which it may be overtaken by another train, the flagman must go back immediately with danger signals a sufficient distance to insure full protection. When recalled, he may return to his train, first placing two torpedoes on the rail when the conditions require it. The front of the train must be protected in the same way when necessary.

(b) The general rule for protecting a train or obstruction by flag requires that the flagman proceed back rapidly with danger signals for a distance of one-quarter to one-half mile (15 to 25 telephone poles), the distance increasing for descending grades, and until he can have an unobstructed view of an approaching train for at least one-eighth of a mile beyond, where he must remain until called by the whistle of his train, as per rules 98 (c and d), or if an approaching train is within sight or hearing, until it has stopped.

(c) At the point to which it is required to proceed, or on the approach of a train before that point is reached, he will display proper danger signals, and, in addition, place two torpedoes on the rails opposite each other, so as to make one report.

(d) Should he be recalled before the arrival of an approaching train, he will take up the torpedo on one side and place it on the rail on the other side, 60 ft. (two rail lengths) from the other, and will, when the view is obstructed by fog or otherwise, place a lighted red fuse on the track and one or more, as may be necessary, at other points, to fully protect his train while he is returning. If first-class train is due within five minutes, flagman will remain out until train arrives, and motorman should not till then give signal to call in flagman.

(e) Should a flagman be recalled before reaching the required distance, he must, before returning, place two torpedoes, 60 ft. apart, a sufficient distance from his own train to protect it while he is returning. When it is necessary to protect the front of a train, or if any other running track is unsafe or obstructed, the same precautions will be observed.

(f) Should the speed of a train be reduced or its rear endangered, making it necessary to check the following train before a flagman can get back, lighted red fuses shall be thrown to the track at intervals.

(g) Responsibility for the protection of a train rests with conductor and motorman, and they must know that their trainmen and flagmen are conversant with and fully understand the application of all rules relating to the protection of train, and comply therewith.

(h) Motormen, hearing one torpedo, will at once bring their trains to a full stop, and then for a distance of 1 mile proceed only with extreme caution. Should there be two explosions, they will immediately reduce speed, proceeding for a distance of 1 mile with trains under full control. Failing to find flagman or obstructions within a distance of 1 mile, they will assume that line is clear, and resume usual speed.

134. Trains will not be backed, or detached cars run over public crossings or highways except at slow speed, and when there is a trainman on or in advance of the leading car, with light at night, who will protect those using the crossing.

135. Messages or orders respecting movement of trains or condition of track or bridges must be in writing.

136. Caution must be used by motormen of trains approaching stations where any train is receiving or discharging passengers, and will approach same under full control.

137. (a) Switches must be left in proper position after using. Conductors will be held responsible for the position of switches used by them and their trainmen, except where switch tenders are stationed.

(b) Whoever opens a switch shall remain at it until it is closed, unless relieved by some other competent employee.

(c) When there is more than one train to use a switch, it must not be left open unless one of the trainmen of the following trains is there and takes charge of it.

(d) At meeting and passing points, in case train backs off of a main line, motorman will personally see that switch is properly returned to main track.

(e) At meeting or passing points the employee attending switch will, after locking it to main track, take position of at least ten (10) ft. from switch stand, remaining there until train has passed.

(f) The employee who opens a switch must see that there is no obstruction between switch points and stock rail, and when switches are closed the same precaution must be taken. The employee who locks a switch must pull the chain to see that the lock is securely fastened.

(g) Flying switches must be avoided whenever possible. When absolutely necessary, the utmost precaution is required, motor to be given the straight track when practicable.

138. Both conductors and motormen are responsible for the safety of their trains, and, under conditions not provided for by the rules, must take every precaution for their protection.

139. In all cases of doubt or uncertainty, the safe course must be pursued and no risks run.

140. (a) Motormen of all trains will register their trains in the train register, at points designated by time-table.

(b) At points designated by the superintendent, motormen will not consult register, but will be furnished (on blank form) a copy of register, over the signature of the operator, showing register of trains affecting the right of his train.

(c) No train will leave a registering station which has telephone service without an order or clearance.

(d) Bulletins will be posted in books or on boards provided for the purpose.

(e) Conductors and motormen will consult bulletins before departing, receipting for the last and all previous bulletins by recording the number of the last bulletin in the place provided, and will be held accountable for all bulletins posted prior to their departure.

(f) Time posted will be endorsed on face of each bulletin, and officer issuing advised that bulletin has been posted. Telephone bulletins affecting safety of trains will be repeated to insure accuracy.

141. In case several trains meet at a station, and it is found necessary to "saw by" or do other work, directions will be given, in order to expedite preference train by the senior conductor.

142. Trainmen will not leave cars standing alone on main line or on grades. One man must remain with cars under such conditions.

143. Work trains, when laying up, will take down classification signals, and after dark will indicate their position by blue signal or signals, displayed conspicuously for approaching trains from all directions.

On arrival of a work extra at destination or on quitting use of road when authorized to run back and forth, prior to the expiration of its orders, motorman will notify superintendent to that effect in writing, using the following form:

"Tied up at.....M,".....after which all rights expire. Operator will forward to despatcher, who will copy in train order book, and repeat back to operator, who, if correctly repeated, will give "O. K.," which will be recorded with time by despatcher. Operator will file with office copies of train orders.

144. Except within yards, no cars will occupy main line until position of all regular trains is ascertained by train register, telephone order, or regiser ticket form....., and its rights to main track are determined.

145. Whenever trains are run over any portion of road without a conductor, the motorman will be regarded and act both as motorman and conductor, and will make and return the conductor's running reports.

146. Except as provided in rule 125, motormen will not assume rights or take time of another train without special orders from the superintendent. In case motormen or conductors change off before completion of trip, they must exchange all unexpired orders that they may have, and know that they are fully understood by the parties with whom they are changing. Trainmen will not be permitted to change off on road without authority from the superintendent.

147. When trains meet by special order, each train must be positively identified to the other.

148. Care must be taken in handling all trains to avoid rough usage of equipment or contents.

149. On doing work in cities and villages, all ordinances or laws must be observed, and where, by city ordinance, fines are imposed for blocking crossings, trainmen are personally liable, unless they can show that blocking was unavoidable.

150. Freight trains authorized to carry passengers will be designated by bulletin or by special order of superintendent.

151. When two trains pass at a siding or leave any point on the line at the same moment, the south-bound train shall have the right of way in starting, and the north-bound motorman shall not throw his motors into full multiple until the south-bound train has been in motion at least twenty-five (25) seconds. In other words, no two motors shall start at the same moment from the same place.

If current should cease, lights will go out. When lights are again perfectly bright, wait for several seconds before proceeding.

When current ceases, all trains must be brought to an immediate standstill, and in no case permit train to coast until current returns.

152. Trains running on double track will keep to the right.

MOVEMENT OF TRAINS BY TRAIN ORDERS

153. For movements not provided for by the time-table, train orders will be issued by authority and over signature of the superintendent. They must contain neither information nor instructions not essential to such movements. They must be brief and clear; in the prescribed forms when applicable, and without erasure, alteration or interlineation.

154. Each train order must be given in the same words to all persons or trains directly affected.

155. Train orders will be numbered consecutively each day, beginning with No. 1 at midnight.

156. Train orders must be addressed to those who are to execute them, naming the place at which each is to receive his copy. Those for a train must be addressed to the conductor and motorman and also to anyone who acts as pilot. Conductors must acquaint their trainmen with all orders.

Annulment and cautionary orders may be addressed to all trains, specifying direction. Annulment orders must also be addressed to agent at initial station of the train annulled.

157. Each train order issued must be written in full in a book provided for that purpose at the superintendent's office, and with it recorded the names of those who have signed for the order, the time and the signals which show when and from what offices the order was repeated, and the responses transmitted.

These records must be made at once, and never from memory or memorandum.

Transfers of orders from one despatcher to another will be made in writing, in a book provided for that purpose, dated and timed, with a complete statement of unexpired orders, addressed to the relieving despatcher, and over the signature of the relieved despatcher.

If for any cause a change is desired in any order already sent, and before "N. O. K." or "complete" has been given, the order must be destroyed and another order under another number sent in its stead.

158. Regular trains will be designated in train order by their schedule numbers, as "No. 10" or "2d No. 10;" extra trains by motor numbers, kind of extra as per definition and direction, thus "Extra 204 east," "Work extra 351," and all other numbers by figures; time will be stated in words

FORM 19

The Scioto Valley Traction Company

TRAIN ORDER No.

Superintendent's Office, 190...

TO CONDUCTOR AND MOTORMAN

Train

At STATION

FORM 19

Form 31X

THE SCIOTO VALLEY TRACTION CO.

TRAIN ORDER No.

Superintendent's Office,

TO CONDUCTOR AND MOTORMAN

Train

At Station.

X. Opr., X. O. K. M Supt.

Form 31X

Superintendent

CONDUCTOR AND MOTORMAN MUST BOTH HAVE COPY OF THIS ORDER

Rec'd M Made At M. Opr

TRAIN-ORDER FORM "19," SCIOTO VALLEY

Superintendent.

CONDUCTOR AND MOTORMAN MUST BOTH HAVE COPY OF THIS ORDER

Made At M Opr.

CONDUCTOR	TRAIN	CONDUCTOR	TRAIN

TRAIN-ORDER FORM "31," SCIOTO VALLEY

The Scioto Valley Traction Company.

CLEARANCE CARD.

190

Conductor and Motorman No.

ORDERS FOR YOUR TRAIN ARE { Form "19" / Form "31" }

(If any order form "31" all order Numbers will be checked by Dispatcher and)

MADE BY

(If no order form "19" or "31" endorse "NONE" in space provided for order numbers and if none of either form state.)

SIGNAL IS OUT FOR

M OPR.

This does not interfere with or countermand any orders you may have received.
Conductors must sign orders form "31" before accepting from Operator.
Conductors and Motormen must each have a copy, and see that their train is correctly designated in the above form.

CLEARANCE CARD, SCIOTO VALLEY

REGISTERING TICKET.

Form 8-189

THE SCIOTO VALLEY TRACTION COMPANY.

190

DAILY WATCH REGISTER.

I have compared time with clock in this office, and find my watch:

SECONDS FAST	SECONDS SLOW	WATCH TIME	NAME

Rule: When watch shows a variation of thirty (30) seconds, fast or slow, train man is required to take his watch at once to Watch Inspector for inspection and adjustment.

FORM FOR REGISTERING CONDITION OF WATCHES, SCIOTO VALLEY

190

Train No.

Signals

Arr. Obetz Jct.

Dep. Obetz Jct.

Conductor

Motorman

TRAIN-REGISTERING TICKET, SCIOTO VALLEY

and figures, except in schedule orders. When train is handled by motor belonging to another company, initial will be used in addition to number.

Form "31" must be used for orders restricting the rights of trains. Form "19" may be used for orders assisting trains of inferior right or making meeting points between trains.

169. When a train is named in the train order, all its sections are included unless particular sections are specified, and each section included must have copies addressed and delivered to it.

A train, or any section of a train, must be governed strictly by the terms of train orders addressed to it, and must not assume any right not conferred by such orders.

171. Train orders once in effect continue so until fulfilled, superseded or annulled. Any part of a train order specifying a particular movement may be superseded or annulled. Train orders held by or issued for a regular train become void when such train loses both right and class, as provided by rules 88 and 127, or is annulled.

172. (2) A fixed signal must be used at each train-order office, except district terminals, which shall display red when there are orders for trains. When there are no orders the signal must display white. The signal must not be changed to white until the object for which red is displayed is accomplished. When red is displayed no train will proceed without receiving a clearance card of the prescribed form addressed to such train, stating over the operator's signature that he has no orders for it, or stating that he has orders, the numbers of which will be shown thereon, together with all of the orders, the numbers of which are so shown. No train will depart from registering station which has telephone service without orders or clearance.

Note.—On account of space, the standard forms of train orders governing movement of trains under all conditions, together with detailed instructions for same, are omitted in this article.

194. (a) Despatchers will issue orders for the movement of trains in the name of the superintendent, in full compliance with the rules herein contained, and see that they are transmitted in the order prescribed. In addition to the records otherwise provided herein, they must keep a record showing the time of arrival and departure of trains at open telephone stations, such record to be carefully filed for subsequent reference.

(b) They must not move a train of inferior right, relying upon motorman of a train of superior right to report for clearance.

(c) They must not depend on train order signal to stop trains for orders at any station during a snow storm, blizzard or other severe storms.

(d) They must not go off duty until relieved by another despatcher, to whom they will give a written transfer of all train orders outstanding, and all other information necessary for his guidance.

(e) When two or more sections of a train are running on a road, and one of the following sections is going only to a junction or non-registering station, notice to that effect must be sent to all trains of the same or inferior class, running in the opposite direction.

The company has also worked out a complete set of instructions for the use of multiple-unit control; and in view of the increasing use of train operation, these rules are reproduced here as being of interest to other interurban operators.

SPECIAL RULES AND INSTRUCTIONS FOR OPERATION OF CARS EQUIPPED WITH SPRAGUE-GENERAL ELECTRIC SYSTEM OF MULTIPLE-UNIT TRAIN CONTROL.

DESCRIPTION OF SYSTEM

The Sprague-General Electric type "M" system of train control is used, and is such that cars may be operated singly, or that two or more cars may be coupled together as a train and operated simultaneously. When combined as a train, the circuit connections are so arranged that the motors on each or all of the motor cars may be controlled from either end of any motor car.

CONTACTORS

The train control apparatus consists in general of two parts.

1. (2) The electrically operated switches, or contactors, which are suspended under the cars, for the purpose of controlling the speed of the cars by effecting the various combinations of motors, and varying starting resistance. There are twenty-six contactors under each motor car, comprising two sets of thirteen each; each pair of motors having its own set of contactors. The contactors in each set are numbered from 1 to 13, inclusive. Following are the numbers of the contactors which are cut in on the respective notches on the master controllers:

First Notch—Nos. 1, 2, 3 and 11.
Second Notch—Nos. 1, 2, 3, 5 and 11.
Third Notch—Nos. 1, 2, 3, 5, 6 and 11.
Fourth Notch—Nos. 1, 2, 3, 5, 6, 7 and 11.
Fifth Notch—Nos. 1, 2, 3, 5, 6, 7, 8, 9, 10 and 11.
Sixth Notch—Nos. 1, 2, 4, 12 and 13.
Seventh Notch—Nos. 1, 2, 4, 5, 6, 12 and 13.
Eighth Notch—Nos. 1, 2, 4, 5, 6, 7, 12 and 13.
Ninth Notch—Nos. 1, 2, 4, 5, 6, 7, 8, 12 and 13.
Tenth Notch—Nos. 1, 2, 4, 5, 6, 7, 8, 9, 10, 12 and 13.

REVERSERS

1. (b) The electrically operated reversers, one located on each side of car, between the contactors and the motors they control (the reverser nearest each set of motors is the one which controls that set). These reversers control the direction of movement of the cars by changing the direction of flow of current through the motors.

MASTER CONTROLLERS

2. Two master controllers, one located in cab at either end of motor cars, by means of which the contactors and reversers are operated.

TO PREPARE TRAIN FOR SERVICE

175. Ends of cars will be numbered 1 and 4, respectively. Motors Nos. 1 and 2 are on the No. 1 end of car, and motors Nos. 3 and 4 are on No. 4 end of car. This is to avoid confusion betwen No. 2 motor and end of car usually known as No. 2 end.

(a) Close main power switches (No. 1) on all motor cars.

(b) If running on third rail, third-rail switches (No. 2) should also be closed. Always open third-rail switches when running on trolley.

(c) Close main control circuit switches (No. 3) on all motor cars.

(d) Close master controller switch (No. 4) in No. 1 end of car, or No. 5 in No. 4 end of car (according to end from which car is to be operated) on motor car from which the train is to be controlled.

ELECTRICAL CONNECTIONS BETWEEN CARS

(e) Great care must be taken in making the electrical connections between cars when making up trains. Always be sure that perfect connection is made by these couplers, and see that plugs are fastened securely into sockets.

The electrical connections between cars consist of the following: (1) One bus-line connection for feeding power from one car to another. (2) One for control circuit.

AIR COMPRESSORS

(f) The air compressor feed-wire is connected to open side of main power switch. This is done to insure the starting and operation of compressor as soon as the cars are cut in for service. When main power switch (No. 1) is closed air compressor should immediately start if main reservoir pressure is below eighty (80) pounds. If air compressor does not start, the cause must be determined before starting car. After closing main power switch (No. 1) air compressor will continue to pump until train line pressure reaches seventy (70) pounds (indicated by black hand), and main reservoir pressure reaches ninety (90) pounds (indicated by red hand). Do not start car or train until main reservoir pressure reaches eighty (80) pounds.

AUTOMATIC AIR GOVERNORS

(g) Pressure in main reservoir is regulated by an automatic governor. Should governor fail to start compressor when main reservoir pressure falls below eighty (80) pounds, or fail to stop compressure when main reservoir pressure has reached ninety (90) pounds, and trouble with governor cannot be remedied, motorman should govern the compressor by pulling out and replacing air compressor fuse (No. 35), as pressure falls below or exceeds the amounts at which the governor should operate.

BRAKE VALVES

(h) Always see that automatic brake valve on end from which car is to be operated is on release position when compressor is pumping. Always cut out train line pipe on opposite end from which car is to be operated, by means of cut-out cock under automatic brake valve.

TO TEST BRAKES

(i) To Test Brakes: Motormen will apply brakes by moving handle to graduated application notch until a reduction of 10 lbs. has been made in train line; then, after placing handle on lap position, motorman or conductor will proceed throughout the train, and see that cylinder piston of every car has moved out to such distance as to indicate that brakes are properly applied on all cars of the train; then release brakes and be careful to see that the cylinder pistons on all cars have moved back to full release, thus indicating that all brake-shoes hang free. This test must be made with both automatic and straight air-brakes.

RULES FOR OPERATION

There are two running positions on the controller, series (fifth notch) and multiple (tenth notch). Short notches on controller are for acceleration only, and must not be used for running points. There are five graduation points on steps from "off" position to series running point, and five more from series running point to multiple running point.

ACCELERATION

176. In regular service, after having received "go ahead" signal, press down controller handle, which closes automatic cut-out device; then move handle to first notch and continue moving from notch to notch until controller is either on series or multiple running point. Acceleration from "off" position to multiple running point should require at least fifteen (15) seconds.

177. Motorman must keep his hand on the controller handle at all times, except when it is on "off" position. This prevents the automatic cut-out device from operating. Motormen must never allow automatic cut-out device to operate unless necessary to quickly stop the train to prevent accident, such as collision, or to save life.

SHUTTING OFF CURRENT

178. In shutting off current, move the controller handle quickly back to "off" position.

179. Motorman are required to give close attention to coasting. To save power, shut off the current as soon as possible after full acceleration is obtained, and still keep your train on time; in other words, coast as much as possible. Under ordinary conditions, when train is up to speed

and on time, the train should be allowed to coast from 800 ft. to 1500 ft. after the controller is thrown to "off" position, before applying brakes in making station stops. Judicious coasting will effect a great saving in power, wear and tear on machinery, and will prevent overheating of motors.

SWITCHING AND YARD MOVEMENTS OF TRAINS

189. Great care must be taken in yard movements of train or cars, in switching or coupling, or in other shifting movements around yards, or over switches, in order to avoid overheating resistance. The controller handle should be moved one or two notches toward series running point, and then back to "off" position, this being repeated until the required movement is made. Controller handle must never be kept on resistance points longer than three or four seconds.

REVERSING MOTORS

181. Motormen must never reverse motors except as a last resort to prevent collision or to save life. Under no circumstances must motors be reversed while brakes are applied, as this would simply blow the main power fuses and make the motors inoperative.

182. Always shut off current at road crossings unless the shoes bridge the gaps in third rail without a break.

183. In accelerating after having thrown off current for gap in rail, when train is up to speed, controller handle may be moved directly from "off" position to sixth notch, and about two or three seconds' time should be used in feeding from sixth notch to multiple running point.

184. Shut off current while passing under sectional insulators and insulated trolley cross-overs.

BRAKES

185. Never leave air-brakes applied when train is standing at terminals or for any length of time at other places; if necessary, set hand-brake to hold cars.

HEATING AND LIGHTING OF CARS

186. Conductors will regulate the heating and lighting of all cars. Thermometers have been installed in all passenger cars, and temperature should be kept as nearly as possible at from 55 degs. to 60 degs., and must not exceed 65 degs. at any time.

187. All motor cars have been equipped with "insulating boards" and "third-rail" circuit breakers

INSULATING BOARDS

(a) Location of insulating boards is as follows: Passenger cars, two in closed seat box in each end of car, making four on each car; baggage cars, two in center of each car. These insulating boards are to be placed between third rail and third-rail shoes in case of electrical fire on the car, or for cutting off all current from the car for the purpose of making repairs while on the road.

THIRD-RAIL CIRCUIT BREAKERS

(b) Third-rail circuit breakers are made of flat bar iron, with wooden handle, and are suspended underneath cars, near the brake cylinders. These circuit breakers are to be used in case of serious electrical fire on or near the car, or in case of wrecks, when the safety of car or passengers is in any way endangered by the third rail. The circuit breaker is to be placed in such cases, with the point under the ball of the running rail, and on top of third rail, and held firmly so as to give good contact. In all cases the circuit breaker should be placed between the car and the main power station, at Reeses, and removed as soon as fire is extinguished or danger removed. When through with the circuit breaker it must in all cases be replaced in the holders provided on the car.

LIST OF SWITCHES AND FUSES

No. 1 Main power switch.
2 Third-rail switch.
3 Main control circuit switch.
4 Controller switch, No. 1 end.
5 Controller switch, No. 4 end.
6, 7 Light switches.
8 Vestibule light switch, No. 1 end (passenger cars only).
9 Vestibule light switch, No. 4 end (passenger cars only).
10 Headlight switch.
11, 12, 13, 14 Heater switches (passenger cars only).
15 Motor cut-out switch, No. 1 motor circuit.
16 Motor cut-out switch, No. 4 motor circuit.
17 Main fuse (600 amp.), No. 1 motor circuit.
18 Main fuse (600 amp.), No. 4 motor circuit.
19 Main control circuit fuse (25 amp.)
20, 21, 22, 23 Branch control circuit fuses (4 amp.), No. 1 control circuit.
24, 25, 26, 27 Branch control circuit fuses (4 amp.), No. 4 control circuit.
28 Light fuse (4 amp.)
29 Light fuse (4 amp.) (passenger cars only).
30 Headlight fuse (4 amp.)
31, 32, 33, 34 Heater fuses (15 amp.) (passenger cars only).
35 Air compressor fuse (5 amp.) (passenger cars only).
Air compressor fuse (15 amp) (baggage cars only).
36 Contactor box containing contactors Nos. 1, 2, 3, 4 and 5 for No. 1 control circuits.
37 Contactor box containing contactors Nos. 6, 7, 8, 9 and 10 for No. 1 control circuits.
38 Contactor box containing contactors Nos. 11, 12 and 13 for No. 1 control circuit.
39 Contactor box containing contactors Nos. 1, 2, 3, 4 and 5 for No. 4 control circuits.
40 Contactor box containing contactors Nos. 6, 7, 8, 9 and 10 for No. 4 control circuits.
41 Contactor box containing contactors Nos. 11, 12 and 13 for No. 4 control circuits.
42 Reverser for No. 1 circuit.
43 Reverser for No. 4 circuit.

TOOLS AND SUPPLIES

The following tools and supplies will be furnished on each motor car before leaving shops:

1 Hammer.
1 Combination pipe and monkey wrench.
1 Pair pliers.
1 Screw-driver.
1 Cold chisel.
2 25-amp. main control circuit fuses.
2 15-amp. heater fuses (except baggage cars).
2 4-amp. headlight fuses.
2 5-amp. air compressor fuses (except baggage cars).
2 15-amp. air compressor fuses (baggage cars only).
2 4-amp. branch control circuit and light fuses.
2 600-amp. ribbon fuses for main motor circuits.
1 Van Dorn coupling link.
1 Double-heading coupling link.
2 Van Dorn coupling pins.
1 Ordinary coupling link (baggage cars only).
1 Ordinary coupling pin (baggage cars only).
3 Incandescent light globes.
1 Switch rod.
1 Broom.
1 Motorman's stool.
2 Destination signs (passenger cars only).
1 Headlight (for each train).
1 Headlight dimmer.
1 Headlight globe.
2 Marker lamps.
2 Classification signal lamps (extra trains only).
2 Red flags.
2 White flags and holders.
2 Green flags and holders.
4 Insulation boards, to place between third rail and third-rail shoes in case of electrical fire, or for cutting off all current from car for the purpose of making repairs while on the road (baggage cars, two each).
1 Third-rail circuit breaker, made of flat bar iron, with wooden handle, to be placed under ball of running rail and on top of third rail, in case of serious electrical fire, or to deaden third rail in case of wrecks, etc.
1 Pad, form 19, train orders.
1 Pad, "report of condition of cars."

INSPECTION OF CARS

188. (a) Motormen taking cars from shop will make inspection of cars as early as possible after received, and report on "report of condition cars" any article missing. Motormen of relief crews must note carefully the reports turned over to them by the crews relieved, and will check same at the earliest opportunity. Responsibility for brooms carried on cars will rest entirely with conductors. Shop foreman will see that hostler checks each car turned into shops, as per above list, making report of such inspection to the master mechanic.

(b) Motormen will, upon arrival at each terminal examine each bearing and the entire brake rigging and other equipment of cars, and make any necessary repairs.

This must be done under all conditions, whether train is on time or not. If anything is found which you cannot repair properly, report same by telephone to the shop department before leaving terminal. The responsibility for proper working condition of cars while upon the road rests entirely upon the motormen.

189. Under no circumstances must blown fuses, burned-out lamps, or damaged supplies of any kind, be put back in tool boxes. Blown fuses must be marked to show number of circuit and car on which they are blown, and left with despatcher, who will forward them to master mechanic, with advice regarding name of motorman by whom they are turned in.

190. (a) When it is necessary to change a brake-shoe while upon the road, put a tag on the shoe removed, and leave shoe under seat inside of car by the side of tool box. This tag should show plainly the wheel from which the shoe was removed and whether from gear or commutator side of motor.

(b) All other damaged supplies will be left in closed seat box.

REPORT OF CONDITION OF CARS

191. Report of condition of cars will be filled out by all crews, on form provided for that purpose. Crews turning cars over to relief crews will fill out this report and turn same over to relief crews. Relief crews will leave this report, together with their own report, in the tool box. This report must cover all damage, defects or trouble with cars, their equipment and supplies, including fuses blown, lamps burned out, brake-shoes renewed, etc.

TO RETIRE TRAIN FROM SERVICE

192. When retiring a car or train from service at terminals or at other points, when car or train is not turned over to hostler or shop force, the following instructions will be observed:

(a) Set hand-brake securely on all cars.

(b) Pull down trolley or break third-rail contact by putting third-rail insulating boards between third rail and third-rail shoes.

(c) Open switches Nos. 1, 2 and 3.

(d) Remove controller reversing handle and straight and automatic brake-valve handles, and place same in switch cabinet No. 1, end of car.

(e) During the winter months, open the drain-cocks on main, auxilliary and whistle reservoirs, and thoroughly drain same.

One very radical departure is made in the handling of train crews. All crews change runs every two weeks from day runs to night runs and from one division to another. In this way all trainmen become familiar with the operating conditions at day and at night, and it entirely eliminates disputes as to seniority, which sometimes occasion considerable trouble. Another rather novel practice is to require all trainmen to submit a letter every sixty days asking five or more questions relative to matters in connection with their duties, or to make suggestions of improvement in operating conditions. These are answered in writing and copies of questions and answers are sent to all trainmen.

SHOP PRACTICE

The company adopted the policy of thoroughly inspecting and keeping up the maintenance of its rolling stock from the start. It is claimed that an immense amount of trouble has been saved by this method. A temporary frame shop building was erected, but the equipment of tools includes a list of machinery which is well up to that of the average interurban road in the State. The company is preparing to erect a very elaborate shop layout, which will follow the lines of a locomotive roundhouse.

It is the practice to keep six cars in the shop every day for inspections and repairs. In this way the passenger cars are in the shop every other day. Usually sixteen men are employed in various kinds of work about the shop. The work is divided up so that each man attends to a certain duty. One man and an apprentice attend to the electrical equipment. One man cares for the air brake equipment. One man, who is a carpenter, attends to any necessary carpenter work and takes care of the trolleys, which on this line is, of course, a small duty. Another man, who is a blacksmith, inspects motors and trucks, running gears, third-rail beams and shoes, in addition to any necessary blacksmith work. Five men attend to the cleaning of cars. Cars are cleaned thoroughly, inside and out, every second day. This work costs $1.08 per car. Oiling of all the bearings is done by the leading man at night. A card record is posted on the wall, showing the numbers of cars as they come in, and each man must designate by signature in the proper column that he has completed his work before the car can go out.

As showing the difference between the cost of maintaining the third-rail and trolley systems, it is stated that the seven miles of trolley wire costs more than twice as much to maintain as the entire third-rail section. Third-rail shoes and installing cost $19.49 for the past six months, and about half a dozen trolley wheels were used up in that time. In periods of severe snow or sleet, it has been quite a problem to keep the third rail clear of ice. Calcium chloride, lamp black and oil, and several kinds of preparations, besides a large number of varieties of metal cutters, have been tried, but without much success. Fortunately, the weather in this valley is comparatively moderate and the trouble is not serious. Altogether, last year, the company lost seven hours from this cause, the longest period being two hours.

In case of trouble with cars on the road, both the motorman and conductor turn in to the superintendent and the train master reports of damages, and a record of troubles is kept against the motorman. Special attention is paid to the record of fuse circuits blown out. The motorman is allowed only two fuses for any one circuit. If the two go out in succession, the motorman is required to lay up the car to determine the trouble.

Actual mileages are kept on motors, axles, brasses, armature bearings, brake shoes, third-rail shoes and steel-tired wheels. Each article is numbered, and a book is kept showing the number of each article and a record of all changes. Similar records are being started on gears and pinions. Recently the master mechanic adopted a flangeless brake shoe. These shoes weigh 26 pounds when new and scrap at 8 pounds. They show a life of 5600 miles. It was found that the life of steel-tired wheels, especially with the flanges, has increased surprisingly since this change. Formerly wheels were run four to

The Scioto Valley Traction Co.

EMPLOYES TICKET.

Name .....

From.....

To .....

Date ..... 190.....

Good only when officially signed and stamped on cover hereof for one continuous passage on trains stopping at last named station

- C. E. No 635

VOID IF DETACHED. L. C. BRADLEY, SUPERINTENDENT.

CONDITIONS.

This ticket is not transferable and is void if presented by any other than the person named, or if any alteration or addition is made upon it. The person accepting and using this ticket, in consideration of receiving the same, voluntarily assumes all risks of accidents and damages and expressly agrees that The Scioto Valley Traction Company shall not be regarded as a common carrier, nor as liable to him for any injury to his person which may occur while using this ticket, whether caused by negligence of the Company's agents or otherwise.

FACE AND REVERSE OF EMPLOYEES' TICKET, SCIOTO VALLEY

five months before turning; now they run eight months. Motormen are required to inspect all bearings, brake shoes and brakes at the end of each trip, there being a 10-minute layover at each terminal. They are also required to lubricate and put new brake shoes if necessary.

Special attention is paid to lubrication. The company uses the best grade of oil at 20 cents a gallon, and the entire car lubrication for journal bearings, motor bearings and armature bearings is 22 cents per thousand miles, not including waste. In oiling the bearings, the attendant is required to be sure that the oil gets to the proper place by removing the packing cover to see that the waste touches the bearing. All the parts must be wiped off carefully, so that the dirt does not get into the bearings.

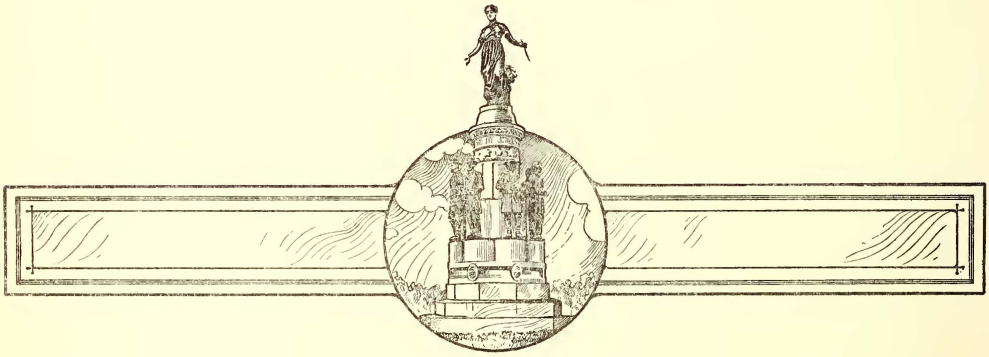
In two years the road has never changed a journal bearing, a condition that is due to careful inspection, ample power and careful acceleration. Nor has any trouble been experienced with armatures from electrical causes, and it has not been necessary to turn a commutator in two years. If an inspector allows a commutator to get down onto the pole pieces, it is cause for dismissal. The road has never broken or reset a car spring, which speaks well for the track. Gears and pinions are numbered in pairs as they are put on, and when any changes are made they are kept together, which insures an even mesh. The gear ratio is 25 to 53, the gear being 22 inches in diameter, the cars having a speed of 60 miles an hour.

It is the practice to paint and varnish cars once a year

throughout, except the head linings. Floors are painted every four months.

The company is very liberal in the matter of transportation to employees. Trainmen and shopmen have passbooks unlimited as to time, and good between certain points. Linemen, general office employees and heads of departments have passbooks good over the entire road. Section foremen have books good between certain points, and they detach slip for the laborers. Each employee is entitled to two passes a month for any member of a family dependent upon him. This is not limited to wives of employees, as with many roads, the management believing that it is better to be liberal on this point than to have conductors deadhead members of their family.

The third rail on this line is unprotected, except at station platforms and highway crossings, where it is broken. Great care is used to see that fences and cattle guards are properly maintained. The fencing used is fine mesh to keep out small animals. When the road was first built, there was considerable anxiety on the part of farmers for fear that the third rail would be dangerous to pedestrians and stock. In two years' operation but one man has been killed, and he was an employee who fell across the rail while running to switch a car. It was found that he had heart trouble, which was undoubtedly the cause of his falling. About eight or ten animals of various descriptions have been killed, but the company has never had a lawsuit due to a third-rail accident.



WAY AND WAY MATTERS

RAILS

Ohio interurban roads generally are using T-rails commonly known as A. S. C. E. standards. The 70-lb. rail is looked upon as standard, although a few roads believe that a 60-lb. section is sufficiently heavy. But two roads of those considered, namely, the Toledo & Indiana and the Scioto Valley, are using heavier than 72-lb. rail. As to length of sections, the majority of roads are using 30-ft. and 33-ft. lengths, but some companies in their later construction work have specified 60-ft. lengths. The advantages of the longer sections are, of course, that the number of bonds and the number of joints to be installed and maintained are correspondingly reduced. With 60-ft. sections it has been found necessary to leave a trifle more space between the ends of the rails to provide for expansion, and one or two roads which did not do this at first found trouble with kinking of rails.

In Indiana and Michigan 72-lb. rails are usually employed in interurban construction. Occasionally, however, the question of delivery necessitates the substitution of some other weight of rail. The heaviest rail used in the two States mentioned is probably 80-lb., which was used in the construction of the track of the Indianapolis Northern Traction Company, between Indianapolis, Logansport and Peru. Rails in 60-ft. sections have been used on several roads, but difficulty has been experienced in keeping them aligned, due to expansion in hot weather. In cities, however, where the paving prevents the rail from getting extremely hot and helps to keep the rail in position, 60-ft. rails are usually found.

Rails of both 60-ft. and 33-ft. lengths are in use by the Indiana Union Traction Company. On this road it is considered that the difficulty in keeping track laid was 60-ft. rails in alignment more than offsets the decreased expense of keeping up the few number of joints and the lessened cost and maintenance of the bonds.

The standard rail used by the Fort Wayne & Wabash Valley Traction Company is 30 ft. long, but some 33-ft. rails are used.

A 70-lb. rail is preferred on the interurban lines of the Detroit United Railways. The preferable length is 30 ft., it having been found that the expansion and contraction of 60-ft rails either pulls the splices apart or buckles the rail. Where 60-ft. rails are used, a slip joint giving a 3-in. movement is placed at intervals of 1000 ft.

Rail braces are found on the curves of several roads. An accompanying illustration shows the method of bracing the rail on curves of the Indiana Union Traction Company. The same type of brace was found in use on several other systems. The Terre Haute Traction & Light Company double spikes the rail on curves.

JOINTS

The majority of Ohio roads are using either 4 or 6-bolt fish plates, and in a few cases 8-bolt plates at joints. The Cincinnati & Columbus Traction Company, the Canton-Akron Railway, the Toledo Urban & Interurban, and others are equipped with mechanical joints, and the management of these roads believe that the joints will keep tight longer and will give a longer life to the track sufficient to pay for the added investment.

Of the 17 roads considered in Ohio, 9 support the joint with ties, while 8 use the suspended method. The majority is clearly in favor of the broken joint, but 2 roads placing the joints opposite and 15 favoring the staggered scheme.

In Ohio a number of the roads do not consider it necessary to use anchoring devices or schemes for holding tracks in gage on curves, although some of them do so on special heavy curves. Six of the roads use tie plates and 7 of them use rail braces. Two of them combine both methods on specially heavy curves, while one road, the Stark Electric, uses a number of tie rods on curves. Few of the roads in this district have been in operation long enough to suffer from broken joints or the necessity for relaying rail.

Twenty-eight miles of track on the Indianapolis & Northwestern are laid with joints opposite. The remainder of the road is laid with broken joints, and this latter construction is preferred. Track on the Indianapolis, Columbus & Southern Traction Company is laid with broken joints, as is also the latest built track of the Terre Haute Traction & Light Company and the track of the Kokomo, Marion & Western Traction Company. Both kinds of joints are found on the tracks of the Fort Wayne & Wabash Valley Traction Company. However, opposite joints are preferred on straight track, as it is believed the car is racked less. On curves broken joints are preferred because of the lessened trouble in keeping the track in alignment. Broken joints are used in interurban construction by the Detroit United Railways and the Detroit, Ypsilanti, Ann Arbor & Jackson Railway.

Practically all of the track inspected had joints suspended between two ties rather than supported. The chief reason for this construction is, of course, that the weight on the joint is supported by two ties rather than by one.

Some roads in Indiana give very close attention to keeping joints tight. Others are somewhat lax in regard to this. The Fort Wayne & Wabash Valley system tightens joints in the spring and in the fall. On the Detroit United Railways joints are inspected about once a week. It is the practice on the Detroit, Ypsilanti, Ann Arbor & Jackson Railway to go over curves and gage them up once a week. In the spring and fall all of the fish-plates are tightened. Practically no trouble is experienced by any of the roads from breaking of joints.

Several roads follow the practice of elevating the outer rail on curves 1 in. per degree of curvature. One road left the elevation of the rail to the track foreman. In general, Trautwine's formula for elevation is followed by the Indianapolis & Cincinnati Traction Company. On the Detroit United Railways the outer rail is not given as much elevation on curves as was formerly the custom. A full-speed curve of 300 ft. radius is given an elevation of 4¼ ins. On the Fort Wayne & Wabash Valley Traction Company all curves are spiraled in accordance with the length of the curve. The rule followed is to allow 60 ft. for each degree of curvature. The track is level at the point of spiral and the outer rail has its full elevation at the point of curve. The interurban lines are elevated for a speed of 50 miles per hour.

T-RAILS FOR CITY STREETS

For city work, the interurbans, wherever possible, have laid 6-in. or 7-in. T-rails, and where this has been prevented by local conditions or local ordinances, they have used high girder rails. The requirements of the authorities in some cities and villages, who have insisted that track be laid with grooved rails, have been responsible for perhaps more trouble than any other feature connected with the entrance of interurban roads into city streets. The grooved rail necessitates cutting down wheel flanges to a degree that is sometimes actually dangerous for roads operating at high speed, especially where the road has many

curves. It is also claimed by some interurban managers that it is impossible to secure good braking effect with grooved rail because the wheels have a tendency to slide on their flanges in the groove. The objections offered against the use of T-rails in paved streets are that it is said to be difficult to lay pavement next to the rail in such a manner as to present a smooth surface for vehicles driving in the track or crossing it. Laying aside the question of the right of teamsters to drive in car tracks, especially in streets frequented by heavy interurban cars, there is no question but that a street can be paved and properly maintained as well with the high T-rail as with the grooved rail. Experience has shown that this is solely a matcity have been trimmed below a point that is desirable by the interurban managers. In Detroit the entering tracks of some of the interurbans are equipped with shallow grooved rails, and this condition is responsible for the failure of an arrangement to operate through limited cars from Cleveland to Detroit, the Lake Shore Electric declining to trim its wheels to size necessary to accommodate this rail.

In Indiana the Kokomo, Marion & Western Traction Company uses a high T-rail and nose brick in city construction. At the time the track was laid there was vigorous objection to the use of such a rail on the part of the cities, but during the several years it has been in use no fault has been found with it.

TABLE II.—SUMMARY OF LATEST PRACTICE IN TRACK CONSTRUCTION ON ROADS TREATED.

NAMES OF COMPANIES.	Rails. Section* and Weight in Lbs. per Yd.	Rails. Length of Rail Section in Ft.	Joints. Type of Joints.	Bonds. Type.	Bonds. Length in Ins.	Bonds. Capacity.	Bonds. Where Applied On Rail.	Bonds. Cross Bonding, Ft.	Ties. Size.	Ties. Wood.	Ties. Spacing Between Centers in Ft.
Northern Ohio Group.											
Cleveland & Southwestern	60 & 70	30 & 60	Angle plate	Soldered, brazed, concealed	8	4-0	Base, under plate		6x8x8	Cedar, oak	2
Lake Shore	70 & 72	30 & 60	Angle plate	Soldered, concealed	7 to 10	4-0	Ball	½ mile	6x8x8	Cedar, oak	2
Eastern Ohio	60	60	Angle plate	Concealed	8	4-0	Under plate	1,000	6x8x8	Chestnut, oak	2
Toledo & Indiana	72	30	Angle plate	Concealed	8	4-0	Ball	1,000	6x8x8	Chestnut, oak	2
Toledo & Western	60	30	Angle plate	Ribbon	6	4-0	Under plate	10 miles	6x8x8	Oak, cedar	2
Toledo, Pt. Clinton & Lakeside	70	33	Angle plate	Soldered	8	4-0	Ball	1,000	6x8x8	Cedar, oak	2
Stark Electric	65	30	Angle plate	Soldered, ribbon	6 to 9	4-0	Ball, under plate	1,000	6x8x8	Oak	2
Canton-Akron	70	30 & 60	Mechanical	Concealed	9	2-0	Under plate	1,000	6x8x8	Oak	2
Central and Southern Ohio Group.											
Western Ohio	60 & 70	33	Angle plate	Concealed, soldered	8	4-0	Ball, under plate	....	6x8x8	Oak, cedar	2
Ft. Wayne, Van Wert & Lima	70	33	Angle plate	Concealed, soldered	8	4-0	Ball, under plate	800	6x8x8	Oak	2
Dayton & Troy	70	60	Angle plate	Concealed	9	2-0	Under plate	1,000	6x8x8	Oak	2
Dayton, Cov. & Piqua	70	30	Angle plate	Stranded wire	10	4-0	Under plate	500	6x8x8	Oak	2
Scioto Valley	72	30	Angle plate	Concealed	9	2, 4-0	Under plate	1,000	6x8x8	Oak	2
Cincinnati & Columbus	70	33	Mechanical	Soldered		4-0	Head	1,700	6x8x8	Oak	2
Cincinnati, Milford & Loveland	70	30	Mechanical	Concealed	10½	3-0	Under plate	....	6x8x8	Oak	2
Interurban Ry. & T., Cincinnati	70	30	Angle plate	Concealed	9	4-0	Under plate	1,300	6x8x8	Oak	2
Cincinnati, Georgetown & P	60 & 70	30	Angle plate	Soldered	6	4-0	Ball	1,000	6x8x8	Oak	2
Indiana Group.											
Indiana Union Traction	80	33			..	..		....	6x8x8	Oak	2
Indianapolis & Northwestern	70	30	Angle plate		..	..	Under plate	800	6x8x8		2
Indianapolis & Cincinnati				Compressed	10	4-0		2,600			2
Indianapolis, Columbus & South'n	60	30	Angle plate		10	4-0	Ball	1,000	7x8x8	Treated oak	2½
Terre Haute, Tr. & Lgt	70	30	Mechanical	Soldered	10	4-0	Flange concealed	....	6x8x8	Chestnut	2
Kokomo, Marion & Western	70	33 & 60	Angle plate	Compressed and soldered	10	4-0		1,300	6x8x8	Oak	2
Ft. Wayne & Wabash	70	30	Mech. & angle plate		11	..		1,300	6x8x8	Oak	2
Michigan Group.											
Rapid Ry., Detroit	70	30	Mechanical		8½	4-0	Ball	1,300	6x8x8	Cedar	2
Detroit, Ypsilanti, A. A. & J	70 & 75	30	Angle plate		7	4-0		....	6x8x8	Cedar	2

* All the roads included in this table use A. S. C. E. standard sections.

ter of building a good foundation in the first place and then providing a trough along the inside of the rail so that the wheel flange will not bear on the edge of the brick and tip them up, thereby destroying the smooth surface of the pavement. This can be accomplished either by arching the pavement between the rails and placing a course or two of narrow brick lengthwise along the rail, or by using a beveled brick. High T-rails are used in Findlay, Lima, Dayton, Indianapolis, Sandusky and a number of other cities and towns, the city ordinances of some of these cities providing that T-rail shall be used exclusively.

In Columbus the interurban roads have long been opposed to the grooved rail used on the loop which was built around the heart of the city for terminal purposes. This loop is constantly crowded with large cars, and considerable trouble has been experienced when the groove becomes filled with snow. Recently, however, permission has been given to lay 7000 ft. of T-rail on this loop. Some trouble of a similar nature has also been experienced in Cleveland, and the flanges on cars entering that

All of the franchises of the Wabash Valley Traction Company grant the right to use T-rails in cities. The rails used are in 60-ft. lengths. Both 6-in., 72-lb., and 7-in., 70-lb. rails are employed. A special type of nose brick, which was laid in Richmond, Ind., eleven years ago, is used.

The city ordinances in Detroit will not permit T-rail to be used, but it is used in several of the smaller cities entered by the interurban lines of the Detroit United Railways. It is also used in the greater number of cities entered by the Indiana Union Traction Company.

BONDS

The question of the most desirable bond is one that is causing much controversy on Ohio roads. The majority of the earlier roads were equipped with some of the numerous forms of bonds which are attached to the ends of the rails by compression and placed under the fish-plate. This type is still very popular with many operators who are building new roads or new extensions,

but the soldered type of bond is undoubtedly gaining ground. There is a difference of opinion as to the best place for the soldered bond. Several roads, notably the Cleveland & Southwestern, have placed the bonds on the base of the rail. This probably gives a better contact and renders it somewhat more difficut to steal the bond than where it is placed on the ball of the rail, but it is also more difficult to inspect. The ease of application makes the ball of the rail a most desirable place, but roads that are using steam locomotives or cars having wide tread have found that there is a tendency to knock off the bond when it is placed in this position. It is also more accessible for the copper thief, and it is undeniably a fact that the depredations of this class of miscreants have increased since the soldered bond placed on the ball of the rail came into general use. One road, the Western Ohio, has had so much trouble of this kind that it is now changing all its soldered bonds from the ball of the rail and placing them under the fish-plate. A new welded bond is attracting considerable attention, as it gives high conductivity and is difficult to remove. It is being used largely by the Canton-Akron and the Cleveland & Southwestern. Of 17 roads considered in Ohio, 9 are using soldered bonds partially or exclusively, while 10 are using concealed bonds partially or exclusively.

Methods of cross bonding vary greatly. Two roads, the Western Ohio and Cleveland & Southwestern, do not consider it necessary to cross bond except around railroad crossings and switches. The Fort Wayne, Van Wert & Lima cross bonds every 800 ft., while other roads run from that up to one-half mile apart. The Cincinnati, Georgetown & Portsmouth uses a soft iron rod bent under the rail and soldered to the side of the rail, the engineer believing that this serves the purpose of tying the rails together, and it does not furnish a desirable asset for the copper thief. Little information is obtainable as to the conductivity of joints, few roads collecting figures on this subject or paying a great deal of attention to it beyond seeing that joints are frequently inspected, although one or two roads keep a man busy with hand instruments making tests.

The greater number of the roads visited in Indiana were equipped originally with compression or plug bonds. As in Ohio, however, there is a marked tendency towards the adoption of soldered bonds, but trouble has been experienced by soldered bonds coming off, due to faulty application. In general, it might be said that the testing of bonds is not carried on in as systematic a manner as the importance of doing so warrants. Cross bonding of tracks occurs at intervals of from 800 ft. to one-half mile.

The plug bonds installed on the Indianapolis & Northwestern tracks when the road was built three years ago are still in good condition. The bonds were recently tested by means of the Herrick bond-testing car. The tracks of the Indianapolis & Cincinnati Traction Company are cross bonded only at intervals of one-half mile. The fact that this is a single-phase system with 2300 volts on the line removes the necessity of frequent cross bonding. Twenty-seven miles of the tracks of the Indianapolis, Columbus & Southern Traction Company are bonded with a plug bond and 13 miles with a compressed terminal bond. The original bonding was done five years ago and the bonds are still in good condition. Repairs are being made with soldered bonds.

On the Kokomo, Marion & Western Traction system 10

TABLE II.—SUMMARY OF LATEST PRACTICE IN TRACK CONSTRUCTION ON ROADS TREATED.

ROADBED AND BALLAST.						LOCATIONS.						GRADES AND CURVES.			TURNOUTS.				
Character of Ballast.	Cost (in Cents) of Ballast per Yd. Delivered.	Depth Under Ties in Ins.	Slope of Banks.	Width at Top of Fills in Ft.	Width at Bottom of Cuts in Ft.	Miles in Highway.	Miles on Private Right of Way Along Highways.	Miles on Private Right of Way Cross Country.	Width of Right of Way in Ft.	Miles Within Municipal Limits.	Miles Outside Municipal Limits.	Maximum Grade, Per Cent.	Length of Maximum Grade in Ft.	Sharpest Curvature Outside Municipalities in Degrees.	Distance Apart in Miles.	Distance Apart in Running Time in Minutes.	Stub End or Through.	Spring or Throw Switches.	Rail Used in Towns
Cinders, gravel, stone	..	8	1 to 1	15	14	41	30	44	20 to 50	20	115	3.5	700	6	3	7½	T	S	7-in. girder.
Gravel and stone	..	6	1½ to 1	14	16	70	40	40	50	30	130	5.0	200	12	5	10	T	S	7-in. T, 7-in. girder.
Gravel and slag	35c.	7	1½ to 1	13	15	10	35	25	40 to 60	3	77	5.0	1,000	60	3	7	T	S	6-in. T.
Gravel	50c.	5	1½ to 1	12	14	..	..	52	33 to 50	4	53	¾ of 1	1,000	..	2	5	T	T	6-in. T.
Gravel and stone	40-50c.	4 to 6	1½ to 1	14	18	2	46	30	30 to 60	2	76	2.0	1,200	13	4	9	T	Both	High T.
Stone and screenings	35-45c.	6	1½ to 1	14	15	..	40	10	33 to 40	2	48	1.0	4,500	15	3½	7	T	S	..
Gravel and cinders	..	8	1½ to 1	12	16	..	..	33	33	4	29	2.0	2,640	9	3½	8	T	S	High T.
Gravel and cinders	..	6 to 8	1½ to 1	12	12	60	..	30	35	10	80	5.0	1,200	45-ft. radius	3	7	T	T	High T.
Gravel and stone	35-45c.	8	1½ to 1	16	20	2	85	37	40	11	101	3.5	500	60-ft. radius	2½	4	S	..	..
Gravel and stone	..	8 to 10	1½ to 1	16	16	..	25	36	50	3	58	2.1	600	12	2½	4	S	T	7-in. T.
Gravel	35c.	6 to 8	1½ to 1	11	12	8	23	..	33	6	25	3.0	1,200	45-ft. radius	2	4	T	S	..
Gravel	..	8	1½ to 1	14	15	32	2	..	..	12	22	5.0	1,200	..	5	10	T	S	..
Gravel	..	10 to 15	1½ to 1	17½	20	..	..	72	70	2	70	2.0	120	2	2	4	T	T	..
Gravel	..	7	1½ to 1	14	15	2	..	50	..	2	52	3.0	1,000	12	3	7	S	T	6-in. T.
Gravel	75c.	6	1½ to 1	14	..	2	26	..	30 to 50	2	26	3.5	1,800	50	3	7	T	S	6-in. T.
Stone	90c.	8	1½ to 1	12	16	..	56	19	40	25	75	..	.....	40-ft. radius	1½	3	S	T	..
Wash gravel and stone	38-42c.	4 to 6	1 to 1	14	15	..	..	56	60	..	...	2.5	16,000	..	1½	4	T	T	..
Gravel	30c.	8	1½ to 1	16	22	..	10	240	66	..	...	3.5	.....	..	2	3½	T	T	..
Gravel	..	8 to 10	1 to 1	16	16	..	..	..	50	10	77	6.0	1,500	6	3½	..	Both	T	..
.....	..	.....	.....	..	..	..	..	..	..	..	...	...	.....	...	..	..	..	..	..
Gravel	..	10 to 12	1½ to 1	18	18	..	..	..	20 to 66	4	...	2.0	600	7	3	..	Both	Both	..
Gravel	..	6	.....	12	..	..	..	..	40 to 120	..	...	6.0	500	..	3	..	S	T	..
Gravel and stone	..	6	1½ to 1	14	18	..	8	15	40	5	23	2.0	700	..	4½	..	Both	T	..
Gravel and stone	..	8	1½ to 1	16	26	6	15	..	18 to 100	..	...	1.5	.....	4	2½	..	S	T	..
Lime, rock and gravel	..	12	1½ to 1	12	..	..	..	..	33 to 60	..	...	5.0	2,600	75-ft. radius	3	..	T	S	..
Gravel and cinders	..	6	1½ to 1	..	..	34	37	..	33	..	...	3.0	.....	10	2½ to 3	..	Both	S	..

miles of track is bonded with 4-0 compressed bonds, while on the remaining 18 miles 4-0 soldered bonds are used. Some of the latter type came off, due to faulty application.

Soldered bonds are also used on the tracks of the Terre Haute Traction & Light Company. Some are placed on the flange of the rail, some underneath the flange and some are concealed. Concealed bonds are preferred. Compressed and pin bonds are used on the Fort Wayne & Wabash Valley tracks. At the present time, however, soldered bonds are being tested. Some soldered bonds are being applied by heating with an electric arc.

Pin bonds, with special application and compression bonds, are in use on the interurban tracks of the Detroit United Railways. At the present time experiments are being made with different types of soldered bonds. One test for such bonds is to note the number of pounds pull required to pull them off.

TIES

In Ohio the white oak tie is usually secured wherever possible, and it is almost universally used on curves. A number of roads are using chestnut ties on straight tracks, while others prefer cedar on tangents. Few of the roads in this district have as yet been obliged to replace ties. The Eastern Ohio, now doing some of this work, reports the life of 7½ years on oak and 10 years on cedar, and the Cleveland & Southwestern has been taking up some oak ties after 8 years of use. The standard 6-in. x 8-in. x 8-ft. tie is almost universally used, and hewn ties are in the majority. The Cincinnati & Columbus Traction Company uses 7-in. x 8-in x 8½-ft. ties on all grades and curves. Spacing of ties on 2-ft. centers is almost universal, although the Toledo, Port Clinton & Lakeside uses 18 ties to each 33-ft. rail. None of the interurbans in Ohio has tried wood preservatives or concrete or steel ties, preferring to let the steam roads do the experimenting in this direction.

It is also almost universal practice on interurban lines in Indiana and Michigan to space the ties with centers 2 ft. apart. The ties are usually 6 in. x 8 in. x 8 ft. in size. Definite figures as to the life of ties could not be obtained, as the roads have not been built long enough to necessitate replacing ties. In only one instance have preservatives been adopted. Cedar, oak and chestnut ties are used.

Hewn oak ties are in use on the Indiana Union Traction system. On the Indianapolis & Northwestern Traction system the ties are cedar on straight track and of oak on all curves of over 1 degree radius. On the main track they are hewn, but on sidings sawn ties are used.

The Indianapolis, Columbus & Southern Traction Company, on the extension which it is now building from Columbus to Seymour, is using black and red oak ties. These are being treated with zinc chloride. On the Kokomo, Marion & Western system hewn oak ties are used almost altogether, but a few sawn ties are laid. There is no special preference for the hewn other than the fact that the quality of the tie can be more easily seen. The Detroit United Railway uses cedar ties on interurban track and white oak ties on city track. It was stated that in cinder ballast cedar ties had a life of from five to seven years and in gravel ballast a life of from seven to ten years. On the Detroit, Ypsilanti, Ann Arbor & Jackson system white oak ties are used on curves and switches and cedar ties on all other portions of the roadway.

BALLAST

The character of ballast depends largely upon the most available material in the vicinity of the road. Stone is preferred by many builders, on account of the stability of the track produced, the cleanliness and the fine appearance of the track. There appears to be little doubt but that a track stays in place better with a good stone ballast than with any other material. The Detroit, Monroe & Toledo Short Line, Western Ohio, Interurban Railway & Terminal Company, Columbus, Delaware & Marion and Toledo, Port Clinton & Lakeside use stone almost exclusively, and their tracks are noted for smoothness and easy riding quality. The last-mentioned road covers the broken stone with rock screenings, which pack down after having been wet, making almost a concrete roadbed. On the other hand, the Scioto Valley, Lake Shore Electric, Dayton & Troy and several other roads maintain excellent roadbeds with coarse gravel.

The Dayton & Troy has an especially fine track and uses very coarse washed gravel. Operators who have had long experience in the business believe that a gravel track, if properly maintained, gives a smoother and easier riding surface than any other material, but there is no denying that it requires more attention than rock ballast. The Eastern Ohio, Cleveland & Southwestern and Stark Electric are using their power house cinders for ballast, and find that this material makes an excellent foundation. The last-mentioned road traverses a district where there are many potteries and uses broken tile quite extensively on its tracks. Furnace slag is used by one or two of the roads. The character of ballast, cost, depth under ties, slope of banks, width of grade, etc., are shown in the accompanying table.

The majority of roads are paying more attention than formerly to the matter of securing good drainage. The aim is to construct good ditches on both sides of the track and keep them open. Several roads are engaged in raising their tracks. The Toledo Urban & Interurban has elevated its tracks 8 ins. to 10 ins. since the road was built, and the Dayton & Troy and several others are doing the same. Under highway crossings and for small streams, the Toledo, Port Clinton & Lakeside uses tile sewer pipe up to 20 ins. and concrete culverts over that size. The Interurban Railway & Terminal Company uses 18-in. and 24-in. vitrified pipe in many places and concrete culverts where necessary. This company has stayed a number of banks with 30-ft. oak piling with steel points. The Toledo & Indiana laid 4-in. drain tile the full length of all track in towns. At one point the Scioto Valley built a sewer a mile long to drain a low place on its road.

LOCATION

The cross-country private right of way location is growing in popularity. Many of the earlier roads were built on pike location under county grant. Some of these have quite advantageous arrangements. The Lake Shore Electric, for instance, for over about a third of its route traverses the Perrysburg turnpike, which is 10 ft. wide. The Columbus, Buckeye Lake & Newark, the Columbus, London & Springfield, the Dayton, Springfield & Urbana and the Dayton & Western, which are now parts of the Indiana, Columbus & Eastern system, were built for considerable portions of their lengths along the national pike, a wide thoroughfare extending entirely across Ohio. In many places they have the advantage of a ditch and pole line between the track and the highway. The use of pikes is practically obsolete for new work, however, and several of the roads, notably the Northern Ohio Traction Company and the Cincinnati Northern, are buying private right of way and throwing their tracks over to new locations. The short life of franchises, the inability to secure good drainage and grades, and the dangers of operation are the chief drawbacks to the pike road. After the pike road came the line built on private right of way adjoining the turnpike. In securing right of way, it was easier in most cases to secure a strip from a man's farm adjoining the highway than it was to cut through his farm and divide it. The advantage of being close to the farmer's home and securing his business also prompted many builders to

seek this location; but of late years, with the advent of high-speed limited cars and the desire of some of the roads to operate freight trains, the cross-country location enabling the road to fence on both sides of the right of way and to suit its own convenience in matters of grade, drainage and speed, is becoming the almost universal practice. The popular scheme, wherever possible, is to parallel closely the right of way of a steam road. The Scioto Valley, Toledo & Indiana, Fort Wayne, Van Wert & Lima, Lima & Toledo and the new portion of the Western Ohio follow this scheme almost entirely. It is found that it enables the road to limit its stopping points to suit its own convenience, and the old idea that there is likely to be a loss of local trade seems to have been disillusionized by the experience of these roads.

Early builders insisted that, to be successful, a traction line must run through the main streets of villages. This also has become an exploded theory. The Scioto Valley, Dayton & Troy, Columbus, London & Springfield and other high-speed roads have thrown their tracks away from the centers of villages and towns wherever practicable, and find they get just as much business and avoid the loss of time and dangers of accidents incident to street operation. The Cincinnati, Georgetown & Portsmouth, a reconstructed steam road, owns every foot of ground traversed by its tracks, and its operation conditions are most advantageous. The private right of way away from turnpikes and village streets enables the road to eliminate sharp curves, which are dangerous for high-speed operation and the running of trains. The accompanying tables show that many of the roads have reduced their curves and grades to a very marked extent.

More attention is being paid to the matter of banking outer rail on curve. Curves are being lengthened and raised 5 ins. or 6 ins. in some cases. A number of roads are laying guard rails on all curves over a certain radius.

Grades are not as severe as in many portions of the country, the western part of Ohio and all of Indiana being remarkably level. However, there are some severe grades, which well demonstrate the remarkable hill-climbing qualities of the electric motor over the steam locomotive. For instance, the Northern Ohio Traction Company has on its main line a grade of 2700 ft., with from 10 to 12½ per cent rise. The Cincinnati, Georgetown & Portsmouth has a grade averaging 2 per cent for 2½ miles; for a portion of this distance it is about 8 per cent. Through the eastern and central portions of Ohio there are numerous heavy cuts and fills, the Columbus, London & Springfield having a fill of 110,000 cu. yds. There is but one tunnel in the district, that on the Columbus, Newark & Zanesville, about 400 ft. long through solid rock.

TURNOUTS

Reference to the table on this subject shows that there is but little double-track line in Ohio at the present time. Up to very recently none of the roads has felt that it had sufficient business to warrant double tracks. Few of them have had better than hourly headway, but with the advent of numerous limited cars and freight trains, double tracking is becoming absolutely necessary. The Northern Ohio Traction & Light has about 18 miles of second track in the 37 miles between Cleveland and Akron. The Lake Shore Electric is double tracking from Cleveland to Lorain, 27 miles. The Dayton & Troy has 10 miles of double track in 31 miles, and the Cincinnati Northern is now double tracking a considerable portion of its line between Cincinnati and Dayton. These are the nearest approach to fully double-tracked lines in the district. To improve the situation many roads are increasing the number of sidings and lengthening them. Especially is this being done by roads that are hauling freight in trains with electric locomotives. Sidings 1000 ft. long are being installed to enable the roads to handle trains of considerable length. While the average steam road operator and a great many electric road managers look upon it as a crude and cumbersome method, there is no doubt that the stub type of switch is gaining in favor, and that, too, with the speediest lines in the district. The subject of through or stub switches is one which is receiving much attention. The arguments in favor of the stub switch are that it reduces the number of facing switch points and the number of switches requiring attention. It reduces the chances of splitting switches and side swiping cars, and in general accidents, resultant from misunderstanding or confusion of orders. Against it are the undeniable facts, that it causes a loss of time in backing out and changing trolleys, and it is especially cumbersome where several cars are operated in a train. Among the roads which have recently adopted this method, are the Western Ohio, Cincinnati & Columbus, Fort Wayne, Van Wert & Lima, and several of the roads recently merged into the Indiana, Columbus & Eastern. The practice of operating, however, is different. The Western Ohio, for instance, requires that the first car which arrives at the passing point shall take the siding. Some of the other roads mentioned require that the car going in the direction facing the switch shall take the siding and back out after the other car has passed. The 'Schoepf" roads have recently adopted the rule of heading in and backing out of all sidings, whether stub or through.

Spring vs. throw switches is another subject which has been widely discussed of late. Earlier roads quite generally adopted the spring switch as a simple and time-saving device, but there is no denying that in Ohio it is losing favor, although some of the best operated high-speed lines in the district continue to use it with perfect satisfaction. The Lake Shore Electric, Cleveland & Southwestern, and Dayton & Troy, all operating limited cars at a speed of 60 miles an hour, are fully equipped with spring switches and have never had an accident by reason of them. The Dayton & Troy does not even require its cars to slacken speed approaching these switches. Frequent and careful inspection and keeping the switch point in condition, it is claimed by these roads, render this type of switch perfectly safe. The Toledo & Indiana recently removed all spring switches because a freight train was derailed at one of them, caused by a piece of coal dropping into the point. Considering what might have happened had it been one of his 60-mile an hour limiteds, the manager immediately ordered a change. A few of the roads using throw switches do not lock them, but the majority, including the roads above referred to as having adopted stub turnouts, require that the switches be kept locked. Practice is about equally divided between the low-stand switches and the high-stand targets, several roads believing that the high target gives an extra precaution.

Some of the very best roads in Ohio do not illuminate their switch stands or sidings, depending upon the headlight of the car to show the location. The Toledo & Indiana, Stark Electric, Lake Shore Electric and Toledo & Indiana and several others illuminate switch stands with incandescent lights. The lights are usually low voltage and low candle-power lamps placed six or seven in series. The Toledo & Indiana, for instance, places five in a telephone booth and one in each switch light. The Interurban Railway & Terminal Company, Canton-Akron, and Dayton & Troy have lights in the telephone booth and a cluster over the switch, but none in the targets. Some of these roads leave the switch lights burning all the time, believing it more economical than to require the train crews to stop and turn them out. Others require the first crew passing them in the evening to turn them on, and the last crew at night to turn them off. The Scioto Valley lights switches with oil lamps burning seven days. The Canton-Akron, Scioto Valley and several other roads have clusters of lights over all stopping points with

a spring switch on the pole, which is thrown by any passenger who desires to stop a car.

The Columbus, London & Springfield has a circuit of five lamps at each switch; two at the targets, two at the locks and one in the telephone booth. At railroad crossings it has red lights at the derailers, notifying the motorman to stop, and green lights 150 ft. from the crossing notifying him to get the car under control, and white lights over all crossings. The Lake Shore Electric has large illuminated signs showing the word "Derailer" at all railroad crossings. The Dayton, Covington & Piqua has red lights 400 ft. from all derailers.

In Indiana the average distance between sidings on the roads visited, varies from about 2¼ to 4½ miles. Both spring and throw switches are used at sidings. The fact that spring switches may be partly opened by the action of heat on hot days or may not be completely closed by the springs, has discouraged several roads in the use of this type of switch. The switches are usually of the standard steam-road type. With few exceptions the switch stands are lighted at night. On several roads electric switch lights are employed.

On the Indiana Union Traction Company's system two 300-volt incandescent lamps are placed in the lanterns on the switch stands. Trainmen turn the lights on and off by means of a switch in a box on a pole near by. On this system cars are always headed into switches and always backed out when passing each other. This regulation is followed, notwithstanding the fact that time would be saved by permitting the car taking the siding to pass the length of the siding and back on the main track at the other end. The rule of heading in and backing out makes it impossible for a switch to be left open. All of the switches on the Indiana Union Traction system are of the throw type. Spring switches were formerly used at one end of sidings, but these were thought to be directly responsible for two serious accidents in one day, and since that time the use of throw switches has been discontinued.

Both stub and through sidings are used by the Indianapolis & Northwestern Traction Company. The sidings vary in length from 250 ft. to 525 ft. The switches are of the lever throw type and are lighted with oil lamps. East-bound trains take sidings for those west bound, and the rule of heading in and backing out is followed.

On the Indianapolis, Columbus & Southern Traction system, the sidings are about 200 ft. long, and at approximately 3-mile intervals. Those at regular passing points are of the through type, while the others are stub end. Spring switches are used at regular passing points, those at stub-end sidings being of the throw type. The switch stands are provided with a target, but no switch lights are employed. It is a rule that a car heading towards a turnout shall take it. As a precautionary measure, cars slow up while passing switches.

Sidings at meeting points on the Kokomo, Marion & Western system are about 4½ miles apart and about 300 ft. long in the clear. At regular meeting points the sidings are of the through type, but the remainder are stub end. Throw switches alone are used. The switches have no semaphores, but are lighted with electric lights. Three 200-volt lights are used in the circuit. At double-end sidings one light is placed on each of the switch stands at each end of the siding, and the third lamp is located in the telephone booth. At stub-end sidings two lamps are placed in the booth. Trains head in and back out at stub-end sidings, but at through sidings the train taking the siding continues on through and passes out on the main track at the other end. As on the Indianapolis, Columbus & Southern system, trains slow up when passing sidings.

The sidings on the interurban divisions of the Terre Haute Traction & Light Company are about 3 miles apart and 100 ft. long in the clear. The switches are always locked and no switch lights are employed on the switch stands. Cars take sidings when ordered, but when a train having a second or third section following it meets a single car the latter takes the siding.

The sidings on the Fort Wayne & Wabash Valley Traction Company average about 4½ miles apart. They are of both the through and the stub-end type and are provided with throw switches. The switch stands are lighted by electricity. The circuits upon which the lamps are placed run into the sub-stations and other central points and the lights are turned on from these points. An unusual feature in the use of sidings is that cars meeting limited trains are due at sidings 4 minutes ahead of the limited. This gives the trainmen time to get their own orders and clearance orders for the limited.

On the Rapid Railway division of the Detroit United Railways the sidings are located to suit the schedule, but are approximately 3 miles apart. They are of the through type and are provided with spring-trailer switches at one end and throw switches at the other. Switches at meeting points are left open. The first car takes the siding and passes on through it and out the other end.

Sidings are 2¼ miles apart on the eastern portion of the Detroit, Ypsilanti, Ann Arbor & Jackson Railway, and 3 miles apart on the western portion. They are 150 ft. long in the clear. Those at meeting points are of the through type, while all of the others are stub end. Spring switches are used at meeting points and the switch stands are lighted by electricity.

RAILROAD AND HIGHWAY CROSSINGS

Interurban builders in Ohio have, as a rule, endeavored to avoid as many grade crossings with railroads as possible. The steam roads have usually been willing to assist the electrics in building overhead or undergrade crossings. The severe grades usually made necessary at such crossings have made them unpopular with some engineers, but experienced managers after a number of years of operation are of the opinion that the illumination of grade crossings by stationary lights or illuminated signs is a good investment in the long run. Crossing accidents are eliminated, time is saved in making the crossing, and it has been demonstrated by experiments that the power consumed and wear and tear on the machinery in making stops at derailers more than compensates for the extra power on stiff grades at such crossings.

Derailers are almost universally used at grade crossings by Ohio interurbans. The derailer handle is placed beyond the railroad track so that the conductor must cross the track to throw it. The Lake Shore Electric, Western Ohio and Toledo & Western each have one or more half interlockers where a targetman throws a derailer on the electric and a semaphore on the steam line. The Toledo & Western has two full interlockers where the two roads have equal rights and protection, while the Toledo & Indiana has all its crossings thus protected by an arrangement with the steam road which it closely parallels. Several Ohio roads use warning signs at all highway crossings. Four of the roads are using metal signs, which are deemed more durable than wood. The method of working has received some attention. Some of the roads use the words "Look Out For The Cars," while others say, "Railroad Crossing, Stop, Look and Listen." It has been held in the courts that a man must show that he did all three of these precautionary acts or he cannot hold the road for contributory negligence. The Columbus, Delaware & Marion and one or two others have erected alarm bells at especially dangerous crossings, the alarm circuit being closed by a trip in the trolley wire.

Several of the roads have special "Slow," "Whistle" and "Stop" signs at points where such precautions are considered necessary or desirable.

CURVE CONSTRUCTION, INDIANA UNION TRACTION

VIEW SHOWING FOUR MODES OF TRANSPORTATION ON COLUMBUS, BUCKEYE LAKE & NEWARK—THE ELECTRIC RAILWAY, STEAM ROAD, CANAL AND HIGHWAY

TYPICAL DOUBLE-TRACK CONSTRUCTION, INTERURBAN RAILWAY & TERMINAL COMPANY, CINCINNATI

DOUBLE-TRACK CURVE, COLUMBUS, LONDON & SPRINGFIELD

TYPICAL CONSTRUCTION, INDIANAPOLIS, COLUMBUS & SOUTHERN TRACTION

TYPICAL SINGLE-TRACK CONSTRUCTION, INTERURBAN RAILWAY & TERMINAL COMPANY, CINCINNATI

TYPICAL CONSTRUCTION, TOLEDO, PT. CLINTON & LAKESIDE

TYPICAL CONSTRUCTION, DAYTON & MUNCIE

DOUBLE-TRACK CONSTRUCTION, DAYTON & TROY

T-RAIL IN LIMA, OHIO, LIMA & TOLEDO TRACTION

T-RAIL IN CINCINNATI, INTERURBAN RAILWAY & TERMINAL COMPANY

T-RAIL IN SANDUSKY, LAKE SHORE ELECTRIC

SWITCH LIGHTS, OVERHEAD SIGNS AND TELEPHONE BOOTH
TYPICAL TURNOUT, STARK ELECTRIC

DERAIL AND SEMAPHORE, INDIANA UNION

SWITCH STAND AND TELEPHONE BOOTH, TYPICAL TURNOUT,
COLUMBUS, DELAWARE & MARION

INTERLOCKER AND SEMAPHORE AT RAILROAD
CROSSING, TOLEDO & WESTERN

TYPICAL SWITCH, WESTERN OHIO

SWITCH STAND AT TURNOUTS, COLUMBUS, LONDON &
SPRINGFIELD

INTERLOCKER, WESTERN OHIO

PROTECTING GUARD-RAIL AT SPRING SWITCH POINT, STARK ELECTRIC

TYPE OF DERAIL, INDIANAPOLIS & NORTHWESTERN

DERAIL AND SEMAPHORE, CINCINNATI, MILFORD & LOVELAND

THIRD RAIL FOR OPERATING SIGNALS AT TURNOUTS, COLUMBUS, NEWARK & ZANESVILLE

INTERLOCKER AND SEMAPHORE AT RAILROAD CROSSING, SPRINGFIELD, TROY & PIQUA

LUDLOW BRIDGE, DAYTON, COVINGTON & PIQUA

BIG DARBY BRIDGE, COLUMBUS, LONDON & SPRINGFIELD

SWING BRIDGE AND TRESTLE AT OAK HARBOR, TOLEDO, PT. CLINTON & LAKESIDE

SCIOTO RIVER BRIDGE, COLUMBUS, LONDON & SPRINGFIELD

THE FAMOUS Y CONCRETE BRIDGE AT ZANESVILLE, OHIO

TYPE OF CONCRETE BRIDGE USED BY SEVERAL INTERURBAN ROADS IN OHIO

NEW GORGE BRIDGE, NORTHERN OHIO

BRIDGE REBUILT FROM OLD STEAM RAILROAD BRIDGE, CLEVELAND, PAINESVILLE & ASHTABULA

OLENTANGY RIVER BRIDGE, COLUMBUS, DELAWARE & MARION

PRIVATE WAY STATION, COLUMBUS, DELAWARE & MARION

WAY STATION, COLUMBUS, LONDON & SPRINGFIELD

WAY STATION, COLUMBUS, NEWARK & ZANESVILLE

PLATFORM AND STOP SIGNAL, INDIANAPOLIS & NORTHWESTERN

WAY STATION, COLUMBUS, DELAWARE & MARION

JUNCTION STATION, LAKE SHORE ELECTRIC

ONE TYPE OF WAY STATION, INDIANA UNION

PRIVATE WAY STATION, FORT WAYNE & WABASH VALLEY

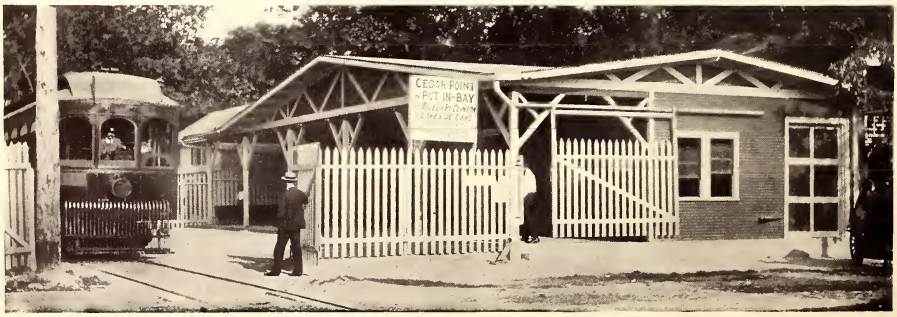
TYPICAL WAY STATION, INDIANAPOLIS & NORTHWESTERN

WAY STATION, KOKOMO, MARION & WESTERN

OLD SHELTER AT ARLINGTON, WITH NEW FREIGHT AND PASSENGER STATION IN DISTANCE, INDIANAPOLIS & CINCINNATI TRACTION

WAY STATION, DAYTON & TROY

PASSENGER AND EXPRESS STATION AT NORWOOD, CINCINNATI & COLUMBUS

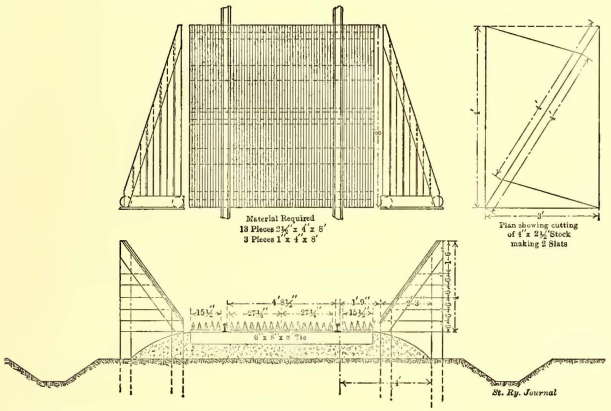


ENCLOSED STATION AT PARK, TOLEDO, PT. CLINTON & LAKESIDE

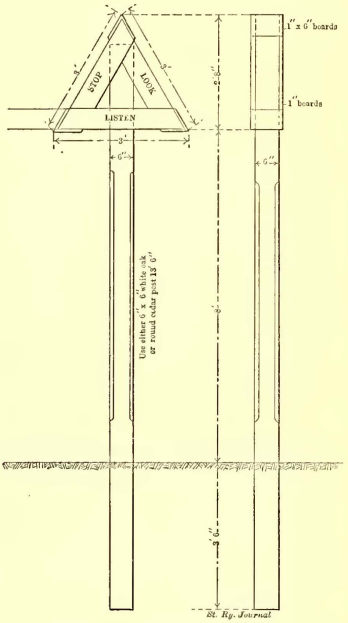
BRIDGES, TUNNELS AND CULVERTS

There is a growing tendency on the part of Ohio interurbans to build their own bridges crossing large streams instead of using highway bridges as many of them did in the earlier days. The increasing weights of cars, the desire to haul freight trains and the delays from team traffic were responsible for this. One of the finest traction bridges in the country is that of the Toledo Urban & Interurban over the Maumee River, near Toledo. It consists of five steel spans, resting on concrete piers with steel and timber approaches, in all about 1800 ft. long. This bridge is said to have cost about $75,000. The Northern Ohio Traction & Light Company recently built a double-track bridge at the Gorge, south of Cleveland. It is about 800 ft. long and 100 ft. high, and eliminates a very heavy grade and two severe curves. It cost $50,000. The Cleveland, Painesville & Ashtabula has a 1200-ft. bridge over Grand River at Painesville, which was rebuilt from two steam railroad bridges. It is amply strong for interurban cars, but was discarded by the steam road when it began running fast Pullman trains. The Lake Shore Electric Railway has a similar bridge on its Elyria branch. The Toledo, Port Clinton & Lakeside has an interesting swing bridge, the high tension lines being carried over the top of the swing portion on towers. The tower over the center span has a pole set on a revolving center so that while the bridge revolves the pole remains stationary. The Cincinnati, Georgetown & Portsmouth, the Scioto Valley, the Dayton, Covington & Piqua and the Cleveland & Southwestern each have some noteworthy steel bridges. Many of the roads in their earlier periods had numerous wood trestles or trestle bridges, but the practice is to fill at these places as rapidly as possible. The Lake Shore Electric and the Western Ohio have each filled several trestles, while the Cincinnati, Georgetown & Portsmouth, which a few years ago had forty-one trestles in 50 miles, now has but eleven, and is rapidly filling these. The Toledo & Western, which handles heavy freight, designed its bridges to carry two 100-ton locomotives coupled together. The Toledo, Port Clinton & Lakeside figures its bridges to carry 62 tons on single span. The Toledo & Indiana figures bridges for 65 tons, and the Interurban Railway & Terminal Company for 100 tons.

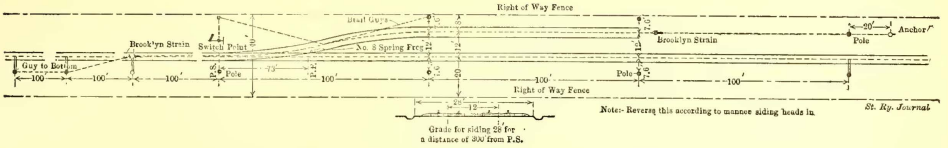
Some little work has been done in this district in the way of solid concrete bridges. The Lake Shore Electric, Western Ohio, Detroit, Monroe & Toledo Short Line and other roads have a number of concrete culverts and there are a few 30 ft. to 40-ft. highway crossings of solid concrete, but the usual practice is to use concrete only for the supporting walls with a steel span for the track. Concrete has been used extensively in building piers for larger bridges and in building retaining walls. Some unusually heavy work in the way of retaining walls is being done by the Cincinnati Northern in the reconstruction of its line between Cincinnati and Dayton.



STANDARD CATTLE-GUARD AND WING FENCE, FORT WAYNE & WABASH VALLEY



STANDARD CROSSING DANGER SIGN, FORT WAYNE & WABASH VALLEY



LAYOUT FOR STANDARD SIDING, FORT WAYNE & WABASH VALLEY

BLOCK SIGNALS

Block signals on interurban roads are not as popular in this district as they were two or three years ago. This is not due entirely to the unreliability of the block signals themselves, but because the roads which used them, as a rule, attempted to place the entire dependence for train handling upon these signals.

Later, as more cars were added, and freight cars with their irregular habits, and limited cars with their higher speed came into prominence it was found necessary to install despatching systems with train orders and the use of the block signals was dispensed with. This was the case with the Toledo Urban & Interurban, the change being made to accommodate the fast cars of the Dayton-Toledo service. Several of the roads are experimenting with block signals of various types.

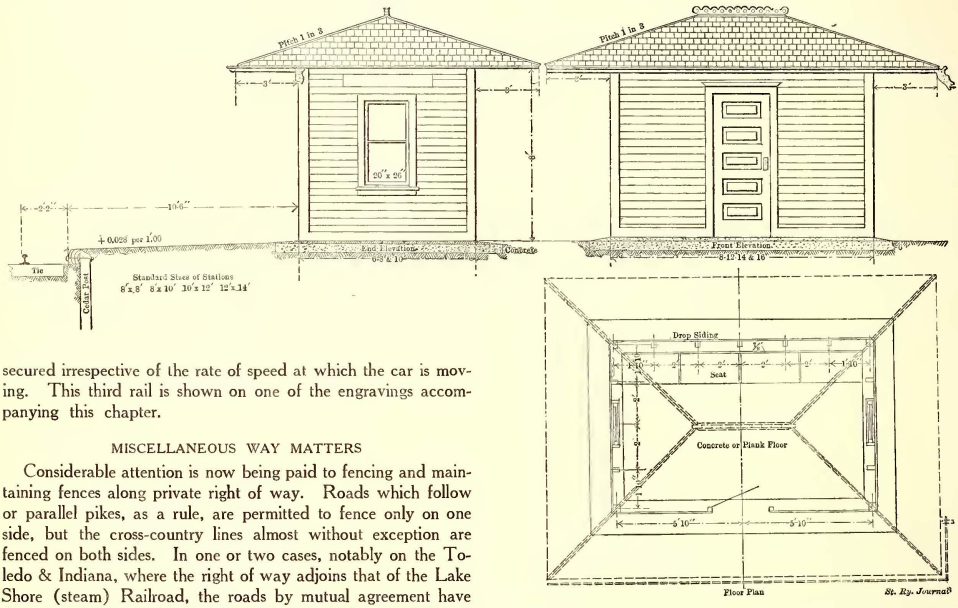
The Columbus, Newark & Zanesville management is working out a system for operating block signals. This includes a stretch of third rail at the entrance to each turnout and a third-rail shoe or contact maker on the car truck. By establishing contact between the car and the section of third rail, a positive and quick-acting medium for automatically actuating the signals will be secured irrespective of the rate of speed at which the car is moving. This third rail is shown on one of the engravings accompanying this chapter.

MISCELLANEOUS WAY MATTERS

Considerable attention is now being paid to fencing and maintaining fences along private right of way. Roads which follow or parallel pikes, as a rule, are permitted to fence only on one side, but the cross-country lines almost without exception are fenced on both sides. In one or two cases, notably on the Toledo & Indiana, where the right of way adjoins that of the Lake Shore (steam) Railroad, the roads by mutual agreement have dispensed with the fence between the rights of way, and they co-operate in the maintenance of a common ditch. Woven wire fences are used by practically all the roads. Several roads use a fence having a fine mesh below and a large mesh above, the smaller mesh keeping out small domestic animals. Several roads use iron posts for fence posts.

The roads are about equally divided between the use of vitrified clay cattle guards and wood guards. One road is using a stamped metal cattle guard.

Some tremendous crops of weed have been grown on the rights of way of interurban roads this year and the destruction of them with the small track forces which the majority of roads can afford has been one of the chief sources of worry for the operating men of late. Various methods have been pursued to get rid of weeds. The Lake Shore Electric, Cleveland & Southwestern and several roads pull their weeds in the spring and then cut them two or three times during the year. The Dayton & Troy has a force at work all summer and the men go over the entire track about once in three weeks pulling the weeds. The Fort Wayne, Van Wert & Lima covers its line once in four weeks, and the Canton-Akron once in five weeks during the summer months. The Scioto Valley goes over the route twice during the spring with scuffle hoes cutting off the roots of the weeds. After that they are cut at intervals as often as they grow beyond a certain height. The Toledo, Port Clinton & Lakeside burns weeds with hand torches early in the spring and cuts them twice during the summer. The Interurban Railway & Terminal Company has used weed exterminator sprinkled over the line with a sprinkling car with considerable success, the cost being about $20 per mile for material and labor. The Dayton & Western tried this plan, and while it killed the weeds it also killed several cows that had browsed on the right of way, bringing the cost of weed killing up to a prohibitive figure. The weed-burning car designed by Manager Darrow, of the Toledo & Indiana, described in the Street Railway Journal for Aug. 4, 1906, is reported to be giving excellent satisfaction. The cost of exterminating is said to be but $3 a mile. Manager Franklin, of the Toledo & Western, is building a weed burner of somewhat different type. The floor and sills of the car will be of metal, and there will be an iron fire-box hung under the car. This will be bricked and heated red hot by oil sprays and sprays of oil will be sprinkled over the track in front of the burner, the oil being ignited as the burner passes over it. Manager Mowrey, of the Stark Electric Railway, is also getting out plans for a weed burner.

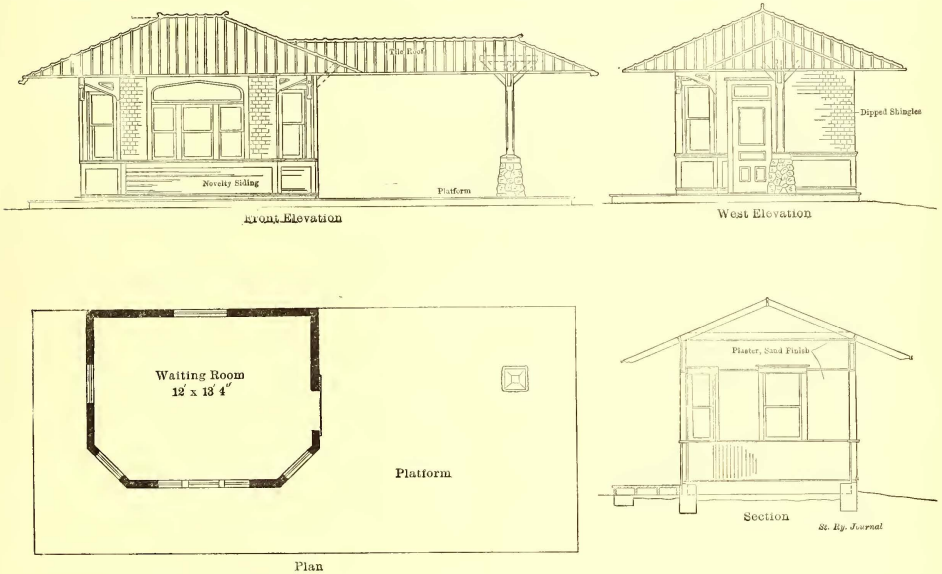


PLANS OF STANDARD SHELTER SHED AT WAY STATIONS, FORT WAYNE & WABASH VALLEY

While methods and appliances may have some bearing upon the condition of a track, the securing of a fine roadway depends more than anything else upon the number of track men constantly employed in track work. The writer was recently going over a line which closely paralleled the main line of the Pennsylvania Railroad. The difference in the appearance of the two tracks was most marked, and with a sigh the manager of the electric road remarked that he hoped some day his track might look like the beautiful stretch adjoining. "How many track men do you employ was the inquiry." "That is the whole story," he replied. "The Pennsylvania has four men to the mile, and we have one to about every 4 miles." The Dayton & Troy

maintains its fine track by employing forty-one men on 31 miles. The Western Ohio, with heavy heavy rock ballast in which weeds do not grow readily, has a man to the mile. The Lake Shore Electric has about the same, while the others in the district vary from that on down to one poor road which has seven men for 50 miles; small wonder if the weeds rub the motors, and the passengers are troubled with seasickness. The Dayton & Troy and Fort Wayne, Van Wert & Lima use hand cars for track men and have section houses for storing of tools and track supplies. The latter road bought a number of small school houses adjoining its right of way for this purpose. The Toledo & Western, Springfield, Troy & Piqua, and one or two other roads use gasoline cars for inspection work. The Dayton & Troy employs track walkers who cover the entire road and inspect all switches daily.

One of the points looked after by roads anxious to develop their business is the erection of suitable station buildings and shelter houses in all towns and way stations. The Scioto Valley has particularly fine buildings in all towns, a number of them in connection with sub-stations, while in other towns the company has erected neat frame buildings, heated in winter by stoves. The smaller stations at cross-roads are not heated, although they are enclosed. The Cincinnati, Georgetown & Portsmouth has twenty-one station buildings with agents in 50 miles of track, with small enclosed station buildings at other points giving an average of five stops to the mile. The Western Ohio, Lake Shore Electric, Dayton & Troy, Fort Wayne, Van Wert & Lima and several roads have their own station buildings in all towns, with small, open or enclosed buildings at stopping points. In a number of instances, the roads assist the farmers in the erection of way stops and shelter houses. Groups of typical way stations in the districts are shown in this connection.



Front Elevation — West Elevation

Plan

SHELTER STATION AT GROUNDS OF COUNTRY CLUB, FORT WAYNE & WABASH VALLEY

TERMINAL STATIONS

At the present time there are no terminal stations in Ohio, which compare with the magnificent stations erected in Indianapolis, Los Angeles, Milwaukee and several other centers, but two years from now conditions will be different in a number of large Ohio cities. Plans have been completed for a very fine station in Toledo. The work is being held up temporarily owing to the action of the city on refusing a franchise for the necessary turnouts to enter the site selected; a blind and senseless policy of obstruction in view of the tremendous amount of business brought into the city by nine interurbans centering there and the inconvenience to the public of the present inadequate method of landing passengers from a street station. Plans for the proposed Toledo station were illustrated in the STREET RAILWAY JOURNAL for Feb. 3, 1906. In Cleveland the interurbans have a fine union freight station with adequate facilities for future growth, and they own a tract adjoining where it is probable that a union passenger station will be erected within a year or two. Preliminary plans for such a station have already been made. The Cleveland interurbans at present radiate from the Public Square and have the advantage of a large shelter house and public comfort station erected by the city at a cost of $12,000. The cars are permitted to lay up in front of the station, and there is a ticket office opposite the building. This arrangement was described in a recent issue of the STREET RAILWAY JOURNAL.

The Interurban Railway & Terminal Company, of Cincinnati, owns a large three-story building with train shed for both passenger and freight cars, which is used by its three lines and by the Cincinnati, Milford & Loveland Traction Company. The terminal has the disadvantage of being laid with broad-gage track and the standard gage roads are unable to reach it. Plans of the station are shown on another page.

The union station at Columbus has long been inadequate to accommodate the numerous interurbans. Last year the Scioto Valley withdrew from the arrangement and established its own station, which is referred to in another part of this issue. The Indiana, Columbus & Eastern Railway has had under consideration the erection of suitable terminal stations in Columbus, Springfield and Dayton, and if built they will doubtless be

designed to accommodate all of the roads entering these centers. Dayton has long felt the need of a union station, and the establishing of such a station has only been held up by the inability to make satisfactory arrangements between three city companies and seven interurbans. Now that the Schoepf syndicate controls several of these roads, the plan will doubtless be carried out. The important terminal station at Indianapolis was fully described in the STREET RAILWAY JOURNAL for Nov. 12, 1904.

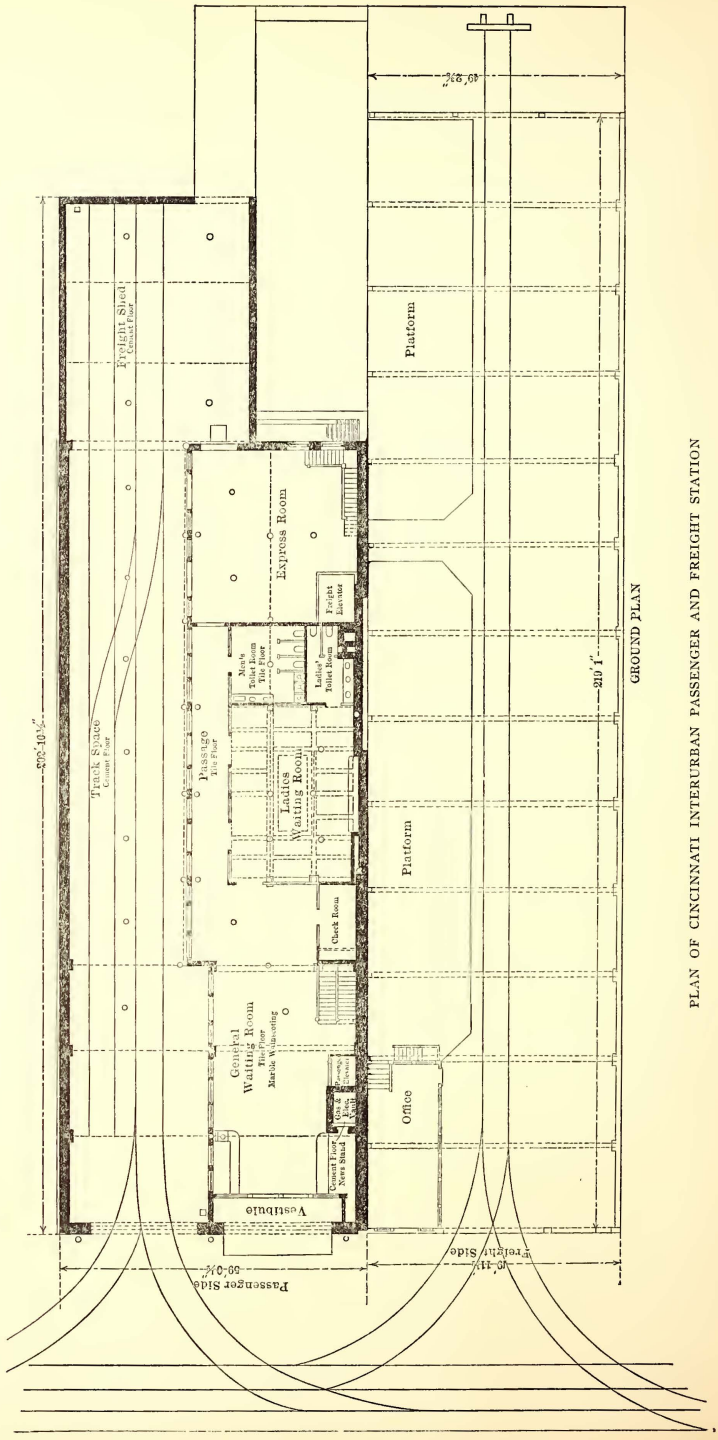
WAY STATIONS

All the interurban systems visited in Indiana and Michigan provide small shelters at the more important stops in the country, and in towns several companies have elaborate passenger and freight stations.

On the interurban lines of the Detroit United Railways an open way station, measuring 12 ft. x 12 ft., is erected at all highway crossings. At the larger towns combination passenger and freight stations are built.

A small enclosed square building is erected at stopping places on the Indiana Union Traction system. The building, which has a hip-roof, is without ornamentation. At some of the larger towns on this system large combination freight and passenger stations are erected. The front portion of the station at Kokomo contains division offices, ticket office and waiting room, and in the rear are freight sheds .

All scheduled stops on the Indianapolis & Northwestern system are provided with platforms measuring 8 ft. wide and 30 ft. long. Signal lamps for signalling the cars are located on a nearby pole, the switch for lighting the lamps being secured to the pole a few feet above the platform. At country stops where the number of passengers warrants it enclosed stations,

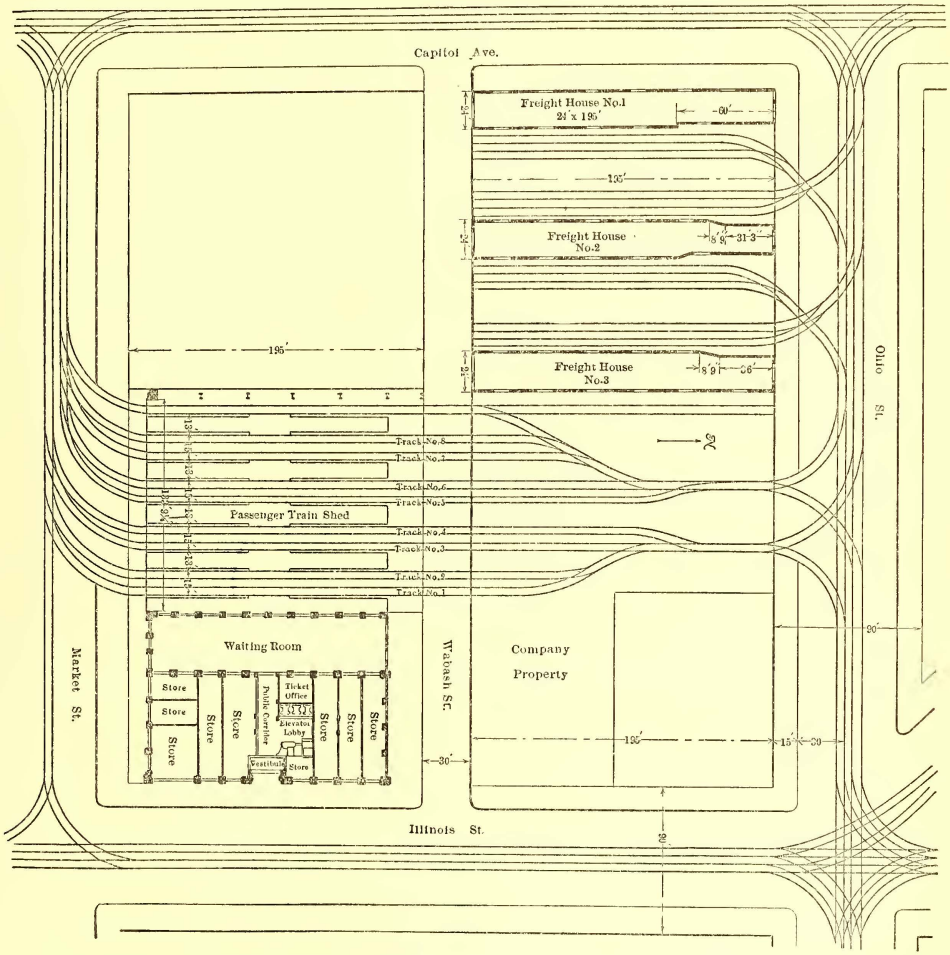


PLAN OF CINCINNATI INTERURBAN PASSENGER AND FREIGHT STATION

GROUND PLAN

measuring 8 ft. by 10 ft., are erected. The overhanging pagoda roof of these shelters adds much to their appearance.

On the Kokomo, Marion & Northwestern system a very small enclosed building is erected at all stopping places. On the Sullivan division of the Terre Haute Traction & Light system the line. Where sub-stations are usually located at towns, a combination sub-station and passenger and freight station is erected. These stations, one of which is at Roanoke, are so arranged that the duties of sub-station operator and ticket and freight agent can be attended to by one man.



GROUND-FLOOR PLAN, INDIANAPOLIS TRACTION TERMINAL BUILDING

a small building, enclosed on three sides and provided with seats, is placed at points where traffic warrants them.

The standard type of way station of the Fort Wayne & Wabash Valley Traction Company are painted a lemon yellow. A sign, bearing the name of the station and the distance in miles from Logansport and Fort Wayne, is suspended from the eaves of the building. Several private stations have been erected along

At the unimportant stops on the Indianapolis & Cincinnati Traction system is built a small shelter with a gable roof. The building is enclosed on three sides. At the more important stops combination freight and passenger stations are being constructed by the management. These structures are one and one-half stories in height and are built back a short distance from the track.

LATEST PRACTICE IN ROLLING STOCK DESIGN AND EQUIPMENT

The earlier interurban railway builders showed a wide difference of opinion as to the most desirable types of cars for interurban service. Limited service had not been attempted at that time and the work to be performed was substantially the same on the majority of roads, i. e., that of taking care of the country trade and the business from town to town. Of course the population tributary to the road was considered somewhat in determining the sizes of car, but in the main, the service on various roads was very similar. Ideas on the best type of car as on many other subjects seem to vary with the locality. For example, the roads around Columbus and through the central portions of Ohio adopted extremely long cars. The greater portion of the rolling stock in this section measure 60 ft. and weigh from 40 to 60 tons. The operators went on the theory that it was better to run a less frequent service and to provide ample seating facilities for all the people that might want to ride. Roads out of Cincinnati and Cleveland went to the other extreme and while, as a rule, they had better territory than the roads in the central portion of the State, yet cars above 45 ft. in length were unknown in these cities up to four years ago. Motor equipment did not run above 200 hp to the car and car weights were usually under 30 tons. The theory of these operators was that it was better to give more frequent headway or run double-headers during certain portions of the day, or even to crowd passengers at times, than to run large cars practically empty during certain portions of the day.

While at the present time there are undoubtedly roads in Ohio that have business sufficient to warrant the use of 60-ft. cars, there are a number of successful operators who believe that the low net earnings and financial embarrassments of some of the roads in Ohio can be attributed to the unwarranted use of ultra heavy, power-consuming rolling stock.

The earlier roads bought numerous combination cars, usually having but two compartments, the baggage compartment being designed to handle the express and freight business which was just commencing to develop. Smokers were accommodated by placing folding side seats or camp stools in the compartment with the trunks and market produce. A year or two later as the freight and express business increased to a point where better facilities were necessary, the majority of roads put on exclusive express cars, and the combination car declined in favor as against the straight passenger coach with a special smoking compartment.

Within the past two or three years there has come the limited car, stopping only at towns and competing with the steam roads for the long distance and town to town business. For a time the operators debated as to the best type of car for this service and different ideas were put into practice. Some of the roads figured that they did not want to carry baggage on these cars because of the delays in handling and the space consumed by the baggage. Others found that a goodly portion of the patronage on the limited cars was made up of traveling men desiring to make quick jumps from town to town, to whom the electric service was of no advantage unless they could take their trunks and sample cases along with them. Hence the necessity for a baggage compartment. At the same time the smoking public demanded accommodations, and on the long through-trips they were not satisfied to sit on the hard benches of a combination car. These contingencies resulted in the building of the three-compartment car. The great popularity of the limiteds and the necessity for higher speeds, together with the demand for smoking and baggage facilities, necessitated the designing of a longer and heavier car, so that the 55 to 60-ft. car is now making its appearance on roads which had tabooed it a few years ago.

The present popularity of the larger type of car is shown by the fact that out of the seventeen roads in Ohio investigated, thirteen have cars of 50-ft. length or over (three of them having cars 60 ft. or over), and on nine of these roads three-compartment cars are used for local as well as limited service. On some of the roads the smaller cars are kept for the local runs and the longer for the limiteds. To take care of the increased business and limited service, the Western Ohio Railway is taking all of its cars apart and adding a baggage compartment. The cars were originally 48 ft. 10 ins. over all, and they are being increased to 52 ft. 10 ins. The floor framing is strengthened by inserting four I-beams the whole length of the car, all the work being done in the company's own shop at Wapakoneta. The cost of the work is about $255 per car, including refinishing, and this gives the road practically a new car. A view of one of these lengthened cars is shown on Plate XL.

It is the aim of every traction manager to secure as wide a car as possible in order to provide comfortable seats wide enough for two passengers, but the aims in this direction are frequently thwarted by local conditions. City companies have less need for wide cars and the "devil strips" are usually altogether too narrow to suit the ideas of interurban managers. Cincinnati and Dayton have many "devil strips" only 3½ ft. wide, so that the cars of the Interurban Railway & Terminal Company and Cincinnati, Milford & Loveland are only 8 ft. 1 in. and 8 ft. 3 ins. respectively. The Dayton, Covington & Piqua cars are likewise 8 ft. 3 ins. By entering on another street in Dayton, the Dayton & Troy was able to get a car 9 ft. wide. The Toledo, Port Clinton & Lakeside entering Toledo has some cars 9 ft. wide, but two of them cannot pass on the same street, which is sometimes inconvenient. For 4-ft. "devil strips" found in the majority of cities an 8-ft. 6-in. car is looked upon as standard, although some cars exceed this width.

Increased weights of cars and higher speeds necessitate greater strength of floor framing. The large majority of cars now being built for interurban service in Ohio have two or three, and in some cases four I-beams extending the full length of the car with channels or plates for side sills. The latest cars for the Lake Shore Electric have four 6-in. I-beams and two 7¾-in. x ⅝-in. steel plates, bolted between oak sills, one of them 5 ins. x 8 ins. and the other 2 ins. x 6 ins. Other cars of equal strength have been built for several Ohio roads.

Some interesting cars of a distinctive type have been built for the limited service on the Ft. Wayne, Van Wert & Lima, and Lima & Toledo lines. They are 62 ft. over all and weigh 45 tons. They have rear platforms 9 ft. long with cosy-corner leather seats on the platform, a passenger compartment 27½ ft. long fitted with sixteen high-back plush seats, a smoking compartment fitted with eight leather upholstered chairs and a couch, and a baggage compartment 9 ft. 2 ins. in length in connection with the motorman's cab. These cars were illustrated and described in the STREET RAILWAY JOURNAL for June 16, 1906.

The best location for the toilet room is an open question with certain managers. It is somewhat more obscure when placed at the rear of the car and it cuts up the car less than when placed between the compartments or in the forward portion of the main compartment, but many managers prefer the central location because the trucks do not become dirtied and there is

TABLE III.—SUMMARY OF LATEST STANDARDS IN ROLLING STOCK ON ROADS TREATED (See also Following Page).

NAMES OF COMPANIES.	No. of Latest Standard Cars.	Service for Which Intended.	Make of Car Body.	Length of Body.	Length Over All.	Length of Platform.	Width Over All.	Height of Steps in Ins.	Height of Floor from Platform to Car Floor.	Single or Double End Operation.	Weight of Car Complete in Tons.	Number of Compartments.	Number of Seats.	Seats Stationary or Reversible.	Covering of Seats.	Seating Capacity.	Color of Body.
NORTHERN OHIO GROUP.																	
Cleveland & Southwestern	30	Interurban and limited.	Niles and St. Louis	40′ 6″	51′	4′ 6″	8′ 9″	16 –16 –16	6″	S	35	3	24	S	Plush and leather	48	Green.
Lake Shore Electric	20	Interurban and limited.	Niles and Brill	47′ 1″	52′	4′ 7½″	8′ 7″	17 –16	6″	S	35	3	28	S	Leather	54	Big 4 orange.
Eastern Ohio	10	Interurban.	Kuhlman, St. Louis	47′	57′	5′	8′ 6″	16	5″	S	30	2	24	R	Rattan	48	Red.
Toledo & Indiana	10	Interurban and limited.	Stephen D. Field	47′	57′	5′	8′ 6″	17 –16	5″	S	35	2	28	R	Plush and leather	56	Big 4 orange.
Toledo & Western	6	Interurban.	Jewett and Niles	40′	47′	4′ 0″	8′ 6″	18 –10 –10	4″	S	26	2	19	R	Cane	40	Pullman green.
Toledo, Pt. Clinton & Lakeside	10	Interurban and limited.	Kuhlman and Niles	42′	50′	4′	9′	18 –10 –10	5″	S	33	2	27	S	Plush and leather	54	Pullman green.
Stark Electric	11	Interurban.	Kuhlman and Niles	40′ 6″	50′	5′	8′ 9″	19 –13 –12	5″	D	34	2	28	S	Cane	56	Pullman green.
Canton-Akron	9	Interurban.	St. Louis and Jewett	52′	57′	5′	8′ 6″	. . . . .	. .	S	40	3	32	R	Plush and leather	64	Pullman green.
CENTRAL AND SOUTHERN OHIO GROUP.																	
Western Ohio	19	Limited and local	Niles and Kuhlman	48′	52′ 10″	4′	8′ 93″	. . . . .	5″	D	31	3	22	R	Cane	44	Pullman green.
Ft. Wayne, Van Wert & Lima	10	Local	Cincinnati	40′	55′	6′	8′ 6¾″	14 –12 –10	6″	S	41	3	28	S	Plush and leather	56	Pullman green.
	2	Limited	Cincinnati	50′	61′ 6″	8′ 4″	8′ 6¾″		6″	S	48	3	32	S	Plush and leather	64	Pullman green.
Dayton & Troy	8	Local and limited	Barney and Smith	38′	50′	6′	8′ 6″	18 –14 –12	0″	D	34	3	27	R	Pantasote	54	Big 4 orange.
Dayton, Covington & Piqua	8	Interurban.	Barney and Smith	51′	42′	5′	8′ 6″	. . . . .	. .	D	22	3	21	R	Plush	42	Maroon and yellow.
Springfield & Xenia	14	Interurban.	Kuhlman and Niles	40′	55′	5′	8′ 6″	. . . . .	6″	D	34	2	25	R	Plush and leather	51	Dark green and yellow
Cincinnati & Columbus	8	Interurban.	Jewett	55′	60′	5′	8′ 6″	. . . . .	. .	D	35	2	25	S	Plush and leather	51	Dark green and yellow
Cincinnati, Milford & Loveland	8	Interurban.	Cincinnati	30′ 9″	40′	4′	8′ 6″	15 –17	5″	D	29	2	20	R	Cane	40	Dark blue.
Interurban Ky. & T., Cincinnati	30	Interurban.	St. Louis	34′	44′	5′	8′ 1″	18 –10 –12	5″	S	25	2	26	R	Plush	52	Pullman green.
Cincinnati, Georgetown & Portsmouth	12	Interurban.	St. Louis	40′	50′	5′	8′ 10″	. . . . .	. .	S	31	2	27	R	Cane	54	Orange.
INDIANA GROUP.																	
Indiana Union	20	Interurban	Cincinnati	41′ 6½″	53′ 5¾″	5′	8′ 3″	. . . . .	6″	S	38	2	29	R	Plush	58	Pullman green.
Indianapolis & Northwestern	20	Interurban	Jewett and Laconia	53′ 6″	60′ 9¾″			11 –11	5″	S	41	3	31	R	Plush and leather	62	
Indianapolis & Cincinnati	.	Limited	. . . . .	. . . . .	. . . . .		. . . . .	13 –13	6¾″	S	. .	. .	. .	. .	Plush	54	Maroon.
Indianapolis, Columbus & Southern	8	Interurban	Jewett	42′ 13″	53′ 73″	R 4′ 8″ F 5′ 2″	. . . . .	11 –11	43″	S	35	2	29	R	Plush and rattan	58	Pullman green.
Terre Haute Tr. & Lt	4	Interurban	. . . . .	48′ 7″	51′ 0″	5′	8′ 5″	10½–10½–10½	0″	D	32½	. .	27	. .	Cane	61	
Kokomo, Marion & Western	.	Interurban	Jewett	34′	45′	5′	8′ 8″	13 –13	6″	S	20	3	31	R	Plush and rattan	46	Pullman green.
Ft. Wayne & Wabash Valley	7	Interurban	Cincinnati	45′ 6″	55′	R 5′ 4″	8′ 8″	13 –13	6″	S	. .	3	27	R	Plush and leather	54	Pullman green.
MICHIGAN GROUP.																	
Rapid Railway System, Detroit	125	Interurban	Cincinnati	41′ 10¾″	52′ 7¾″	R 4′ 10″ F 4′ 2″	8′ 8¾″	12 –12	6″	S	32	2	26	R	Plush and leather	53	Pennsylvania red.
Detroit, Ypsilanti, A. A. & J.	12	Interurban	Barney and Smith	41′ 9¼″	51′ 9¾″	5′	8′ 9″	10½–10½–10½	0″	S	32	2	30	R	Plush	60	Brown.

less opportunity for a dishonest passenger to secrete himself in the closet and escape paying his fare, a trick which is frequently worked where the toilet room is in the rear. There is a growing tendency to carry water flushers and to improve the sanitary conditions by the use of rubber or enameled sheet metal for floor and sides, so that the car cleaners can turn the hose into the toilet room and wash it out thoroughly. The carrying of disinfectants in toilet rooms is also becoming common practice with the best roads.

The designing of steps so that they will not extend out too far beyond the side of the car and at the same time keep the rear platform wide enough for safety is quite a problem. The use of heavier equipment has raised the cars to such an extent that a third step is often desirable, the 18-in. or 19-in step used by a number of roads being a source of annoyance to ladies, especially where mounting in the country where tracks are elevated. The Dayton & Troy Electric has equipped all its cars with a folding step which is dropped at each stopping point. The Stark Electric provides each car with a small stool or box and the conductor is supposed to place it on the ground at each stop, the same as is done by a Pullman porter.

Interurban cars on the roads visited in Indiana and Michigan vary in length from 51 ft. 6 ins. to 61 ft. 6 ins. over bumpers. The longest cars are those in limited service over the tracks of the Indiana Union Traction Company and the Fort Wayne & Wabash Valley Traction Company between Fort Wayne and Indianapolis. Most companies in these districts appear to favor a car about 53 ft. long for local interurban service. However, the cars of the Indianapolis & Northwestern Traction Company, which are 60 ft. 8¾ ins. over bumpers, have been in use three years and have been found well adapted to ordinary interurban service. New cars recently purchased by the company are of practically the same length. The new cars recently put in service by the Fort Wayne & Wabash Valley Traction Company are 55 ft. long. The older cars of the Detroit, Ypsilanti, Ann Arbor & Jackson Railway are being lengthened in the shops of the company to an over-all length of 51 ft. 9⅝ ins., which is the length of new cars purchased by the company. The usual width of cars over sills is about 8 ft. 6 ins. This brings the width over all to about 8 ft. 8 ins. or 8 ft. 10 ins. The cars of the Terre Haute Traction & Light Company, which are 8 ft. 5 ins. over sills, were the narrowest found. The width of 8 ft. 6 ins. over sills is generally conceded to be too narrow, but has been adopted because of the width of the devil strip in cities. Although the Winona Interurban Railway Company, operating between Winona and Goshen, Ind., was not one of the roads visited for the purposes of this investigation, it might be mentioned that in the construction of the cars for this road quite a

departure from usual practice was made. They measure 9 ft. 4 ins. over all, and this width and the manner in which the sides of the car are constructed give the interior of the car a width only 3 ins. narrower than a standard Pullman car. The extra width was permissible by reason of the fact that the cars do not at the present time enter any city where the tracks are double. As for the future, it is believed by the management that within a few years the devil strip in cities will be widened to accommodate wider interurban cars.

All of the passenger cars of the roads visited in Indiana and Michigan have two compartments and some of them have three. The limited cars of the Indiana Union Traction Company and the regular cars of the Detroit, Ypsilanti, Ann Arbor & Jackson Railway are the only ones not having baggage compartments. With one exception the construction of all of the cars is patterned much after steam coaches. They have the steam-coach type of hood and the side windows raise instead of dropping. The one exception is the interurban car of the Terre Haute Traction & Light Company. The construction of this car follows closely that of the usual type of car for heavy city service. The roof is of the monitor type, the side windows drop, the letter board is absent and the ceiling is lower than usually found in interurban cars.

The cars of the Terre Haute Traction & Light Company are intended for double-end operation. The interurban cars of all of the other systems are intended to be operated in one direction only. The platforms of cars are usually about 5 ft. long. In some cases, as on the cars of the Indiana Union Traction Company, the front platform, which is used exclusively for a motorman's cab, is a few inches shorter than the rear platform.

There is a tendency to build the floors of the platforms at the same level as the car floors. The new limited cars used between Fort Wayne and Indianapolis are constructed in this manner, as are also the cars of the Detroit, Ypsilanti, Ann Arbor & Jackson Railway. This construction permits the sills to be run through from bumper to bumper. In many cases the rear platform alone is dropped. This drop is usually about 6 ins. The bottom of the sills of the cars is usually from 40 ins. to 43 ins. above the rail. With a drop platform this necessitates two steps of from 11 ins. to 13 ins., the lower step being about 17 ins. above the rail. When the platform is not dropped, three steps are often used.

The rear platforms of the interurban cars of the Detroit United Railways are open. They are constructed similar to open platforms of city cars and are provided with a safety gate on one side.

The older cars of the Detroit, Ypsilanti, Ann Arbor & Jackson Railway also have open rear platforms. On this system, however, closed vestibules are preferred, and all new cars are being purchased with closed vestibules, and the platforms on the older cars are being enclosed.

The height over all of cars in these States is usually about 13 ft. The Detroit, Ypsilanti, Ann Arbor & Jackson cars measure 12 ft. 11⅞ ins. to the top of the trolley plank; the new cars of the Fort Wayne & Wabash Valley Traction Com-

TABLE III.—SUMMARY OF LATEST STANDARDS IN ROLLING STOCK ON ROADS TREATED.—*Continued* (See also Following Page).

NAMES OF COMPANIES.	Type of Trucks.	Wheel Base.	Truck Centers.	Wheels.				Axles.				Method of Lubricating.
				Material of Wheels.	Diameter in Ins.	Width of Tread in Ins.	Width of Flange in Ins.	Depth of Flange in Ins.	Weight in Lbs.	Life in Miles.	Diameter of Axles in Ins.	Material.	Size of Journal in Ins.	
Northern Ohio Group.														
Cleveland & Southwestern	Baldwin	6' & 7'	29'	Forged steel	36	3½	1½	1 1-16	650	200,000	5½ and 6	Forged steel	5 x 9	Oil and waste.
Lake Shore Electric	Baldwin and Brill	7'	28' 6"	Steel tire, forged steel	37½	3	1½		700	.....	6	Forged steel	4½ x 8	Oil and waste.
Eastern Ohio	Peckham	6' 6"	24'	Cast iron	33	3½	1½		450	50,000	4½ to 5½	Forged steel	4¾ x 9½	Grease and waste.
Toledo & Chicago	Peckham	6' 6"	29'	Cast iron	33	3½	1½		500	50,000	5	Rolled steel	5 x 8	Oil and waste.
Toledo & Western	Peckham and Dorner	6' 6"	29'	Steel tire	33	3½	1 1-16		500	85,000	5½	Rolled steel	5½ x 8	Oil and waste.
Toledo, Pt. Clinton & Lakeside	Peckham	6' 6"	27'	Cast iron	36	3½	1½		800	.....	5½	Rolled steel	5½ x 8	Oil and waste.
Stark Electric	Peckham and Dorner	6' 6"	26' 6"	Steel tire	36	3½	1		600	*60,000	6	Rolled steel	4½ x 7	Oil and waste.
Canton-Akron	St. Louis	6'	34'	Steel tire	36	3	1		750	200,000	5½	Open hearth steel	4½ x 8	Oil and waste.
Central and Southern Ohio Group														
Western Ohio	Peckham	6'	28'	Rolled steel	36	3	1½	1 5-16	....	*60,000	5	Rolled steel	4½ x 8	Oil and waste.
Ft. Wayne, Van Wert & Lima	Baldwin and Taylor	6' 6"	32'	Steel tire	37½	3½	1½	....	....	120,000	6½	Rolled steel	4½ x 8	Oil and wool waste.
			37'											
Dayton & Troy	Barney and Smith	7'	26'	Steel tire	37 & 39	3½	1½	....	900	350,000	5	Open hearth steel	4½ x 8	Oil and waste.
Dayton, Covington & Piqua	Barney and Smith	6' 6"	28'	Steel tire	34	3½	1½	....	900	350,000	5	Cold steel	4½ x 7	Oil and waste.
Scioto Valley	Brill	6' 6"	27'	Steel tire	36	4½	1½	1 1-16	585	350,000	6½	Forged steel	5½ x 9	Oil and wicking.
Cincinnati & Columbus	Peckham	6'	35'	Steel tire	36	..	1½	....	....	55,000	6½	Forged steel	4½ x 9	Oil and waste.
Cincinnati, Milford & Loveland	Taylor special	4' 6"	27'	Cast iron	33	3½	..	1	....	55,000	5½	.....	.....	
Cincinnati, Newport & Covington	St. Louis	6' 6"	28'	Steel tire	33	3½	1½	1 1-16	....	*80,000	5½	Forged steel	4½ x 8	Oil and waste.
Cincinnati, Georgetown & Portsmouth	St. Louis	6'	26'	Cast iron	33	4½	1½	1¼	600	.....	5	Forged steel	5½ x 9	Oil and wool waste.
													4 x 7	Oil and waste.
Indiana Group.														
Indiana Union	Baldwin	6' 6"	29' 6"	Steel tire	37½	2¾	1⅜	....	700	100,000	5½	Steel	4½ x 8	Oil and waste.
Indianapolis, Northwestern	Baldwin	6' 6"	31' 2"	Steel tire	34	2¾	1 3-16	....	....	.....	6½	Steel	5 x 9	Oil and waste.
Indianapolis & Cincinnati	Baldwin	6' 6"	31' 2"	Steel tire	33	..	..	....	....	.....	6½	Steel	5 x 9	Oil and waste.
Indianapolis, Columbus & Southern	Peckham	6' 6"	31' 1"	Steel tire	33	2¾	1½	1 3-16	750	.....	5½	.....	4½ x 8½	Oil and waste.
Terre Haute Tr. & Lt.	Baldwin	6' 3"	27' 1"	Solid steel	33	3	1⅜	..	590	.....	..	.....	.....	Oil and waste.
Kokomo, Marion & Western	Peckham	6' 9"	24' 7"	Steel tire	33	2¾	1⅜	..	....	.....	5	.....	5 x 9	Oil and waste.
Ft. Wayne & Wabash Valley	Baldwin	6' 6"	32' 4"	Steel tire	37½	3	1	....	....	.....	6½	.....	.....	Oil and waste.
Michigan Group.														
Rapid Railway System, Detroit	Baldwin	6' 6"	28' 23"	Rolled steel	36	3	1½	¾	....	.....	5½	.....	4½ x 8	Oil and waste.
Detroit, Ypsilanti, A. A. & J.	Peckham	6' 10"	30' 10⅜	Cast iron	36	..	1⅝	¾	650	40,000	5⅝	Steel	4½ x 7	Oil and waste.

* Before first trucing.

TABLE III.—SUMMARY OF LATEST STANDARDS IN ROLLING STOCK ON ROADS TREATED.—*Concluded.*

NAMES OF COMPANIES.	BRAKES.			BRAKE SHOES.					Type of Drawbar or Coupler.
	Make of Brake.	Type.	How Hung.	Composition.	Inserts Used.	Braking Pressure.	Weight Original in Lbs.	Weight Discarded in Lbs.	Life in Miles.	
NORTHERN OHIO GROUP.									
Cleveland Southwestern	Christensen, Westinghouse	Straight	Inside	Gray iron	No	90% weight of car	..	..	....	No drawbars.
Lake Shore Electric	Westinghouse	Straight	Inside	Cast iron	Yes	90% weight of car	..	..	....	Van Dorn.
Eastern Ohio	Christensen	Straight	Inside	Steel iron	No	450 lbs	..	..	....	
Toledo & Indiana	Christensen	Straight	Inside	Gray iron	Yes	..	..	..	....	Van Dorn.
Toledo & Western	Christensen	Straight	Outside	Gray iron	No	95% weight of car	38	12	....	Jewett radiating.
Toledo, Ft. Clinton & Lakeside	Westinghouse	Straight	Inside	Cast iron	No	..	..	..	....	Niles.
Sandusky, Norwalk & Mansfield	Westinghouse and Christensen	Straight	Inside and outside	Steel iron	No	40,000 lbs	45	15	6,000	M. C. B.
Canton-Akron	Christensen	Straight	Inside	Gray iron	No	9,000 lbs. per shoe	41	15	....	
CENTRAL AND SOUTHERN OHIO GROUP.									
Eastern Ohio, Weir & Lima	Christensen	Straight	Outside	Gray iron	No	..	..	..	....	Home made.
Fostoria & Findlay	Westinghouse	Straight	Inside	Gray iron	Yes	Air, 75 lbs	38½	12	2,500	Van Dorn.
Dayton & Troy	Christensen	Straight	Inside	Gray iron	No	8,000 lbs. per shoe	36	15	....	
Dayton, Covington & Piqua	Christensen	Straight	Inside	Gray iron	No	..	24	10	7,100	Barney and Smith.
Scioto Valley Colerain	Westinghouse	Straight and automatic	Outside	Gray iron	Yes	40,000 lbs	26	8	5,000	Van Dorn.
Cincinnati, Milford & Loveland	Westinghouse	Straight	Inside	Gray iron	No	..	29	11	....	Cincinnati Car Co.
Interurban Ry. & T. Cincinnati	Westinghouse	Straight	Outside	....	....	....	..	..	....	
Cincinnati, Georgetown & Portsmouth	Christensen and Westinghouse	Straight	Outside	Gray iron	Yes	48,000 lbs	27	10	3,000	
							..	..	....	
INDIANA GROUP.									
Indiana Union	Christensen	Straight	Inside	....	....	90% weight of car	33	..	....	Van Dorn.
Indianapolis & Northwestern	Westinghouse	Straight	Inside	Gray Iron	No	10,000 lbs. per shoe	37	12	1,000	Van Dorn.
Indianapolis & Cincinnati	....	....	....	....	....	90% weight of car	28	..	....	Van Dorn.
Indianapolis, Columbus & Southern	....	....	....	....	....	90% weight of car	24	16	....	St. Louis.
Terre Haute, I. & E.	Westinghouse	Automatic	Inside	....	Yes	..	35	..	....	Van Dorn.
Winona Int. Ry. & Western	....	Straight	Inside	Composition filled	No	....	35	..	....	Home made.
Ft. Wayne & Wabash Valley	Westinghouse	Straight	Inside	Composition filled	....	....	26	8	3,600	
MICHIGAN GROUP.									
Rapid Railway System, Detroit	....	Straight	Inside	Medium hard cast iron	No	90% weight of car	32	14	....	Van Dorn.
Detroit, Ypsilanti, A. A. & J.	Westinghouse	Straight	Inside	Cast iron	No	..	28	..	....	

pany, 13 ft. 1 in.; those of the Terre Haute Traction & Light Company, 12 ft.; and those of the Indiana Union Traction Company, 13 ft. 6 ins. to the top of the roof.

There is very little relation between the total weights of the cars as given and the seating capacity. This is partly accounted for by the fact that the baggage compartment in some of the cars reduces the number of seats. The heaviest cars found, which were those of the Indianapolis & Northwestern Traction system, weigh 82,000 lbs. The weight of the new cars of the Fort Wayne & Wabash Valley Traction Company is estimated at 80,000 lbs.

It is interesting to note that the weight of interurban cars, as usually constructed, is about equally divided between the body and the trucks and motors. Of the total weight of 76,000 lbs. for the Indiana Union Traction Company's car the body weighs 38,000 lbs.

The floor framing is either of wood construction entirely, or, as is more customary, the center sills consist of I-beams sandwiched between wood fillers. The side sills are also sometimes of compound construction. The cars of the Indianapolis & Northwestern system have solid wood center, and intermediate sills and side sills consisting of two pieces of yellow pine with a ½-in. plate sandwiched between. The cars of the Indiana Union Traction Company have compound center sills, solid intermediate sills, and the wood side sills reinforced by a steel plate. The center and intermediate sills of the Terre Haute Traction & Light Company's car are of compound I-beam construction, and the side sills are reinforced by an 8-in. x 8-in. steel angle-bar.

In Indiana and Michigan the rear of the car is the usual location of the toilet room. Frequently the most serious objection to this location, the restricting of the passageway at this point, is avoided by placing the rear door to one side of the car and omitting a seat opposite the toilet. One objection to placing the toilet room in the forward portion of the car is that the view ahead is restricted. Usually the toilet room is fitted with a dry hopper, but the interurban car of the Terre Haute Traction & Light Company is provided with a hopper flushed with water, a tank being provided in the roof of the car. The new car of the Winona Interurban Railway, in addition to being fitted with a hopper flushed with water, is lined with enameled steel, which adds to the sanitation. The same is true of the new cars of the Detroit United Railways.

SEATS

On a majority of latest cars in Ohio the seats are being made stationary, this, of course, only being possible on single-end cars. While the reversible type of seat allowing a party of passengers to face each other is admittedly very convenient for the passengers, it affords a chance for the selfish passenger to occupy more than his share of the room, obliging others to stand. Besides with the high head-roll seats which usually have considerable rake, it is impossible to place them back to back without reducing the seating capacity of the car. Sentiment is about equally divided

on the subject of seat coverings. Leather or pantasote is being used in the latest smoking compartments and several roads are using one or the other throughout. The cane seat is preferred by many on account of its cleanliness and durability and is largely used for local service. While high-back roll-top plush upholstered seats are preferred by a number of roads for the long-distance service, several roads combine the two, placing plush seats in the main passenger compartment and leather seats in the smoking. Chair seats, which were used by a number of roads in their limited service a year or so ago, are being given up because of the reduction in seating capacity of the car.

The passenger compartments in Indiana and Michigan are usually equipped with reversible or walkover seats. Wicker chairs are frequently found in the smokers of limited cars. The seats in the passenger compartment, with one exception, are covered with plush. Rattan or leather serves as a covering for the seats in the smoker.

A few years ago the interior of cars was usually finished with cherry. Within the last few years mahogany has largely been used for the interior finish. At the present time there is a tendency to change to a dark oak finish. The cars of the Indianapolis, Columbus & Southern Traction Company are finished in oak, as are also those of the Kokomo, Marion & Western Traction Company, and the Detroit, Ypsilanti, Ann Arbor & Jackson Railway.

CAR COLORS

Painting of cars is no small item in the maintenance account. Many Ohio roads are following the example of the steam roads in respect to colors and are adopting the Pullman type of green, which is thought by many to be the most durable color. Ten roads out of seventeen in Ohio considered for this article are using this finish. The Toledo & Western formerly finished its cars dark red, but now uses the green. It reports a saving of about $25 on the finishing of the car, and the finish is said to be 25 per cent more durable. The Western Ohio has made a similar change.

A number of roads believe it to be a good advertisement to have a distinctive color. The Toledo & Indiana, Lake Shore Electric and Dayton & Troy favor the "Big Four" orange with brown trimmings for this reason. This finish is also said to be very durable as compared with some other colors. The Cleveland & Southwestern is known everywhere as the "Green Line" by reason of its light green finish. The Cincinnati, Milford & Loveland uses a dark blue and is known as the "Royal Blue Line" in Cincinnati. Several of the Everett-Moore lines out of Cleveland and Detroit use Pennsylvania red with gold trimmings.

Pullman green has also been adopted by several companies in Indiana as a body color for cars. This color is used by the Indiana Union Traction Company, the Fort Wayne & Wabash Valley Traction Company, the Indianapolis, Columbus & Southern Traction Company and the Kokomo, Marion & Western Traction Company. Its lasting qualities and the attractive appearance which it gives the car are arguments in its favor.

The cars of the Indianapolis & Cincinnati Traction Company are painted a maroon, and the Indianapolis & Cincinnati Traction Company is advertised as the "Red Line" in all of the company's literature. Brown

TABLE IV.—SUMMARY OF STANDARD ELECTRIC EQUIPMENT AND CONTROL ON CARS (See also Following Page).

NAMES OF COMPANIES.	Type of Motors.	No. of Motors to Car.	Single Double End Operation.	Type of Controller.	Type of Rheostats (Grid or Pand).	Trailer and Train Operation.	Method of Lubricating Motor Bearings.	Method of Lubricating Armature Bearings.	Trolley Poles		Trolley Wheels.		Trolley Catcher or Retriever.
									Length.	Pressure Maintained at Wheel in Lbs.	Diameter in Ins.	Life of, in Miles.	
Northern Ohio Group.													
Cleveland & Southwestern	West. 112, 93, 76, 56	4	S	Type M, L-4	Grid	No	Oil cups	Oil cups	12′	28	5½	3,500	R
Lake Shore Electric	G.E. 57, West. 76, 121	4	S	Type M	Grid	Occasionally on limiteds	Oil	Oil	11′ 4″	40	6	2,500	R
Eastern Ohio	Lorain 34	4	S	K-14	Grid	No	Grease	Grease	12′				
Toledo & Indiana	West. 56	4	S	K-14	Grid	Passenger no; freight in trains	Packed wool waste	Packed wool waste	12′	40	6	2,500 on locals, 1,500 on limiteds	R
Toledo & Western	Lorain 34, West 76	4	S	Lorain, 4, K-6	Grid	Passenger no; freight in trains	Grease	Grease	12′	30	6	6,000	R
Cincinnati & Columbus	Lorain 34, West 76	4	S	Lorain, 4	Grid	Passenger no; freight in trains	Grease	Grease	12′	33	6	6,000	R
Stark Electric	West. 76, 56	4	D	K-14, L-4	Grid	Trailers for excursions	Oil	Oil	12′	28	6	4,000	R
Canton-Akron	G.E. 73	4	S	Type M	Grid	No	Oil	Oil	14′	34	6	6,611	C
Central and Southern Ohio Group.													
Western Ohio	West. 56	4	D	K-14	Grid	Passenger no; freight in trains	Oil cups	Oil cups	14′	30	6	3,000	C
Ft. Wayne, Van Wert & Lima	West. 56, 85, 121	4	S	Type M	Grid	No	Oil cups	Oil cups	11′ 4″	45	6	2,500	R
Dayton & Troy	West. 76	4	D	L-4	Drum	No	Oil	Oil	14′	28–34	6	4,200 locals and 8,000 limiteds	R
Dayton, Covington & Piqua	G.E. 67	4	D	K-14	Grid	No	Grease	Grease	12′	30	6	7,000	C
Springfield & Xenia	G.E. 73	4	D	Type M	Grid	Both passenger and freight trains	Oil cups	Oil cups	12′	30	6		R
Cincinnati & Columbus	G.E. 73 hp.	4	S	Type M	Grid	No	Oil cups	Oil cups	12′		6		R
Cincinnati, Milford & Loveland	Bullock 50 hp.	4	D	Bullock	Grid	No	Grease	Grease	12′	18	6	7,500	R
Interurban Ry. & T. Cincinnati	West. 49, 56	4	S	K-12, K-14	Grid	No	Oil cups	Oil cups	12′ 6″	32	5½	4,000	R
Cincinnati, Georgetown & Portsmouth	West. 56	4	S	K-14	Grid	Freight trains	Grease	Grease	12′	20	5½	4,000	R
Indiana Group.													
Indiana Union	West. 85	4	S	L-4	Grid	Trailers on special occasions	Oil and waste	Oil and waste	12′		6	5,000	C
Indianapolis & Northwestern	G.E. 73	4	S and D	Type M	Grid	No	Oil and waste	Oil and waste	12′	30	6	5,000	R
Indianapolis & Cincinnati	West. 106A	4	S and D	Electro-pneumatic	Grid	Equipped for train operation	Oil and waste	Oil and waste	12′	30	6		R
Indianapolis, Columbus & Southern	G.E. 57H	4	S	K-14	Grid	Equipped for trailer operation	Oil and waste	Oil and waste	12′	30	6	4,500	C
Terre Haute, I. & E.	G.E. 73	4	D	Type M	Grid	No	Oil and waste	Oil and waste	12′	30–35	6	5,000 to 7,500	R
Kokomo, Marion & Western	West. 93	4	D	K-16	Grid	No	Oil and waste	Oil and waste	12′	40	6		R
Ft. Wayne & Wabash Valley	West. 121	4	S	Electro-pneumatic	Grid	No	Oil and waste	Oil and waste	13′ 6″		6		C
Michigan Group.													
Rapid Railway System, Detroit	West. 112	4	S	Electro-pneumatic	Grid	Equipped for trailer operation	Oil and waste	Oil and waste	12′	35–40	6	4,000	R
Detroit, Ypsilanti, A. A. & J.	West. 76, 93A	4	S	L-4	Grid	No	Oil and waste	Oil and waste	12′	25–30	6		C

TABLE IV.—SUMMARY OF STANDARD ELECTRIC EQUIPMENT AND CONTROL ON CARS.—*Concluded.*

NAMES OF COMPANIES.	HEATERS.		GEARS.			PISTONS.		Type of Headlights.	Type of Signal Lamps.	Type of Pilot or Fender.	Type of Sanding Device.	Type of Destination Signs.	Locations of Signs on Cars.
	Type.	Location.	Type.	Life of, in Miles.	Material of Gear Cases.	Type.	Life in Miles.						
NORTHERN OHIO GROUP.													
Cleveland & Southwestern	Hot water	Baggage room	Solid	300,000	Metal	Steel	175,000	Oil	Oil	Fender	Air	Illuminated	On dash.
Lake Shore Electric	Hot water	Vestibule	Solid	.....	Metal	Steel	.....	Arc	Electric	Steel fender	Air	Illuminated	On dash.
Elyria & Cleveland	Hot water	Front vestibule	Solid	.....	Metal	Steel	.....	Arc	.....	Fender	.....	Board and metal	Top deck, in front.
Toledo & Indiana	Hot water	Front vestibule	Solid	.....	Wood	Steel	.....	Arc	Oil	Grid iron fender	.....	Small wood	Front dash.
Toledo & Western	Hot water	Front vestibule	Solid	.....	Wood	Steel	.....	Arc	Oil	Fender	.....	Metal	Front dash.
Toledo, Ft. Clinton & Lakeside	Hot water	Front vestibule	Split	.....	Metal	Steel	.....	Arc	Electric	Fender	Air	Metal	Front dash.
Stark Electric	Hot water	Front vestibule	Solid	.....	Metal	Steel	.....	Arc	.....	Wood pilot	Air	Illuminated	Front and rear dash.
Canton-Akron	Hot water	Baggage room	Solid	.....	Metal	Steel	.....	Arc	Electric	Wood pilot	Air	Illuminated	Above front windows.
CENTRAL AND SOUTHERN OHIO GROUP.													
Western Ohio	Hot water	Baggage room	Solid	.....	Wood	Steel	.....	Arc	Oil	Pilot one end, fender the other	Air	Don't use	Name on side of car.
Ft. Wayne, Van Wert & Lima	Hot water	Baggage room	Solid	.....	Metal	Steel	.....	Arc	Electric	Wood pilot	.....	Illuminated	Front and side of car.
Indiana Union	Electric	Under seats	Solid	300,000	Metal	Steel	150,000	Arc	Oil	Wood pilot	.....	Limbeds only	Front dash.
Dayton, Covington & Piqua	Electric	Under seats	Solid	.....	Metal	Steel	.....	Arc	Oil	Wood pilot	.....	Don't use	Name on side of car.
Sidoto Valley	Electric	Under seats	Solid	.....	Metal	Steel	.....	Arc	Oil	Iron pilot	.....	Metal	Front and rear dash.
Cincinnati & Columbus	Hot water	Front vestibule	Solid	.....	Metal	.....	.....	Arc	.....	Wood pilot	.....	Don't use	Name on side of car.
Cincinnati, Milford & Loveland	Electric	Under seats	Solid	.....	Wood	.....	.....	Arc	.....	Fender	.....	Don't use	Front on side of car.
Lancaster, Logan & Hocking	Hot water	Front vestibule	Solid	.....	Metal	Steel	.....	Arc	Oil	Fender	Air	Illuminated	Front.
Cincinnati, Georgetown & Portsmouth	Hot water	Rear end	Solid	.....	Metal	Steel	.....	Arc	Electric	Wood pilot	Air	Metal	Front dash.
INDIANA GROUP.													
Indiana Union	Hot water	Separate compartment in smoker	Solid	.....	Metal	Steel	.....	Arc	Electric	Wood pilot	Air	Steel on front, wood on rear	Frt. and sd. near ent.
Indianapolis & Northwestern	Hot water	Front vestibule	Solid	150,000	Metal	Steel	100,000	Arc	Oil	Wood pilot	Air	Steel	Front and side.
Indianapolis & Cincinnati	Hot water	Front vestibule	Solid	.....	.....	Steel	.....	Arc	Oil	Wood pilot	Air	Wood on side	Front and side.
Indianapolis, Columbus & Southern	Hot water	Cab	Solid	.....	.....	Steel	.....	Arc	Electric	Fender	Air	Painted on dash	Front and side.
Terre Haute, Ft. & Tel	Hot water	Smoker	Solid	.....	Metal	Steel	.....	Arc	Oil	Wood pilot	Air	Collapsible, illuminated	Front.
Kokomo, Marion & Western	Hot water	Front vestibule	Solid	.....	.....	Steel	.....	Arc	.....	Wood pilot	Air	Wood	Sides local, frt. lds.
Ft. Wayne & Wabash Valley	Hot water	Rear of baggage compartment	Solid	.....	.....	Steel	.....	Arc	Electric	Wood pilot	Air	Steel	Front and sides.
MICHIGAN GROUP.													
Rapid Railway System, Detroit	Hot water	Rear of passenger compartment	Solid	.....	.....	Steel	.....	Combination	Oil	Fender	.....	Sheet iron	Frt. and sd. near ent
Detroit, Ypsilanti, A. A. & J.	Electric	Along truss plank	Solid	.....	Metal	Steel	.....	Arc	Electric	Fender	Lever	Sheet iron	Front and sides.

has been adopted by the Detroit, Ypsilanti, Ann Arbor & Jackson Railway. Pullman green was formerly used, but peculiar atmospheric conditions or some other cause prevented this color holding up. Brown was adopted after a series of tests, in which it was found that this color lasted better.

TRUCKS

With a reduction in curves on high-speed lines there has come a chance for trucks of longer wheel base, giving steadier riding qualities to the car. The Ft. Wayne, Van Wert & Lima, Lake Shore Electric and Cleveland & Southwestern, on their latest cars are using the heaviest type of M. C. B. trucks with 7-ft. wheel base.

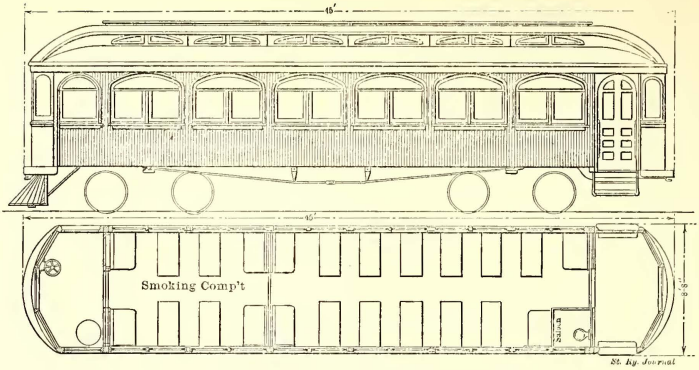
The interurban cars of all the roads examined in Indiana and Michigan are mounted on trucks of the M. C. B. type. Both forward and rear trucks are usually of the same type, as all four axles carry motors.

Within the last few years the weight of trucks has been gradually increased and each truck, exclusive of motors, will now weigh from 10,000 lbs. to 12,000 lbs. The trucks under the cars of the Indiana Union Traction Company weigh 10,500 lbs. each. A few years ago the wheel base of trucks for interurban cars was usually found to be 6 ft. The use of larger sizes of motors, however, necessitated lengthening the truck, and at the present time either 6 ft. 6 ins. or 6 ft. 10 ins. is the usual length of wheel base. The lengthened wheel base has introduced no difficulties in taking curves, but it has been necessary to design the under side of the car so as to provide for the greater swing of the truck.

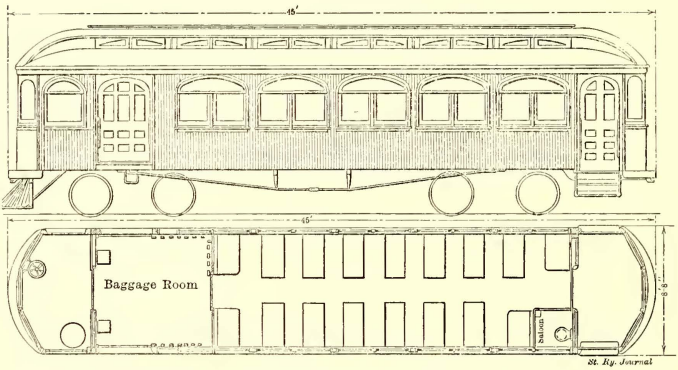
WHEELS

With the increase of speeds there has come a tendency on the Ohio roads to increase the diameter of wheels. With the larger wheel it is not necessary to increase the gear ratio to obtain the higher speeds, and it is believed it gives an easier and steadier riding effect. The 36-in. wheel is now looked upon as standard by the high-speed roads, while a few of them have gone beyond this, the Ft. Wayne, Van Wert & Lima and Lake Shore Electric using a 37¼-in. wheel, and the Dayton & Troy going to the extreme of 39-in. wheels for its limited cars.

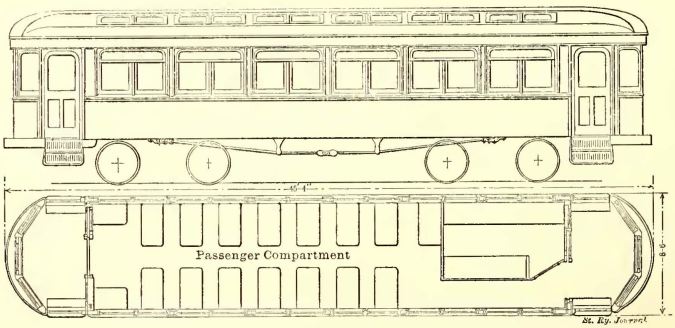
But few roads in Ohio have used steel wheels long enough to determine their exact life. The Dayton & Troy removed some wheels with 2½-in. steel tires after 250,000 miles, and it is believed that the 3½-in. tires will give 350,000 miles or better, and the 4-in tire probably 500,000 miles. The actual life depends a great deal upon the methods of treating the wheels and the diameter to which they are turned. Some roads are turning wheels down to within a quarter of an inch of the tire depth, while others believe that ½ in. or ⅝-in. margin is safer from an operating standpoint. Whether to allow wheels to run until they are all out of shape, or "take the stitch in time" and trim them frequently is also a debated question. The Dayton & Troy ran part of its wheels 40,000 miles and turned off ¼ in., while others ran 60,000 miles



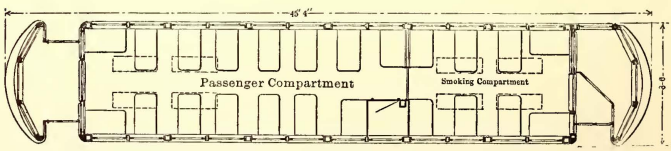
KOKOMO, MARION & WESTERN CAR



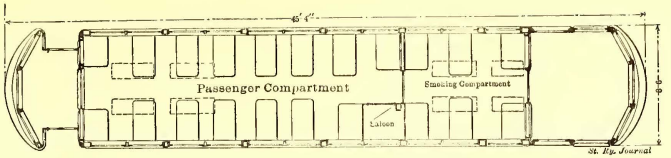
KOKOMO, MARION & WESTERN COMBINATION CAR



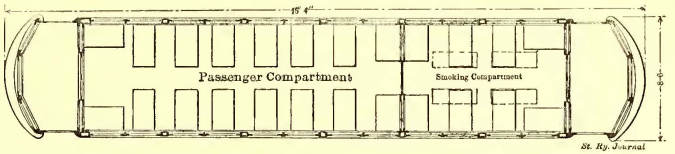
MAHONING VALLEY RAILWAY CAR



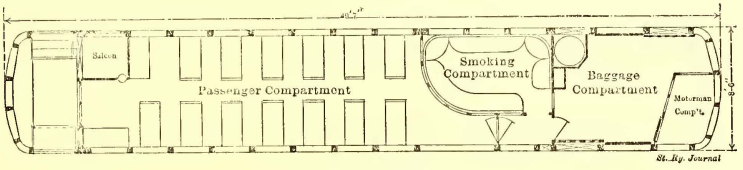
SINGLE-END CAR, WITH SMOKING AND PASSENGER COMPARTMENTS



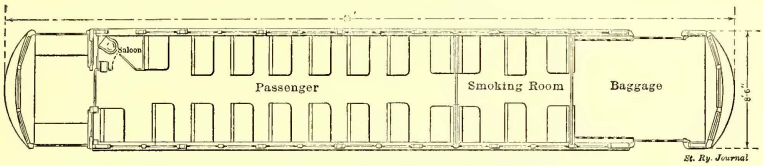
CAR WITH COMBINATION BAGGAGE, VESTIBULE, SMOKING AND PASSENGER COMPARTMENTS



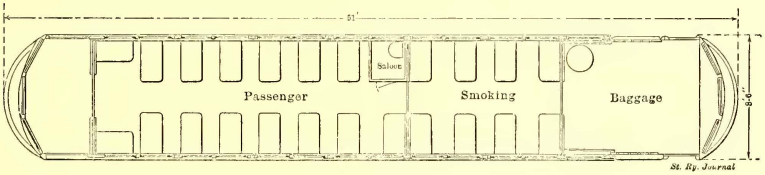
"DOUBLE-END" CAR, WITH SMOKING AND PASSENGER COMPARTMENTS



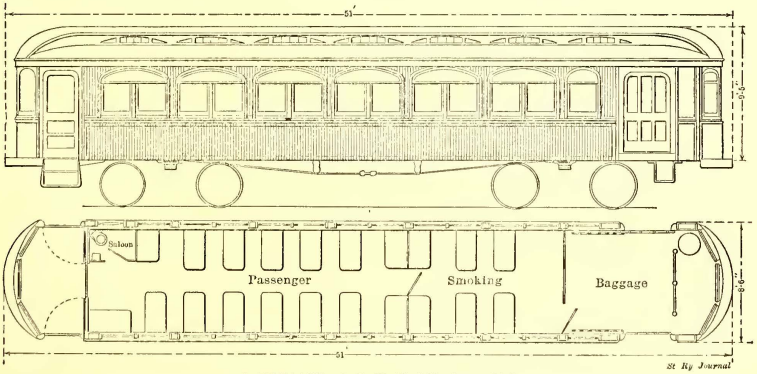
LAKE SHORE ELECTRIC CAR



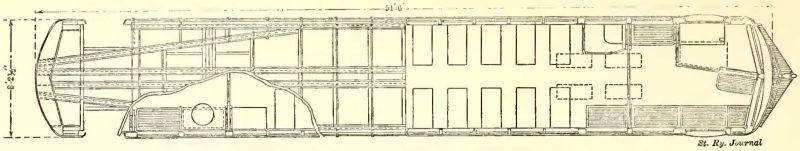
CAR WITH SHORT SMOKING COMPARTMENT



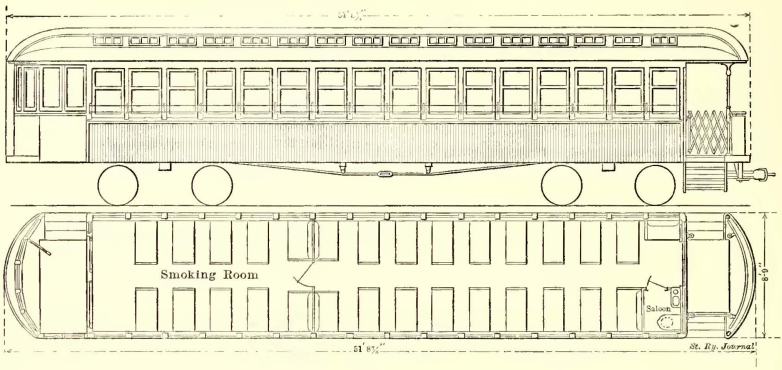
"DOUBLE-END" CAR, WITH TOILET ROOM IN CENTER



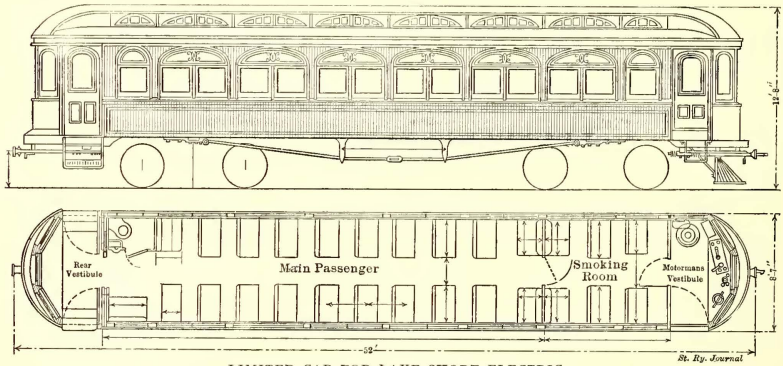
CLEVELAND & SOUTHWESTERN CAR



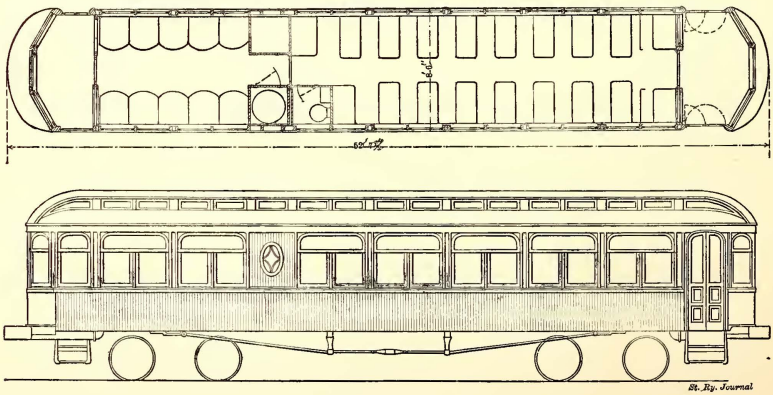
CAR OF TERRE HAUTE TRACTION & LIGHT COMPANY



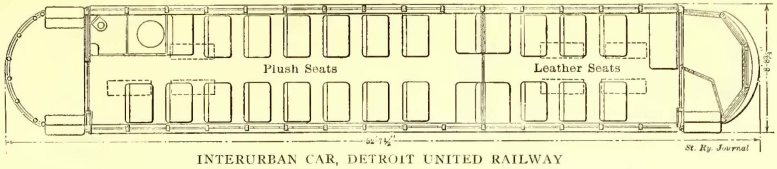
CAR FOR DETROIT, YPSILANTI, ANN ARBOR & JACKSON



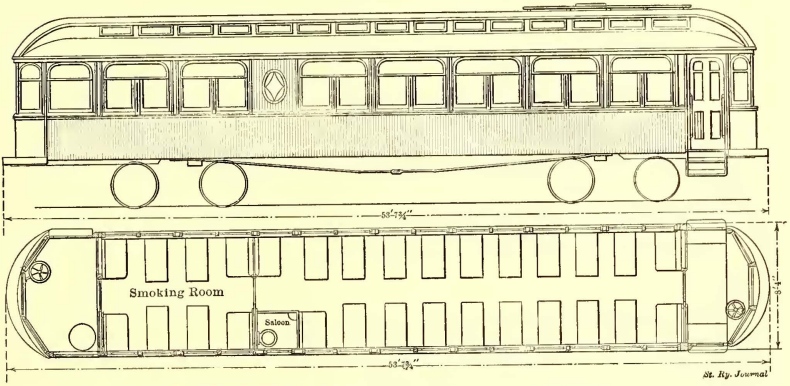
LIMITED CAR FOR LAKE SHORE ELECTRIC



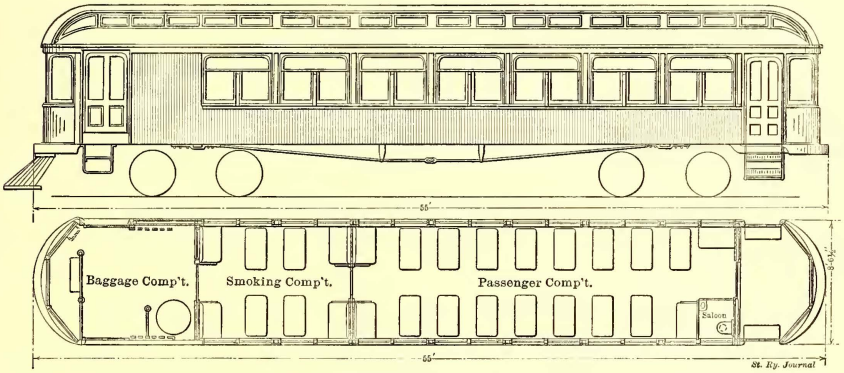
STANDARD CAR, INDIANA UNION



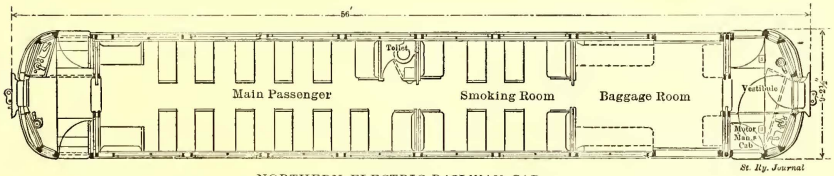
INTERURBAN CAR, DETROIT UNITED RAILWAY



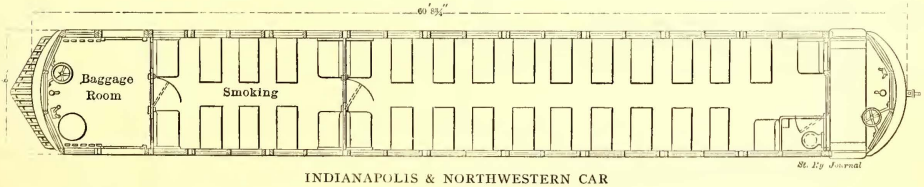
STANDARD CAR, INDIANAPOLIS, COLUMBUS & SOUTHERN



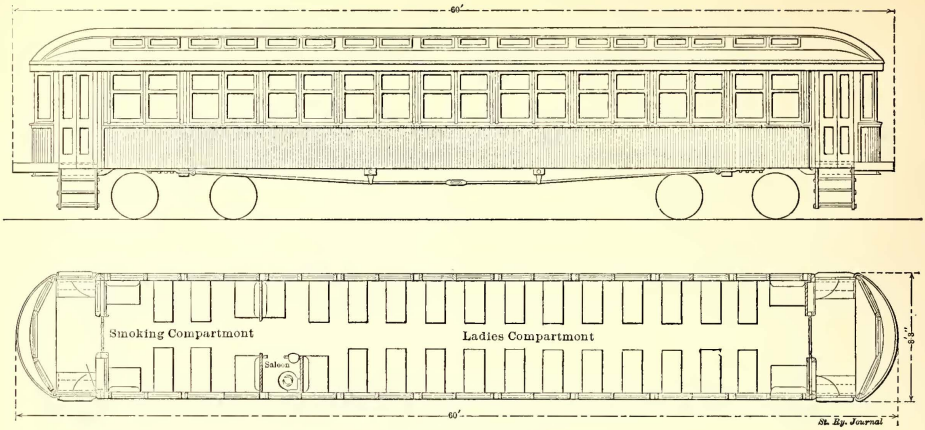
FORT WAYNE & WABASH VALLEY CAR



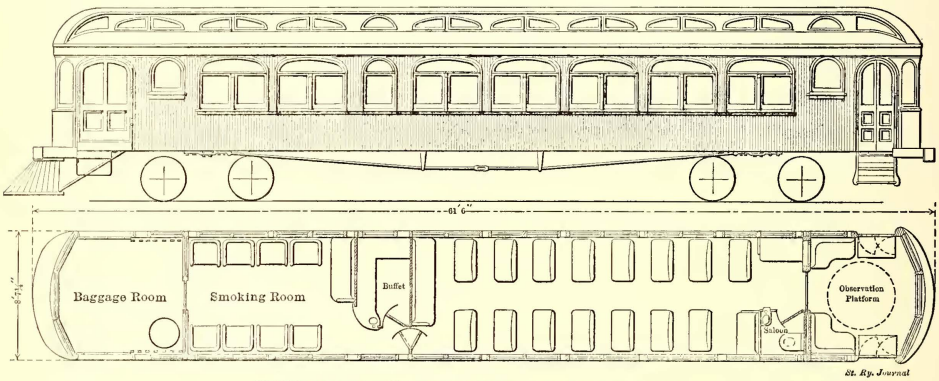
NORTHERN ELECTRIC RAILWAY CAR



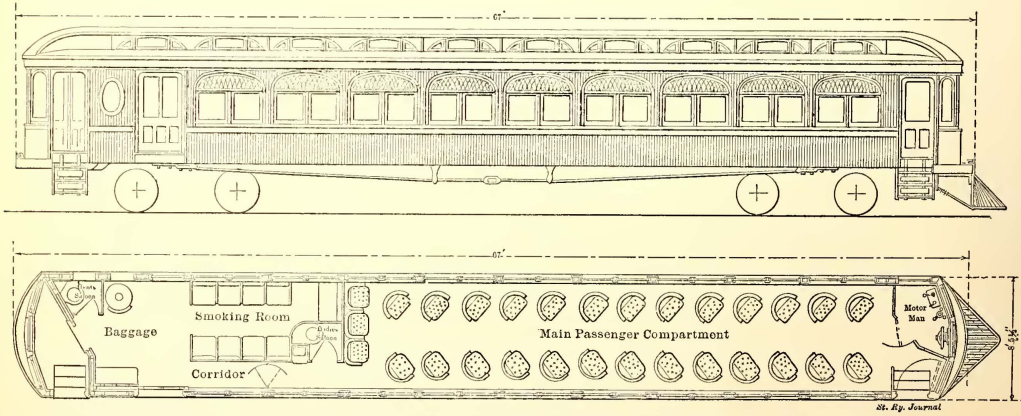
INDIANAPOLIS & NORTHWESTERN CAR



SCIOTO VALLEY CAR



COMBINATION CAR, FORT WAYNE & WABASH VALLEY



LIMITED CAR, COLUMBUS, DELAWARE & MARION

TERMINAL STATION AT MARION, COLUMBUS, DELAWARE & MARION

TRAIN SHED, INTERURBAN UNION STATION, INDIANAPOLIS

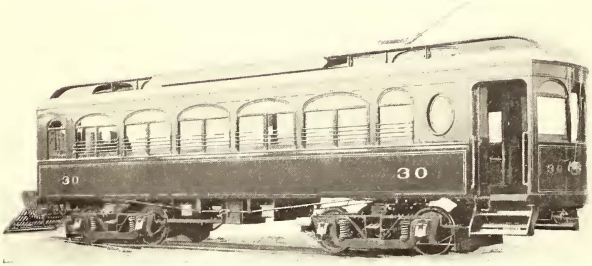
TERMINAL STATION AT COLUMBUS, SCIOTO VALLEY

FREIGHT TERMINAL AT DAYTON, DAYTON & TROY ELECTRIC

INTERURBAN STATION, CLEVELAND & SOUTHWESTERN

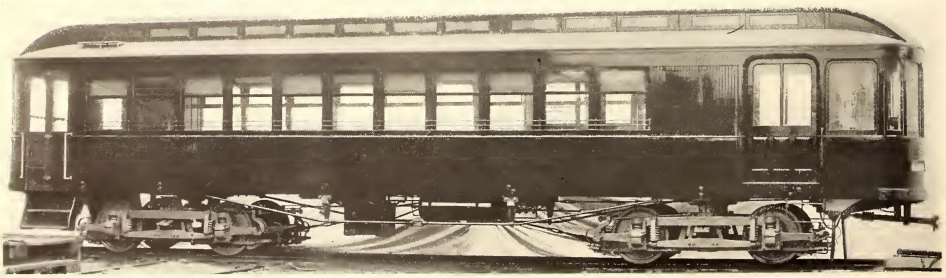
INTERURBAN, PASSENGER AND FREIGHT UNION STATION, CINCINNATI

STEEL CAR, SOUTHEASTERN OHIO



CAR NORTHERN OHIO (AKRON, BEDFORD & CLEVELAND)

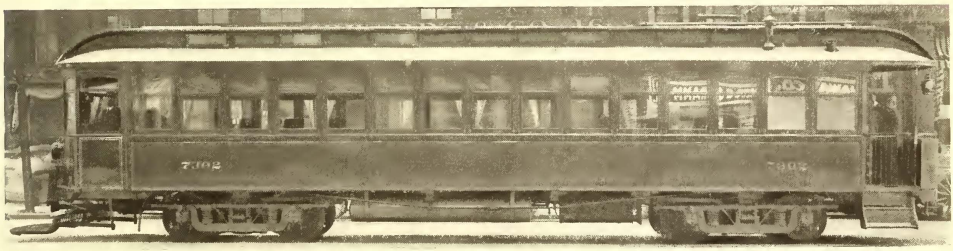
CAR, DAYTON, COVINGTON & PIQUA



LATE CAR OF THE LAKE SHORE ELECTRIC

STANDARD CAR, COLUMBUS, NEW ALBANY & JOHNSTOWN

STANDARD CAR, COLUMBUS, NEWARK & ZANESVILLE



LIMITED CAR, DETROIT UNITED

CAR, NORTHERN ELECTRIC

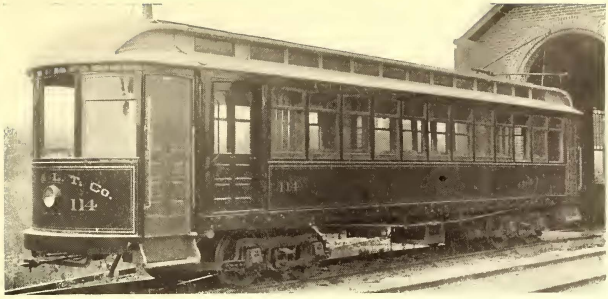
STANDARD CAR, DETROIT, YPSILANTI, ANN ARBOR & JACKSON

STANDARD CAR, SCIOTO VALLEY

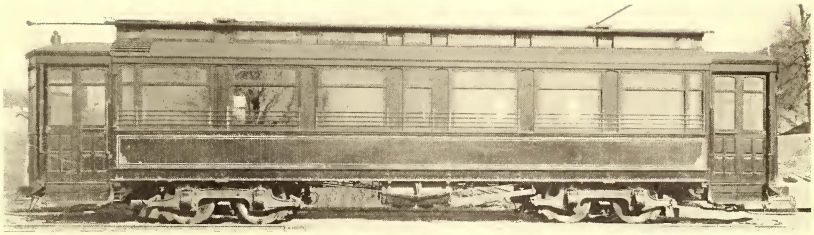
STANDARD CAR, TOLEDO, PORT CLINTON & LAKESIDE

67 FT. EXCURSION CAR, COLUMBUS, DELAWARE & MARION

STANDARD CAR, INDIANAPOLIS, COLUMBUS & SOUTHERN

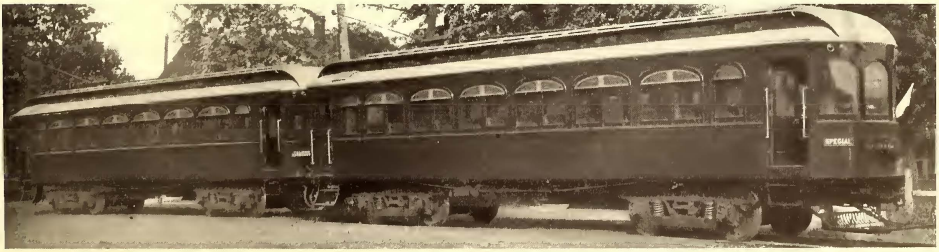


STANDARD CAR, CINCINNATI, MILFORD & LOVELAND

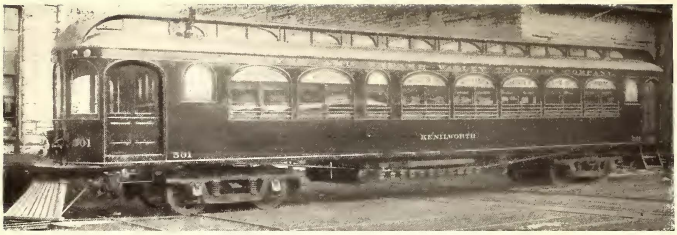


STANDARD CAR, INTERURBAN RAILWAY & TERMINAL

MOTOR AND TRAILER FOR EXPRESS AND FREIGHT SERVICE, SCIOTO VALLEY TRACTION

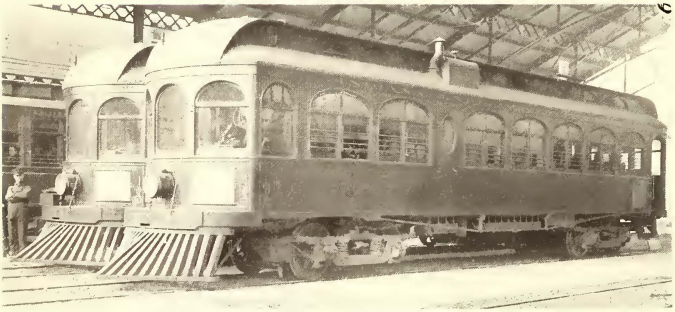


TWO-CAR LIMITED TRAIN, LAKE SHORE ELECTRIC



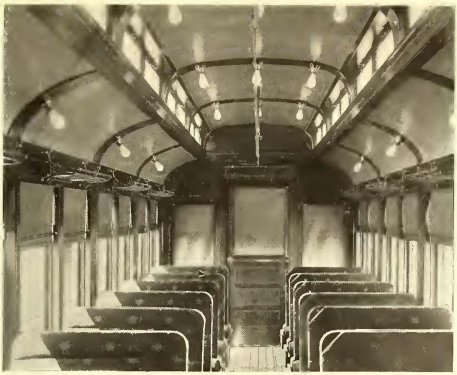
LIMITED CAR, INDIANAPOLIS-FORT WAYNE ROUTE

LIMITED CAR, WESTERN OHIO RAILWAY (LENGTHENED IN OWN SHOPS)



LIMITED CARS, INDIANA UNION

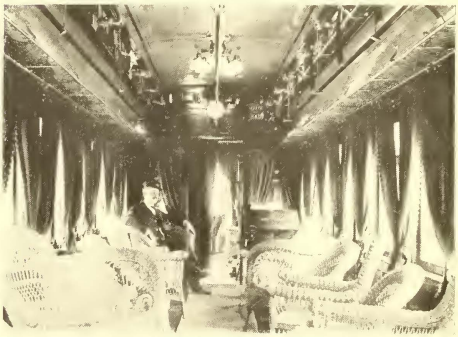
LIMITED CAR, DAYTON & TROY



INTERIOR STANDARD CAR, COLUMBUS, NEWARK & ZANESVILLE

INTERIOR 67-FT. EXCURSION CAR, COLUMBUS, DELAWARE & MARION

INTERIOR PARLOR CAR, DAYTON, COVINGTON & PIQUA



INTERIOR LIMITED PARLOR CAR, TOLEDO & INDIANA

INTERIOR PARLOR CAR, COLUMBUS, LONDON & SPRINGFIELD

INTERIOR TYPICAL INTERURBAN CAR IN THE CENTRAL WEST

T. & I. Limited

Canton-Akron

C., L. & S.

Rapid Ry. Limited

Ind., Col. & S.

Ind. Union Limited

D. & T. Limited

D., Y., A. A. & J.

Cleveland & S. W. Limited

Ft. W., V. W. & L. Limited

Scioto V. Non-Coupling

Scioto Valley Coupling

SOME END-ON VIEWS OF INTERURBAN CARS, ILLUSTRATING INDIVIDUALITY IN PILOTS, DESTINATION SIGNS, HEADLIGHTS, ETC.

and turned ½ in. It rather favors the first mentioned plan, although this necessitates more shop work. Other roads are allowing wheels to run 70,000 and 80,000 miles before turning them, and while this plan reduces the amount of shop work, it undoubtedly reduces the life of the wheel, because it is necessary to take deeper cuts to get the wheel back into proper shape. The Columbus, London & Springfield, Canton-Akron, Dayton & Troy and several other roads have designed simple heating outfits for shrinking steel tires onto the centers. They consist of circular gasoline burners built of tubing having fine holes drilled on the inner circumferance so as to give an even heat all the way around the tire. The axle with center attached is lowered into the rim by means of a chain hoist.

A wheel which has a special locking ring for the tire is being used with success by several roads, while the bolted tire has also been found very satisfactory.

Rolled and forged-steel wheels have many friends with some of the best high-speed roads. The Cleveland & Southwestern reports 200,000 miles with forged wheels, while the Western Ohio ran wheels of this type 60,000 miles before turning.

In spite of the widespread use of the steel wheel and the remarkable mileages shown, there are a number of roads which claim that the cast iron chilled wheels are fully as safe and more economical in the long run. The Toledo & Indiana, whose limiteds are as fast as any in the two States, formerly used steel tires and has gone back to the chilled wheel. Manager Darrow, of the company, reports 50,000 to 60,000 miles with chilled wheels at less than one-seventh the cost of steel-tire wheels. Unevenness of wear and the necessity for turning off heavy cuts on some wheels and lighter ones on others are among his objections to the steel wheel. The Cincinnati, Milford & Loveland feels well satisfied with 55,000 miles for chilled wheels.

As intimated in another column, many of the interurbans have been obliged to keep their wheel flanges down to a point that is undesirable, owing to the unsuitable tracks and special work on city entrances. There is a tendency on the part of a number of city roads to consider this matter in laying new track and special work. The Cleveland Electric Railway, for instance, in its new work aims to permit the interurbans to use flanges 1¼ ins. wide, which gives an excellent margin of safety, especially where steel tires are used. On account of city pavements it has been necessary to reduce the tread to 3¼ ins. or 3½ ins. in most cases. The Scioto Valley and the Cincinnati, Georgetown & Portsmouth use practically M. C. B tread, and the latter uses a standard 1½ in. x 1¼-in. flange. The practice of the various roads investigated is shown in Table III.

With one exception steel wheels or steel tire wheels are used on the roads visited in Indiana and Michigan. The Detroit, Ypsilanti, Ann Arbor & Jackson uses chilled wheels. Good results are obtained with them and the company has seen no cause to adopt steel tires. An average mileage of 40,000 miles is obtained. The cars operate over the tracks in Detroit and the depth and width of flange is ⅞ in., yet no trouble is experienced by broken or chipped flanges. This is partly due to the fact that the girder rails in Detroit have been well grooved out. An all-steel wheel weighing 590 lbs. is used by the Terre Haute Traction & Light Company. Rolled steel wheels are also used by the Detroit United. Wheels of diameters varying from 37¼ ins. to 33 ins. are used. The larger diameter has been adopted by the Indiana Union Traction Company and the Fort Wayne & Wabash Valley Traction Company, while the smaller one is employed by the Terre Haute Traction & Light Company. Flanges range in depth from ⅞ in. to 1⅛ ins. and the width of tread varies from 2½ ins. to 3 ins. Both special fasteners and double-lipped riveted retaining rings are used in connection with steel tirees. In one instance where double-lipped rings are employed, preference was expressed for the fasteners, the objection to the double-lipped rings being the breaking of the edge of the tire when worn thin, and also the necessity for putting the wheels in the lathe and turning the edge of the tire to make possible the removal of the retaining rings. In another shop where double-lipped retaining rings were used, they were thought better than the special fasteners.

Axles were found to vary in diameter from 5 ins. to 6½ ins. The heaviest car had a 5½-in. axle. With one exception axles are made of steel. The axles of the Detroit, Ypsilanti, Ann Arbor & Jackson Railway, however, are of iron.

Heavier axles and larger journals on the interurbans in the Central West are becoming the rule. The Scioto Valley and Fort Wayne, Van Wert & Lima with their heavy equipment are using 6½-in. axles. The Stark Electric, which has a 34-ton car and 50-hp motors uses a 6-in. axle with a 7-in. gear seat. Journals on the latest Cleveland & Southwestern cars are 5 ins. x 9 ins. In Indiana lengths of journals varied from 3½ ins. to 5 ins. and widths from 7 ins. to 10 ins. The smallest journal, 4¼ ins. x 7 ins., was found on a car weighing 65,000 lbs. The largest, which measures 5 ins. x 9 ins., was in use on the Fort Wayne & Wabash Valley Traction Company and the Indianapolis & Cincinnati Traction Company.

The variety of sizes of journals emphasizes the necessity for standardization of journals and journal boxes.

LUBRICATION

Babbitted brass journal bearings are used on the greater number of roads. The Terre Haute Traction & Light Company, however, uses a composition bearing, and the Indianapolis & Northwestern Traction Company an all-brass bearing. The general practice is to lubricate journal bearings by packing the boxes with oil and waste, although two or three roads in Ohio continue to use grease for journals.

BRAKES

Straight air brakes are almost universally used by Ohio roads. The Scioto Valley has its cars equipped with both straight and automatic air to provide for train operation. The Dayton & Muncie uses a storage air system, as does also the Detroit, Monroe & Toledo Short Line. While the storage systems have been found convenient and economical, they possess the disadvantage of rendering it impossible for these roads to send their cars over other lines, a decided handicap since interline excursion business is becoming quite prevalent in this district.

Without exception, air brakes are employed on the interurban cars of the roads visited in Indiana and Michigan, and practically all use straight air equipments, notwithstanding the fact that several are equipped with multiple-unit control systems.

It seems to be universal practice to hang the brake shoes between the pairs of wheels of a truck rather than outside. A few years ago many outside-hung brakes were to be found. The change in practice has been brought about partly because of the tendency of outside-hung brakes to pull the ends of the truck frame down and increase the chattering of the shoes.

BRAKE SHOES

The practice on the different roads varies widely with regard to brake shoes. Plain gray iron shoes without inserts and with steel or wrought-iron inserts, as well as composition filled shoes, are used. Steel back shoes are also being employed. The argument in favor of the steel back shoe is that it can be worn down very thin without danger of it breaking and causing derailment of the car. There is very little in the service on different interurban roads, and there are no local conditions that necessitate a difference in practice with regard to brake shoes on different roads, yet a wide variety in practice exists. The shoes are invariably used with a holder or head. A few years

ago shoes were frequently made with lugs on them, so that the shoe itself could be attached to the truck lever. However, this method increased the weight of that portion of the shoe that goes into scrap, and it also required more time in changing shoes. The chief reason for the shoes being made in this manner was probably because of the limited space between the wheels. The lengthening of the wheel base a few inches has removed the difficulty, and the brake-shoe head has been generally adopted.

The original weight of shoes is found to vary from 24 lbs. to 35 lbs. Where the space is not limited it would seemingly be good practice to use the heavier shoe. This would remove the necessity for frequently changing the shoes. In several instances the weight at which shoes were discarded could not be given. The figures given for discarded shoes varied from 8 to 16 lbs. The lowest figure was for a well-worn steel back shoe. This figure was given with the added statement that this was the weight to which it was intended that the shoes should be worn.

In general, it might be said that the weight at which shoes are discarded could with advantage be given considerably more attention than is customary. The scrap heap offers convincing evidence of this. Shoes are frequently found worn thin at one end while the other end has not been in contact with the wheel, and it is safe to say that not more than two-thirds of the available metal is usually worn away. The fault usually lies in the length and adjustment of the brake hangers. Varying loads on the cars make it impossible to keep the brakes in exactly the proper position, but, judging from the manner in which discarded shoes are worn, the opinion is formed that in some cases, at least, improvements could be made in the brake apparatus so as to get more even wear of the brake shoes. Very few figures were obtained as to the mileage of brake shoes. On the Detroit United Railways new brake shoes cost 0.043 cent per car mile. This figure, however, does not include credit for the scrapped shoes. The number of stops and the weight of cars differ so widely on different systems that widely varying brake shoe mileages are obtained. Figures as to the mileage of shoes on the Marion Special, which operates over the Indiana Union Traction system, and makes but two scheduled stops in 72 miles, would be high, as compared with similar cars in local service. The mileage of shoes, in fact, offers very little grounds for comparison of the results on different roads. Difference in operating conditions is probably largely responsible for the wide difference in brake shoe mileage obtained on the Indianapolis & Northwestern Traction Company and the Fort Wayne & Wabash Valley Traction Company. On the former road a mileage of 1050 is obtained with a 27-lb. shoe, and on the latter 3500 miles are secured with a 26-lb. shoe. The brake levers are usually proportioned to give a braking pressure of from 80 to 90 per cent of the weight of the car.

Seven roads in Ohio favor outside-hung brake shoes, while ten roads believe best braking results can be obtained from hanging the brakes between the wheels. Few roads in Ohio have given much attention to the subject of most desirable braking pressure or to the life of brake shoes. Hardly a road keeps accurate mileages on brake shoes. The Stark Electric is using a soft iron shoe weighing 45 lbs., and reports 6000 miles wear. Others say their shoes wear less than 1000 miles. Five roads favor the use of inserts in brake shoes and eleven favor the plain type.

The tendency to run cars in trains has occasioned a demand for drawbars which will allow the close coupling of cars, and, at the same time, enable them to take the right angle curves in city streets. The Scioto Valley and the Lake Shore Electric have their latest cars equipped with drawbars especially designed for train operation.

SINGLE END OPERATION

Preference for single end operation is on the increase. Roads out of Dayton are obliged to use double end cars, as there are no loops available in that city, but several of these roads would change if they could. The ability to run a car in either direction and from either end is undoubtedly an advantage, and the claim is made by several master mechanics that motors, gears and pinions show better life where they run in both directions, but, as a rule, the objections are thought to overbalance the advantages. The Fort Wayne, Van Wert & Lima has controllers at both ends, so it is possible to run cars in either direction, but the operation is in one direction only. The arguments advanced by roads favoring single end operation are numerous. This practice enables the arrangement of cars to remain the same at all times, so that ladies are not obliged to climb over a lot of trunks, or pass through obnoxious smoking compartments to get to their seats. Where this is necessary, it is claimed that it necessitates longer stops for ladies desiring to leave the car. Aside from the saving in cost in dispensing with one set of controllers, the controller on the rear platform is apt to be tampered with, besides which it takes up space, necessitating a longer platform. The coming type of car is that in which the sides are carried continuous to the forward end, giving a car without front platform. This type enables the motorman to have a cab by himself where he cannot be annoyed by passengers and where he is in close proximity to the baggage compartment, enabling him to readily assist in loading. Single end operation eliminates the necessity for placing fenders or pilots at both ends, and, on the whole, a more symmetrical car can be built with this arrangement than with the other. Of the Ohio roads investigated, eleven have single end operation and six double end.

With one exception, cars of the roads visited in Indiana and Michigan are built for operation in one direction only. The one exception is the system of the Terre Haute Traction & Light Company. The cars of the Indianapolis & Northwestern Traction Company, as well as those of the Indianapolis & Cincinnati Traction Company, while built for operation from one end only, are fitted with controllers at both ends, to facilitate the movement of cars in switching and at other times when occasion may require.

MOTORS AND CONTROLLERS

Four-motor equipments are universal in Ohio on interurban roads. Two or three years ago the Lake Shore Electric used two motors, one on each truck, and for a long time the Indiana Union Traction Company used but two motors, placing both on the rear trucks.

The use of larger cars, higher speeds and longer runs has resulted in the use of larger motors. The 75-hp may be said to be the standard equipment in this district, although some of the roads in recent purchases for high-speed cars have gone beyond this. The new Lake Shore Electric cars have four 85-hp motors, and the Fort Wayne, Van Wert & Lima has adopted similar equipment. The Scioto Valley is the only road which has gone beyond this, and it uses 100-hp motors. On the other hand, the Toledo & Indiana and the Western Ohio, both operating at speeds of 60 miles an hour, believe that the 50-hp equipments are heavy enough and more economical in power consumption than the larger motors. The experience of the Western Ohio is interesting. Its cars cover the run from Dayton to Toledo and return, 320 miles, in 12 hours, with practically no layovers, a number of stretches calling for 60 miles an hour, and it is claimed there is no heating of the motors and that they are not overworked. It is claimed that tests have shown that the cars consume 2.43 kw-hours per car-mile, while it is said that the cars of another road in the same

service in making the same schedules consume 3.01 kw-hours per car-mile, the cars being practically the same weight, 31 tons.

There is a decided tendency towards the adoption of multiple-unit controllers. In adopting these controllers probably the future operation of cars in trains has been considered, but evidently the avoidance of controller troubles has been the main consideration. The direct controller is generally conceded as being ill suited for controlling the larger types of motors. Flashing in the controller when the circuit is broken necessitates constant attention to the controller to keep it in operating condition. On one of the roads visited which has a direct controller on large cars it is the custom to throw off the current by means of the circuit breaker whenever the car is not up to speed. This practice usually results in the circuit breaker being put into such condition that it cannot be relied upon to care for overloads. On the Indianapolis & Northwestern Traction provision is being made to change the wiring on some L-4 controllers that are in use in such a manner that the circuit will be broken through contactors underneath the car.

The multiple-unit system of control is now used on the latest cars of six of the roads in Ohio, although only two of these, the Lake Shore Electric and the Scioto Valley, are using train operation in regular service, and that, too, only on occasions of especially heavy traffic. The Scioto Valley, Western Ohio, Springfield, Troy & Piqua and Dayton & Troy frequently haul trailers behind their express cars, the trailers being equipped with air brakes, with train control of brakes, but no motor trailers are used in the express service. The Stark Electric owns a number of old Manhattan Elevated cars, which have been equipped for trailers, but the train control system is not employed.

After experimenting with several different types of rheostats, the grid type has been generally adopted. It is considered the standard on all of the roads visited. The adoption of this type has reduced the maintenance cost of rheostats, as well as increased the reliability. Where the proper number of rheostats are provided and rheostats are properly proportioned, very little trouble is experienced with them.

While the cars on some systems are equipped with multiple-unit controllers, the practice, in Indiana and Michigan, of running single cars instead of cars in trains is followed entirely. On the Detroit United Railways a train is sometimes divided into two or three sections. Difficulty in getting in and out of cities is probably largely responsible for the practice of operating cars singly, but there are several other reasons which combine to make the practice preferable. The Indiana Union Traction Company has several trail cars of about the same length as the motor cars, and on special occasions some of the cars are operated with trailers. To avoid cutting down the schedule when trailers are used, it is at times the practice to divide a train into two sections, the front section having the trailer, while the rear section consists of a single car. The first train makes only a few stops, and is thereby enabled to run on scheduled time and to stay ahead of the rear section, which makes all of the local stops.

As far as Indiana and Michigan are concerned, a few years ago the cars of several interurban systems were equipped with two motors, but this practice seems to have been generally abandoned, and all of the later types of cars are supplied with four motors. The better traction obtained by having all of the wheels drivers was probably the reason most influencing the change, yet there were, in fact, no great advantages in employing but two motors. The total horse-power of the motors under the cars varies from 200 to 400. Several of the cars are equipped with four 75-hp motors, which size seems to give very good satisfaction.

LUBRICATION OF ARMATURE AND MOTOR BEARINGS

Oil lubrication of armature and motor bearings, as well as journal bearings, is becoming the popular method in Ohio. Some of the roads are simply using the receptacles provided on the motors, plugging up the slot provided where grease was formerly used, and filling the chamber with waste or wicking and oil. Others are using special oil cups designed for this purpose. Several of the roads in the district have given contracts to leading oil concerns for the entire lubrication of their cars on a flat rate of so much per thousand miles with very satisfactory results. Others prefer to do their own experimenting and design lubricating devices to suit their particular requirements. The quality of oil used in this service varies. The Stark Electric Railway uses a red engine oil, costing 14 cents per gallon, packing the lower surface with cotton waste and using wool waste above. Its expense for lubrication, exclusive of waste, is about 10½ cents per thousand miles. The Scioto Valley reports that its entire car lubrication cost is 22 cents per thousand miles. It uses oil at 25 cents a gallon, and, of course, its equipment is much heavier and speed considerably higher than the other road mentioned.

The Toledo, Port Clinton & Lakeside uses grease on its motor bearings and oil cups on its armature bearings. Five roads use grease exclusively.

In Indiana there is a tendency to abandon babbitted motor axle bearings. Brass bearings without babbit lining are used on the Indianapolis, Columbus & Southern system, the Indianapolis & Northwestern system and the Fort Wayne & Wabash Valley system. Where babbitt is used it is usually only a thin lining of about 1-16 of an inch. The same practice with regard to babbitting is followed in armature bearings. With such a lining, should the bearings get hot and the babbitt melt, the armature will not fall down far enough to touch the pole pieces. The shell is either of brass or a composition metal. Bronze shells are used by the Fort Wayne & Wabash Valley Traction Company. Both motor armature bearings and motor axle bearings in the later types of motors are lubricated by means of oil and waste packed in housings. With some of the older types of motors special oil cups are inserted in the grease cups.

TROLLEY WHEELS

The little trolley wheel probably makes more trouble for the average master mechanic than any other single piece of mechanism in the equipment of the road. While there are a number of very excellent wheels on the market, a fortune awaits the man who can invent a trolley wheel which will do the work demanded of it and show a life approaching to that of other wearing parts of the equipment. While the average life of several well-known makes of wheels is very creditable, it is the great variation of results which annoys the master mechanic. Some wheels of a certain lot will show surprising results. Wheels which have run 6000 to 8000 miles are found frequently, yet the next few wheels of the same lot may develop soft spots or may not be perfectly round, and they go to pieces in a few hundred miles.

The high-speed limited service, with its rapid acceleration and heavy flow of current, is extremely hard on trolley wheels. On the Dayton-Toledo limited run of 320 miles of almost continuous operation, at speeds frequently reaching 60 miles an hour, it is no uncommon thing to have to stop once or twice to change trolley wheels. This, in spite of the fact that it has become the practice to place a new trolley wheel on limited cars each day and then change them to the local cars after the day's run.

In justice to trolley wheel makers, it should be said that the life of a wheel is almost directly proportional to the speed of

cars and to the tensions placed upon the wheel. Roads operating at high speeds have increased the tension higher and higher, so that the trolley wheel will not leave the wire, and, quite naturally, the wheel suffers. This will be seen in the case of the Dayton & Troy, where on local cars the tension is 28 lbs. and the average mileage 4200 miles, and on limiteds 34 lbs. and the mileage 3000 miles. The Fort Wayne, Van Wert & Lima, with 45-lb. tension, gets 2500 miles, while the Cincinnati, Milford & Loveland, with speeds not exceeding 45 miles an hour and 18 lbs. tension, gets 7500 miles. The Lake Shore Electric and the Toledo & Indiana make their own trolley wheels; the latter averages only 1500 miles on its limited cars, using a tension of 43 lbs.

Other conditions have an important bearing upon the life of the trolley wheel. Oil reservoirs should be kept filled and the holes admitting the oil to the bearing should be large enough, or numerous enough, to admit sufficient oil to keep the bearing well lubricated at highest speed. An attempt to save oil on trolley wheels is usually a poor investment. Bearings should be inspected frequently and pins changed when they become worn. An excessive amount of play between the pin and the bushing causes an arcing effect, and the bearing runs dry and the wheel quickly wears out.

Some master mechanics believe that a free-playing trolley base which allows the pole to swing at every curve will increase the life of the wheel, and the roller or ball-bearing base is preferred for this reason.

Several roads are experimenting with iron wheels. An iron wheel has been used for the past year by the Stark Electric Railway, with an average mileage of 4000. This wheel is said to be made of a magnetic metal whose base is iron, giving, it is claimed, a conductivity approaching closely to copper. It is claimed that the wheel will not injure the wire and that there is no arcing effect. The low cost of the wheel renders its use advantageous, it is claimed.

Interurban roads in Indiana seem to have gotten well away from the small sized trolley wheel. A few years ago many roads were using the small wheel usually found on city lines. All the roads visited, however, are now using a 6-in. wheel. The mileage obtained varies more than the differences in scheduled speed, current consumption and other influencing factors seem to warrant. The extremes are 500 to 5000 miles, and, moreover, these extremes are obtained with the same type of wheel, with practically the same scheduled speeds and with very little difference in the weight of the cars. In one instance where short mileage is obtained, the equipment, as well as the track and overhead construction, are comparatively new, and this may be partly responsible for the difference. On another road, where short mileage is obtained, the tension carried is rather high. On the Indianapolis & Cincinnati Traction system the trolley wheel question is of minor importance, as the wheel trolley is used only about one-tenth of the time. This road, it will be remembered, is operated by single-phase, alternating current, and a bow trolley is used, except in towns and cities.

The trolley retriever has been substituted for the trolley catcher on most roads in the Central West. Where the catcher is still used, no objection was found to it. On the Detroit, Ypsilanti, Ann Arbor & Jackson Railway it was stated that it was not deemed advisable to abandon the catchers in use for retrievers, because it was a rare occurrence for the trolley to leave the wire, and this is due largely to the fact that trolley bases are given close attention and kept in good condition.

TROLLEY BASES AND POLES

Objection to ball-bearing trolley bases was made by one road on the grounds that the grooves soon wore out and prevented the base from operating properly. On another system where such bases were used they were giving entire satisfaction, the statement being made that when the ball-bearing base was given proper attention no difficulties were experienced. The usual length of trolley pole is 12 ft. This length is used by seven of the nine roads visited in Indiana and Michigan. In view of the fact that the height of the trolley varies from 18 ft. to 22 ft., and the height of the cars varies also, it would be expected that different length poles would be used.

On the Terre Haute Traction & Light system poles 14 ft., 13 ft. and 12 ft. in length have been tried. The best results have been obtained with a 12-ft. pole. The trolley wire is 19 ft. high and the roof of the car is 12 ft. above the rail. This gives a difference of 7 ft. between the roof and the trolley.

Practically the same difference between the car roof and the trolley exists on the Fort Wayne & Wabash Valley Traction Company, yet a trolley pole 13 ft. 6 ins. long is used. The cars are about 13 ft. from rail to roof and the trolley is 20 ft. high, giving a distance between roof and trolley of about 7 ft., as on the Terre Haute Traction & Light Company.

On the Indianapolis & Northwestern Traction Company the cars are 12 ft. 9 ins. high and the trolley is 18 ft. above the rail. There is, consequently, a difference of 5 ft. 3 ins. between the roof and the trolley. A 12-ft. pole is used. There is evidently some angle between the trolley pole and the wire that gives best results, but the foregoing figures show that widely varying angles exist on different roads. Some close attention to this detail of practice might result in some very valuable information as to the most suitable length of trolley pole.

There has within the last few years been quite a change in Indiana and Michigan in practice regarding the tension on the trolley pole. Where, a short time ago, 15 to 25 lbs. was the prevailing pressure, 30 to 40 lbs. is now found. This is another matter which warrants attention. The condition of the overhead construction and the speed of the cars are about the only reasons for a difference in pressure being used. On the roads investigated, while the usual tension was about 30 lbs., there was a variation of from 25 to 40 lbs., and this wide range existed on roads upon which the scheduled miles per hour are practically the same. The mileage of a trolley wheel is shortened considerably when a pressure greater than that necessary is used, and as the maintenance of trolley wheels is quite an item, the question of the proper tension to be used with given speeds would bear investigation. Many companies, evidently underestimating the importance of having the trolley pole tension right, allow the repair men to set the tension without the use of scales. What may appear 30 lbs. pull to one man may actually be 50 lbs. There are, no doubt, cars operating on one system with a 100 per cent difference of tension.

To guard against this a spring balance is used by C. M. Bange, master mechanic of the Detroit, Ypsilanti, Ann Arbor & Jackson Railway, to test the trolley tension. The trolley rope is caught by a grip on the balance so that the necessity of removing the rope from the trolley catcher is avoided. The tension on all cars is tested at frequent intervals. A tension of from 25 to 30 lbs. is carried, and this is about the lowest found on any of the roads visited.

HEATERS

The hot water type of heater is favored by thirteen out of seventeen Ohio interurban roads. The Canton-Akron Railway builds its own hot water heaters. The electric heater is preferred by a number of the roads on account of its cleanliness, uniformity of heat and the ability to turn it off immediately when it is not needed. The Scioto Valley finds that the cars consume about 4-10 of a kw-hour per car-mile more in winter than in summer, but, of course, all of this cannot be charged to the heaters, part of it being due to the heavier traction on

account of snow. Eight roads in Ohio using hot water heaters place them in the front vestibule adjoining the motorman, while four place them in the baggage compartment. The motorman usually appreciates the heat in extremely cold weather, but frequently at times it is altogether too hot for comfort. The Cincinnati, Georgetown & Portsmouth places its heater in the rear end and the conductor takes care of it.

The hot water heater also has been generally adopted by interurban roads in Indiana and Michigan. The cost of operation has had influence in determining practice with regard to heaters, but the fact that the car may be heated should it be left out on the line by the cutting off of the current has been considered also. One company, the Detroit, Ypsilanti, Ann Arbor & Jackson Railway Company, uses electric heaters. It is acknowledged that the cost of operating these is somewhat greater than for hot water heaters, but the company regards the appearance and the cleanliness of the car as of sufficient importance to compensate for the increased cost occasioned by the electric heaters. The increased carrying capacity of the car is considered also. Care has been taken to provide enough heaters to keep the car at a comfortable temperature in the coldest weather encountered.

The proper location of hot water heaters is as yet an undecided question in these districts. The front portion of the car, either the smoking compartment or the motorman's vestibule, appears to be the most frequent location. The value of the space occupied by the heater is evidently appreciated more than it was a few years ago, as on many of the systems the heater is so installed that it can be readily removed in winter and the space utilized either to increase the seating capacity of the car or to carry baggage.

GEARS

Solid gears are being used by the great majority of roads in Ohio and others are adopting them as rapidly as possible. The breaking of bolts, or the loss of nuts on split gears, has been the source of annoyance and accidents on a number of high-speed roads. The Toledo & Western Railway is using a sectional gear on which the rim may be detached and replaced with a new one when it becomes worn. The central portion is made in two sections, one of which is pressed onto the axle like a solid gear and held by a key. A shoulder of the disc fits into a groove on the gear. A locking disc is threaded onto the hub section of the gear by means of a special wrench and a shoulder on this fits into a corresponding groove in the gear. It is possible to take off the locking disc several times and insert new gear sections without removing the center from the hub. The gear has never worked loose, and it is believed to furnish a source of economy in the life of gears. Few roads attempt to keep any mileages on gears. The Dayton & Troy and Cleveland & Southwestern report about 300,000 miles on solid gears with 5-in. face.

Interurban systems in Indiana and Michigan seem to have gotten entirely away from city car practice with respect to gears. On all the roads visited solid gears are used, the use of split gears having been abandoned. The gears and pinions are usually either of 5 in. or 5½-in. face, and the diametral pitch is usually 2½ in. Figures as to the life of gears and pinions are hard to obtain, due partly to the fact that on many roads the gears originally furnished with the motors have not been worn out. The life, moreover, varies greatly with the attention they receive. Moreover, when cars are operated in both directions the life is increased somewhat, due to the fact that both sides of the teeth are worn. On the Detroit United Railways the cost of gears on both city and interurban cars for a period of 2,250,000 miles was 0.03 cent. per mile. On the Indianapolis & Northwestern Traction Company gears have a life of about 150,000 miles. The cars are operated in one direction only, but Mr. Clarke, master mechanic of the system, gets more mileage than would otherwise be obtained from them by turning them so that the other side is worn when a new pinion replaces a worn one. This practice has another good feature. When one new gear is used with an old one, the teeth do not mesh properly and their operation is attended with more or less grinding. By turning the gear when a new pinion is supplied, so far as the meshing of the teeth is concerned, the effect is practically the same as is obtained with both a new gear and pinion.

GEAR CASES

Wood gear cases have caused much discussion among master mechanics. But four roads out of seventeen in Ohio are using them. One or two roads have tried them and say they are not satisfactory for high-speed service, the claim being that they soon wear out, the screws shake out and they fall to pieces. The advocates of wood cases claim that, if properly made, they hold together and give excellent satisfaction, and they point the finger of scorn at the metal gear cases and say that nuts work off and the covers drop down, sometimes tearing the gears to pieces, but that when the wood gear cases drop off, no damage is done. There is no uniformity of ideas as to how a wood gear case should be made. The master mechanic of the Cincinnati, Milford & Loveland saws oak strips lengthwise, places them overnight in the feed-water heater at the power station, and then bends them over a steel gear case, forming them the proper shape for the top. He uses galvanized iron for the sides, bending it over the top and securing it with plenty of screws. This case costs about $2.50. The Toledo & Western makes the sides of one piece of rough wood and nails on a galvanized iron top, the whole being painted black. The cost is but $1.05. The Toledo & Indiana makes cases entirely of wood, the sides being of one piece and the tops of half stuff glued together at a total cost of about $1.50.

Several of the roads in Indiana are using both sheet steel and wood gear cases. Sheet steel gear cases have been found very satisfactory by the Indianapolis & Cincinnati Traction Company. The Terre Haute Traction & Light Company is also using gear cases of this type. The Detroit United Railway has adopted a wood gear case made in its own shops. On the Detroit, Ypsilanti, Ann Arbor & Jackson Railway, a sheet steel gear case is used, which was formerly made by the mechanical department. It is now obtained from a local metal shop. The corners are of angle-iron, while the surfaces are of No. 14 sheet steel. The sheet steel is riveted to the angle-iron corners at frequent intervals with cold rivets. These cases have been in use on the system for several years and are preferred to cast cases largely because the danger of derailment of the car by the dropping down of a gear case is avoided.

HEADLIGHTS

Electric headlights have almost entirely superseded oil lamps, although it is believed many motormen prefer a good oil lamp on account of the absence of shadows and the failure of the arc lamp when the trolley comes off, which is often at a critical moment. This has been remedied by one road by the use of a storage battery on the car. The tendency of large cities and a number of small towns to require that arc lights shall be shaded is a source of considerable annoyance. The combination arc and incandescent lamp supplied by two or three makers obviates this difficulty. The Western Ohio Railway has equipped all of its headlights with a simple curtain device, the motorman simply pulling a string attached to the curtain when passing through a town and releasing it when in the country.

The combination arc and incandescent headlight is being generally adopted in Indiana. This headlight is preferred on many roads because city regulations will not permit the undimmed arc

to be used inside city limits. The combination arc and incandescent headlight removes the necessity of screening. One of the illustrations presented shows the "Marion Flyer" of the Indiana Union Traction System with the headlight mounted in the hood of the car. While it was most probably located in this position in order that the approach of this car might be more easily distinguished from regular cars, it is stated that there are no serious drawbacks to this location.

SIGNAL LIGHTS

As more of the roads adopt steam railroad regulations in their train operation, there has come an increased use of signal lamps. The majority of high-speed roads in Ohio now use either oil or electric signal lamps, and among those which have adopted a new electric system of electric classification lamps are the Toledo, Port Clinton & Lakeside, the Lake Shore Electric, the Canton-Akron and the Fort Wayne, Van Wert & Lima.

On several systems in the other States mentioned, the old style of oil classification lamps and markers is being replaced by the electric classification lamps. Oil lamps must be given considerable attention to keep them in order. Electric marker lights have heretofore had the objection that in case the trolley came off or the current was cut off for any reason, the lights were extinguished. The new system of classification and marker lights has a small storage battery so connected in the circuit that the lights will burn several hours without being supplied with current direct from the trolley. The lamps are of very small candlepower and are placed behind concentrating lenses of proper colors.

The classification lights of the Indianapolis & Northwestern Traction System cars are mounted inside the car instead of on the front corner post. They are located just back of the forward window so that there is no loss in the brilliancy of the light.

In addition to the usual marker lights, the Detroit United Railways use what is termed a stereopticon lamp. This has a concentrating lense about 6 ins. in diameter and is lighted by an electric lamp. It is hung in the center of the rear platform. As classification signals, the Detroit, Ypsilanti, Ann Arbor & Jackson uses white for extra cars and red for car following. Instead of the customary flag during the daytime, round sheet metal discs are employed. A reproduction from a photograph presented in this issue shows the head end of the standard car of this system with this disc placed in a socket on the bumper. The objection to the use of flags is that they are hard to discern when the car is going at high speed.

FENDERS AND PILOTS

Owing to the objections of the city authorities in Toledo, Cleveland and Cincinnati, the interurban roads entering these places are unable to use built-up pilots and use fenders. The majority of roads centering from Dayton and Indianapolis and two of the Cincinnati roads which do not enter the center of the city, use solid built-up timber pilots, similar in shape to those used on locomotives. The Canton roads use a peculiar half-pilot, illustrated on another page. The Scioto Valley has two types of pilot, both of iron. One is very short and is built of tubing, permitting the cars to be coupled together, and the other is a large strap iron affair with a projecting front. These are shown in Plate XLII. The Columbus, Delaware & Marion has a fender which is attached to the car by means of bolts dropped through the bumper and braces extending back under the car. The bolts holding the braces are provided with springs so that any obstruction raises the front of the fender slightly, thus relieving the jar. The fender can be removed and carried to the other end by simply lifting out the pins in the bumper. A number of the roads use their pilots for snow plows, placing a board or sheet metal covering over the surface.

Heavy fenders are used by the Eastern Ohio, Cleveland & Southwestern and Toledo, Port Clinton & Lakeside and several other roads in Ohio. The Western Ohio and Dayton & Troy carry fenders on one end and pilots on the other on the cars used in the Dayton-Toledo limited service, to comply with the Toledo ordinance.

The Lake Shore Electric, Detroit, Monroe & Toledo and Toledo & Indiana use a heavy sheet iron fender resembling a huge "grid iron," by which name it is known. The Springfield, Troy & Piqua and Northern Ohio Traction & Light Company use a tilting fender. This is valuable in cities, and it is said to have picked up objects practically uninjured and without much damage to the fender at speeds up to 35 miles an hour.

Three of the nine systems visited in Indiana equip their cars with a wood pilot of the steam locomotive type. The angle of the bottom timbers of these pilots is usually about 45 degs. The staves are usually mortised in the top and bottom timbers, and the pilot, as a whole, is secured to the car by bolts through the bumpers and by braces running up from the bottom timbers to the platform timbers. Pilots are usually carried at from 8 to 12 ins. from the rail. On the Indianapolis & Northwestern system, clearances permit them to be carried 7 ins. from the rail, but 2-in. margin is allowed and they are hung 9 ins. above it. A mistake sometimes made when this type of pilot is adopted, is that the pilots are built too weak and are not secured to the car body properly. They should be constructed of oak and the staves should always be mortised into the upper and lower members and further secured by bolts passing through the stave and the members to which they are fastened. Frequently, lag bolts alone are depended on to secure the staves. The pilots should be constructed with a view to removing heavy obstructions from the track, but instead they are frequently built so that they crush under the car when such obstructions are encountered. The Indiana Union Traction System was one of the first roads to use this type of pilot and they are now used on all of the interurban cars of the system. The Indianapolis, Columbus & Southern Traction Company uses a fender of heavy construction. The interurban cars of the Detroit United Railways are equipped with a special drop fender manufactured by the company. The Detroit, Ypsilanti, Ann Arbor & Jackson Railway also uses a special type of fender, built in its own shops. The general design of these fenders may be observed in the photographs of head ends of cars presented on Plate XLII. in this issue.

SANDERS

Air sanders are used on the cars of nearly all of the systems visited in the three States. One objection to the manner in which sanding devices are frequently installed on cars is that the sand is not thrown close enough either to the rail or to the wheel. A great deal of the sand does not strike the rail, and some of that which does is jarred off or blown off before the wheel reaches it. The Indianapolis & Northwestern Traction Company is using a sanding device, by means of which the objections mentioned are removed. The pipes conducting the sand to the track throw the sand under the wheel. This device which is essentially an air sander is made in the shops of the company and it has many features to recommend it. The sand is carried in a heavy galvanized iron can in one corner of the motorman's cab. The can is covered by a wood-box which forms a seat and a protection for the can. The bottom of the can is of heavy oak. Bolts extending through the wood secure a heavy pipe flange to the bottom with a piece of metallic insertion packing between the flange and the wood bottom. A 1-in. pipe connection which is screwed into the flange leads to a mixing device under the car immediately below the sand-box. This device consists primarily of an ordinary cross-pipe fitting of which the bottom opening is plugged. The opening on one side is connected to an air valve in the cab by a connection which

terminates in the cross-connection in a ¼-in. pipe. From the other opening a pipe and a rubber hose lead to a long sweep double-branch elbow and from this the two 1-in. delivery pipes carry the sand to the rail. The admission of air through the valve in the cab blows the sand out of the mixer through the connecting pipes. The siphon effect produced, aided by gravity, causes sand from the box to fall into the mixer. A dividing appliance inside the double-sweep elbow divides the sand equally between the two delivery pipes. The cab is believed to be the proper place for the sand-box on account of the lessened liability of the sand to become damp. One idea in having the can holding the sand enclosed in a wood-box is to reduce this liability. With this arrangement no trouble at all is experienced with moist sand.

The Detroit United Railway uses a lever sander of its own make. The Detroit, Ypsilanti, Ann Arbor & Jackson Railway also uses a lever sander.

REGISTERS ON INTERURBAN CARS

There is a tendency to abandon registers on interurban cars having long runs. Some of the fares are beyond the range of registers usually in use at the present time and cash-fare receipts must be given for them. Since this is necessary for a portion of the fares on some roads, it is considered better to give receipts for all cash fares. The Indianapolis & Northwestern Traction Company uses a register only for registering 5-cent fares charged for going into and out of Indianapolis. Cash-fare receipts are given for purely interurban fares. The Detroit, Ypsilanti, Ann Arbor & Jackson Railway follows the same method.

On the Brazil division of the Terre Haute Traction & Light System cash-fare receipts are given for through fares and the fares are also rung up on the register. At the end of the route the cash-fare receipts are collected. Other than through fares are collected by 5-cent sections and rung on the register. On the Sullivan division a double register is used. One side indicates 10-cent fares and the other side cash collected for baggage.

SIGNS

Practice with respect to destination signs seems to vary according to location. The Cleveland roads all use a stenciled metal sign in a slot on the dash and illuminated at night by lights. On the Lake Shore Electric, the Sandusky limiteds show yellow, and the Toledo limiteds, red. The Northern Ohio Traction & Light Company, the Eastern Ohio and Cleveland, Painesville & Eastern have large board signs carried on the side of the deck giving names of the principal towns. The Columbus roads nearly all have plain metal signs on both front and rear, cars in this city being all double enders. The majority of the Dayton roads and the Western Ohio Railway do not carry any destination signs beyond the name of the road on the side of the car. At terminals they depend upon announcers to get people onto the right car. Limiteds on these roads are designated by large signs in front. The Canton-Akron Railway carries a revolving illuminated sign at one side of the front of the car above the motorman's head. It contains the names of all the routes on the system and is changed by turning a hand roller. The Interurban Railway & Terminal Company and the Cincinnati, Milford & Loveland have the names of towns printed on the deck windows with an illuminated revolving sign carried on the hood in front. Practically all roads operating limiteds carry board signs below the windows at the sides. Destination signs in Indiana are usually carried on both the front vestibule and the sides of the car near the rear door. Usually the signs bear the names of the terminal cities as well as of one or two of the intermediate towns. Wood signs are in many places being replaced by those of sheet steel. This is especially so for the signs on the front vestibules as the vestibules are frequently curved and necessitate the use of a curved sign. Some systems paint the names of the terminal cities directly on the vestibule dash. This method can only be adopted where the cars are always operated over one division.

CAR INSPECTION AND CLEANING

The importance of keeping the interior of cars clean and of making frequent inspections of the trucks and electrical apparatus is generally recognized by all of the roads visited. On the majority of the systems it is customary to clean the cars and inspect them after runs of from 80 to 200 miles. The runs are usually so arranged that after a car has made this mileage it is taken into a terminal house for a layover of an hour or more.

On the Indianapolis & Northwestern Traction System a 2-minute inspection is made of cars every trip of 60 miles. This inspection is made as the cars pass the shops at Lebanon by an inspector located in a small house near the track who occupies his spare time in cleaning headlights, marker and classification lights. The inspection made by this man includes trucks and bearings, trolley wheels, lights, etc. This inspector also keeps the water cooler filled. Every three days or after a mileage of about 1380 miles, the cars are brought into the shops for oiling and for a general inspection of electrical apparatus.

The Indianapolis, Columbus & Southern Traction Company give a great deal of attention to the cleaning of cars. The runs are arranged so that after each round trip from Columbus to Indianapolis the cars are laid over in the car house at Columbus. Two extra cars are kept at Columbus and this permits 2 hours to be spent in cleaning each car. Five men are employed to clean the cars and the cost per car is about 66 2/3 cents per day.

When the cars are brought in after each round trip, the car house foreman inspects the controller and rubs a little vaseline on the dry segments. The truck inspector inspects and oils the bearings and changes the brake-shoes when necessary. He also inspects the motors and the brushes. Another man cleans the windows, while another cleans the outside of the car body. Usually this is wiped with dry cotton waste, but when the body is unusually dirty, the waste is saturated with a cleaning compound and the car body is afterwards wiped dry. The floor of the car is mopped after each trip, the woodwork and light fixtures are cleaned and the seats are blown out with air. A 3/16-in. round air nozzle is used. Flat nozzles have been tried but round ones are preferred. The floors are painted about once in two months. Every six months all the seats are removed from the car and these as well as the car are given a thorough cleaning. The cars are touched up and revarnished once each year.

THE GENERATION AND TRANSMISSION OF POWER

A few years back, when most of the interurban roads were promoted and built by separate groups of promoters, the practice was to build a separate power station for each road. Individual engineers followed their own ideas as to designs of stations and methods of generating and transmitting current, and the result of these numerous individual and disconnected efforts was that up to a year or two ago there were in Ohio a large number of comparatively small power stations, each supplying in its own way a single property regardless of conditions nearby.

Direct-current generation and transmission were used on the majority of the earlier lines, and as late as four or five years ago direct current was advocated and used on new roads of less than 30 to 35 miles. As a matter of fact, the direct-current scheme of transmission still has many advocates among the operators of the shorter lines, who, while they are paying somewhat more per kw for current generated and have heavy investments in copper, which must some day be replaced, yet it cannot be denied they enjoy a comfortable feeling of security in times of high winds and severe storms, and they are inclined to view with sympathetic amusement the high tension and sub-station troubles of their larger neighbors.

Several of the earlier roads in Ohio using alternating current transmission employed a potential of 10,000 to 13,000 volts, but later years have seen a growing tendency towards larger stations, larger units and higher voltages. Six years ago witnessed the building of the Toledo, Fremont & Norwalk Railway, now a part of the Lake Shore Electric Railway, with a 2000-kw station, 65 miles of road and 16,500 volts transmission. This was the most ambitions interurban project attempted in the district up to that time, and the layout represented the highest developments in the art. A little later came the Stark Electric and the Cleveland & Southwestern, with 22,000 volts and 24,000 volts transmission, respectively. Then came the Western Ohio with an 80-mile line, 3300-kw station and 33,000-volt transmission lines. This high potential was looked upon with some skepticism at the time, but it has since been adopted by the Toledo Urban & Interurban, the Fort Wayne, Van Wert & Lima, Cincinnati Northern, Columbus, Delaware & Marion and the Cincinnati & Columbus.

The consolidation of interests and the grouping of systems which have been going on during the past two or three years have led to the abandonment of many of the smaller stations and the increasing of capacities of the larger ones, enabling power to be furnished over a number of connecting links from a single station.

The economy of large plants and the advantages of centralization of power have become generally recognized and there are several small roads in the district that are buying their power at a flat rate instead of producing it themselves. Thus, the Lake Shore Electric supplies the Sandusky, Norwalk & Mansfield; the Western Ohio supplies the Wort Wayne, Van Wert & Lima; and the Springfield, Troy & Piqua supplies the Springfield & Xenia and Springfield & South Charleston.

The St. Mary's power station of the Western Ohio takes care of 177 miles of road. The Cleveland & Southwestern, with 135 miles of road, has a single station, and it is the intention to add 86 miles to its load. The Medway power station of the Indiana, Columbus & Eastern supplies about 165 miles, and a considerable mileage will be added to this. The Schoepf syndicate, in completing its system from Cincinnati to Toledo, plans to supply power with three and possibly two power stations, while its line from Indianapolis through Dayton and Columbus to Zanesville will eventually be taken care of by either two or three stations. In view of the centralization and consolidation plans now under way, it is quite possible that five years will see 3000 miles of interurban roads in Ohio operated from ten and possibly fewer power stations where at present there are fifty interurban stations in the State.

Of seventeen roads in Ohio, three still use the direct current system transmission. These three are among the smaller systems, and are independently owned and operated. One large road rents its power, while the others employ transmission voltages ranging from 10,000 to 33,000 volts. Eight generate at low voltage alternating current and step-up to the desired transmission voltage. Five generate at the high voltage and transmit without the use of step-up transformers. A potential of 13,500 volts has been considered the maximum voltage at which current should be generated, but the Lake Shore Electric has one large unit generating at 16,500 volts. The roads using the higher voltages generate at a low voltage, usually about 400, and then step-up. The longest transmission at this voltage is that of the Western Ohio, which transmits 95 miles from the station. The Lake Shore Electric supplies about 225 miles of road from its two stations. This line has a single stretch of 120 miles, and its stations, which are approximately the same size, are located at suitable distances from the ends of the line to distribute the loads between the two stations to best advantage. This company believes that two generating stations are better than one for a road of this length. The transmission lines are all tied in together and one station can assist the other in cases of emergency, even to the extent of handling the entire load if necessary. Of course, under normal conditions each station takes care of its half of the load, and the longest transmission is not more than 35 miles on the main line. The Western Ohio has its St. Mary's station practically in the center of its system, with lines radiating in four directions. The Cleveland & Southwestern station at Elyria is also well centered, transmission lines extending in three directions.

Sizes of units have increased with the growth of stations. In the earlier stations the 500-hp engine was looked upon as the most economical size. Later, in providing for additional equipments, many of the roads installed 1000-hp units instead of two 500-hp, while in the new power houses on roads of 60 to 75 miles, two 1000-hp units have been selected. New and additional equipments of more recent date have consisted of 1250-hp engines in the cases of the Cincinnati & Columbus and the Toledo, Port Clinton & Lakeside, 1500 hp for the Scioto Valley and 1600-hp engines in the cases of the Lake Shore Electric and the Columbus, Buckeye Lake & Newark.

Steam turbines have been installed to some extent, and what are said to have been the first turbines used on electric roads were installed in Ohio. The first large installation of Westinghouse-Parsons turbines was that of the Cleveland & Southwestern, which has had two 1250-kw units in use for more than three years. One of these turbines commenced operation Dec. 20, 1903, and the other was started Aug. 4, 1904. The station also has two large direct-current reciprocating units, which take steam from the same steam lines and supply to common bus-bars. On several eight-hour tests with the turbines running alone, the fuel consumption has been 3 lbs. of coal per kw-hour. On ten-hour tests, with one engine and one turbine running, the fuel consumption was 3.8 lbs., while for a twenty-four-hour run, with all machines in service, the consumption was 4.25 lbs. per kw-hour. There has been no opportunity for making tests of the fuel consumption over a period of twenty-four hours with turbines alone in service. Under average conditions the station generates current at about 5½ mills per kw-hour. The two 1250-kw turbines occupy one end of the engine room in the

TABLE V.—SUMMARY OF POWER STATION DATA ON ROADS TREATED (See also Following Page).

NAMES OF COMPANIES.	Number and Location of Generating Stations.	System of Power.			Engines.	Total Rated Capacity of Engines in Hp.	Generators.
		Voltage Generated.	Voltage Transmitted.	Trolley Voltage.			
NORTHERN OHIO GROUP.							
Cleveland & Southwestern	1—Elyria	390 A.C.	24,000	650	2— 750 hp. Slater 2—1,250 kw. Parsons turbines	4,500	2— 500 kw. West. 2—1,250 kw. West.
Lake Shore Electric	2—Fremont Beach Park	390 A.C. 650 D.C., 16,500 A.C	16,500 16,500	650	4— 700 hp. West 2— 400 and 1 1,600 hp. Cooper	5,200	4— 500 kw. West. 2— 300 kw. Siemens & Halske D.C. 1—1,200 kw. G.E.
Eastern Ohio	2—Gates Mills Chagrin Falls	650 D.C 650 D.C.	13,000 650 D.C.	650	1,100 hp. 1,250 hp.	2,350	1— 900 kw. 1— 750 kw.
Toledo & Indiana	1—Stryker, O	13,500 A.C.	13,500	650	2—1,000 hp. Cooper	2,000	2— 750 kw. G.E.
Toledo & Western	1—Sylvania	13,200 A.C.	13,200	650	2—1,000 hp. Russell	2,000	2— 700 kw. G.E.
Toledo, Pt. Clinton & Lakeside	1—Pt. Clinton	375 A.C.	20,000	675	2—1,250 hp. Allis-Chalmers	2,560	2— 800 kw. Bullock.
Stark Electric	1—Maximo	360 A.C.	22,000	650	2— 750 hp. Russell	1,500	2— 500 kw. West.
Canton-Akron	1—Canton	13,200 A.C.	13,200	650	1—2,000 kw. Curtis turbine 2— 700 hp. Allis-Corliss 1—1,500 hp. Allis-Corliss	5,300	1—2,000 kw. G.E. 1— 800 kw. G.E. 2— 400 kw. G.E.
CENTRAL AND SOUTHERN OHIO GROUP.							
Western Ohio	1—St. Mary's	420 A.C.	33,000	675	2—1,200 hp. Cooper 2— 800 hp. Cooper	4,000	2—1,000 kw. West. 2— 650 kw. West.
Ft. Wayne, Van Wert & Lima	Buy power from Western Ohio Ry.	420 A.C.	33,000	675			
Dayton & Troy	1—Tippecanoe City	650 D.C.	650 D.C., 950 D.C.	600	2— 650 hp. Buckeye	1,300	2— 400 kw. West.
Dayton, Covington & Piqua	1—West Milton	650 D.C.	650 D.C.	650	2— 500 hp. Buckeye	1,000	2— 300 kw. G.E.
Scioto Valley	1—Reeses Station	375 A.C.	27,000	700	2—1,500 hp. Hamilton	3,000	2—1,000 kw. Bullock.
Cincinnati & Columbus	1—Cohoon	380 A.C.	33,000	650	2—1,250 hp. Cooper	2,500	2— 800 kw. G.E.
Cincinnati, Milford & Loveland	1—Loveland	400 A.C.	16,500	650	2— 750 hp. Allis-Chalmers	1,500	2— 500 kw. Bullock.
Interurban Ry. & T. Cincinnati	2—California and So. Lebanon	10,000 A.C.	10,000	650	2— 800 hp. and 2—650 hp. Buckeye 2— 800 hp. Buckeye	4,500	2— 400 kw. and 2—500 kw. West. 2— 500 kw. West.
Cincinnati, Georgetown & Portsmouth	1—Hazen	360 A.C.	15,000	650	2—1,000 hp. Hamilton-Corliss	2,000	2— 600 kw. West.
INDIANA GROUP.							
Indiana Union*	1—Anderson	385 A.C	15,000, 30,000	650	5—1,000 hp. Rice & Sargent	6,600	5—1,000 kw. West.
Indianapolis & Northwestern	1—Lebanon	390 A.C.	30,000	625	3—1,200 hp. Hamilton-Corliss	3,600	3— 800 kw. G.E.
Indianapolis & Cincinnati (single-phase)	1—Rushville	2300 A.C.	33,000	3,300 A.C.	2— 500 kw. Curtis turbines	....	2— 500 kw. G.E.
Indianapolis, Columbus & Southern	1—Edinburg	370 A.C.	15,000	625	1 Buckeye single, 1 Buckeye compound	1,650	Stanley.
Terre Haute Tr. & Lgt	3—2 at Terre Haute, 1 at Brazil	2,200 A.C. and 600 D.C.	11,000, 22,000	550	Curtis turbines	....	Curtis turbines.
Kokomo, Marion & Western	1—Kokomo	2,300 A.C.	11,000, 22,000	600	Russell	1,200	Stanley.
Ft. Wayne & Wabash Valley	3—Boyd Park, Ft. Wayne, Huntington†	13,200 A.C. 16,500 A.C.	13,200, 16,500	600		....	1— 450 kw. G.E. 1— 250 kw. West. 1— 500 kw. G.E. 3— 200 kw. G.E. 1— 100 kw. G.E.
MICHIGAN GROUP.							
Rapid Railway System, Detroit	1—New Baltimore	390 A.C.	16,500	650	3—1,200 hp. Vertical compound 1—1,200 kw. Parsons turbine	5,200	West.
Detroit, Ypsilanti, A. A. & J.	1—Ypsilanti	390 A.C., 650 D.C.	22,000	650	8 West	2,665	West.

* Union Traction and Indianapolis Northern Traction only. † New station being built at Huntington. Present stations will be dismantled.

station, while the other end is occupied by the two 500-kw reciprocating engines, and there is space in the turbine end for a third unit.

The Canton-Akron Railway Company has a 2000-kw Curtis turbine which has been in service about six months. The advantage of economy in space is particularly marked in this installation, as the machine was placed between two other machines without enlarging the station, which would not have accommodated another reciprocating unit, and the capacity of the station was increased from 1600 kw to 2600 kw by the new machine. The cost of current at this station is less than 4½ mills per kw-hour. On one occasion the turbine carried the entire load of the system for eight days without assistance.

The Northern Ohio Traction & Light Company has a 500-volt, direct-current Curtis turbine at Akron, and is installing a large a. c. turbo unit at the present time.

The Columbus, Delaware & Marion Railway has a 2000-kw Curtis turbine in service and is installing a second one.

The Ohio Central Traction Company has a 150-kw De Laval turbine, which has been in service for three years.

The Lake Shore Electric Railway is installing a 2000-kw Parsons turbine in its Beach Park station, and plans are being laid to install a similar unit in its Fremont station.

Water-tube boilers of the Stirling or B. & W. type predominate. The tendency is towards the use of larger units, in order to economize space and labor. In the later installations 450 and

500-hp units are the popular sizes.

Up to a year or so ago very few plants in the district were equipped with stokers, probably because most of the roads were built with limited investment. As lines have been extended and power stations made larger, the theories have undergone a change. It has been found that for a plant of over 2000 hp stokers will usually effect a saving in fuel and labor accounts which will more than pay for the added investment.

Eight out of seventeen plants investigated are now equipped with stokers and two or three others are figuring on such equipment.

The same condition applies in a more limited degree to the use of fuel handling outfits. Engineers for the larger stations are becoming convinced that it is economy to have some sort of apparatus which will take the fuel directly from the cars, pass it through crushers and then distribute in into overhead bunkers so that it will flow by gravity or by means of conveyors to the stokers.

Some interesting comparisons may be made from the columns in the accompanying tables showing the rated capacity of various power stations per mile of track supplied, and per car operated on an average schedule. It will be seen that there is a wide variation in these data results. The table shows that several roads are badly handicapped by a shortage of power. The average rated capacity of seventeen stations per mile of track was 24.1-kw, and the average per car operated on an average schedule was 156.2 kw. The size of cars and the frequency of service of course causes a variation in the results of the second mentioned table; for instance, while the Lake Shore Electric approaches closely to the average on the miles of track supplied, its frequent service and high-power cars reduce the power station capacity per car operated to the low figure of 88.3 kw. It might be stated, however, that this company is largely increasing its power equipment at the present time.

The data on current consumption per car-mile also show some interesting variations. The results were obtained by dividing the station output for the year by the car mileage. Several roads do not keep accurate records, hence it was impossible to secure figures from all of the companies. The average for ten roads was exactly 3 kw per car-mile, but as will be seen there was considerable variation from this. It was intimated to one manager that his figures were considerably above the average. He admitted this and explained

TABLE V.—SUMMARY OF POWER STATION DATA ON ROADS TREATED.—*Concluded.*

NAMES OF COMPANIES.	Total Rated Capacity of Generators in Kw.	Boilers.	Total Rated Capacity of Boilers in Hp.	Condensers.	Economizers.	Mechanical or Induced Draft.	Feed-Water Heater.	Mechanical Stokers.	Total Output all Stations in Kw.	Maximum Output all Stations.	Rated Cap., Kw., all Stations per Car Operated on Daily Average Schedule.	Kw. Hours per Car Mile for Year.
NORTH ERN OHIO GROUP.												
Cleveland & Southwestern	3,500	3— 500 hp. Heine, 2—325 hp. Stirling 2— 345 hp. Stirling, 2—500 hp. Stirling	3,880	Surface jet	No	No	Hoppes	Roney	3,500	50% overload	116.6	3.9
Lake Shore Electric	3,800	2— 400 hp. B. & W 4— 300 hp. Stirling, 3—350 hp. Stirling 1,250 hp	5,050		Yes	Yes	Cochrane	Murphy	3,800	50% overload	88.3	3.18
Eastern Ohio	1,650		1,800	Jet	No	No		Jones	1,650	50% overload	126.9	
Toledo & Indiana	1,500	4— 400 hp. Stirling	1,600	Surface	No	No	Cochrane		1,500	50% overload	136.2	3.01
Toledo & Western	1,400	4— 250 hp. Stirling	1,000	Jet	No	No	Cochrane		1,400	50% overload	116.6	
Toledo, Fremont & Lakeside	1,000	4— 250 hp. Stirling	1,000	Barometric	No	No	Cochrane		1,000	50% overload	228.6	
Stark Electric	1,000	4— 350 hp. Stirling	1,400	Jet	No	No	Cochrane	Green Eng. Co	1,000	50% overload	166.6	
Canton-Akron	3,600	8— 300 hp. B. & W. and Heine	2,400	Barometric	No	No	Cochrane	Model and Roney	3,600	1,500 kw	246.6	3.01
CENTRAL AND SOUTHERN OHIO GROUP.												
Western Ohio	3,300	10— 300 hp. Stirling	3,000	Jet	No	No	Davidson	Model	3,300	50% overload	183.3	2.97
Ft. Wayne, Van Wert & Lima	800	3— 400 hp. B. & W	1,200	Jet	No	No	Stillwell-Bierce		800	1,200 kw	22.9	3.00
Dayton & Troy	600	4— 150 hp. Hodges	600	Jet	Yes	Yes	Wainwright	Roney	600	720 kw	17.6	2.1
Dayton, Covington & Piqua	600	4— 450 hp. Franklin	1,800	Barometric	No	Yes	Wainwright	Roney	2,000	4,500 kw	25.0	3.1
Scioto Valley	2,000	4— 400 hp. A. & T	1,800	Surface	Yes	Yes	Cochrane	American	1,600	2,400 kw	30.7	
Columbus, Grove City & Urbana	1,000	4— 400 hp. Stirling	1,600	Barometric	No	No			1,000	1,500 kw	27.0	142.8
Cincinnati, Milford & Loveland	1,000	4— 350 hp. A. & T	1,600	Surface and jet	No	No	Cochrane		2,800	4,200 kw	28.6	93.3
Interurban Ry. & T. Cincinnati	2,800	6— 350 hp. A. & T	3,500	Barometric	No	No	Stillwell-Bierce		1,200	1,800 kw	20.	125.
Cincinnati, Georgetown & Portsmouth	1,200	5— 300 hp. A. & T	1,500									
INDIANA GROUP.												
Indiana Union*	5,000	10—400 hp., 4—600 hp	6,400	Jet	No	No	S. B. and S. V	B. & W. chain grate	5,000			4.4
Indianapolis & Northwestern	2,400	6— 500 hp. Stirling	3,000	Surface	No	No	Cochrane	Roney	2,400		27.5	4.77
Indianapolis & Cincinnati (single-phase)	3,000	B. & W	2,800	Jet and surface	No	No	S. B. and S. V	B. & W. chain grate	3,000			4.25
Indianapolis, Columbus & Southern	2,000	B. & W	1,200	Jet	No	No	Hoppes		1,100		29.	
Terre Haute Tr. & Lgt. & Southern	2,000	B. & W		Surface	No	No	Hoppes	None		†	†	†
Kokomo, Marion & Western	733	Stirling	1,000	Jet	No	Yes	Cochrane	E. E. S. Co. shaking grates		†	†	2.5
Ft. Wayne & Wabash Valley	750 1,200	B. P., 3—350 hp. A. & T. F. W., 1,400 hp. Stirling & Bass										
MICHIGAN GROUP.												
Rapid Railway System, Detroit	2,700	4— 300 hp. B. & W., 2—500 hp. Stirling	2,200	3 Barometric, 1 Dry vacuum jet	Yes	Yes	Cochrane	Roney	2,700		45.	3.6
Detroit, Ypsilanti, A. A. & J	2,000	8— 228 hp. B. & W	1,824	Barometric	Yes	Yes	Bareguandath	Roney	2,000		20.	

* Union Traction and Indianapolis Northern Traction only. † Combined railway and lighting station.

that the line losses were excessive, due to insufficient feeders and poor bonding. He said that this condition was being corrected as rapidly as possible. The Western Ohio, while operating at very high speed, reported a current consumption of 2.97 kw per car-mile, showing the results of smaller motors than the average, and the advantage of liberal installations of feeders, bonding, sub-stations and general power conditions. The Scioto Valley, with ample power, plenty of feeders and good bonding, shows but 3.1 kw-hours per car-mile in spite of the use of 40-ton cars and 400-hp motors to the car. Low grades and few stops also improve conditions for this road. The Dayton, Covington & Piqua, which had a low mark of 2.1, has only 35-hp motors, very light cars, and its feeders and return circuits are ample.

REORGANIZATION AND STANDARDIZATION OF POWER EQUIPMENT OF THE SCHOEPF-M'GOWAN SYNDICATE ROADS

The Schoepf-McGowan Syndicate now controls a large majority of the electric railway mileage in Central and Western Ohio and practically all of the roads of Central Indiana centering in Indianapolis. These roads include the following properties:

Cincinnati & Northern Traction Company; Indiana, Columbus & Eastern Traction Company; Lima & Toledo Traction Company; Dayton & Muncie Traction Company; Richmond Street & Interurban Railway Company; Indianapolis & Eastern; Indianapolis & Western; Indianapolis & Northwestern; Indianapolis Coal Traction Company; Indianapolis & Martinsville Rapid Transit Company; Indianapolis Traction & Terminal Company; Indiana Union Traction Company; La Fayette-Logansport Line.

The Indiana, Columbus & Eastern is a consolidation of the Dayton & Western; Dayton & Northern; Dayton, Springfield & Urbana; Urbana, Bellefontaine & Northern; Columbus, London & Springfield; Grove City & Southwestern; Central Market; Columbus, Buckeye Lake & Newark; Columbus, Newark & Zanesville; Zanesville Railway & Light Company, and Columbus & Lake Michigan Railway.

The Lima & Toledo Traction Company includes the Fort Wayne, Van Wert & Lima, the Lima Railway & Light Company and the new line between Lima and Toledo.

The syndicate's system, consisting, as it does, of the consolidation of a very large number of small properties built under independent auspices, contains a wide variety of small power stations which, naturally, lack uniformity, and the syndicate is now actively engaged in standardizing the power equipment of the whole system, which, when completed, will present a uniform scheme of power transmission at 33,000 volts pressure. The accompanying map shows the lines owned by this syndicate, as well as the new lines under construction. The present plans of reorganization include the building of new stations at Fort Wayne and at Lindenwald, a suburb of Hamilton, Ohio, the addition of new machinery at Zanesville, Hebron, Medway, Indianapolis and Lima, and the abandonment of about a dozen smaller direct-current stations, which will be either entirely dismantled or re-equipped for sub-stations. As far as possible, the standards to be adopted in all the new work and additions to the old stations which have been retained include the use of 1500-kw Westinghouse turbo-generator units and 33,000-volt transmission lines. The standard car equipment will consist of four 75-hp Westinghouse motors per car, operated by the unit switch system of multiple control.

THE FORT WAYNE POWER STATION

The most important work of reconstruction includes the new power stations at Fort Wayne and Hamilton, both of these stations, in conformity with the plans for standardization, being almost identical. The accompanying illustrations show a cross-section of the Fort Wayne power house and coal-handling apparatus, from which the general design of the plant may be readily seen. The chief feature of the design is the placing of the turbine room above the boiler room.

The main building is a two-story structure, the foundation being of concrete and the superstructure of red pressed brick. The lower floor is used as a boiler room and the second floor for the steam turbines and generators. The equipment of the generator room includes two 1500-kw, 25-cycle Westinghouse turbo-generators; one 400-kw, 25-cycle Westinghouse turbo-generator; six 375-kw, oil-insulated, self-cooling transformers, and three 500-kw, 25-cycle rotaries. In addition to the above-mentioned equipment, which is for interurban railway purposes, the station will also contain two 1500-kw, 60-cycle, 2300-volt Westinghouse turbo-generator units, one 500-kw, 60-cycle turbo-generator for lighting purposes, and one 300-kw, 60-cycle rotary transformer for power purposes. The location of these units is indicated on the plan of the engine room shown herewith. It will be seen that the capacity of the station can be indefinitely increased by extending the length of the building and adding as many similar units as may be required.

The boiler equipment consists of ten 400-hp Babcock & Wilcox boilers, which will carry 175 lbs. pressure, and contain superheaters for superheating the steam to 75 degrees. The boilers are equipped with Roney stokers, and the ashes are delivered to a pit beneath the furnaces and underneath the boiler room floor. These ash pits communicate by means of doors with a passage under the boiler room floor running the full length of the building, and a track will be provided in this passage-way for cars into which the ashes from the pits can be emptied and carried away. The boilers are fed by two Yough pumps built by the Boyts-Porter Company, of Connellsville, Pa. These have 20-in. and 12-in. cylinders by 30-in. stroke. These pumps are located in the passage-way back of the boiler room, which runs the full length of the building.

Each of the 1500-kw turbine units exhausts into a pair of 24-in. Bulkley twin condensers. The 500-kw turbine is connected to an 18-in. condenser and the 400-kw turbine to a 16-in. condenser of the same make. The circulating pumps for all of the turbine units are of the same make as the boiler feed pumps. Those for the large units are 20 ins. and 36 ins. by 48 ins., and those for the small turbines are 12 ins. and 20 ins. by 48 ins. All of the station auxiliaries exhaust into two Platt Iron Works' heaters of 3000-hp capacity each. There are also two tank pumps of 12 ins. and 12 ins. by 18-in. stroke for pumping water from a hot-well to an overhead tank for the house supply. This tank is of 25,000 gallons capacity, and was built by the Chicago Bridge & Iron Works. The Custodis chimney is located in the rear of the building near the center, and is 12 ft. inside diameter by 185 ft. in height.

The generator, rotary converter and exciter switchboards are arranged parallel to one side of the station in front of the generating units on the second floor. The generator room is faced with white enameled brick, and contains a 20-ton traveling crane built by the Niles Tool Works. The generating sets are provided with casings from which a supply of cool air from outdoors circulates. This air is taken in through a duct extending the full length of the building underneath the floor of the generator room, and the air, after circulating around the generator units, is discharged into the boiler room. It was found that the amount of air required for cooling purposes corresponded almost exactly to the amount necessary for the boilers, so that, by discharging it into the boiler room, it was easily and conveniently disposed of.

The water supply for this station is taken from a river near which the station is located by means of a concrete intake pas-

sage extending the full length of the building, and a branch from this running out at right angles to the river. A crib was built at the intake end of this passage and water from the river flows into the lowest level of the passage. The hot water is discharged at a higher level in the same passage-way, on the down-stream side of the crib, at some distance from the point of intake, so as to avoid any return of the hot water for condensing purposes.

One of the most interesting features of this plant is the coal-handling device, which is shown in cross-section in one of the accompanying illustrations. A large concrete pit for coal storage is built at one side of the station, extending the whole length of the building. This pit has a capacity for storing 7500 tons of coal, and is entirely open overhead. It is surmounted by a traveling gantry crane built by the Fairbanks, Morse Company, which has a track gage of 60 ft. The crane carries a 1-ton Kester bucket, into which the coal is raised from the pit and deposited in a single-roll McCaslin coal crusher on the side of the crane next to the power house. The gantry crane has a travel of 180 ft., which is the full length of the building, and the coal, after passing through the crusher, is delivered into a bunker extending the full length of the building and having a capacity of about 400 tons of coal. From this bunker chutes pass down in front of each boiler and feed the coal into the stokers.

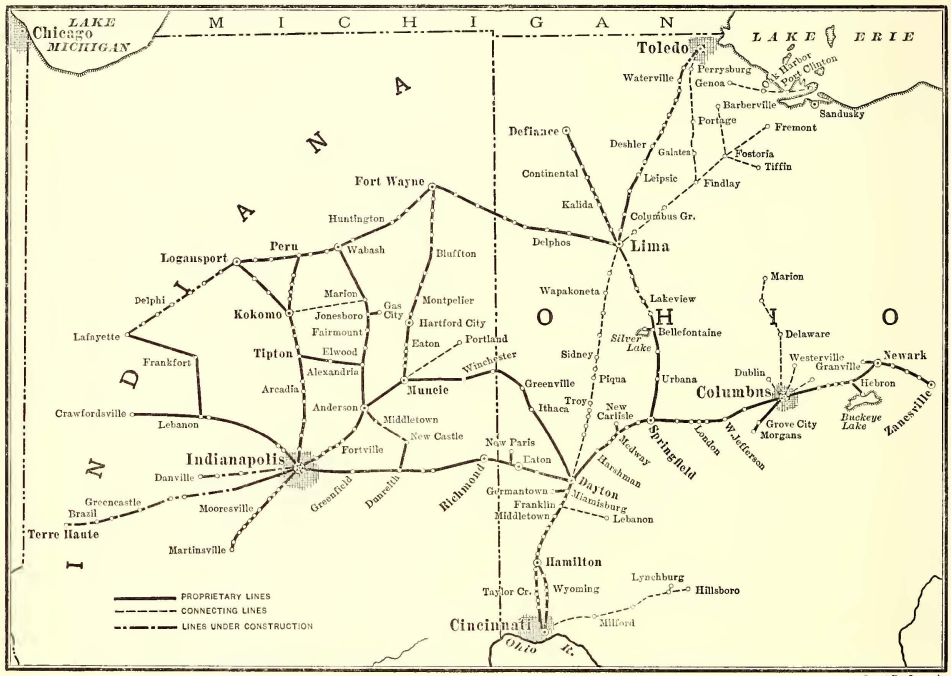
The coal is delivered to the pit from a railroad siding, the cars passing directly overhead on the tracks. By means of this arrangement no overhead coal storage is required in the station building, which greatly reduces the cost of coal storage equipment. Furthermore, the fire risk to the station is greatly reduced by having all the coal stored in the open air, where, in case of fire, no damage to the building would result.

The step-up transformers are located in vaults at one side of the generator room, and all of the high-tension wiring is to be run in ducts.

LINDENWALD POWER STATION

The other new station is located at Lindenwald, near Hamilton, Ohio, and is so generally a duplicate of the Fort Wayne plant that the buildings were erected after the same drawings. Almost exactly the same arrangement of machinery will be found in the latter station, except that there are no lighting units at Lindenwald.

This station contains three 1500-kw and one 750-kw Westinghouse turbo-generator units, and eight 400-hp Babcock &



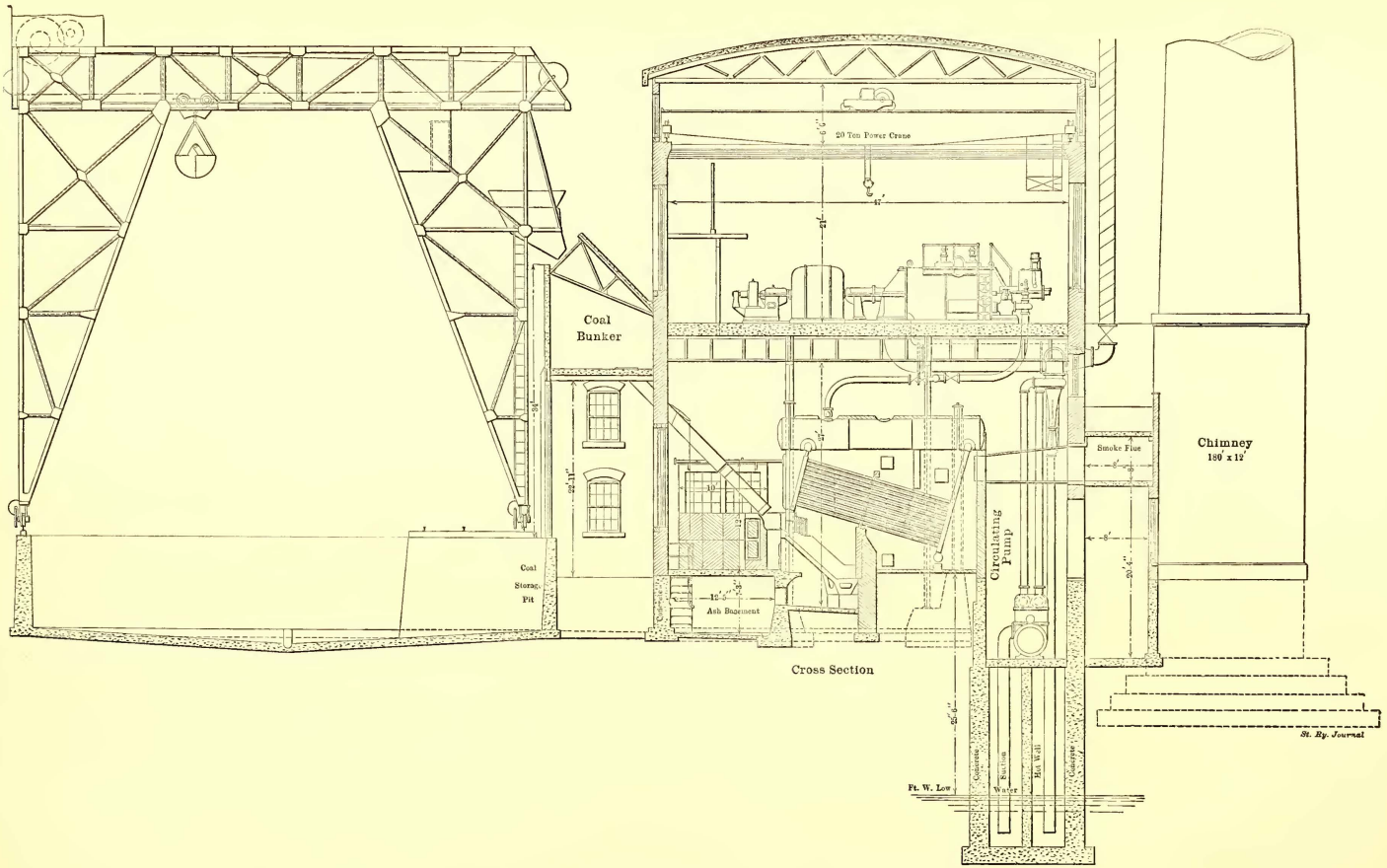
MAP OF OHIO AND INDIANA, SHOWING THE SCHOEPF PROPERTIES

Wilcox boilers with superheaters. The same type of auxiliaries is used here as at Fort Wayne, and, as their location and arrangement is exactly the same, a detailed description is unnecessary.

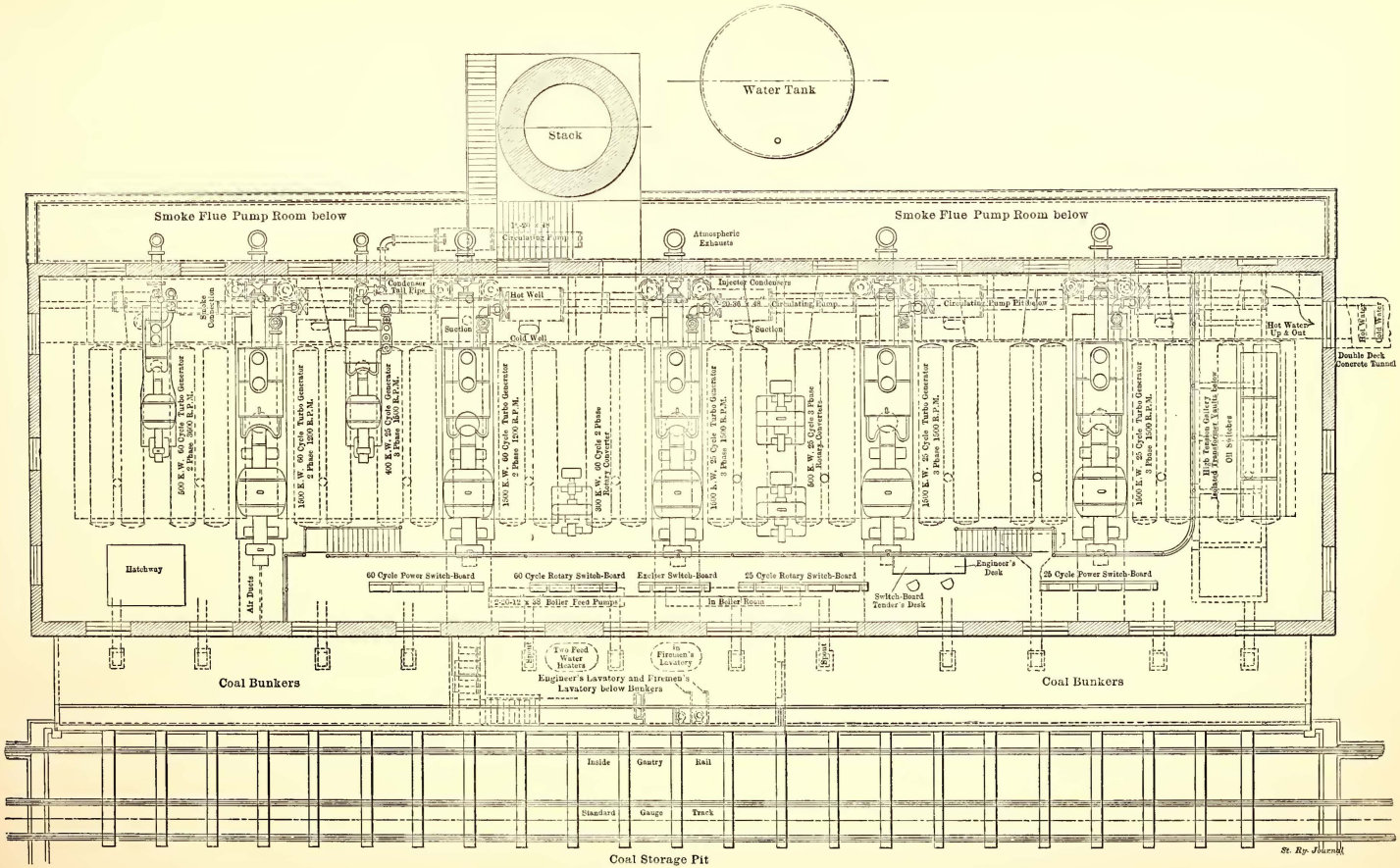
ADDITIONS TO OLD PLANTS

The present plant at Medway, Ohio, has been enlarged by the removal of one 325-kw, direct-current generator and the addition of one 1500 and one 750-kw Westinghouse turbo-generators. The current from these machines is stepped-up to 33,000 volts by three 70-kw Westinghouse oil-insulated, self-cooling transformers. The section of the road adjacent to the station is supplied by means of one 300-kw Westinghouse rotary converter and three 110-kw transformers, which have also been recently installed.

The boiler room of this plant has been extended 39 ft., and two 525-hp Babcock & Wilcox boilers with superheaters are to be added. A new red brick stack is now in course of erection, which will be 9 ft. in diameter at the bottom, 8 ft. at the top, and 150 ft. high. Wheeler surface condensers and centrifugal pumps are being installed for the new units, which make the total electric capacity of the station 4500 kw.



CROSS-SECTION NEW DOUBLE-DECK POWER STATION AT FORT WAYNE, FOR THE SCHOEPF PROPERTIES. THE TURBINE ROOM IS OVER THE BOILER ROOM



PLAN OF NEW POWER STATION AT FORT WAYNE, FOR THE SCHOEPF PROPERTIES

At the Indianapolis station there are being added two 1500-kw. Westinghouse turbo-generator units and four 500-kw Westinghouse oil-insulated, self-cooling transformers, one of which is held in reserve. The turbo-generators deliver current at 390 volts, which is stepped-up to 33,000 volts for the overhead distribution. One 1500-kw rotary is also being installed to feed about six miles of the interurban line now building west of Indianapolis. The boiler room is being enlarged by the addition of 2400-hp Babcock & Wilcox boilers with superheaters, the boilers being in 400-hp units. Baragawanth condensers are being installed for the new units, and the condensing water will be supplied by Boyts-Porter pumps. All of the boilers are provided with Roney stokers, and the new units have settings faced with white enameled brick.

As the water in this station is bad, especially at certain seasons of the year, a water-purifying plant has recently been installed, which is giving excellent results. This plant was built by the United States Wind & Engine Company, of Batavia, Ill., and consists of three tanks, each having a capacity of 77,000 gallons. Water from the river is pumped into these tanks and is thoroughly aerated by means of compressed air, and to each tankful of water is added 110 lbs. of lime and 29 lbs. of soda ash. Each tank is alternately filled and allowed to settle, after which the water is found to be perfectly clear and soft.

In order to care for that part of the new interurban line between Lima and Toledo, which was recently opened as far as Leipsic, the power plant at Lima is being enlarged by the addition of one 375-kw, 550-volt Westinghouse direct-current generator, which is direct connected to a 530-hp Buckeye tandem engine.

The length of line just opened on this road is about 30 miles, and, as no high-tension alternating current is available at this point, a booster set has been added to the Lima station, to take care of the farther end of this line. The booster set consists of a 220-hp, 550-volt Westinghouse motor and a 150-kw, 250-volt, 600-ampere Westinghouse generator, which raises the feeder pressure to 800 volts. There are two 400-hp Babcock & Wilcox boilers to be added to this plant, which is designed to take care of the new extensions until final plans for the proper development of this section have been completed.

The capacity of the station at Hebron is being increased by the addition of more boilers, and at Zanesville a 500-kw Westinghouse motor-generator set and a 300-kw rotary transformer are being installed to provide for the extreme eastern end of the system.

It is the aim of the Schoepf-McGowan syndicate to standardize its lines and equipments throughout, as far as possible. The plant of the Indiana Union Traction Company, which contains five 1000-kw Westinghouse alternating-current generators, is the only one of the interurban power plants which is to be retained without some changes. This is an entirely modern and up-to-date equipment, and has already been thoroughly described in the technical press, so that further details at this time are unnecessary.

When the present additions and changes have been completed the company will have attained a remarkably uniform plan of power development and distribution, which will not only greatly simplify the operation of the system as a whole, but will largely decrease the amount of spare apparatus and repair parts which must always be carried in stock.

STORAGE BATTERIES

Many of the interurban roads in Ohio and Indiana are equipped with powerful storage batteries, used to improve the operation of the systems, as well as for reducing the operating costs. These storage batteries are usually installed with plates, merely sufficient to meet the demands of the load at the time that they are put in. The containing tanks, boosters and other accessories are, however, often considerably larger, so that as the load grows the battery may be increased in size by the addition of plates; and, as to giving an idea of the great extent to which batteries are used in this class of work, it will be interesting to know that at the present time there are over 25 installations in the State of Ohio and 16 or more in Indiana, making a total of over 40 for the two States on interurban work alone. These have been furnished by the Electric Storage Battery Company, of Philadelphia. These aggregate an initial capacity of 9376 kw at the 1-hour rate of the battery and 11,710 kw-hours when the batteries have been increased to their ultimate capacity.

The Northern Ohio Traction & Light Company has a battery with an initial capacity of 192 kw and an ultimate capacity of 288 kw operating at its Bedford station. Before this battery was installed it was necessary to operate two 250-kw generators to carry the load at all times. Since the battery was installed the road has operated a large portion of the time with but one generator, which has resulted in a large saving of coal. Another battery, with a capacity of 140 kw, is operated on the Revenna division as a line battery. This installation has resulted in maintaining a minimum voltage of 400 volts on this line, whereas previously it fluctuated between 100 and 500 volts.

The Cincinnati Northern Traction Company has a battery of 120 kw in glass jars installed at its Dwyer sub-station. This battery, by removing the fluctuations due to starting and stopping of cars, climbing grades, etc., enables the station to be operated a very large portion of the time with one rotary.

The Dayton & Northern Traction Company was the pioneer of Ohio in the use of storage batteries for interurban work. It was the first to equip its road in this manner, and the installations at Brookville and Arcanum each consists of a 260-kw battery operating in sub-stations. This road was especially designed with a view to the use of batteries, and it was, therefore, enabled to install smaller generators and rotaries than had the batteries been omitted.

VOLTAGES

In the table showing the voltages used on interurban systems in the States visited, it will be seen that there is considerable difference in the figures, and that the reason for these differences is not obvious. There has been a steady increase in the voltage of three-phase transmission lines, and even at the present time there appears to be nothing to check this increase.

Sixty-six hundred volts was at one time considered to be about the limit for this work, and a little later this figure was doubled, giving the well-known figure of 13,200 volts. In the meantime, one or two systems had started operation at 11,000 volts. Soon after some installations began operating at 13,200 volts a few roads were projected, which, on account of their length, required transmission voltage higher than this figure, and it was again doubled, making the figure 26,400 volts. In the meantime, other plants found it advisable to double the figure 11,000, giving some plants operating at 22,000 volts, and in cases where this was insufficient 33,000 volts had been used; and there were also a few plants where 11,000 volts appeared to be insufficient, and where 22,000 was higher than seemed necessary. These plants split the difference and adopted the voltage 16,500. It will be noticed that all of these figures are multiples of 110, the well-known figure for incandescent lamps.

It will also be found that many of the railway plants have voltages which do not fall exactly on these figures, but come more or less closely to one of these—e. g., the 26,400 may be either as low as 25,000 or as high as 27,000, and there are many intermediate figures between 10,000 and 13,200.

These latter variations in voltages are partly due to the various interpretations which are placed on the standardization recommendations of the American Institute of Electrical Engineers, which read as follows: "In alternating-current, high-pressure

circuits, at the receiving end the following pressures are in general use, and are recommended: 1000 volts, 2000 volts, 3000 volts, 6000 volts, 10,000 volts, 15,000 volts, 20,000 volts." As these figures were stated as being the voltage at the receiving end, the voltage at the generator, or step-up transformers, was a variable quantity, such as 5, 10 or 15 per cent greater, depending on the slide rule calculations and assumptions of the engineer in charge of the transmission. Consequently, one man winds his generator for 10,000 volts, while others wind for 10,500, 11,000, 11,500 or 12,000, or intermediate figures, and all of these people believe they are following the Institute standard.

It is also a matter of pride with operating engineers to have the voltage of their system higher than their neighbors, so that they will always mention the voltage of the generator or step-up transformers rather than the voltage at the receiving end. Also, the number of plants which generate at one point and have their load concentrated at a single point are extremely few, so that the receiving voltage must be graded all the way from the generating station to the most distant point, where the line drop is greatest.

With few exceptions, 25 cycles is the standard frequency for railway rotary converter work, and a tabulation of the plants operating at this frequency will show that there are more operating at 13,200 volts than at any other figure. The usual practice in railway work, not only at this voltage, but at the higher voltage, is to wind all the transformers at the full line potential, adding taps (usually four) giving 10 per cent range in 2½ per cent steps. This arrangement makes the transformers interchangeable, and permits of adjustment to compensate for as much as 10 per cent line drop, this figure being rarely exceeded in railway transmissions, and, in fact, cannot be greatly exceeded without the chance of starting pulsation of converters. The taps also have the additional advantage of compensating for differences in ratios of transformers and converters of the same or different manufacture.

It is obviously desirable to have in general use as few different voltages as will meet the various requirements, as this should not only mean better prices and deliveries on main apparatus, but also on auxiliary apparatus, such as switches, current and potential transformers, insulators, lightning arresters, cables, etc.

At the present time there is a general tendency to make use of 33,000 volts on systems where 13,200 volts is not enough. If these transformers are made Y connected for 33,000 volts they may be connected delta at approximately 19,100 volts, in case the length of transmission or the load are such as to make operation at the higher figure unnecessary. Two lines of transformers, therefore, namely, 13,200 volts and 33,000 volts, Y connected, would appear to be sufficient to meet most of the railroad requirements at the present time, and the proposed use of any other voltage on 25-cycle railway work should be questioned. The cases where other voltages are justified are cases where nearby systems are already in operation at other figures. In these cases the inevitable extensions and consolidations will, sooner or later, make it desirable to operate the two systems either from one large power house or interchange power for greater flexibility and reliability in operation, e. g., as has been done in large city works. For instance, Chicago has an extensive system in operation at 9000 volts. Buffalo and New York City have railway systems operating at 11,000 volts, while most of the other large cities—San Francisco, St. Louis, Minneapolis and St. Paul, Baltimore, Philadelphia and others—operate at 13,200 volts.

In the State of Ohio there are a number of roads operating at 26,400 volts, and others at 33,000 volts. The latter and higher figure is in better standing and of more general use, but there may be locations where the possible purchase or interchange of power would justify standing by the lower figure.

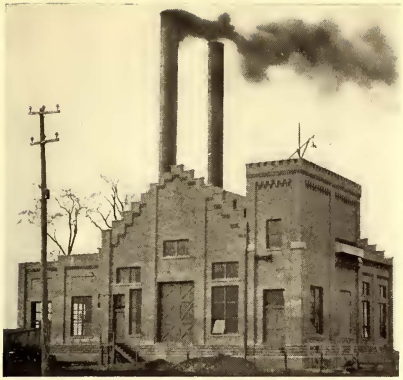
The transformer is a very flexible piece of apparatus, and while this has advantages it also has disadvantages—e. g., a man having transformers wound for 33,000 volts may decide that this voltage is too high for his needs and decides to operate at 16,500 volts by parallel connection of primary coils. Another man under the same conditions, instead of parallel connection, may change from Y to delta connection and operate with this same apparatus at, roughly, 19,000 volts. Another engineer, finding that his road has outgrown the original 13,200-volt transmission, will change his transformer from delta to Y and operate at approximately 22,800 volts. This flexibility of connections, while at times convenient, is obviously the direct means of introducing a large number of new "standard" voltages. It is apparent, therefore, that any recommended figures for standard transmission voltages which do not take into account the same transformer connected both Y and delta, will have little following. This ratio is $\sqrt{3}$, (1.73) in the case of changing from delta to Y, or $\frac{1}{\sqrt{3}}$, (0.58) in the case of changing from Y to delta. A consistent line of transformers, therefore, would take these ratios into account—e. g., 11,000 volts, 19,100 volts, 33,000 volts, 37,000 volts, 100,000 volts. Each of these figures is 1.73 times the next lower and 58 per cent of the next higher. The figure 100,000 is forecasting the future a little; but, approximately, the figure 57,000 is already in considerable use. Even if these figures were taken as standard, and transformers built only to meet these voltages, there would be nothing to prevent the purchaser from halving any of these figures by connecting coils in parallel, and again connecting the paralleled coils in Y, which would immediately make a lot more of "standard" voltages.

On 13,200-volt plants it is common practice to generate directly at this figure, thus dispensing with the use of step-up transformers. This is by no means the possible limit of direct generation, as one road in Ohio generates directly at 16,500 volts; but 13,200 is the highest figure for direct generation in common use. Where the voltage must be higher than this, such as 33,000 volts, the generators are usually wound for 2200 volts, unless there happen to be rotary converters in the same building with the generators, in which case three-phase generators, operating at approximately 370 volts, give the desired direct-current voltage of 600.

Twenty-two hundred volts is selected on account of the moderate size cables required, and also because switches and other accessory apparatus are developed and in general use at this figure. Twenty-two hundred, like the other figures, is also a multiple of 11, and, therefore, the high-tension voltages of 13,200, 33,000, etc., are multiples of the low-tension voltage.

Three hundred and seventy volts, while quite satisfactory for the smaller generators, requires very cumbersome connections, cables, switches, bus-bars, etc., as soon as the generator gets to be as large as 1000 or 2000 kw. On account of the simplified switching equipment, many roads regard generator and bank of transformers as single unit, making low tension connections permanently between the two, and thus dispensing with large low-tension bus-bars and switches. In fact, this simplification and saving is so great that some roads are found with converters in the same room, making use of both step-up and step-down transformers to feed these converters. While this means increased losses and increased transformer expense, the simplified switching is considered to justify the arrangement.

A few years ago more or less publicity was given to a con-



POWER STATION, TOLEDO, PT. CLINTON & LAKESIDE

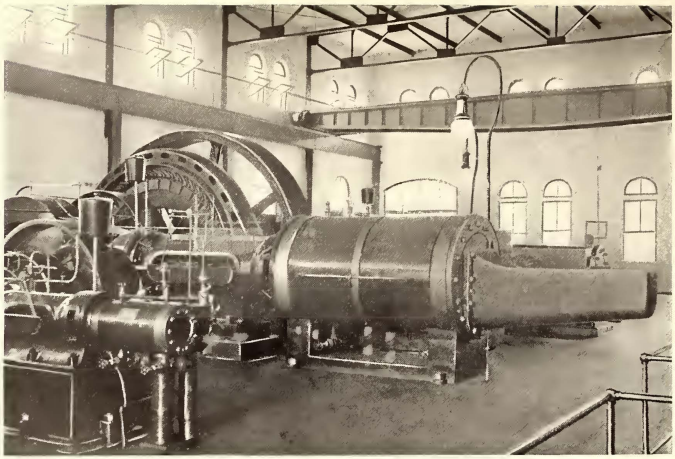
POWER STATION, BATTERY HOUSE AND WATER-COOLING TRAYS, DAYTON & MUNCIE

POWER STATION AT HEBRON, COLUMBUS, BUCKEYE & NEWARK

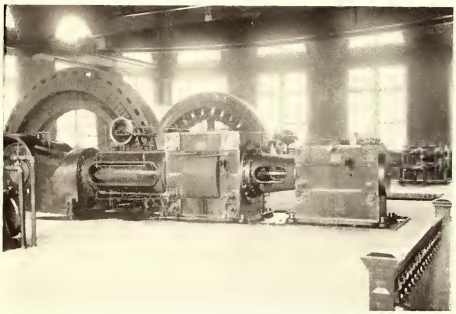
POWER STATION AT MEDWAY, DAYTON, SPRINGFIELD & URBANA

POWER STATION AT FINDLAY, TOLEDO URBAN & INTERURBAN

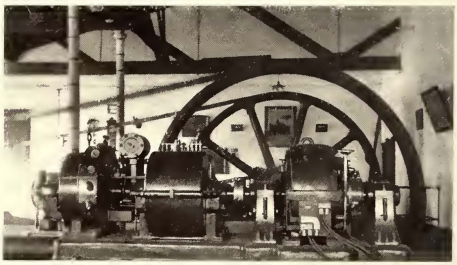
POWER STATION AT ELYRIA, CLEVELAND & SOUTHWESTERN



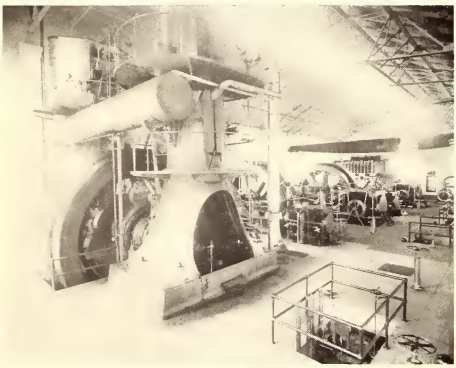
HORIZONTAL ENGINES IN STATION OF DAYTON & MUNCIE



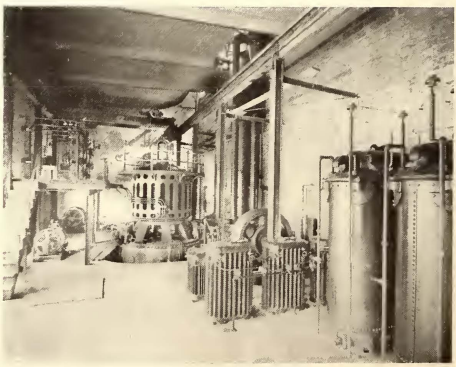
HORIZONTAL ENGINES IN STATION OF TOLEDO & INDIANA



SINGLE-WHEEL TURBINE IN STATION OF OHIO CENTRAL TRACTION



VERTICAL AND HORIZONTAL ENGINES IN HEBRON STATION OF COLUMBUS, NEWARK & ZANESVILLE



VERTICAL TURBINE IN STRATFORD STATION OF COLUMBUS, DELAWARE & MARION

TILE SUB-STATION AND WAITING ROOM, CANTON-AKRON RAILWAY

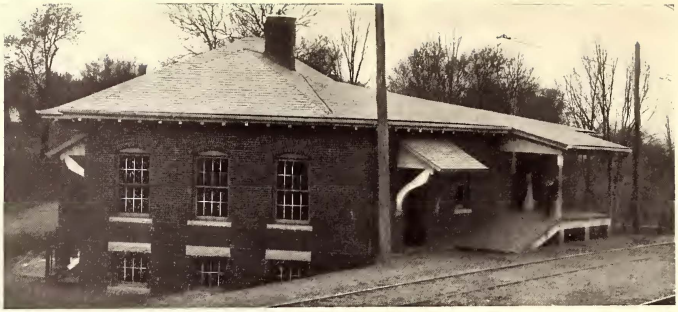
SUB-STATION AND BATTERY HOUSE, DAYTON & MUNCIE

COMBINED SUB-STATION AND RESIDENCE, WESTERN OHIO

COMBINATION SWITCH TOWER AND SUB-STATION, TOLEDO & WESTERN

CONCRETE BLOCK SUB-STATION, TOLEDO & INDIANA

SUB-STATION, COLUMBUS, NEWARK & ZANESVILLE



TYPICAL SUB-STATION, STARK ELECTRIC RAILWAY

AMELIA SUB-STATION AND WAITING ROOM, INTERURBAN RAILWAY & TERMINAL COMPANY, CINCINNATI

FORESTVILLE COMBINED PASSENGER AND SUB-STATION, INTERURBAN RAILWAY & TERMINAL COMPANY, CINCINNATI

TABLE VI.—SUMMARY OF SUB-STATIONS AND TRANSMISSION ON ROADS TREATED (See also Following Page).

NAMES OF COMPANIES.	To What Voltage is Current Stepped Up for Transmission.	Number, Size and Make of Step-up Transformers.	Longest Transmission at High Voltage in Miles.	Number of Sub-stations.	Average Distance Between Sub-stations, in Miles.	To What Voltage is Current Stepped Down.	Number, Size and Type of Step-down Transformers.
NORTHERN OHIO GROUP.							
Cleveland Southwestern	24,000	6—800 kw. West., oil cooled	48	7	15	390	6—100 kw. Stanley, oil cooled. 18—100 kw. West., oil cooled.
Lake Shore Electric	16,500	6—400 kw. West., oil cooled	50	14	10	390	60—150 kw. West., oil cooled.
Eastern Ohio	13,000	8—100 kw. West., oil cooled	8	1	..	390	2—100 kw. West., oil cooled.
Toledo & Indiana	*13,500		40	5	12	390	22—125 kw. G. E., oil cooled.
Toledo & Western	*13,200		42	9	10¾	390	9—125 kw. G. E., oil cooled. 9—125 kw. Kuhlman, oil cooled.
Toledo, Ft. Clinton & Lakeside	22,000	8—500 kw. Bullock, water cooled	25	5	10	375	15—150 kw. Bullock, oil cooled.
Stark Electric	22,000	6—200 kw. West., oil cooled	18	3	11	360	36—100 kw. West., oil cooled.
Canton-Akron	*13,200		32	6	11	370	18—100 kw. G. E., air cooled.
CENTRAL AND SOUTHERN OHIO GROUP.							
Western Ohio	33,000	6—450 kw. West., oil cooled	95	8	12	420	48—100 kw. West., oil cooled.
Dayton, Van Wert & Lima	65,000		65	5	10	440	15—100 kw. G. E., oil cooled.
Ft. Wayne, Van Wert & Lima	†		..	..	..	..	
Dayton & Troy	†		..	..	..	..	
Dayton, Covington & Piqua	†	6—370 kw. Wagner, oil cooled	41	7	10	555	18—150 kw. Wagner, oil cooled. 6—150 kw. G. E., oil cooled.
Scioto Valley	27,000	8—370 kw. G. E., air cooled	31	5	10	370	5—440 kw. G. E., air cooled.
Cincinnati & Columbus	16,500	6—300 kw. Bullock, self-cooled	12	3	10	400	6—125 kw. Bullock, oil cooled.
Cincinnati, Milford & Loveland	16,000		27	3	12	382	18—125 kw. West., oil cooled.
Interurban Ry. & T. Cincinnati	*10,000	6—200 kw. West., oil cooled	23	4	10	360	3—100 kw. West., 9—200 kw. West.
Cincinnati, Georgetown & Portsmouth	15,000						
INDIANA GROUP.							
Indiana Union	15,000 and 30,000	7—500 kw., 15—250 kw. West	60	15	17	385	35—873 kw., 6—75 kw., West
Indiana, Northwestern	30,000	9—270 kw. G. E., air blast	33	4	16	870	12—225 kw.
Indianapolis & Cincinnati	33,000	Westinghouse and G. E. air blast	40	8	12	3,300	16—300 kw.
Indianapolis, Columbus & Southern	15,000	1—200 kw. Stanley	21	2	10	360	6—225 kw. Stanley.
Terre Haute Tr. & Lgt	11,000 and 22,000	2—200 kw., 2—160 kw. oil cooled	26	3	15	2300	2—150 kw., 3—75 kw. West., oil cooled.
Kokomo, Marion & Western	22,000 and 44,000	2—225 kw. West., oil cooled	17	2	16	2300	3—150 kw. West., oil cooled.
Ft. Wayne & Wabash Valley	*16,000 and *18,200		..	7	12¼	380	Oil cooled.
MICHIGAN GROUP.							
Rapid Railway System, Detroit	16,500	6—400 kw. oil cooled	38	6	12	390	36—150 kw., West, oil cooled.
Detroit, Ypsilanti, A. A. & J	22,000	2—500 kw. West., oil cooled	41	6	16	390	18—200 kw. West.

* Initial voltage. † This company buys power from the Western Ohio Ry. ‡ D. C. transmission.

venient rule for determining transmission voltages. This was to take 1000 volts for every mile of transmission. This rule is very easily applied, and, while not far from general practice, it doubtless was responsible for much of the special apparatus and unusual voltages.

The advantages of recognizing as small a number as possible of different voltages as standard for railway work are so obvious as to require no further comment.

SUB-STATIONS

Opinions differ considerably among engineers and operators as to the most desirable sizes of sub-station equipment and the distance between sub-stations. Some engineers figure that it is better to use a number of small stations and place them at frequent intervals, claiming that the voltage is better maintained and that the loss of one or two sub-stations on a line affects the service less than where the stations are further apart and the size of rotary converters larger. The Toledo & Western has an average distance between stations of 8½ miles, and the capacity of each station is either 250 or 300 kw. The company makes a practice of cutting out one or two of its intermediate sub-stations during hours of lightest travel. The Lake Shore Electric has an average distance between sub-stations of 10 miles and on one end of its system these stations are equipped with two 200-kw rotaries, while on the other end there are one or two 400-kw rotaries. The company advocates the use of the larger machines as they provide a greater reserve, being capable of greater overloads during periods of peak loads. The company is planning to place larger rotaries in several of the stations now equipped with 200-kw units, and it will probably transfer some of the smaller machines to other stations, giving some of the stations a large and a small machine; the larger machine to be used during normal condition and the smaller one to help on peak loads or to handle the load alone on very light load. The Western Ohio, with sub-stations averaging 12 miles apart, also has two 200-kw machines in the majority of its stations. While its power conditions are excellent, the company rather advocates the use of larger machines. The Toledo & Indiana, with an average distance of 12 miles, takes an intermediate position, and uses 360-kw rotaries. The Cincinnati, Milford & Loveland, Cincinnati & Columbus and Interurban Railway & Terminal Company each use 400-kw rotaries with but one in the sub-station. The Toledo, Port Clinton & Lakeside and the Scioto Valley using Bullock apparatus were extremely liberal in the equipment of their sub-stations, which average 10 miles apart and are equipped with 450-kw rotaries.

The working voltage through which current is reduced in sub-stations also varies considerably. Two roads, the Stark Electric and the Cincinnati, Georgetown & Portsmouth, both using Westinghouse apparatus have a secondary voltage for the transformers of 350. The Toledo, Port Clinton & Lakeside and the Scioto Valley with Bullock apparatus reduce it to 375 volts. The Western Ohio, with Westinghouse apparatus, reduces to 420, and the Fort Wayne, Van Wert & Lima, with General Electric transformers, to 440 volts. The sub-stations on the Canton-Akron, Cincinnati & Columbus, Toledo Urban & Interurban and the Medway and Hebron stations of the Indiana, Columbus & Eastern, equipped by the General Electric Company, have transformers cooled by air supplied by motor-driven fans. In the majority of the General Electric Company's latest installations in this district, oil-cooled transformers have been used. The Toledo & Indiana has one station equipped with oil-cooled transformers, built by the Kuhlman Electric Company, of Elkhart, Ind. These transformers are unusually large for the capacity and have plain cases. Below each transformer is a tank, into which the oil can be drained in case of fire or other emergencies.

With reference to the best sites for sub-stations in general, there are two distinct ideas on this subject. One is to place sub-stations in villages and have the attendant perform the varied duties of station attendant, ticket agent and freight agent. This necessitates the designing of buildings to accommodate all of these requisites, and it might be said that this practice has been largely followed. Lately, however, there has been an inclination on the part of some roads to isolate their sub-stations by placing them in the country and allowing the attendant to give his exclusive attention to the sub-station apparatus. The theory is that when something goes wrong, the man should be on the spot to remedy the difficulty as quickly as possible, and it is claimed that he cannot always do this if he is out selling tickets or checking baggage. The growing tendency in small towns to object against the passing of high-tension lines through their streets also has a bearing on this point. The Scioto Valley believes in isolating its sub-stations and machinery, and although in a number of places its stations are in towns, the ticket office and freight station are in another building and have a separate attendant. The Western Ohio has several isolated sub-stations and for these it has built very attractive two-story brick residences, fitted with all the conveniences of a modern home, and the attendant lives there and is on duty practically all the time. The Toledo & Western has several combined residences and stations, but they are all in towns and the agent divides his duties.

In Indiana the average distance between sub-stations on the roads visited varies from 21 to 12 miles. The greatest distance was found on the Indianapolis, Columbus & Southern, where there is but one sub-station in addition to one in the power house. A distance of about 15 miles is the average for all of the roads visited.

On the Indianapolis Northern division of the Indiana Union Traction Company, sub-stations are, with one exception, 17 miles apart. This is a somewhat greater distance than on the older portion of the system, as on this the stations are from 7 to 11½ miles apart.

Usually the locations of sub-stations are not the most economical ones so far as the line losses are concerned. In most every instance they are located in small towns along the line with a view, in some cases, to combining the sub-station attendant's duties with others. The sub-stations of the Indianapolis & Northwestern system, however, are located 16 miles apart irrespective of towns.

The step-down transformers in the sub-station range in size from 300 kw to 150 kw. With few exceptions they are of the oil-cooled type. Those of the Indianapolis & Northwestern system are air cooled.

TABLE VI.—SUMMARY OF SUB-STATIONS AND TRANSMISSION ON ROADS TREATED.—*Concluded.*

NAMES OF COMPANIES.	Number, Size and Type of Rotary Converters.	Location and Capacity of Storage Batteries.	Method of Using Storage Batteries.	Number and Capacity of Portable Sub-stations.	Method of Using Portable Sub-stations.	Longest D.C. Transmission in Miles.
NORTHERN OHIO GROUP.						
Cleveland & Northwestern	2—300 kw. Stanley, 8—300 kw. West.	None		1—300 kw. West	In case of break-down or extra loads	12
Lake Shore Electric	13—400 kw., 14—200 kw. West	None				124
Eastern Ohio	2—250 kw. West., one cnd inverted	400 amp. battery at Gates Mills power station	Case of emergency and to boost line			28
Toledo & Indiana	5—300 kw. G. E.	None		1—360 kw	Constantly	6
Toledo & Western	5—250 kw. G. E. 3—300 kw. G. E.	None		2—250 kw	1 used all time, other for heavy business	8½
Toledo, Pt. Clinton & Lakeside	5—500 kw. Bullock	None				13
Stark Electric	4—250 kw., 2—300 kw. West	None				7
Canton-Akron	9—300 kw. G. E.	None				7
CENTRAL AND SOUTHERN OHIO GROUP.						
Western Ohio	14—200 kw., 2—800 kw. West	None				12
Ft. Wayne, Van Wert & Lima	5—300 kw. G. E.	None				6
Dayton & Troy		None				15
Ohio Connecting & Piqua	6—450 kw. Bullock, 2—450 kw. G.E.	None				17
Scioto Valley	6—400 kw. G. E.	None				2
Cincinnati & Columbus	2—400 kw., 1—800 kw. Bullock	None		1—400 kw	Occasionally for heavy traffic	9
Cincinnati, Milford & Loveland	1—400 kw., 1—800 kw. West	None				10
Interurban Ry. & T. Cincinnati	2—400 kw., 4—800 kw. West	None				12
Cincinnati, Georgetown & Portsmouth	2—200 kw. West 4—250 kw. West	None				5
INDIANA GROUP.						
Indiana Union	29—250 kw. West	At all sub-stations	Use differential booster	2		10
Indianapolis & Northwestern	8—800 kw. in each sub-station	None		None		8
Indianapolis & Cincinnati	None	None		None		Single phase none
Indianapolis, Columbus & Southern	2—350 kw 2—300 kw., 1 motor set	None		None		11
Terre Haute Tr. & Lt	2—300 kw., 2—800 kw.	320 amp. hour capacity storage battery in each sub-station	Use differential booster	None		8
Kokomo, Marion & Western	1—200 kw. West, rotary converter			None		11
Ft. Wayne & Wabash Valley	2—200 kw., or 1—300 kw. at each sub-station	None		1		6½
MICHIGAN GROUP.						
Rapid Railway System, Detroit	4—300 kw., 14—200 kw	None		None		6
Detroit, Ypsilanti, A. A. & J	2—250 kw. at 5 sub-stations 1—250 kw. at 1 sub-station	None		None		6½

NOTE.—The Eastern Ohio has one 100 kw. engine driven booster which boosts to 850 volts at end of line. The Dayton & Troy has one motor-driven booster which boosts to 900 volts at end of line.

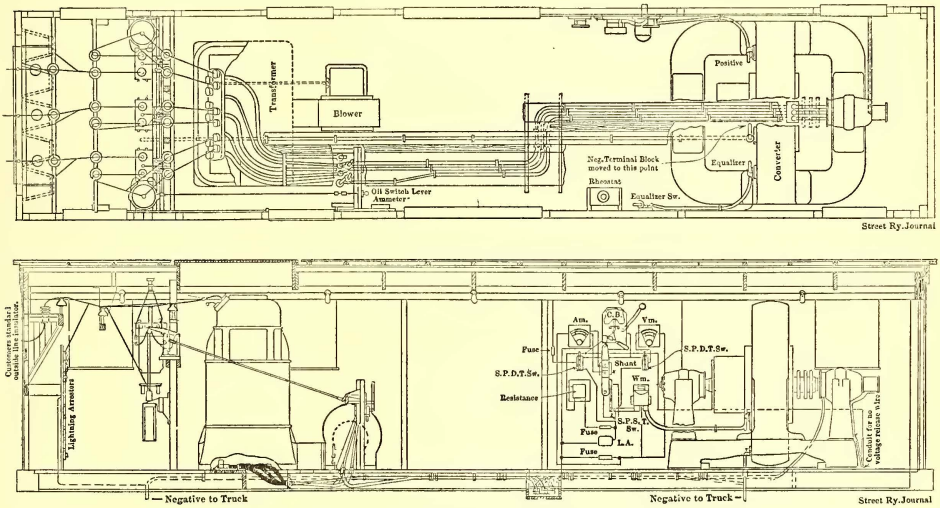
These transformers, moreover, are peculiar in that they have two separate secondary circuits so that two rotary converters can be supplied from one set of transformers. Rotary converters range in size from 350 kw on the Indianapolis, Columbus & Southern system to 200 kw.

The earliest sub-stations were designed with the high-tension switches, lightning arresters and transformers in a room separate from that in which the switchboard and rotaries were installed. However, there is a decided tendency to abandon this practice. Practically all of the stations erected in the last few years have all of the apparatus in one room. In many instances the high-tension apparatus has no railing, screen or protection of any kind around it. The new stations of the Fort Wayne & Wabash Valley Traction Company have protecting screen about the high-tension switches and transformers. On the Rapid Railway division of the Detroit United Railway the high-tension apparatus is separated from the balance of the room by a railing and in some instances it is on an elevated platform. The sub-stations of the Detroit, Ypsilanti, Ann Arbor & Jackson Railway are provided with an entrance tower and in this and immediately underneath it all of the high-tension apparatus is installed so that it is partially isolated.

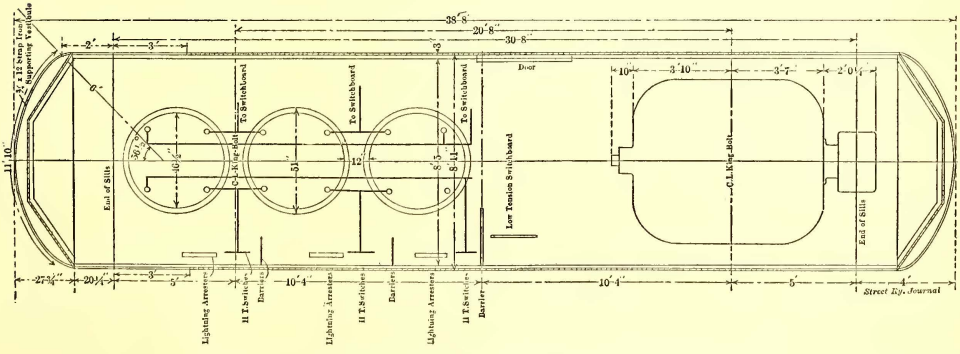
There is no generally adopted method of bringing the high-tension wires into the sub-station. On the Terre Haute Traction & Light system the wires are brought in through the center of 12-in. drain tiles. The inner end of each tile is provided with a disc of plate glass and the wire is carried through a 3-in. hole in the center of this. The high-tension wires are brought into sub-stations through porcelain tubes on the Indianapolis, Columbus & Southern system.

The sub-stations of the Indianapolis & Northwestern Traction Company were the only ones found in which motor-operated oil-break high-tension switches are employed. The Westinghouse "stick" type combination fuse and switch is used by the Indiana Union Traction Company, the Fort Wayne & Wabash Valley Traction Company and by several other of the systems visited. The Indianapolis, Columbus & Southern Company employ Stanley hand-operated oil switches. In the sub-stations of the Indianapolis & Cincinnati system no automatic switches are provided. This road is operated by single-phase current and the sub-stations are merely transformer stations. As no attendant is required, the breakers are placed in the power house only.

On the Indiana Union Traction system, as originally laid out, fourteen sub-stations are fed from six circuits. Additional sub-



PLAN AND ELEVATION, CINCINNATI & COLUMBUS PORTABLE SUB-STATION



PLAN OF PORTABLE SUB-STATION, CLEVELAND & SOUTHWESTERN

stations of roads operated by this company will be fed from these circuits within a short time. Two circuits are usually run to those sub-stations nearest the power house. Two sub-stations of the Indianapolis & Northwestern system are fed from one circuit. The longest transmission at high voltage in Indiana and one of the longest in existence where the current is not generated by water power is that of the Indiana Union Traction Company between Anderson and Logansport, a distance of about 60 miles, and from Anderson to Hill Top, about 61 miles. For the greater portion of the distance to Logansport two No. 6 transmission lines are employed. The Fort Wayne & Wabash Valley Traction Company will transmit 50 miles when present plans are put into operation. On the Detroit, Ypsilanti, Ann Arbor & Jackson Railway system current is transmitted 41 miles, and on the Indianapolis & Cincinnati Traction system current is carried from the power house at Rushville to the city limits of Indianapolis, about 40 miles distant.

The power distribution system of the Indiana Union Traction Company is the most extensive one in the Middle West. For the past two years fifteen sub-stations have been fed from the one generator station at Anderson. Within a few months seven sub-stations will be fed from the Rushville power house of the Indiana & Cincinnati Traction Company and the distribution system planned for the Fort Wayne & Wabash Valley Traction Company will include seven sub-stations.

FLOATING OR PORTABLE SUB-STATIONS

Portable sub-stations are used extensively on the longer roads in Ohio. The uses to which they are put, however, are not identical in every case. Several roads which had rather indefinite plans for extensions when the original installations were made adopted the idea of placing the sub-stations in cars, so that they might be moved if later extensions were made and a change in the distribution system found desirable. Thus, the Toledo & Western, the Toledo & Indiana and the Cleveland, Painesville & Ashtabula each had two or three portable sub-stations. These were laid up on convenient sidings and served the purpose of permanent sub-stations. This practice has since undergone some change on these roads. The Toledo & Indiana had one of its cars struck by lightning, the oil transformers exploding and completely destroying the car and its equipment. The difficulty of placing suitable protecting apparatus in so limited a space necessarily constructed of wood caused the company to abandon the idea of using it for a permanent station, and a concrete building was substituted. The Toledo & Western uses one of its portable sub-stations practically all of the time, while the other is side-tracked for use in cases of emergency. It is believed that this later use is the true function of the floating sub-station.

In addition to the roads mentioned, the Cleveland & Southwestern, Cincinnati & Columbus, Toledo, Port Clinton & Lakeside and the Dayton & Muncie have floating stations used in this way. On occasions of heavy loads on certain parts of the road, such as fairs or base-ball games, or on longer periods of exceptional traffic, these cars are placed on the most advantageous side track and assist the regular sub-station in that district in carrying the load. An illustration on another page shows a portable sub-station placed on a side track adjoining one of the permanent stations, the two operating in parallel and providing double the output ordinarily needed for that section of the road. In cases of accident to one of the permanent sub-stations the portable apparatus is quickly shifted to that locality and the service is maintained without interruption. The longer roads which own such stations as a rule believe that the added investment for the sub-station equipment is well spent, as it provides an assurance against interruption of traffic which could not otherwise be obtained. In several instances the floating stations are simply old freight cars strong enough to carry the weight, while in others special cars were designed. The floating sub-station designed for the Cincinnati & Columbus Traction Company shows unusual attention to details in that it is equipped with complete systems of oil switches and high-tension lightning arresters, which some of the earlier cars did not have. This outfit was described in the STREET RAILWAY JOURNAL for July 8, 1905. It contains a 440-kw rotary in one end, larger than is found in other floating sub-stations, and at the other end is one tri-phase transformer, this outfit being lighter and smaller than where three single-phase transformers are used. In the rear of the transformer are the lightning arresters and lever operated oil switches, potential and current transformers, etc. The high-tension lines enter through an anchorage at the same end of the car, so that no high-tension apparatus passes in front of the transformer, insuring safety to the sub-station attendant. The transformer is of the air blast type, and the current of air passes through a chamber below the car floor, in which are also the low voltage and direct-current wiring. The Columbus, Newark & Zanesville was recently called upon on short notice to handle an unusually large excursion at Buckeye Lake, and the manager, in solving the power problem, arose to the occasion by dismantling one of the permanent sub-stations, loading the sub-station apparatus on a flat car and placing this improvised portable sub-station on a siding near the lake, where it distributed direct current to the line as required.

With the exception of the Indiana Union Traction Company and the Fort Wayne & Wabash Valley Traction Company, none of the systems visited in Indiana employ sub-station cars to serve as reserve capacity. The Rapid Railway Division of the Detroit United Railways has ample reserve capacity in each sub-station in permanently installed apparatus, as do several other of the systems.

The Indiana Union Traction Company has two portable sub-stations. One of these is contained in a box car, 21 ft. 6 ins. long and 8 ft. 8 ins. wide, and consists of three 87½-kw, oil-cooled, step-down transformers and a 250-kw rotary converter. The transformers are located in one end of the car, the converter in the opposite end, while the switchboard occupies the space in the center. The second portable sub-station is mounted in a car somewhat longer, but containing practically the same apparatus as the first one. The roof of the second car is arranged so that it can be lifted off in two sections. This is to facilitate changing the transformers should it be necessary. In such an event it is intended that the car shall be run under the crane in the power house so that the roof and the apparatus can be handled by the crane. This portable sub-station of the Fort Wayne & Wabash Valley Traction Company consists of a 200-kw rotary converter and three oil-cooled transformers mounted in a car of practically the same dimensions as are the sub-station cars of the Indiana Union Traction Company. The cars on both systems are used when, for any reason, traffic on any portion is exceedingly heavy. They are also used whenever it is necessary to repair the regular sub-station apparatus.

LINES AND CABLES

Practically every road in Ohio carries its high-tension lines on the poles supporting the trolley wires and direct-current feeders. In other words, there are few separate transmission lines except in several instances cross-country lines have been built to provide short cuts from power stations to sub-stations. In the case of the Toledo Urban & Interurban, which was equipped with high-tension transmission several years after its original road was built, on some sections separate poles have been erected for the high tension. Poles are uniformly 35 ft. or 40 ft., except in a number of instances where poles of 50 ft. and 60 ft. were employed to carry the high-tension wires over the tops of trees. Roads following highways and passing through villages in Ohio have been greatly troubled by the presence of trees, which, as a rule, owners were unwilling to have trimmed. There are a number of instances where pole lines were carried to the rear of lots in order to avoid trees, and nearly every road has one or two places in which it was obliged to carry its transmission lines to the rear of towns in order to avoid the trees and accommodate the ideas of village authorities.

Methods of arranging and attaching high-tension wires to poles have furnished another subject for wide discussion among engineers, but it may be stated that notions which were prevalent a few years ago are now being dispelled and the various roads are coming nearer to a standard on their transmission lines. This, of course, is largely the result of combinations of interest and the necessity for putting various lines together.

For example, one prominent engineer provided in his specifications that there should be no iron of any kind at the tops of the poles, all pins, bolts and braces being of hardwood. In later construction on this same road this idea has been modified, as it was found that such precautions were unnecessary, and that the line was not as strong as where metal was used more freely. Up to two or three years ago the majority of engineers held firmly to the belief that three-phase transmission lines should be arranged in an equilateral triangle and that they should be transposed at regular intervals. The majority of Ohio operating men now believe that these two ideas were the result of too much theory and not enough practice. The latest transmission lines are attached to cross-arms, according to the arrangement which is most convenient, and there is no transposition of wires. While the triangular arrangement is still used, it is largely the result of the desirability of using two sets of transmission lines, and two cross-arms are employed, one, shorter than the other, carrying two insulators on its ends, and the other carrying four insulators. On some of the roads the longer arm is placed above, while in others the opposite arrangement is followed.

On the matter of spacing circuits, however, one point is becoming impressed on roads using the higher voltages, and that is that there should be ample space between the wires to avoid short circuits and jumping across in case of overloads. The Western Ohio, for example, formerly had 32 ins. between wires for 33,000 volts transmission. It is now spreading these, and, at the same time, strengthening its construction, using 10-ft. arms for four pins and 8-ft. arms for two pins and providing for a minimum distance between wires of 36 ins. Pins are 15 ins. long instead of 10 ins., as formerly used. The Fort Wayne, Van Wert & Lima and the Toledo & Lima follow this practice quite closely in their new work. The Cleveland Construction Company, which is building several new lines, is providing for a spacing of 42 ins. between wires, and it uses 16-in. pins boiled in carbo-linium. It might be stated here that wood pins are almost universally used.

The idea of placing one pin on the top of the pole and the other two on a cross-arm below it where but a single transmission line is provided for, is losing favor among some of the best engineers. The pin and insulator on the top of the pole almost invariably gives more trouble than the other two. There are, of course, several methods of attaching this pin. The Toledo, Port Clinton & Lakeside uses a metal ridge pin with four heavy lag screws, which is undoubtedly a strong form of construction. On the Cincinnati, Milford & Loveland and several other roads a wood block is attached to the side of the pole and the pin is batted to this. On a number of roads the top of the pole is drilled and the pin set in. The objection found to this is that moisture gathers in the hole and the pole rots in the center. On several roads this has been partially overcome by boring "weep" holes for the moisture to drain out and by placing porcelain plates around the top of the pole, but after trying these various devices there are a number of prominent engineers who believe it is best to get the insulator off from the top of the pole and place all these wires on a single cross-arm. This has been done on recent construction work on the Western Ohio and the Toledo & Indiana, using one insulator on one side of the pole and two on the other. The Cleveland & Southwestern on some recent work used two short cross-arms with an insulator on the end of each, the fourth insulator being for a spare wire which is used in case of breakage to any of the other three. Tell-tale devices in the sub-stations tell which wires are dead, and the spare wire can be thrown instantly into service in case of accident. This device has saved a tie-up on several occasions. A variation from usual forms of cross-arm braces was used in this work, a triangular shaped block of wood soaked in carbolineum to prevent cracking, being used instead of metal braces, which had given trouble.

Copper lines are used by the great majority of roads, although considerable aluminum has been used during the past two or three years. During the past twelve months, however, builders of roads have been unable to secure proposals from manufacturers of aluminum wire because they are too busy with other work, hence it is not being used on roads under construction. One of the chief advantages found for aluminum is that sleet does not stick to it, in spite of the larger area of surface, and aluminum lines have gone through the most severe sleet storms without interruption, where copper lines have broken down in many places. The lower fusing point of aluminum, as compared with copper, and its liability to break when coming in contact with electric light or telephone wires, are, of course, disadvantages which perhaps more than compensate for the advantage mentioned. At times when copper has been high in price aluminum has been considerably lower for the same carrying capacity, and, as a rule, it is always a trifle lower in price, the price being based upon the price of copper. On long spans, aluminum has been known to stretch considerably when first erected, but one of the advantages frequently pointed out for aluminum is that the manufacturers have always insisted upon inspecting all erection work, requiring that the feeders be strung at the proper tension and in the most substantial manner possible.

The Scioto Valley Traction Company uses seven-strand aluminum of No. 2 capacity for its lines, and has had excellent results. The Western Ohio, Lake Shore Electric and Cleveland & Southwestern have secured very satisfactory results from aluminum.

Lines of No. 4 capacity are used by the majority of roads of medium length, while the roads with heavier equipment, longer transmission and higher voltages use a larger conductor.

The Canton-Akron Company's system is about equally divided between No. 2, No. 4 and No. 6, starting out of the house with the larger conductor and tapering down to the smaller at the ends. The Western Ohio uses No. 2 and No. 4, with the to adopt this on extensions and new lines, in order to secure ample capacity to handle the road from some other station in case the usual base of supply is interrupted.

Glass insulators are being used by several roads with the

TABLE VII.—SUMMARY OF PRACTICE IN HIGH TENSION TRANSMISSION LINES ON ROADS TREATED.

NAMES OF COMPANIES.	Voltage on Transmission Line.	Number of Circuits.	Material of Line.	Size of Conductors.	Length of Transmission Poles in Ft.	Distance Apart of Transmission Poles in Ft.	Diameter Transmission Poles at Top in Ins.	Arrangement of Circuits.
Northern Ohio Group.								
Cleveland & Southwestern	24,000	3	Copper and aluminum	No. 4	35	100	8	Triangle.
Lake Shore Electric	16,500	2	Copper and aluminum	No. 2	35	90	7	Triangle.
Eastern Ohio	13,000	1	Copper	No. 4	35	100	7	Flat.
Toledo & Indiana	13,500	1	Copper	No. 4	35	100	7	Flat.
Toledo & Western	13,500	1	Copper	No. 4	35	100	6	Triangle.
Toledo, Ft. Clinton & Lakeside	20,000	2	Copper	No. 4	35	100	7	Triangle.
Stark Electric	22,000	2	Copper	No. 4	35	100	6	Triangle.
Canton-Akron	13,200	3	Aluminum and copper	Nos. 2, 4, 6	35	100	9	Triangle.
Central and Southern Ohio Group								
Western Ohio	32,000	3	Aluminum and copper	Nos. 2, 4	40	100	7	Flat.
Ft. Wayne, Van Wert & Lima	32,000	1	Copper	No. 2	40	100	7	Flat.
Dayton & Troy	.....	..	.....	.....	..	....	..	
Dayton, Covington & Piqua	.....	..	.....	.....	..	....	..	
Scioto Valley	27,000	2	Stranded aluminum	No. 2	40	100	8	Triangle.
Cincinnati & Columbus	33,000	1	Copper	No. 4	40	100	8	Triangle.
Cincinnati, Milford & Loveland	16,500	2	Copper	No. 4	35	100	6	Triangle.
Interurban Ry. & T. Cincinnati	10,000	2	Copper	No. 4	40	100	8	Triangle.
Cincinnati, Georgetown & Portsmouth	15,000	2	Insulated copper	No. 4	35	100	7	Triangle.
Indiana Group.								
*Indiana Union	15,000 and 30,000	6	Copper	Nos. 3, 5	40	100	7	2 triangular, 1 flat.
Indianapolis & Northwestern	30,000	3	Phosphor bronze	No. 4	36	100	6	Triangular.
Indianapolis & Cincinnati	33,000	5	Copper	No. 4	35	100 and 120	8	Two-phase flat.
Indianapolis, Columbus & Southern	15,000	1	Aluminum	No. 0, copper equivalent	35	100	8	Triangular.
Terre Haute Tr. & Lgt.	11,000 and 22,000	2	Aluminum and copper	No. 4	40	100	..	Triangular.
Kokomo, Marion & Western	11,000	1	Aluminum	No. 2	40	100	6	Triangular.
Ft. Wayne & Wabash Valley	16,500 and 13,200	3	Copper	No. 2	40	100	7	Triangular.
Michigan Group.								
Rapid Railway System, Detroit	16,500	2	Copper	No. 1	40 to 60	...	7	Triangular.
Detroit, Ypsilanti, A. A. & J.	22,000	3	Copper	Nos. 3, 4	40	...	8 to 10	Triangular.

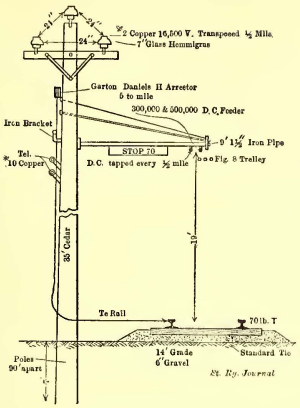
* Union Traction Company of Indiana and Indianapolis Northern Traction Company only considered.

TABLE VII.—SUMMARY OF PRACTICE IN HIGH TENSION TRANSMISSION LINES ON ROADS TREATED.—*Concluded.*

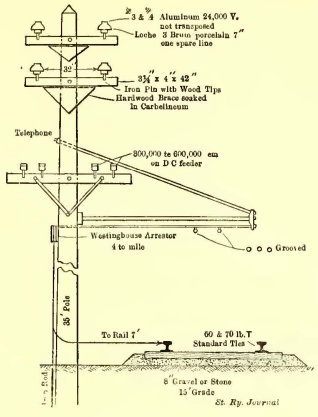
NAMES OF COMPANIES.	Distance Between Wires of Circuit in Ins.	How Often Are Wires Transposed.	Type of High-tension Insulators.	How Are Insulators Attached to Cross Arms.	How is High-tension Line Protected Against Lightning.
Northern Ohio Group.					
Cleveland & Southwestern	32	Not transposed	7-in. porcelain, 8-in. glass	Wood pins	Arresters.
Lake Shore Electric	24	Every mile	7-in. glass	Wood pins	Arresters.
Eastern Ohio	24	.....	7-in. porcelain	Wood pins	Arresters.
Toledo & Indiana	18	Not transposed	7-in. glass	Wood pins	Arresters.
Toledo & Western	24	Twice on road	5-in. white porcelain, 7-in. glass	Wood pins	Arresters.
Toledo, Ft. Clinton & Lakeside	28 and 30	Every 3d mile	7-in. porcelain	Wood pins	Arresters.
Stark Electric	24	.....	6-in. porcelain	Wood pins	Arresters.
Canton-Akron	26	.....	6-in. glass	Wood pins	Arresters.
Central and Southern Ohio Group					
Western Ohio	36	Not transposed	7-in. porcelain	Wood pins	Arresters.
Ft. Wayne, Van Wert & Lima	36	Not transposed	8-in. porcelain	Wood pins	Arresters.
Dayton & Troy	..	.....	.....	.....	
Dayton, Covington & Piqua	..	.....	.....	.....	
Scioto Valley	30	2 miles	8-in. porcelain	Wood pins	Arresters.
Cincinnati & Columbus	..	.....	8-in. porcelain	Wood pins	Arresters.
Cincinnati, Milford & Loveland	24	3½ miles	7-in. porcelain	Wood pins	Arresters.
Interurban Ry. & T. Cincinnati	28	.....	7-in. porcelain	Iron pins	Arresters.
Cincinnati, Georgetown & Portsmouth	28	.....	7-in. porcelain	Iron pins	Arresters.
Indiana Group.					
*Indiana Union	35	Every mile	7½-in., 9-in. glass	11½-in. locust pins	Arresters.
Indianapolis & Northwestern	36	Not transposed	Brown porcelain	.....	Arresters.
Indianapolis & Cincinnati	36	Not transposed	Brown porcelain	Iron pins and stud bolts	Arresters.
Indianapolis, Columbus & Southern	19 and 30	Not transposed	Glass insulators	Wood pins	Arresters.
Terre Haute Tr. & Lgt.	..	Every 90 poles	Porcelain	Wood pins	Arresters.
Kokomo, Marion & Western	40	.....	9-in. porcelain	11½-in. locust pins	Arresters.
Ft. Wayne & Wabash Valley	30	Every mile	Porcelain	Locust pins	Arresters.
Michigan Group.					
Rapid Railway System, Detroit	31	Not transposed	Porcelain	Iron pins	Fuse arresters in power house, substations and other points where there is competent attendance.
Detroit, Ypsilanti, A. A. & J.	18	Not transposed	Replacing glass with porcelain	Wood pins	Arresters.

* Union Traction Company of Indiana and Indianapolis Northern Traction Company only considered.

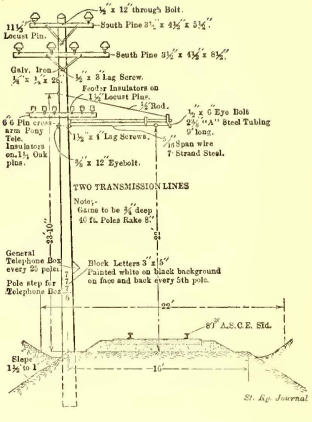
same arrangements. The Lake Shore Electric has all No. 2, in order to render it possible to run all the sub-stations from one power house if necessary, necessitating a transmission of about 100 miles. The Fort Wayne, Van Wert & Lima has No. 2 throughout, and there seems to be a tendency among other roads medium voltages of from 12,000 to 16,500, but the roads using the higher voltages of from 20,000 to 33,000 seem to prefer porcelain insulators, the usual size being 7 ins. The Lake Shore Electric, with 16,500, uses 7-in. glass with most satisfactory results, while the Cleveland & Southwestern has a num-



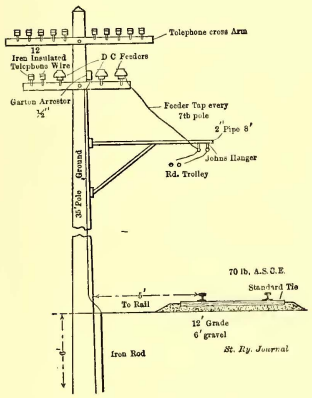
Lake Shore Electric



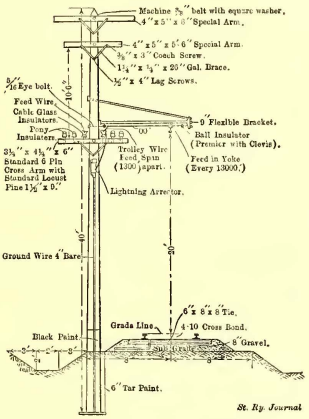
Cleveland & Southwestern



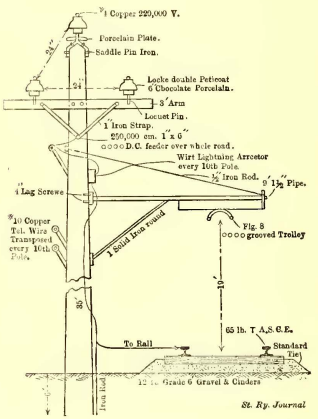
Indianapolis Northern Traction



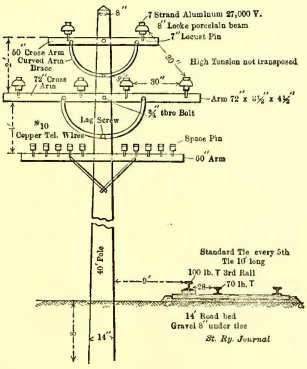
Dayton, Covington & Piqua



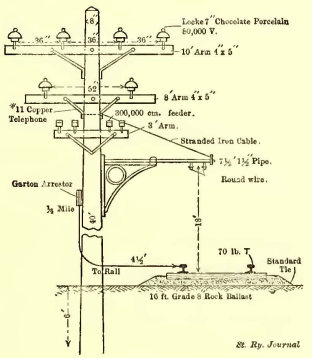
Fort Wayne & Wabash Valley



Stark Electric



Scioto Valley



Western Ohio

TYPES OF STANDARD OVERHEAD AND TRACK CONSTRUCTION

ber of stretches of 8-in. glass insulators, which are giving excellent service. The Toledo Urban & Interurban and the Cincinnati & Columbus, with their 33,000-volt transmission lines, use 8-in. x 8-in. porcelain insulators designed for 90,000 volts, and the tendency is in this direction.

Considerable interest is being displayed in high-tension lightning arresters placed on poles, but as yet they have not been adopted by any of the roads in the district. The Detroit, Monroe & Toledo and Toledo Urban & Interurban string a galvanized iron barbed wire at the top of the pole and ground it at every tenth pole, which is said to be an excellent protection against lightning. Other engineers who have considered this scheme say that while it may be some protection, the comparatively short life of galvanized iron wire, as compared with copper wire, is likely to cause a great deal of trouble when the barbed wire commences to rust through and break, falling on the high-tension lines.

The majority of roads are now taking unusual precautions to protect their wires against telegraph wires at railroad crossings. In a number of places cradles have been erected below the transmission wires so that they cannot fall onto the telegraph wires. At one undergrade crossing, the Toledo & Western has insulated its high-tension lines and carries them under the crossing. The Dayton & Muncie in one place has erected 100-ft. lattice iron poles to carry the high tension over telegraph wires. At Lorain, crossing a navigable stream where vessels with tall masts frequently pass, the Lake Shore Electric has erected two 350-ft. towers and passes the wires over with a thousand-foot span, stranded aluminum wire being used.

In the other States visited copper is used for high-tension conductors in the majority of cases. Aluminum conductors are used by three systems, and in one instance the conductors are of phosphor-bronze. High-tension conductors vary in size from 1-0 copper equivalent to No. 5. The smallest size is used on the older portion of the Indiana Union Traction Company. On this system the two sub-stations between Anderson and Indianapolis are fed by one line, consisting of No. 5 copper conductors. Each of the sub-stations contain two 250-kw rotaries, and one is 13 miles and the other 24½ miles distant from the power station. On practically all of the new work of this system the high-tension wires are of No. 3 copper. On all the systems visited, with the exception of the Indianapolis & Cincinnati Traction Company, the high-tension circuits are carried on the trolley poles. On this system, however, a second and separate pole line, placed on the opposite side of track from the trolley poles, is used. The majority of the systems use transmission poles 40 ft. long. The size, however, varies greatly, as poles with tops varying from 6 ins. to 10 ins. are used. On all of the systems visited the poles are placed 100 ft. apart.

Disposition of the high-tension wires in the form of a triangle was found in every instance, with the exception of the single circuits on the Indiana Union Traction system. The wires of these single circuits are all on one cross-arm, two being on one side of the pole. Wide differences were found in the distance between the separate wires of high-tension circuits. The distances range from 18 ins. to 40 ins., and, moreover, the greatest width was found on that system having the lowest transmission voltage. On the systems carrying the highest voltage distances of 35 ins. and 36 ins. between wires are usually employed.

The practice of transposing high-tension wires is adhered to by some companies and is not followed by others. Three systems were found having high-tension wires transposed. In two instances the transpositions are made every mile and in another they occur every 9000 ft.

Porcelain high-tension insulators are used on all but two systems visited. On one system on which glass insulators are used it was stated that no trouble whatever is being experienced with them except their occasional breakage by boys, but on another system glass insulators are being replaced by porcelain whenever breakage occurred. On the Rapid Railway division of the Detroit United Railways, and also on the Indianapolis & Cincinnati system, the high-tension insulators are carried on iron pins secured to the cross-arm by stud bolts. On all the other systems visited wood pins, usually locust, are used.

Several recent installations throughout the country have ground wires on the cross-arms carrying the high-tension wires as a protection against lightning. This practice was not found on any of the systems visited.

OVERHEAD CONSTRUCTION

Grooved, or Fig. 8, wire is used for trolley by the majority of Ohio roads. There is a growing tendency to equip with double trolley wire and reduce the size of the d. c. feeders. On the Toledo & Indiana, Cincinnati & Columbus and several other roads where the sub-stations are ample and fairly close together, the use of d. c. feeders was dispensed with, the trolley wires being used exclusively for carrying the direct current. The Canton-Akron Railway Company uses a special trolley wire, known as the Myers special, which is a modification of the Fig. 8, except that it is flat on top. It is believed that it gives the ear a better gripping surface, but, as it is unique, there is some difficulty in getting new ears and repair parts.

As with high-tension lines, aluminum has been used by a number of roads for d. c. feeders, and the same conditions apply as with the high-tension wires. The majority of the roads using a. c. transmission and having No. 000 single trolley use a 300,000 c. m. d. c. feeder. The Cleveland & Southwestern uses a 300,000 c. m. feeder where it has double trolley and 500,000 c. m. to 600,000 c. m. with much of its single trolley. A portion of this system has direct-current transmission, and on these sections it uses 60,000 c. m. The Dayton & Troy, with d. c. transmission, has No. 00 trolley and 1,000,000 c. m. feeders.

Practically all the work done in Ohio in the past two years has been bracket construction for single track. The older portions of the Lake Shore Electric, Eastern Ohio Traction, Cincinnati, Georgetown & Portsmouth and Toledo, Port Clinton & Lakeside are cross suspension, but later extensions were built with bracket construction, which has been found cheaper to build and to maintain. Span construction is used on practically all of the double track in the State, there being but very little center pole construction. The height of trolley above rail varies from 16 ft. on the Cincinnati & Columbus to 21 ft. on the Dayton & Troy, the usual practice being 18 ft. This is a point which ought to be adjusted, in view of the growing tendency to run cars over other lines. Soldered and clinch ears are about in equal favor, with possibly a growing sentiment in favor of the former. There is an increasing tendency to use longer and heavier ears, many 15-in. and 16-in. ears now being used.

Line voltages vary from 550 to 650, with a growing tendency toward the higher voltage. In figuring feeders, the usual rule is to allow for a maximum voltage drop of about 25 per cent, although several roads estimate copper upon a drop of only 100 volts.

Pole lightning arresters are used by all the roads. Arresters are placed from 1 to 6 to the mile, and it might be stated that there is a growing tendency to use more arresters and to see that they are maintained in order. Six out of seventeen roads visited ground the arresters to the rail exclusively, three ground to an iron rod driven into the ground, two ground to a copper plate and six use a combination of these methods, grounding both to rail and earth.

Bracket trolley construction is followed in practically all of

TABLE VIII.—SUMMARY OF OVERHEAD CONSTRUCTION ON ROADS TREATED (See also Following Page).

NAMES OF COMPANIES.	Shape and Size of Trolley Wire.	Number of Poles to the Mile.	Length of Poles in Ft.	Diameter of Poles at Top in Ins.	Material of Poles.	Bracket or Span Suspension.	Height of Trolley Wire Above Rail in Ft.	Single or Double Trolley.	Type of Hanger.	Type of Ear.
NORTHERN OHIO GROUP.										
Cleveland & Southwestern	No. 00, grooved and round	53	35	8	Cedar and chestnut	B	18	Both	O. B.	Clinch and clamp.
Lake Shore Electric	No. 000, Fig. 8	53 and 58	35	7 and 8	Cedar and chestnut	Both	19	D	O. B.	Clinch.
Eastern Ohio	No. 000, Fig. 8	52	35	6½ and 7	Cedar	B	18	D	O. B.	Soldered and clinch.
Toledo & Indiana	No. 000, round	62	35	7	Chestnut	B	17	D	Boston, West End O. B.	4-screw.
Toledo & Western	No. 000, Fig. 8	52	35	6½ and 7	Cypress	B	17½	S	Jones	Clinch.
Toledo, Pt. Clinton & Lakeside	No. 000, Fig. 8	52	35	7	Chestnut	Both	19	S	O. B.	Screw.
Stark Electric	No. 000, Fig. 8	52	35	7	Chestnut	Both	19	D	O. B.	
Canton-Akron	No. 0000, Myers T	52	35	7	Chestnut	B	18	S	O. B.	15-in. clinch.
CENTRAL AND SOUTHERN OHIO GROUP.										
Western Ohio	No. 00, round	52	40	7	Cypress	B	18	D	O. B.	12-in. solder.
Ft. Wayne, Van Wert & Lima	No. 000, round	52	40	7	Idaho cedar	B	18	S	Type M	15-in. clinch.
Dayton & Troy	No. 00, Fig. 8	48	35	7	Cedar	Both	21	D	O. B.	24-in. clinch.
Dayton, Covington & Piqua	No. 000, round	62	35	7	Cedar	B	18	D	Johns	Soldered.
Scioto Valley	3d rail		40	8	Chestnut	3d rail	18	S		
Cincinnati & Columbus	No. 0000, grooved	52	35	7	Chestnut	B	16	S		
Cincinnati, Milford & Loveland	No. 0000, round	52	35	7	Chestnut	Both	18	S	Craighead solid	Clamp.
Cincinnati, Newport & Covington	No. 000, round	52	35	7	Cedar	Both	20	D	Craighead cap and cone	Soldered.
Cincinnati, Georgetown & Portsmouth	No. 000, round	52	35	6	Chestnut and cedar	Both	18	D	4-screw	Soldered.
INDIANA GROUP.										
Indiana Union, Northwestern	No. 000, grooved	52	30	7	Cedar	Both	20	S		Clinch.
Indianapolis & Northwestern	No. 000, grooved	52	36 and 32	6	White cedar	B	18	S		Clinch.
Indianapolis & Cincinnati	No. 000, grooved	Old work 52, new work 44	40	7	White cedar	B	18	S	Special	Swivel.
Indianapolis, Columbus & Southern	Old work 2—0, round; new work 4—0, round	52	35	8	Cedar	B	18	D	O. B.	Clinch.
Terre Haute Tr. & Lgt	No. 00, round	52	40	..	Cedar	B	19	S		Clinch.
Kokomo, Marion & Western	No. 000, round	52	40	..	Cedar	B	19	D		12-in. clinch.
Ft. Wayne & Wabash Valley	No. 000, round	52	40	7		B	20	S new work; D old work	O. B.	Clinch.
MICHIGAN GROUP.										
Rapid Railway System, Detroit	No. 00 and No. 000, round, and Fig. 8	48	40	..		B	19	Mostly D		15-in. clinch.
Detroit, Ypsilanti, A. A. & J.	No. 00, Fig. 8	52	40	..	Cedar	B	19 to 20	D		

the new work in Indiana and Michigan. Both round and Fig. 8 trolley is employed, but there is a tendency towards the abandonment of the Fig. 8 section. Three sizes of wire, No. 00, No. 000 and No. 0000 trolley, are used, the smaller sizes being employed when a double trolley is employed.

Opinion varies in this section as to the advantages and disadvantages of single and double trolley wire. The Fort Wayne & Wabash Valley Traction Company is building all new work with single trolley, although the old lines are of double trolley construction. On the Detroit United Railways system, upon which most of the construction is with double trolley, this construction is preferred.

On the several roads visited the height of the trolley above the rail ranges from 18 ft. to 20 ft. There is a tendency to place the trolley a little higher than is absolutely necessary, with a view to accommodating higher cars should these be adopted at any time in the future. It would seem that neither difference in the height of cars nor operating features would warrant the wide variation found in the height of the trolley. On the Terre Haute Traction & Light Company system, which uses the car of least height, the trolley is 19 ft. high, while on the Indianapolis & Northwestern system the trolley is 1 ft. lower and the cars are about 9 ins. higher. Other similar examples lead to the belief that one standard height of trolley could be adopted by practically all systems.

Where 500 or 525 volts was the pressure formerly carried on the trolley, 600 to 625 volts pressure is now found. Of the systems visited in Indiana the lowest voltage is carried by the Terre Haute Traction & Light Company and is 550 volts. Several d. c. systems carry 650 volts.

Practice differs greatly in Indiana as to the number of lightning arresters necessary for proper protection to the line. From two to five per mile are used. Various methods of grounding arresters are in use. On the Indianapolis & Cincinnati Traction system the arresters are grounded to a galvanized iron pipe driven 10 ft. into the ground. None of them is grounded to the rails. On the Indianapolis, Columbus & Southern Traction system every fifth arrester is grounded to the rail. Arresters on the Kokomo, Marion & Western Traction system are all grounded to ⅝-in. rods driven into the ground. In addition to this, the ground wire from each arrester is connected alternately to one rail and to the other. Ground plates are used by the Fort Wayne & Wabash Valley Traction Company. On the Detroit, Ypsilanti, Ann Arbor & Jackson Railway some of the arresters are grounded to the rail and some to ground plates. The grounding wires consist of wire from old motor field coils.

The Detroit United Railway system grounds each arrester to both rails and to ground rods. In addition to gap arresters, this company places fuse arresters in the power houses, sub-stations and at other points where there is competent attendance. These arresters consist of several No. 22 cotton-covered wires connected in multiple between the trolley and ground terminals in such a manner that the insulation of the wire prevents the passage of the current. A lightning discharge, however, jumps across this insulation. Fusing of the wire breaks the current after a discharge.

Direct-current feeders of about 500,000 c. m. are usually employed. On the Detroit United Railway system No. 0000 feeders are preferred, several being placed in multiple when necessary. The great advantage of a feeder system consisting of this size of feeders is its flexibility. Whenever conditions of load change some of the feeders may be taken down and replaced on other portions of the line where the load demands.

The frequency of feeder taps varies on the different systems. On the Indianapolis, Columbus & Southern Traction system within five miles of substations two taps per mile are made. At greater distances there are five taps per mile. The spacing of feeder taps on the Detroit United Railway system is governed by the demands for load. In level country the taps are 1320 ft. apart. On curves, or where the service is extremely heavy, they are from 700 ft. to 800 ft. apart.

The collection of drawings on page 657 forcibly illustrates the lack of uniformity in pole and overhead construction. There seems to be no standard rule whatever for number or dimensions of cross-arms, methods of attaching the arms to the poles, and arrangement of high-tension wires, d. c. feeders and telephone wires.

In reference to telephone wires, it may be stated that the trouble with telephone circuits carried on the same poles with high-tension circuits, which was freely predicted when high-tension work was first suggested, has not been serious. It is now quite the common practice to carry the company's own telephone wires on the railway pole line, and no serious difficulty due to the high-voltage circuits is encountered, even when, as is now common practice, the power circuits are not transposed. Some companies as an extra precaution against noisy telephone lines transpose the telephone wires at frequent intervals. On a number of roads the telephone wires are carried on pins let into the pole instead of on cross-arms, and in cities where span construction is used it is common practice to carry the telephone wires on the span wires.

Of the roads treated eleven use chestnut poles, cedar coming next in favor. Diameters of poles at the top range from 6½ ins. to 8 ins., with 7 ins. predominating. Lengths range from 25 ft. to 40 ft. and spacing of poles varies from 48 to the mile to 60 to the mile with 52 a good average.

The Cincinnati, Georgetown & Portsmouth has had an excellent opportunity of testing the theory that the escaping gases from steam locomotives is injurious to the feed and trolley wires of the overhead electric railway system. This road handles part of its freight business with steam locomotives, and it has watched this point with some anxiety; but after three years of constant and frequent freight train service, it has been unable to discover that there is any unusual deterioration of insulation, or breaking off of soldered connections due to this cause. The only effect noticed is a heavy coating of soot on the entire overhead and feeder system.

In Tables VII. and VIII. are given the details of high-tension transmission lines and overhead construction on the twenty-six roads investigated in Ohio, Indiana and Michigan. These tables are worthy of study as setting forth the latest ideas and practices in designing transmission lines and overhead construction for interurban roads.

TABLE VIII.—SUMMARY OF OVERHEAD CONSTRUCTION ON ROADS TREATED.—*Concluded.*

NAMES OF COMPANIES.	Voltage on Trolley Wire at the Station.	Number of Arresters Per Mile.	How are Arresters Grounded.	Material of D. C. Feeders.	Standard Sizes of Feeders Used.	Feeder Taps to Mile.	How is Tap Made.	Maximum Voltage Drop for Which Feeders are Calculated.
NORTHERN OHIO GROUP.								
Cleveland & Southwestern	600	4	To earth and rail	Copper and aluminum	300,000 to 600,000 c.m	4	Soldered	150
Lake Shore Electric	650	5	To rail	Copper and aluminum	300,000 to 500,000 c.m	4	Soldered	25%
Lorain, Elyria & Cleveland	650	6	To rail	Copper and aluminum	No. 0000	3 and 4	Soldered	25%
Toledo & Indiana	650	2	To rail	Copper		4	Screw	25%
Toledo & Western	650	5	To iron rod	Copper	300,000 circ. mil	4	Soldered	150
Toledo, Ft. Clinton & Lakeside	650	5	To copper plate	Copper	No. 0000	4	Bronze feeder tap ear	200
Stark Electric	600	5	To iron rod and to rail	Copper	250,000 circ. mil	Every 20 poles	Soldered	150
Canton-Akron	650	5	To ground, to copper plate	Aluminum	500,000 circ. mil	5	Clamp soldered	100
CENTRAL AND SOUTHERN OHIO GROUP.								
Western Ohio	650	5	To rail	Copper	500,000 circ. mil	2	Soldered	...
Ft. Wayne, Van Wert & Lima	600	6	To rail	Copper	No. 0000	2	Soldered	220
Dayton & Covington & Piqua	600	5	To copper plate and rail	Aluminum	1,000,000 circ. mil	4	Soldered	125
Dayton, Springfield & Urbana	610	1	To iron rod	Copper	3 No. 0000	7	Solder and screw	210
Scioto Valley	650	...	...	...	...	...	...	...
Cincinnati & Columbus	650	...	...	...	...	...	...	...
Cincinnati, Milford & Loveland	650	...	...	Copper	No. 0000	5	Special lug soldered	200
Cincinnati, Newport & Covington	575	5	To rail	Copper	800,000 circ. mil	4	Special ear soldered	145
Cincinnati, Georgetown & Portsmouth	550	3	To iron rod	Copper	...	5	Soldered	137
INDIANA GROUP.								
Indiana Union	650	2	To rail and ground plate	Copper	550,000 circ. mil	2	Feed in ear and hanger	...
Indianapolis, Northwestern	650	3	To rail and a pipe driven into ground	Aluminum and copper	400,000 circ. mil	5	Special feed in ear	...
Indianapolis & Cincinnati	3,800	3	To rail and a pipe driven into ground	No feeders	None	...	...	...
Indianapolis, Columbus & Southern	625	5	On ground rods and every 6th arrester to the rail	Copper	300,000 circ. mil	2 per mile near sub-station, 5 per mile 5 miles from sub-station	Special feed in ear	...
Terre Haute Tr. & Lgt	550	4	On iron pipe driven 16 ft. into the ground	Copper	500,000 circ. mil	5	Special feed in ear	...
Kokomo, Marion & Western	600	4	To ground rod and to rail	14 miles aluminum, 300,000 circ. mil; Copper equivalent	500,000 circ. mil	4	Special feed in ear, soldered to copper; feeder is clamped to aluminum feeders	150
Ft. Wayne & Wabash Valley	600	3	To a ground plate	...	...	4	Special feed in ear	...
MICHIGAN GROUP.								
Rapid Railway System, Detroit	625-650	2	Through ground rods and bonded to rail	...	400,000 circ. mil	In level country 1,320 ft.; on curves and hills 700 to 800 ft.	Special feed in hanger of own type	...
Detroit, Ypsilanti, A. A. & J	650	3	To rail and ground	Copper	400,000 circ. mil. to No.8		...	...

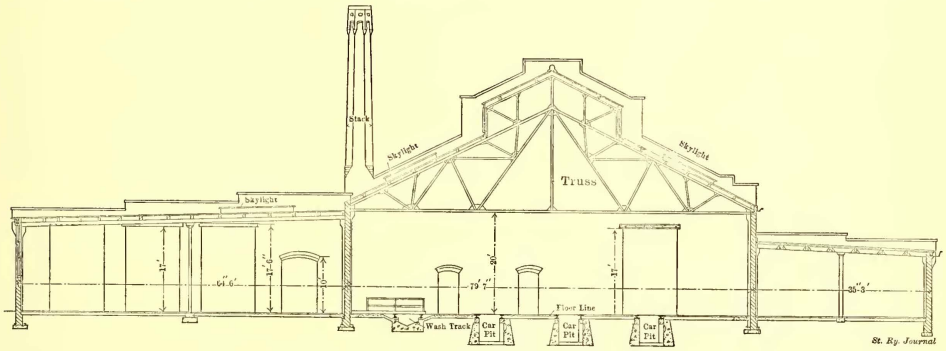
CAR HOUSES AND SHOPS

A number of the early interurban builders in Ohio "saved money" by either not building shops at all, or else putting up the cheapest forms of buildings with practically no equipment beyond a few hand tools. Cars were jacked up with hand jacks, and motors lifted out by man power. In one or two instances interurban roads equipped with the most expensive type of cars and power equipment actually did all their repairs on an open track with a hole in the ground for a pit and a small shack in which to keep a few hand tools and repair parts. Needless to say, the work performed by workmen laying on their backs in snow and water, with weather hovering around zero, was not of a character calculated to give the highest class of service, and while the directors of the roads themselves probably could not understand why their maintenance expenses were high, an experienced manager could doubtless have demonstrated the situation in short order. It is almost invariably the case that when an inexperienced lot of men build an electric road and buy good rolling stock, they labor under the delusion that it should not wear out for a long time to come and they see no reason for providing elaborate shop layouts at the start. The experienced operator knows that the old saying of "a stitch in time saves nine," is nowhere more applicable than in caring for the rolling stock of a traction line. If the equipment is allowed to run down, even for a very short period, it is difficult to get it back to its original efficiency and it depreciates very rapidly. On the other hand, if the equipment is thoroughly inspected at regular and frequent intervals and kept up from the very start, and if the shop is provided at the start with tools for taking care of the work in a rapid and efficient manner, the item of maintenance in the long run is surprisingly smaller than by the other method. Unfortunately, while the majority of master mechanics and managers fully appreciate these facts they find it difficult to impress these conditions upon directors and stockholders who are anxious to have the roads pay dividends soon after they commence operation.

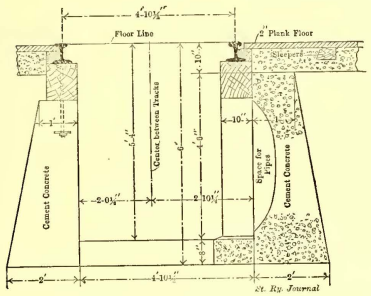
For the reason that the repair shop has too often been looked upon as a needless expense, complete, not to say elaborate outfits are the exception rather than the rule in Ohio, even at this late date. There is, however, a decided tendency for the better in this direction. Roads have outgrown their old shop equipments, which in the first place were designed for the then small properties and are preparing to erect more elaborate plants, while several new companies are planning to provide better facilities at the start than were formerly considered necessary. The grouping of roads into larger systems is also necessitating the erection of more elaborate and better equipped shops, where heavy work for a large system can be taken care of.

The Schoepf syndicate has commenced work at Lima on a very large shop and headquarters building for its four lines radiating from that city. It will be designed to take care of repairs for about 300 miles of road. The layout for these buildings is shown on page 664.

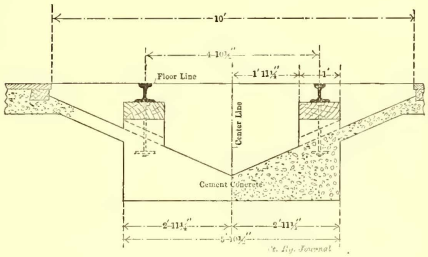
A very modern shop layout is being erected by the Cleveland & Southwest Traction Company at Elyria. It was designed



ELYRIA CAR SHOPS, CLEVELAND & SOUTHWESTERN



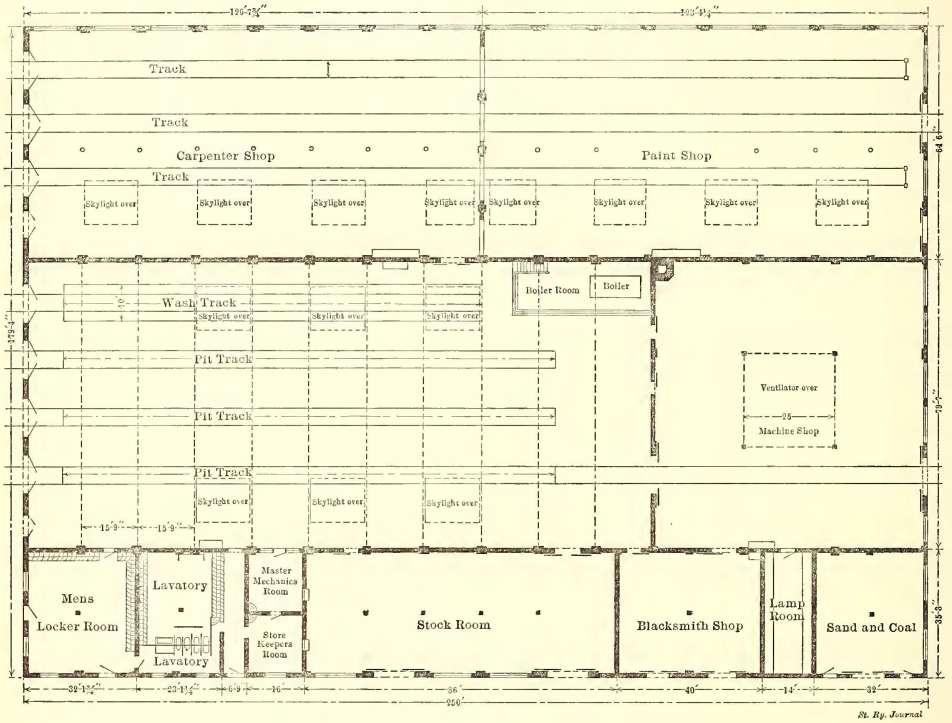
DETAIL OF PITS, ELYRIA SHOPS



DETAIL OF WASH TRACK, ELYRIA SHOPS

by C. N. Wilcoxson, general manager, and follows somewhat the arrangement of the Western Ohio shops, hereafter described, of which road Mr. Wilcoxson was formerly superintendent. The shops occupy a triangular shaped piece of property of thirteen acres, the main line of the road extending along one side a distance of 1200 ft. The entering tracks to shops and yard all lead from the apex of the triangle, so that there are practically no curves or special work in the layout. The building has an outside measurement of 250 ft. x 179 ft. The building is divided into three sections, the central section having a peaked roof, supported by steel trusses. The central portion contains the inspection room in front and the machine shop proper in the rear. There are two flat-roof wings, one containing the carpenter shop and

The Western Ohio Railway was not one of those that overlooked the value of a good shop. Its layout at Wapakoneta, erected three years ago, is one of the best exclusively interurban shop in Ohio at the present time. The main portion is the machine shops proper. There are open concrete inspection pits with a transfer table traveling across three tracks. There is an air hoist in the center for elevating one end of a car so that the trucks can be run off onto the transfer table and shifted to another track for inspection and repairs. An extra set of trucks is kept on hand and the trucks are substituted so that a car is usually out of service only a very short time. A swinging crane covers the transfer table, a wheel press and a large wheel lathe for turning steel-tire wheels. Among other tools are a



CAR SHOPS AT ELYRIA, CLEVELAND & SOUTHWESTERN

the paint shop and the other the men's locker room, offices and storekeeper's room, stock room, blacksmith shop, lamp room and sand and coal room. The building is admirably lighted with skylights over the wings and central section.

There are four pit tracks for repairs in the main room, the pits being built of concrete. The pit tracks rest on 10-in. x 12-in. sleepers, bolted through into anchors in the concrete. One side of the pit is hollowed out for heating pipes and wiring, and on this side the sleepers rest on concrete posts. Air hoists will be provided adjoining the pits for elevating car bodies. One of the tracks is a wash track with a V-shaped section 10 ft. wide with a depth of 17 ins. below the rail in the center. The tracks rest on timber and concrete sleepers and the rails are bolted through into concrete, and the track is drained at a number of points. The machine and carpenter-shop equipment will be of the most modern type, and air will be used for tools and hoists and for cleaning.

bolt threading machine, drill grinder, drill presses, bending machine, etc. Pits are provided with air hoists and air is conveyed to all parts of the shop for operating drills and blowing out machinery and car seats. The blacksmithing, babbitting and armature winding departments are fully equipped. A large carpenter shop in the rear of the machine shop is equipped with all necessary machinery for building as well as repairing cars. As stated in another part of this issue, the company is engaged in lengthening all its cars, about half of them having been completed. Two very substantial freight and express trailers have recently been built. In connection with the shop are recreation room, locker and wash rooms for the crews, large stock room and separate offices for the master mechanic, general superintendent and train despatchers. Several tracks adjoining the buildings provide trackage for all the cars of the system, it being the policy to store cars out of doors when not in service.

The Canton-Akron Railway Company has a well-equipped

STUDY FOR PROPOSED CAR SHOPS, SCIOTO VALLEY TRACTION COMPANY, COLUMBUS, OHIO

PLAN OF CAR HOUSE AND SHOPS AT LIMA, LIMA & TOLEDO TRACTION

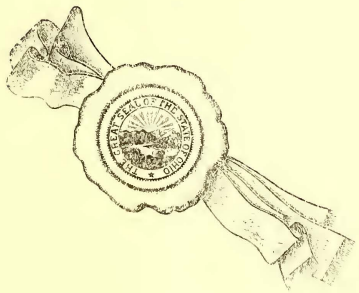
shop at Canton, although it was built up piecemeal. It adjoins the company's large car house for the city and interurban cars, and, of course, work for both branches of the service is taken care of. Originally it consisted simply of a large room for machine shop with carpenter and paint shop in the rear. Special buildings with suitable equipments have recently been built for these departments with provision also for blacksmith shop and babbitting department, while the rear of the storage house has been partitioned off for a machinery room, leaving the main shop open for inspection and general overhauling. There is a transfer table with pit tracks provided with air jacks, and a large air hoist covering a considerable portion of the room. The machinery room in addition to the usual run of tools contains a wheel grinder, a boring mill for boring wheels and turning wheels, a vise for straightening axles and armature shafts, a tire-shrinking heater, taping machine, dipping tubs and electric bake oven for armature and coil work.

The Toledo & Indiana, Dayton & Troy, Toledo & Western, Indiana, Columbus & Eastern, Lake Shore Electric and several other roads also have rather complete shop layouts. The last mentioned road is said to be preparing to erect an elaborate plant to take care of its enlarged system.

A very interesting and novel shop layout has been planned by L. C. Bradley, superintendent of the Scioto Valley Traction Company. He was formerly a steam road man and follows steam road practice as closely as possible in all branches of the operation of his road, and he sees no reason why the round-house idea of a repair shop and storage house, which through many years of practice has been demonstrated to be the best for locomotive repair work, is not applicable for car maintenance work. The accompanying plan will probably be carried out wholly or partially in shops which the company will build within a year. Space for all of the cars may not be provided at once; possibly only half of the building shown will be built at first. It will be seen that each car has an individual stall. Mr. Bradley believes that the great objection to nearly all shops of the usual type is that too much shifting of cars is necessary. A car goes into the shop and other cars are placed in front of it and it is necessary to shift these cars before the first car can be gotten out or another placed in the desired position for repair work. Under the round-house plan, ordinary inspection and the lighter classes of repairs will be taken care of in the stalls. The plans provide for space for working around the cars in the stalls, and there will be an overhead traveling crane for carrying any heavy parts around the rear of the cars through the general repair shop and into the machine shop, with tracks to some of the tools. The general repair shop will have pits for two cars with hoists for lifting car bodies. The various tools will be in a section by themselves. The paint shop, with capacity of two cars, will be back of the general repair shop, and the store room, master mechanic's office, locker room, etc., in the rear of the machine shop. A motor operated turntable will provide access to the various stalls, and there will be operating switches at several convenient places near the entrances so that the table can be turned for any desired track by an employee without the necessity of going to the turntable.

The various approaches to the turntable are long enough for one car each, if it is desirable to allow a car to stand there. Separate entrance and exit tracks will avoid delays in entering or leaving the shop.

Mr. Bradley claims that this type of layout will occupy no more space than a rectangular shop of similar capacity and believes that in many ways it will be more convenient and economical to work in. Although not shown in the plan, provision is made for a large water tank and pipe line extending around the rear of the round house and through the various shops. Each stall will have a fire-proof folding door and it is possible that fire-proof walls may separate some of the stalls.



SCHEDULES, LIMITED SERVICES, SPEEDS, FARES, DESPATCHING AND MISCELLANEOUS MATTERS

DETERMINING SCHEDULES

Most of the early interurban roads in the Central West provided for hourly service, and schedules were prepared to have cars leave terminal points on the even hour. This practice is still followed by a number of roads, but the theory that it is always the most satisfactory method of handling the business is losing ground. It is convenient for the public to know that cars leave on the even hour, and the people become accustomed to it and expect it, but this plan is very often a losing proposition for the road. For instance, if cars leave on the even hour, it frequently is necessary for a car to lay up at a terminal for from ten to forty minutes. Wages of crews, interest and other expenses go on, but the car is earning nothing during a very considerable portion of the day. In such cases it is better to have the car leave one of the terminals at some uneven fraction of the hour, and thus keep the car earning a greater portion of the time; frequently it is possible to dispense with one car and a crew on a line by this method. The idea, too, that all cars should run through over the entire line is meeting with less favor. On a number of roads the traffic on an extension is not sufficient to warrant the frequent service that is demanded on other portions.

In some portions of Ohio, near Cincinnati, for instance, the roads have abandoned almost entirely the idea of giving even-hour service, and they lay out their schedules as do railroads, running trains at times of day when the business demands. This is directly opposed to the old street car and suburban railway plan, but it is a question that is receiving serious consideration. Reference to the table on page 667 will show that the Cincinnati, Georgetown & Portsmouth, for instance, runs trains at very irregular intervals. There are periods in the middle of the day when trains are one and one-half to two hours apart. In the morning there are three times as many trains into the city as are going in the other direction, while in the evening there is frequent service out of the city and but few trains in the other direction. A portion of the trains run about half the length of the road; seven a day go through to Georgetown, while only four a day go beyond that point to Russellville. This company follows the idea of polling trains at intervals; that is, the conductor takes a vote to see whether the passengers are pleased with the time of departure and arrival of the train, or whether some would prefer to have it a little earlier or a little later. If it is found that a train is not paying, it is taken off and tried at some other time of day.

This scheme, of course, necessitates liberal advertising of time tables, and it might not work out satisfactorily on a line running between two large cities.

The question of operating cars at more frequent intervals than hourly headway has been much considered of late. The business of a number of roads has grown to a point where more frequent service is demanded, and some of them have put on half-hourly cars between certain points. Usually the half-hour cars are operated only in summer. A number of roads argue that there is little advantage in this plan, claiming that the public does not become acquainted with the fact that half-hourly cars are in operation until it is time to take them off in the fall, and that the traffic on the hourly cars is relieved but little by this method. Again, people board the half-hourly cars and are disgruntled to find that they only go part way to their destination and they must lay up at some intermediate point. The majority of operators believe that it is a much better plan to handle increased traffic by running double headers. In this way on rainy days, or during unpleasant weather, the extra car need not go on, thus saving much mileage as compared with the plan of having the extra car leave always on the half hour. It is claimed also that this is much safer from an operating standpoint, because, as a rule, it is considered undesirable to operate half-hourly headway on single track roads with infrequent turnouts, especially as a number of the roads are operating numerous freights and limiteds in addition to the local cars. While a number of the roads have cars equipped with train control apparatus, only the Scioto Valley, the Stark Electric and the Lake Shore Electric are operating cars in trains, and the two latter only at infrequent intervals. Many of the roads would be glad to solve the problem in this way, but the objections of city councils, right-angle turns in towns, and, in some cases, weak bridges, make train operation impractical. The tendency is in this direction, however.

The Lake Shore Electric has a very flexible arrangement for varying its service on the main line between Cleveland and Toledo. The heaviest traffic is, of course, in and out of the large cities. During the summer months the company runs half-hourly service out of Cleveland to Lorain, and this part of the road has been double-tracked for this service, while out of Toledo it runs occasional half-hour cars. These, of course, are in addition to through hourly cars and five through limited trains a day.

For its winter schedule, it has announced a change which greatly reduces its mileage, but, at the same time, maintains the service in very good shape. There are hourly local cars out of both terminals, as in summer; but the cars which precede the five limiteds a day out of Cleveland and Toledo run only to Lorain and Fremont, respectively, at which points they are passed by the limiteds in the same direction. In this way there is full hourly service between the points of heaviest traffic, with the limiteds on the heaviest half hours, while between Fremont and Lorain, where the business is light, there is a car every hour, but the limiteds, of course, only make the city stops. The Canton-Akron system operates hourly cars from Akron to New Philadelphia, while between Canton and Massillon and between Canal Dover and New Philadelphia there are additional cars, which give 30-minute and 15-minute service.

The frequency of stopping points is another subject that is being much discussed. The earlier roads figured on getting the bulk of their business from the farmers, and in order to secure rights of way they put in about as many stopping points as were demanded. The tendency is now very much in the other direction. Long experience has shown that the country people are short-distance riders as a rule, and that the making of frequent stops is often the cause of severe loss to the company. The actual cost of stopping and starting a heavy interurban car is considerable, and the rider who stops a car and rides only to the next stopping point for five cents is an unprofitable customer. Several roads have located their stopping points a mile apart and make a minimum charge of ten cents between stations. The Scioto Valley makes but one stop to the mile, while the Cincinnati, Georgetown & Portsmouth and the Dayton, Covington & Piqua have five stopping points to the mile. The difference in their service is apparent from their schedules, which are indicated in the table on page 667. The Lake Shore Electric has reduced its stops to two to the mile, and the Toledo Indiana has followed the same practice. Indiana roads make less frequent stops. The Indianapolis & Northwestern has its stopping points three-quarters of a mile apart, while the Indianapolis & Cincinnati has them a mile apart. Trains on the Kokomo,

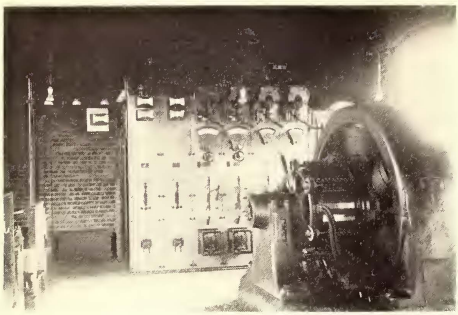
COMBINATION PASSENGER, FREIGHT AND SUB-STATION, FORT WAYNE & WABASH VALLEY

PORTABLE SUB-STATION, DAYTON & MUNCIE

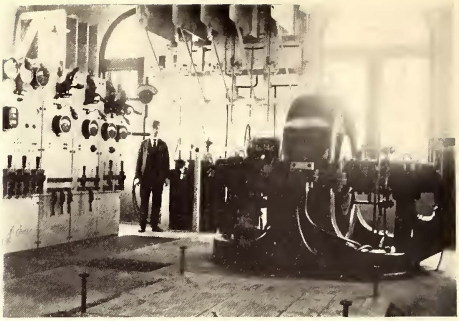
PORTABLE SUB-STATION, TOLEDO & WESTERN RAILWAY

PORTABLE SUB-STATION, CINCINNATI & COLUMBUS

PORTABLE SUB-STATION, COLUMBUS, DELAWARE & MARION

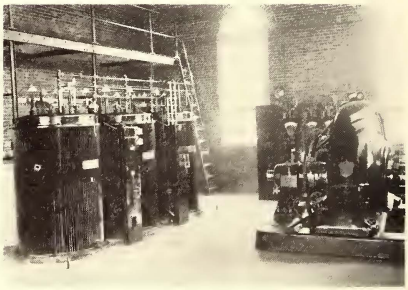


INTERIOR PLEASANT VALLEY SUB-STATION, COLUMBUS, NEWARK & ZANESVILLE



TYPICAL SUB-STATION, CLEVELAND & SOUTHWESTERN

INTERIOR CHASELAND SUB-STATION, COLUMBUS, DELAWARE & MARION

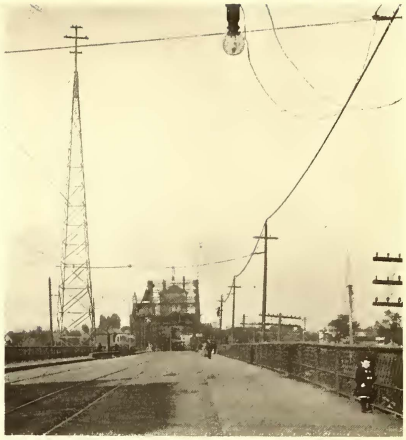


TYPICAL SUB-STATION, SCIOTO VALLEY

LINE ANCHORAGE AT POWER STATION, SCIOTO VALLEY

PROSPECT SUB-STATION, COLUMBUS, DELAWARE & MARION

CAR HOUSE AND SHOPS AT NEWARK, OHIO, COLUMBUS, NEWARK & ZANESVILLE



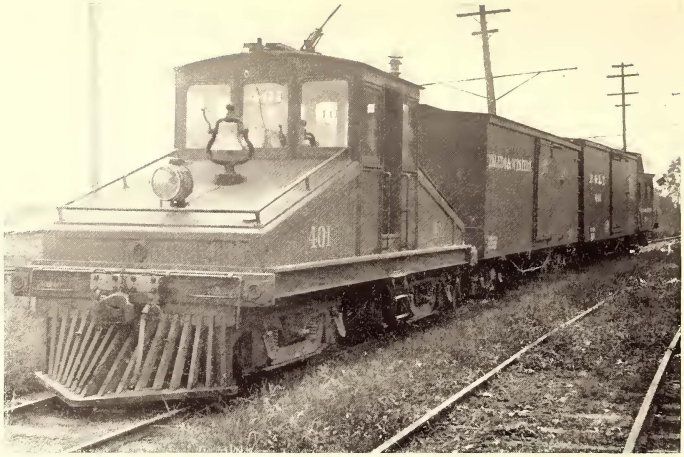
TOWERS CARRYING HIGH-TENSION WIRES OVER NAVIGABLE STREAM, LAKE SHORE ELECTRIC

CAR HOUSE, SHOPS AND OPERATING HEADQUARTERS, WESTERN OHIO RAILWAY

LINE CAR, COLUMBUS, DELAWARE & MARION

STORING CARS OUTDOORS, PROTECTING FENCE TO SHIELD THEM, PAID FOR BY ADVERTISING, STARK ELECTRIC

CAR FOR STRINGING WIRE, COLUMBUS, DELAWARE & MARION



75-TON LOCOMOTIVE AND FREIGHT TRAIN, TOLEDO & WESTERN

FREIGHT TRAIN, WESTERN OHIO

EXPRESS CAR, STARK ELECTRIC

EXPRESS CAR, CLEVELAND & SOUTHWESTERN

ELECTRIC TRUCK FOR HAULING EXPRESS, CINCINNATI, GEORGETOWN & PORTSMOUTH

TABLE IX.—DETAILS OF SCHEDULES, SPEEDS, LIMITED SERVICE, ETC., ON ROADS TREATED (See also Following Page).

NAMES OF COMPANIES.	How Are Schedules Determined.	Details of Actual Schedules.	Schedule Speed Including Stops in M. P. H.	Maximum Speed Between Stops in M. P. H.	Number of Stops to Mile.	Average Time in Minutes Taken at Stops.	Advantage of Limited Service.	Excess Fare on Limiteds.
NORTHERN OHIO GROUP.								
Cleveland & Southwestern	Locals leave Cleveland on hour, limiteds at intervals extra.	Southern division—7 locals to Wooster, 4 to Berea only, 3 limiteds to Wooster. Western division—18 locals to Wellington, 12 locals to Norwalk, 12 limiteds to Oberlin, 4 limiteds to Norwalk.	Limiteds 26.8 Locals 18	50	3	½	Get long distance riders and traveling men.	No
Lake Shore Electric	Locals leave Cleveland on hour and half hour, limiteds at intervals extra.	13 through locals, Cleveland to Toledo; 6 locals to other points; 19 locals to Elyria, 5 limiteds to Toledo, 2 limiteds to Sandusky.	Limiteds 27.4 Locals 20	60	2	½	Get long hauls and extra business that could not otherwise get.	No
Eastern Ohio	Leave Cleveland on the hour on two divisions, half hour cars to intermediate points in summer.	Eastern division—21 cars to Gates Mills, 14 through to Chardon, 7 through to Middlefield. Garrettsville division—19 cars to Chagrin Falls, 5 to Garrettsville, 2 limiteds.	Locals 17	40	4	⅔	Get suburban commuters	No
Toledo & Indiana	In summer local cars hourly from Toledo, with 5 limiteds each way extra. In winter local cars 2 hours, limited cars 2 hours, leave Toledo on the hour.	9 locals to Bryan, 7 limiteds to Bryan	Limiteds 31.9 Locals 24	55	2	½	Get long hauls	Summer only for chair seat.
Toledo & Western	Cars at irregular intervals, best suited to handle the traffic	8 cars to Fayette, 4 cars through to Pioneer on main line. 11 cars to Adrian on Adrian division. No limiteds.	Locals 20.2	40	5	1		
Toledo, Pt. Clinton & Lakeside	Leave Toledo on the half hour	15 locals, Toledo to Marblehead; 2 limiteds, Toledo to Marblehead.	Limiteds 26 Locals 22.8	50	2	½	People want faster service	No
Stark Electric	Leave Canton on the hour	16 cars daily, Canton to Salem; 2, Canton to Alliance; 3, Alliance to Salem. No limiteds.	Locals 21.1	50	4	¾		
Canton-Akron	Hourly service over whole line, half hour Canton-Massillon.	15 locals daily, Akron to New Philadelphia; one-half hour cars Canton to Massillon; 3 limiteds to Cleveland.	Limiteds 23 Locals 18	45	4	¾	Get through business	No
CENTRAL AND SOUTHERN OHIO GROUP.								
Western Ohio	Irregular service on various divisions best suited to handle the traffic.	8 locals daily from Findlay to Celina, 2 others run one-half way each way. Picqua to Wapakoneta, locals every 2 hours. 6 limiteds daily, Picqua to Findlay.	Limiteds 30.5 Locals 21	60	3	½	Get long hauls	No
Ft. Wayne, Van Wert & Lima	Hourly cars leaving Lima at 5 minutes after hour	9 locals daily, Lima to Ft. Wayne; 5 limiteds, Lima to Ft. Wayne.	Limiteds 30 Locals 24.4	62	3	½	Secures much business that could not get otherwise.	No
Dayton & Troy	Keep service ahead of demand. Hourly local cars, Dayton to Piqua; 4 extras to Tippecanoe City; 7 through limiteds additional.	13 locals, Dayton to Piqua; 4 extras to Tippecanoe City only; 7 through limiteds.	Limiteds 30 Locals 22	60	4	½	Get business from steam roads	No
Dayton, Covington & Piqua	Hourly from Dayton on the hour	16 locals, Dayton to Piqua; 3 extras, Dayton to West Milton; no limiteds.	Locals 19.4	45	5	..		
Scioto Valley	Hourly service, one division on the hour, other on half hour.	15 hourly to Chillicothe; 15 hourly to Lancaster; no limiteds.	Locals 28	60	1	½		
Cincinnati & Columbus	Cars at irregular intervals as found desirable	13 cars daily, Cincinnati (Norwood) to Hillsboro; 2 extras to Milford; no limiteds.	Locals 25	55	2	..		
Cincinnati, Milford & Loveland	Cars at irregular intervals. Average 40 minutes to Milford, once in 2 hours to Blanchester.	24 cars to Milford, 6 go through to Blanchester; no limiteds.	Locals 20	45	5	..		
Interurban Ry. & T. Cincinnati	Cars at irregular intervals, frequent service to nearby points, three divisions.	Suburban division—11 cars to Bethel, extras to Coney Island and Hamlet. C. & E. division—13 cars to New Richmond. Rapid division 13 cars to Lebanon, extras to Deer Park; no limiteds.	Locals 17.5	40	6	¾		
Cincinnati, Georgetown & Portsmouth	Cars at irregular intervals like steam road. Frequent service mornings and evenings and between nearby points.	16 cars daily to Bethel, 7 go through to Georgetown and 4 a day to Russelville, Saturdays and Sundays extras; no limiteds.	Locals 19.7	45	5	¾		
INDIANA GROUP.								
Indiana Union	Governing feature is the making of connections with steam roads.	Comprehensive local and limited service	Limiteds 23 Locals 28	69.8 On down grade	..	..	Get steam railroad passengers	Small excess
Indianapolis & Northwestern	Regular cars to leave Indianapolis on the hour	7 local cars; 3 limiteds to La Fayette and Crawford.	Limiteds 27.5 Locals 20	65	1¼	1½		Small excess
Indianapolis & Cincinnati	To leave Indianapolis on the hour	6 on Rushville division, 5 on Shelbyville division; limiteds Ind. to Rushville and Shelbyville.	Limiteds 27 Locals 21	50	1	½		Small excess Small excess.
Indianapolis, Columbus & Southern	To make connections with steam roads at Columbus and interurbans at Indianapolis.	5 cars; no limiteds	Locals 23	45	1	2½		
Terre Haute Tr. & Lgt	To leave Terre Haute on the hour	2, Sullivan line; 3, Brazil line; 2, Clinton line; 1, St. Mary's line; no limiteds.	Locals 26.6	52	1	2		
Kokomo, Marion & Western	Connections with other roads are considered	3 cars, limiteds Kokomo and Marion	Locals 22.3	50	All road crossings	..		No
Ft. Wayne & Wabash Valley	To make connections and leave terminals at most convenient intervals.	5 cars, locals one-half hour, limiteds 4 hours	Limiteds 30 Locals 23	75.9	1.5	..	Get class of business could not get otherwise.	
MICHIGAN GROUP.								
Rapid Railway System, Detroit	To leave terminals on the hour	Local cars and limiteds, Detroit and Pt. Huron.	Limiteds 28 Locals 20	..	..	½	Accommodates the public and creates traffic.	No
Detroit, Ypsilanti, A. A. & J		Local cars and limiteds, Detroit and Jackson	Limiteds 26 Locals 20	57	All cross roads and private stops	..	Get passengers who would otherwise take steam road.	Small excess.

Marion & Western stop at all road crossings. On the Ft. Wayne & Wabash Valley system there are 104 scheduled stops in 75.9 miles, making an average of about one and one-half stops per mile. The franchise of the Detroit, Ypsilanti, Ann Arbor & Jackson system compels it to stop trains at any point along the line where the signal may be given. As a result, there are a great many private stops, and stops are also made at all cross-roads. The tendency of most of the systems is to avoid private stations and to stop only in towns and at important road crossings.

LIMITED SERVICE

Out of 26 leading Ohio, Indiana and Michigan interurban lines investigated for this article, 17 are giving limited service. Methods of running these cars and the objects in view differ somewhat. One of the first roads in the district to run limited service was the Cleveland, Painesville & Eastern, which, about six years ago, commenced the operation of a fast car from Painesville into Cleveland in the morning and returning in the evening. It stopped only at certain points, and was designed to accommodate the commuters of Painesville and the more distant points on the line. The Indiana Union Traction Company was also one of the first to give a limited service, the idea being to accommodate the people of the larger towns. This idea has been followed largely by other roads, and several of the high-speed roads are giving a service designed to attract the long-distance traveler. These cars do not stop in the smaller towns and make only station stops in the larger towns, and they compete very closely with the steam trains making a similar number of stops. The institution of this class of limited service has brought to the interurbans a large amount of business which they could not otherwise get. The plan recently adopted of running limited cars over two or three connecting lines and giving fast service between the important centers has also brought the roads a large amount of new business, while the practice now being generally adopted by

TABLE IX.—DETAILS OF SCHEDULES, SPEEDS, LIMITED SERVICE, ETC., ON ROADS TREATED.—*Concluded.*

NAMES OF COMPANIES.	Points Between Which Limited Service is Given.	Distance.	Time.	Time on City Track in Minutes.	Number Regular Stops.	Number of Limiteds Each Way Per Day.	Regular Fare.	Steam Fare.	Time on Steam Trains.	Baggage on Limiteds.	Charge for Baggage.	Largest Side Without Change. Miles.
Northern Ohio Group.												
Cleveland & Southwestern	Cleveland to Wooster	52	2 hours, 30 minutes	30	3	3	$1.05	$0.70	1 hour, 5 minutes	Yes	No	52
	Cleveland to Oberlin	37	1 hour, 35 minutes	30	1	12	.60	.25	1 hour, 40 minutes			56
	Cleveland to Norwalk	56	2 hours, 15 minutes	30	3	4	.95					
	Cleveland and Toledo	120	4 hours, 30 minutes	60	12	5	1.75	2.25	Local 3¼ hours	No	No	120
Lake Shore Electric	Cleveland and Sandusky	60	2 hours, 30 minutes	40	6	2	Chartered.	1.30	Local 1 hour, 45 minutes			
Eastern Ohio	Cleveland to Akron	40	1 hour	40	6	1	Chartered.	.40	1 hour, 10 minutes	No	No	42
	Cleveland to Chagrin Falls	18	1 hour		3		$0.30					
Toledo & Indiana	Toledo to Bryan	56	1 hour, 40 minutes in summer	18	5 in summer, 9 in winter.	5 in summer, 7 in winter.	1.15	1.10	1 hour, 30 minutes	Yes	No	56
			1 hour, 50 minutes in winter.				Toledo to Bryan, $1.15. Toledo to Pioneer, $1.15. Toledo to Hicksville, 85 cents.					
Toledo & Western		...		...	...	...		...		...	No	60
Toledo, Pt. Clinton & Lakeside	Toledo and Marblehead	52	2 hours	23	7	2	1.10	1.10	3 hours to change cars	No	25c	52
Stark Electric	Canton to Cleveland	60	2 hours, 40 minutes	60	2	3	95 cents, $1.05 round trip	1.15	Av. train 2 hrs., 10 min.	No	No	37
Canton-Akron		(23 on C. A. Ry.)	(1 hour on C. A. Ry.)					$2.30 round trip				60
Central and Southern Ohio Group.												
Western Ohio	Dayton to Toledo	160	6 hours	20	14	7	Dayton to Toledo $3.00. $5.25 round trip.	$3.10	Av. train 5 hrs., 20 min.	Yes	No	160
		(80 on W. O.)	(2 hours, 57 min. on W. O.)		(5 on W. O.)							
Ft. Wayne, Van Wert & Lima	Lima to Ft. Wayne	62	2 hours, 10 minutes	18	7	5	$1.20	1.45	Average train 2 hours	Yes	No	62
Dayton & Troy	Dayton to Toledo	160	6 hours	26	14	7	Dayton to Toledo $3.00. $5.25 round trip.	3.10	Av. train 5 hrs., 30 min.	Yes	No	160
		(31 on D. & T.)	(1 hour, 9 min. on D. & T.)		(3 on D. & T.)							
Dayton, Covington & Piqua		...		...	...	...		...		...	No	34
Scioto Valley		49	1 hour, 40 minutes	28	...	...		...		...	No	49
Cincinnati & Columbus		52	2 hours, 5 minutes	...	23	...	$1.00	1.00	Av. train 2 hrs., 30 min.	...	25c	52
Cincinnati, Milford & Loveland		28	1 hour, 20 minutes	45	...	...		...		...	25c	38
Interurban Ry. & T. Cincinnati	Cin. to Bethel (local)	38.5	1 hour, 38 minutes	35	...	...	$0.60	...		...	25c	32.5
	Cin. to New Richmond (local)	32.5	2 hours, 15 minutes		...	...	.40	...				
	Cin. to Lebanon (local)	21.7	1 hour, 25 minutes		...	...	.35	...				
Cincinnati, Georgetown & Portsmouth		54	2 hours, 45 minutes	35	...	...	...	....	...	...	25c	49
Indiana Group.												
Indiana Union	Indianapolis to Muncie	57	2 hours, 5 minutes	35	10	9	Ind. to Muncie 85 cents	....	2 hours	Yes	No	138
	Indianapolis to Marion	72	2 hours, 25 minutes									
	Indianapolis to Logansport	80	2 hours, 30 minutes									
Indianapolis & Northwestern	Indianapolis to Lafayette	77	2 hours, 35 minutes	34	7	8 Westbound 9 Eastbound	$1.05	....	2 hours, 40 minutes, 2 hours	Yes	No	69
	Indianapolis to Peru	69	2 hours, 10 minutes		15							
Indianapolis & Cincinnati	Indianapolis to Rushville, and to Shelbyville	41	1 hour, 32 minutes	...	3	2	.60	.82	1 hour, 15 minutes	Yes	25c	41
		29	1 hour, 12 minutes		2		.45	.58	50 minutes			
Indianapolis, Columbus & Southern		...		...	...	...		...		...	25c	26
Terre Haute, I. & E.		...		...	...	...		...		...	Yes	
Kokomo, Marion & Western	Kokomo to Marion	...		...	5	...	50 cents, 95 cents round trip	.55	1 hour	Yes	25c	
								$1.55 round trip.				
Ft. Wayne & Wabash Valley	Ft. Wayne to Peru	59	2 hours	15	4	4	$2.35 Ft. Wayne to Ind.	....		Yes	No	138
	Ft. Wayne to Indianapolis	138	4 hours, 40 minutes									
Michigan Group.												
Rapid Railway System, Detroit	Detroit to Pt. Huron	68	2 hours, 15 minutes	45	17	3		Same as electric	1 hour, 50 minutes	No	25c	74
Detroit, Ypsilanti, A. A. & J.	Detroit to Jackson	76	3 hours	40	4	7	$1.05	....	2 hours, 30 minutes	No	25c	76

roads giving such service, of providing schedules which will allow for close connections, is rapidly building up the long-distance traffic to a point where the electric lines of Ohio, Michigan and Indiana are becoming serious competitors of the steam roads on journeys of from 100 to 300 miles. Such trips are already common occurrences, and plans for new limited services over new routes are constantly enlarging the possibilities in this direction. As yet the idea of traveling 200 or 300 miles on a stretch on electric cars is apt to be sneered at by professional traveling men and those who live much of the time in steam railway coaches, but all the objections are being rapidly overcome. However, it is not the commercial men alone to whom the interurbans are catering for long-distance business. The occasional traveler, or the tourist who enjoys seeing the country and the numerous villages, towns and cities passed through, those to whom time is not an all-important factor, and those to whom the saving of money is an important consideration, are the ones that are being attracted to the possibilities of long trips offered by the electrics.

The entire absence of smoke and dust and the pleasure of riding through the country at high speed, with the windows open and arriving at destination without being covered with soot and cinders, are some of the strongest arguments in favor of electric travel, and they are arguments which almost invariably result in a new patron for the electric lines once a person is induced to try such a trip.

It is not intended to convey the idea that the bulk of the business on limited trains in this district comes from the long-haul passengers. In fact, the contrary is true, but the long hauls form a new class of patronage, and a very profitable one, to the interurbans. It can probably be stated without offense that a number of operators rather overestimated the possibilities of getting this class of business when the long-distance services were first started. Some of the roads believed that by offering service de luxe they could secure a considerable portion of the class of passengers who travel in parlor cars on steam roads. They started out by offering all the comforts of the finest Pullman trains, chair seats, Brussels carpets, reading tables and literature, and, in one or two instances, buffet service. As far as Ohio roads are concerned, these ideas have been pretty largely dispelled. The chair seats necessarily reduced the seating capacity of the cars; there was an objection to the excess fare, which the roads felt obliged to charge for the superior service; and while the cars secured considerable new business, they shut out those who really wanted the faster service, but did not care to pay for the high-class accommodations.

The standard practice for this class of service has settled down to a longer car, with comfortable roll-top upholstered or leather seats and larger seating capacity; and, so far as the Ohio roads are concerned, the excess fare has been entirely eliminated. This is, of course, due partially to the two-cent fare law on steam roads, which made necessary closer figuring for the electrics, but it was mainly due to the reasons above mentioned that the special accommodations were abandoned.

In Indiana the idea of charging a graduated excess fare, running from 5 to 25 or 30 cents, according to distance, is the rule. The chief object of this is to keep off the local traffic going from one town to the next, and it is practical because the rates in that State are considerably lower than in Ohio and the steam roads have not been forced down to the lower rate.

The Indiana Union Traction Company and the Fort Wayne & Wabash Valley in their Indianapolis-Fort Wayne service afford facilities for light buffet lunches, and, as this is one of the longest runs in the district, it is fairly well patronized. The cars used on this run have chair seats in the smoker, but not in the main passenger compartment.

The practice of making every other car a limited, adopted at first by the Indiana roads, has recently been taken up on some of the Ohio properties, but the scheme more generally used in Ohio is to run from two to five limited trains a day, in addition to the regular local hourly service. A more detailed description of some of the limited services offered in this district follows:

Cleveland-Toledo.—While not the longest nor perhaps the speediest service in the district, the facilities offered by the Lake Shore Electric Railway are worthy of first mention. This was the first road to demonstrate that people could be induced to ride in electric cars for distances over 60 to 75 miles. The service was started three years ago; and, in the face of the finest steam road service in the country and day and night boat lines eight months in the year, the venture has been a tremendous success. Originally there were three fast through cars a day at a schedule of 5 hours for 120 miles, an hour faster than the local cars. This was reduced to 4¾ hours and then to 4½ hours, and plans are under way for a still further reduction in time, which will be made possible by the building of a cutoff and by the important double-tracking work now under way. This speed is really very creditable when all the circumstances are considered.

The cars make 12 station stops and 13 stops for derailers, while stops are frequently necessary at passing points. They traverse 21 miles of city streets, including terminals, for which 147 minutes are allowed. This leaves but 2 hours and 3 minutes for the 99 miles of high-speed track, requiring an average speed of 48.2 miles an hour. There are numerous stretches which are covered at better than 60 miles an hour to accomplish this. The cars show a remarkably creditable record for being on time, much better in this respect than the trains of the steam road. The cars used in this service were described and illustrated in a recent issue of the STREET RAILWAY JOURNAL. They have leather upholstered seats, and, in order to give a maximum seating capacity, the baggage department was dispensed with on the latest cars. Two-car trains, or double-headers, are frequently necessary on these runs. The cars have four 85-hp motors and can make 65 miles an hour.

A year ago the earnings per car-mile for all of the limiteds was 38 cents. At the present time, with two additional limiteds each way, all limited cars are averaging a trifle over 50 cents a car-mile—an earning capacity which probably cannot be equaled in the district.

Dayton-Toledo.—The longest interurban run in the district is the Dayton-Toledo service operated in conjunction by the Dayton & Troy, Western Ohio and Toledo Urban & Interurban lines. For two years the first-mentioned roads gave limited service from Dayton to Lima, 80 miles, in 2 hours and 30 minutes. The completion of the Western Ohio extension to Findlay made possible the new service this summer, and by an alliance with the last-mentioned road it was extended to Toledo. The parlor car excess fare service which was given on the shorter trip was abandoned, and each road now furnishes two special cars for the service. There are seven limited trains a day each way, of which six cover the entire route. On the Western Ohio and Toledo Urban & Interurban the cars superseded regular local cars, but the Dayton & Troy, with heavier traffic, continues its hourly local service. The cars run through without change, but each road operates the car while on its line. The long run and the fact of operating over three roads made it desirable to give more time than the trip could actually be made in, under different operating conditions. Five minutes layover is allowed in each of the division points—Findlay, Lima and Piqua—and this allowance of 15 minutes enables the roads to make a very creditable showing in the way of keeping the cars on time. The scheduled time for the 162 miles is 6 hours. Including the allowances for layovers and for 16 scheduled stops, the cars

spend 144 minutes on 26 miles of city track, which calls for a speed of approximately 40 miles an hour for the remaining 136 miles. The schedule calls for 60 miles an hour on a number of 4-mile and 5-mile stretches. The cars have practically no layover in Toledo, and the round trip of 324 miles of continuous running is a severe test as to the standing up and heating qualities of the modern interurban electric motor. Baggage is carried on these cars, no charge being made, a practice which has very recently been adopted. The one-way fare for the through trip is $3, which is but 5 cents cheaper than the railroad fare since the 2-cent law went into effect, but the round-trip rate is 75 cents less than that of the steam road. The through business is proving very satisfactory to the companies concerned, while the town-to-town business, which is, of course, the bulk of the traffic, gives the cars an earning capacity of 2 to 3 cents a car-mile better than the local cars on the lines concerned. Two days a week the roads have been giving cheap excursion rates—$3 round trip from Dayton to Toledo and $4.25 round trip to Detroit or the Lake Island resorts, the latter being under an arrangement with the lake boat lines. These excursions are run from all points on the system with corresponding rates.

Indianapolis-Fort Wayne.—The most noteworthy service of this class in Indiana is that between Indianapolis and Fort Wayne, a distance of 138 miles, which is operated jointly by the Indiana Union Traction Company and the Fort Wayne & Wabash Valley Traction Company. The one-way trip is made in 4 hours and 40 minutes. This service was described at some length in the STREET RAILWAY JOURNAL for June 16, 1906. The one-way fare between Indianapolis and Fort Wayne on this limited service is $2.45. Three-compartment buffet cars are employed. The rear compartment is for passengers, and the forward compartment, which includes the motorman's cab, is a baggage room. Between these is a smoking room. Light refreshments are served from the buffet, consisting of sandwiches, eggs, bread and butter, tea and coffee, etc. Sixteen scheduled stops are made between Indianapolis and Fort Wayne. When limited service was first inaugurated on Indiana railway lines, in order to cut down the running time, very few stops were made; but at the present time limited trains on the majority of the roads stop at all the towns of any size. The gain in running time is made by cutting out the cross-road and other country stops. This change in practice is well illustrated on the Indianapolis & Muncie division of the Indiana Union Traction Company. When limited service was first inaugurated on this system the only stop made between Muncie and Indianapolis, a distance of 56 miles, was at Anderson. At the present time ten town stops are made. C. A. Baldwin, superintendent of transportation of the Indiana Union Traction Company, states that in his experience the best returns from limited service are obtained when stops are made at all the principal towns. The only exception to this practice made by the Indiana Union Traction Company is in the operation of the "Marion Flyer," which makes but two scheduled stops between Marion and Anderson, a distance of 72 miles. The Indiana Union Traction Company has gone into limited service rather extensively. On the Indianapolis & Muncie division the limited cars and regular cars making all stops are alternated, the limited cars being run at two-hour intervals. The same is true on the Indianapolis Northern division of the road. On these limiteds a fare slightly in excess of the regular fare is charged, and the cars used are always the newer ones and are furnished somewhat better than the regular cars. The object in charging the excess fare is largely for the purpose of excluding the shorter-haul travel. It is believed that by excluding this element from the regular cars, many people who would otherwise travel by the paralleling steam roads are induced to patronize the electric line. With the exception of the cars in the Fort Wayne special service, the limited cars of the Indiana Union Traction Company are not equipped for carrying baggage, and the baggage of a passenger traveling on the limited cars is carried on the regular train either preceding or the one immediately following the limited car.

On the Indianapolis & Northwestern system limited cars are run at about three-hour intervals. The run between Indianapolis and La Fayette, over a distance of 68.75 miles, is made in 2 hours and 30 minutes, the regular cars making the run in 3 hours and 15 minutes. The gain in time is made by cutting out the stops at the small country towns and having the limited trains make only three regular town stops and four flagged stops. An excess fare of 20 cents is charged between Indianapolis and La Fayette, the regular fare being $1.05. Baggage is carried on the limited trains, as the cars in this service are of the same type as those in regular service and are provided with baggage compartments. One limited train in each direction is run in the morning and in the evening on each division of the Indianapolis & Cincinnati Traction Company. The limited trains on the Rushville division make three scheduled stops between Indianapolis and Rushville, a distance of 41 miles. The run is made in 1 hour and 32 minutes, or at the scheduled speed of 27 miles per hour. An excess fare of 15 cents is charged to Rushville, the regular fare being 60 cents. Baggage is carried on the limited cars. On the Kokomo, Marion & Western system limited trains are run in each direction every three hours and no excess is charged on them. The only limited service given on the Fort Wayne & Wabash Valley system is that of the Fort Wayne special, which, as has previously been said, is operated jointly by the Indiana Union Traction Company and the Fort Wayne & Wabash Valley Traction Company.

Limited trains are operated over all of the interurban divisions of the Detroit United Railways. To the company the operation of these trains is simply a matter of creating new through business. The rate is the same on the limited as on the local cars. Henry Bullen, general superintendent of the system, is of the opinion that it is a mistake to charge excess fare on limited cars. He believes that it is due to the fact that no excess is charged that the limited cars operated by the company always carry full loads and are the source of a great deal of revenue. Four limited trains are operated daily in each direction over the Toledo division, two over the Flint division, and three over the Port Huron division. The time from Detroit to Port Huron, a distance of about 68 miles, is 2 hours and 15 minutes, which gives a schedule of 28 miles per hour, and this is practically the same schedule as that of the Fort Wayne special between Fort Wayne and Indianapolis. Limited cars of the Detroit, Ypsilanti, Ann Arbor & Jackson Railway make two stops at all large towns, one stop being in the east end of the town and the other in the west portion. Seven limited trains are operated daily in each direction. The run between Detroit and Jackson, a distance of 76 miles, is made in 2 hours and 30 minutes. An excess fare is charged on the limiteds and no baggage is carried on them.

The Toledo & Indiana Railway has an unusual scheme for limited service. During the summer months it operates parlor cars, making the 56 miles from Toledo to Bryan in 1 hour and 45 minutes. These cars are in addition to the regular hourly service and an excess fare is charged. They secure the better class of through business and pleasure traffic. During the winter months the parlor cars are retired from the service, more stops are made by the limiteds, and the time is increased to 2 hours, the cars alternating with the local cars. Manager Darrow, of this company, finds that there is not the demand for the parlor cars in winter, and the scheme reduces the mileage in the winter months. No excess is charged in winter.

The Fort Wayne, Van Wert & Lima gives very fast service between Fort Wayne and Lima with five cars each way, making the 62 miles in 2 hours and 10 minutes. The service competes

very closely in time with the parallel steam road. The cars are duplicates of those used on the Indianapolis-Fort Wayne service.

The Cleveland & Southwestern has increased its business tremendously the past summer by frequent limited service. On its western division it ran hourly limited cars as far as Oberlin, four a day going through to Norwalk, in addition to hourly local cars to Norwalk and Wellington, leaving Cleveland on the half hour. It also has three limiteds to Wooster on the southern division in addition to hourly local cars. No excess is charged on limiteds and free baggage is carried. The Northern Ohio Traction Company, acting in conjunction with the Canton-Akron Company, which it now controls, has recently started limited service between Cleveland and Canton. This is in addition to limited service between Cleveland and Akron, started some months ago. The cars cover the 60 miles in 2 hours and 40 minutes, of which 1 hour is spent on 10½ miles of city track. The round trip rate is $1.65, as compared with $2.30 on the parallel steam road. The Cleveland, Painesville & Eastern and the Cleveland, Painesville & Ashtabula recently started joint limited service between Cleveland and Ashtabula, making the 60 miles in 2 hours and 30 minutes. Very fine cars are being delivered for this service. The Toledo, Port Clinton & Lakeside runs two cars each way a day between Toledo and Marblehead, 52 miles, in two hours. The Eastern Ohio has a limited car each way on each of its two divisions. The one on the eastern division runs to and from Gates Mills and presents an unusual arrangement. It is known to the country people as the "Blue Blood Special," being in reality a chartered car run for the benefit of wealthy suburbanites, who clubbed together for its operation. It makes no city stops, and only at points in the country where members of the club, who designate their membership by holding up a yellow card, desire to board the car.

The Schoepf syndicate has announced that it is soon to resume the operation of limited cars between Dayton and Indianapolis. Before the consolidation of the properties on this route, the three roads operated what was known as the "Interstate Limited," giving parlor buffet service with excess fare. This was abandoned some months ago. It is understood that the new cars will be similar to those on the Indianapolis-Fort Wayne service, and that the 108 miles will be covered in 4 hours, 15 minutes better than the previous service.

It seems quite probable also that the Schoepf syndicate will resume limited service between Dayton and Columbus, and possibly between Columbus and Zanesville. These services were abandoned some months before the sale of the properties to the Schoepf interests on account of poor power conditions. These conditions are now being improved and it is reasonable to suppose that the service will be resumed, as it is needed to complete the chain across Central Ohio and Indiana. Fast service will also doubtless be given between Dayton and Cincinnati as soon as the improvements on the Cincinnati Northern, now well under way, are completed.

The Scioto Valley Traction Company and the Cincinnati & Columbus Traction Company do not give special limited service, but their local service is very fast, the former running 49 miles in 1 hour and 40 minutes, equal to about 28 miles an hour, while the latter has a schedule of 2 hours and 5 minutes for 52 miles, or a fraction under 26 miles an hour. These roads have but one stopping point to the mile.

LONG DISTANCE TRIPS

Four hundred miles in a day is now possible on the regular every-day limited cars of this district. From Indianapolis to Cleveland by electric cars is a roundabout ride, but it can be covered in a day. Here is the proof, taken from the time cards of the various roads concerned. Under present conditions it is not a trip that is likely to be taken except for amusement, but another year will see cutoffs in operation which will reduce the time and distance by more than 25 per cent.

				MILES.
Indianapolis-Ft. Wayne Ltd...	Lv. Indianapolis....	7.00	a.m.	134
	Ar. Ft. Wayne.....	11.40	"	
Ft. Wayne-Lima Ltd.....	Lv. Ft. Wayne.....	12.05	p.m.	65
	Ar. Lima.....	2.10	"	
Lima-Toledo Ltd.....	Lv. Lima.....	2.15	"	81
	Ar. Toledo.....	5.20	"	
Toledo-Cleveland Ltd.....	Lv. Toledo.....	7.30	"	120
	Ar. Cleveland.....	12.00	"	
Total				400

A large number of trips above 250 miles can be made on traction lines in less time than they can be made on steam roads, because of the infrequency of steam road service and long delays in making connections for isolated points. Tickets are sold every day out of Cleveland for Detroit, 180 miles, and it is possible to continue on from that point to Port Huron, Mich., 250 miles, with better connections than can be made by steam. Tickets are frequently sold out of Dayton for Port Huron, Mich., a trifle under 300 miles, and people have frequently gone from Zanesville, Ohio, to Indianapolis and points beyond, 250 to 300 miles, actually making better time than by steam roads for the reasons mentioned.

FARES

Last year the majority of the roads in Ohio raised their rates to approximately 2 cents a mile for one-way cash fares, and, in spite of the recent reduction of the rates on steam roads in Ohio, to 2 cents a mile, this basing rate is still retained by the majority of electric roads. As a matter of fact, there are two instances where the interurban roads are getting more than 2 cents a mile, and there are several instances where the rates between certain points on electric roads are now a trifle higher than rates of the parallel steam roads, due to shorter mileage on the latter. The fact that the interurban roads are maintaining practically the same rates as the steam lines on single one-way trips offers a remarkable commentary on the advantages of interurban electric roads, namely, frequent service and the operation of cars to convenient points in the business centers of large cities. The situation was watched with considerable anxiety after the passage of the 2-cent fare bill. It was feared that the electrics would be forced to go back to their old rates and might even be obliged to cut below the comparatively lower rates in force in Indiana and Michigan, but after six months of the lower competition, it has not been found necessary to change this basing rate, and almost without exception the roads have shown greater increase in earnings than in any similar period in their histories.

On a number of roads this has been effected largely by improving the service through the purchase of new rolling stock and by faster schedules and more frequent limited trains. The growth of the systems and the ability to make better connections have also had much to do with this result. Steam roads have found that the short-haul travel was not profitable at the lower rates, and have cut off many of their local rains, thus improving conditions for the electrics. On the majority of the longer hauls the interurbans have been holding their own or making gains. This is evidenced by the experience of the Lake Shore Electric, whose Cleveland-Toledo limiteds have been increased from three to five a day and they have been earning about 50 cents a car-mile, where a year ago they earned less than 40 cents a car-mile.

The Lake Shore Electric, Stark Electric, Interurban Railway & Terminal Company, Cincinnati, Georgetown & Portsmouth and several other roads make a reduction of 5 to 10 per cent on one-way ticket fares as compared with cash fares paid on the car. This is, of course, to encourage the sale of tickets at ticket offices.

The Toledo & Indiana makes the increased rate of 5 cents flat above the ticket rates to any point, and issues a cash receipt, which is good for a rebate of five cents at any ticket office. The Dayton, Covington & Piqua does not sell tickets.

Much of the success of the Ohio interurbans in holding their own against the new competitions is due to the fact that, as a rule, they are making considerable reduction on round-trip tickets, whereas the steam roads in Ohio have cut off all reductions on round trips. An example of this is furnished in the case of the through Dayton-Toledo service, where the one-way rate is $3 and the round-trip rate $5.25. The steam rate is $3.05, with no reduction for round trip. The reductions made vary considerably. In the case of the Scioto Valley, Cincinnati & Columbus and Cincinnati, Milford & Loveland, the round trip rate is 1.9 cents, while on the Cincinnati, Georgetown & Portsmouth it is but 1.35 cents per mile.

years ago nearly all of the roads sold mileage books, but at present only 5 out of 17 roads in Ohio have such books.

The interchangeable coupon book of the Central Electric Railway Association has been pretty generally adopted. This, of course, gives the reduction of 16 2-3 per cent from the one-way cash fare rate. The sales of this form of book have been increasing steadily during the past few months, the gain for August being $3,700 over the previous month. Ten roads sell school tickets. In the northern and eastern parts of Ohio the rate is 1 cent a mile, the tickets being good on school days only. The roads around Cincinnati seem to make a considerable reduction in this, the Cincinnati, Milford & Loveland selling such tickets at 0.60 cent, and the Cincinnati, Georgetown & Portsmouth at 0,61 cent per mile.

There is a considerable difference of opinion as to the advisability of making special rates on Sundays and holidays. Some

TABLE X.—RATES OF FARE IN CENTS PER MILE ON ROADS TREATED (See also Following Page).

NAMES OF COMPANIES.	Cash Fare Per Mile, in Cents.	Ticket Rate Per Mile, in Cents.	Round Trip Rate Per Mile, in Cents.	Family Commutation Rate Per Mile, in Cents.	Individual Commutation Rate Per Mile in Cents.	Mileage Books. Rate Per Mile, in Cents.
Northern Ohio Group.						
Cleveland & Southwestern	1.82	1.82	1.61	1.44 Limit 6 months.	1.27 Limit 60 days.	
Lake Shore Electric	2.00	1.82	1.71	1.55 No limitations.	1.25	
Eastern Ohio	2.21	2.21	....	1.83	1.10 Limit 30 days.	
Toledo & Indiana	5c. more than ticket rect. redeemed.	2.00	1.80	....	1.60	
Toledo & Western	2.00	2.00	1.50	....	1.00	1.50
Toledo, Pt. Clinton & Lakeside	1.75	1.75	1.61	1.40	....	....
Stark Electric	2.00	1.75	1.75	No.	No.	1.50 Good for anyone.
Canton-Akron	1.75	1.75	1.50	No.	No.	No.
Central and Southern Ohio Group.						
Western Ohio	2.00	2.00	1.80	1.75	....	1.75
Ft. Wayne, Van Wert & Lima	2.00	2.00	1.80	....	....	....
Dayton & Troy	2.00	2.00	1.80	1.33	....	1.10
Dayton, Covington & Piqua	2.00	No tickets.	....	....	1.33	1.50
Scioto Valley	2.00	2.00	1.90	1.67 No limitations.	1.20 30 days limit.	....
Cincinnati & Columbus	2.00	2.00	1.90	No.	1.00	No.
Cincinnati, Milford & Loveland	2.11	2.11	1.90	.66 One month only.	1.17 10-trip book.	No.
Interurban Ry. & T. Cincinnati	1.75	5 to 10c. less.	1.66	1.57	1.42 30 days.	No.
Cincinnati, Georgetown & Portsmouth	2.00	1.50	1.35	....	....	1.25 Family.
Indiana Group.						
Indiana Union	1.50	1.50	Slight reduction	No	No	1.25
Indianapolis & Northwestern	1.50	1.50	5 to 10c. reduction	....	20 rides at rd. trip rate	
Indianapolis & Cincinnati	1.50	1.50	5 to 10c. reduction	Interchangeable coupons good for family		
Indianapolis, Columbus & Southern	1.50	1.50	15c. reduction to Columbus, 41 miles.	No.	16⅔% reduction from round trip rate.	No.
Terre Haute Tr. & Lgt	1.00—2.00	None.	No.	No.	No.	No.
Kokomo, Marion & Western	1.67	....	5c. reduction for fares over 15c.	No.	No.	Yes.
Ft. Wayne & Wabash Valley	2.00	2.00	Slight reduction for round trip.	No.	About 1c. per mile	Yes.
Michigan Group.						
Rapid Railway System, Detroit	1.50	1.50	Slight reductiou for round trip.	$10 book at ⅓ reduction.	....	Yes.
Detroit, Ypsilanti, A. A. & J	2.00 W. of A. A. 1.00 E. of A. A.	Slight reduction from cash fare W. of A. A.	....	No.	No.	E. of A. A. 1.00c, W. of A. A. 1.50c per mile

There is little uniformity of practice in regard to the sale of commuter and mileage books, each road governing its practice by the local conditions and the competition offered; but, as stated, many of the roads are finding their positions stronger than formerly through the cutting off of local steam trains. Family commuter books are sold by ten out of seventeen roads in Ohio. They are limited usually to six months or a year, but the tendency is to drop all other limitations, making the books practically wide open for any one who desires to use them. The rates vary from 0.66 cent per mile on a monthly family book sold by the Cincinnati, Milford & Loveland, to 1.83 cents on the Eastern Ohio for this class of book. Individual commuter books are not so generally used. The Toledo & Western and the Cincinnati & Columbus give as low as 1 cent a mile on such books, which are good for thirty days, with no rebate for unused portions. Several roads have books selling at the rate of about 1.25 cents per mile, with sixty-day limitation. Several of the roads, particularly those in the western part of the State, make a rate of 1 1-3 fare for round trips on special days, while the roads in the Cleveland district feel that they can get all the people they can carry at the regular rates. Week-end rates with tickets good for three days are made by several of the roads, but the general sentiment is against this. Under the head of "other rates" there are several peculiar schemes. The Toledo & Indiana makes a rate of 1 cent a mile for evening rides after six o'clock. The Toledo, Port Clinton & Lakeside makes all its rates 5 cents cheaper in summer than in winter. The Dayton & Troy and Western Ohio run semi-weekly long-distance excursions at the very low rate of 1 cent a mile. Chartered car rates vary considerably; but, as a rule, they are based on 1 1-3 fare for a party of twenty or more. Several roads make a flat rate for the use of cars between certain points.

The rates of fare over the roads visited in Indiana and Michigan vary from 1 to 2 cents per mile, the lowest rates being on

the Brazil division of the Terre Haute Traction & Light Company and on the Detroit, Ypsilanti, Ann Arbor & Jackson Railroad east of Ann Arbor. On the eastern end of the latter road the charge is made by townships, the fare being 5 cents per township, which usually means a distance of about 5 miles. This low rate is the result of franchise requirements. On that portion of the road west of Ann Arbor the franchise permits of a 2-cent-per-mile fare, and this fare is charged. This road, therefore, represents the two extremes of interurban fares of the roads visited.

Tickets are sold by practically all of the systems. Usually no reduction is made from the regular fare paid on the train for a ticket fare, the only exception to this rule being the Detroit, Ypsilanti, Ann Arbor & Jackson Railway, which sells tickets over that portion of the road west of Ann Arbor at a slight reduction from the fare when paid on the train.

The State laws of Indiana are said to practically prevent the tion Company gives a 5-cent reduction when the one-way fare is more than 15 cents.

The interchangeable coupon book of the Central Association is used by all the Indiana and Michigan roads visited, with the exception of the Terre Haute Traction & Light Company, the tracks of which are not yet connected to those of any other system, and the Detroit, Ypsilanti, Ann Arbor & Jackson Railway, which uses a mileage book not limited to the use of one person. The Indianapolis & Cincinnati Traction Company issues a special contract by which the interchangeable coupon book of the Central Electric Railway Association may be used on the lines of the company by the purchaser or by members of his family or firm. It may also be used in payment of the personal fare of any traveling companions for whom it may be presented. The Fort Wayne & Wabash Valley uses, in addition to the interchangeable coupon book, an individual mileage book. This

TABLE X.—RATES OF FARE IN CENTS PER MILE ON ROADS TREATED.—*Concluded.*

NAMES OF COMPANIES.	Interchangeable Coupons, Rate Per Mile in Cents.	School Tickets, Rate Per Mile in Cents.	Sunday Rates, Per Mile in Cents	Week-end Rates, Per Mile in Cents.	Other Rates.
NORTHERN OHIO GROUP.					
Cleveland & Southwestern	1.51	1.00 School days only.	....	....	
Lake Shore Electric	1.51	1.00 School days only.	....	....	
Eastern Ohio	....	1.10 School days only.	....	....	
Toledo & Indiana	1.67	....	1.33	....	Evening rate 1c. a mile, good only for evening issued.
Toledo & Western	....	1.00	1.33	....	
Toledo, Pt. Clinton & Lakeside	1.53	....	....	....	Summer rates 5c. cheaper than winter.
Stark Electric	No.	No.	No.	No.	20 party rate 1.33c. per mile.
Canton-Akron	No.	No.	No.	No.	20 party rate 13½ miles for 15c. each person.
CENTRAL AND SOUTHERN OHIO GROUP.					
Western Ohio	1.67	1.00	....	1.25	
Ft. Wayne, Van Wert & Lima	1.67	....	....	....	
Dayton & Troy	1.67	....	1.05	1.05	Long distance excursion twice a week, 1c. per mile.
Dayton, Covington & Piqua	1.67	....	....	....	
Scioto Valley	Don't sell.	1.00	....	....	
Cincinnati & Columbus	No.	.75 School days.	1.00	1.33	No.
Cincinnati, Milford & Loveland	No.	.60 School days.	No.	No.	No.
Interurban Ry. & T. Cincinnati	No.	.87 School days.	No.	No.	No.
Cincinnati, Georgetown & Portsmouth	No.	.61 School days.	No.	No.	No.
INDIANA GROUP.					
Indiana Union	Yes.	....	No.	....	
Indianapolis & Northwestern	Yes.	1.00	Where rate is over $1, Sunday rate is made $1.	No.	
Indianapolis & Cincinnati	Yes.	$2.50 for 100 coupons, school days.	1c. per mile to Indianapolis only.	From Indianapolis out Sat. return Sun. or Mon. 1c. per mile.	
Indianapolis, Columbus & Southern	Yes.	No.	No.	No.	One-way coupon books, 25 round trips, not trans'ble.
Terre Haute Tr. & Lgt.	No.	No.	No.	No.	No.
Kokomo, Marion & Western	Yes.	½ off during school term.	Yes, especially in summer.	....	Working book ½ off reg. fare
Ft. Wayne & Wabash Valley	Yes.	No.	Occasionally.	No.	
MICHIGAN GROUP.					
Rapid Railway System, Detroit	Yes.	1 fare round trip limited to certain hours.	No.	No.	
Detroit, Ypsilanti, A. A. & J.	No.	Discontinued.	No.	No.	Special excursions.

charging of excess fares on trains. In order to charge excess for cash fares a ticket agent must be at the window of the ticket office constantly for one-half hour before the departure of trains, in order that passengers may buy tickets if they so desire. As the duties of ticket agents are usually combined with those of freight agent, and occasionally with the duties of sub-station man, to comply with the law it would be necessary to employ additional help, the cost of which would often more than offset the excess obtained from cash fares. Usually a reduction is made from the regular fares when round-trip tickets are purchased. On the Indiana Union Traction Company the round trip fare is about 80 per cent of the double one-way fare. The Indianapolis & Cincinnati Traction Company gives a 10-cent reduction from the double one-way fare on round trip tickets on the Rushville division, and from 5 to 15 cents reduction on the Shelbyville division. The Kokomo, Marion & Western Traction is made up of 5-cent coupons, and a book of $10 worth of coupons is sold for $8, giving a 20 per cent reduction, or reducing the fare to 1.6 cents per mile. A one-way coupon book of twenty-five round trips is sold over the Indianapolis, Columbus & Southern road. The coupons are good only for thirty days and are not transferable.

The only system using a family commuter ticket is the Detroit United Railways. A $10 book of fares is sold at a reduction from the regular rate of about 30 per cent. On the Indianapolis & Northwestern system a 20-ride commutation ticket is sold at round trip rates. An individual commutation ticket is sold on the Indianapolis, Columbus & Southern Traction Company at a reduction of 16 2-3 per cent under the round trip fare. This ticket is good only between stations designated by several of the systems. There is no uniformity of the regulations governing the use of such tickets on the different roads. The

Indianapolis & Northwestern system issues school tickets to persons under eighteen years of age at 1 cent per mile. A certificate, to the effect that the purchaser is a student or scholar, is required from the superintendent of the school. A school ticket of 100 5-cent coupons is sold by the Indianapolis & Cincinnati Traction Company for $2.50. This is at a reduction from the regular rates of 50 per cent. The teacher must give a certificate, and the tickets are accepted only between the hours of 7 a. m. and 5 p. m. The Kokomo, Marion & Western Traction Company sells school tickets at a reduction from the regular rates of 33 1-3 per cent. The tickets are not limited to hours or ages, but are good only during school terms. School tickets are sold at the rate of one fare for the round trip by the Detroit United Railways. The tickets are issued to students in schools ranging in grade from kindergartens to high schools and are limited to certain hours. No school tickets are issued by the Detroit, Ypsilanti, Ann Arbor & Jackson Railway. They were formerly issued, but were recently discontinued.

The majority of the roads visited make no special Sunday rates. The Indianapolis & Northwestern Traction Company, however, makes a slight concession by charging a maximum fare of $1 on Sundays. Special Sunday rates are frequently made on the Kokomo, Marion & Western Traction Company. Very few Sunday rates are made by the Fort Wayne & Wabash Valley system, but they are made on special occasions.

The Indianapolis & Cincinnati Traction Company makes a Sunday rate of 1 cent a mile from all points on the Rushville division to Indianapolis. Travel in the opposite direction is taken care of by "week-end excursion tickets," which are sold at the Indianapolis terminal ticket offices on Saturdays and Sundays for all stations on the Rushville division, and are good returning either on Sunday or on Monday.

The Kokomo, Marion & Western Traction Company issues a "work book," which sells at a reduction of 33 1-3 per cent from the regular fare. However, it is good only between the hours of 5 and 8 a. m. and 4:30 and 7:30 p. m. All of the systems make special rates for special cars. These rates, however, are made on different bases by the different roads. Some base the rates on the mileage, some on the time the car is in use, and some consider the number of passengers carried, as well as the mileage and the period of time the car is in service.

The Detroit, Ypsilanti, Ann Arbor & Jackson Railway charges $75 for a special car between Jackson and Detroit, a distance of 76 miles. The party carried is limited to sixty people. No extra charge is made for the layover in Detroit. On the Fort Wayne & Wabash Valley system a charge of 60 cents per car-mile is made. The party is limited to the comfortable loading of the car. In addition to the mileage, a charge of $1 for each hour of layover is made. The minimum rate for a special car is $10.

TRAIN DESPATCHING

In spite of the fact that the average operator in speaking of his train despatching system claims that it is exactly like steam-road practice, there is a remarkable lack of uniformity on this important subject. There are variations in the methods of transmitting messages, methods of receiving them, methods of recording them and many variations in the methods of handling trains. The telephone is of course used by all Ohio roads in transmitting messages, but the Toledo & Western offers a variation from this in that many of its orders are transmitted by telegraph to the agents the same as in steam road practice, but the orders delivered to crews at sidings along the line are by telephone. There is a considerable difference of opinion as to the advisability of allowing agents to handle messages. The roads which come the nearest to genuine steam practice of course transmit orders through agents. The Lake Shore Electric, Toledo & Western, Toledo, Port Chester & Lakeside, Cincinnati, Georgetown & Portsmouth, Dayton & Troy and several other roads deliver many of their messages in this way. The Dayton & Troy delivers messages through agents, and all agents not only keep a record of the passing of trains, but report each train to the despatcher. The advantages claimed for the plan of having agents to handle messages is that it saves the time of crews and avoids the necessity for the crews calling at certain points when there may be no orders. It is possible also when agents are maintained at stations to reach crews at critical times.

On the other hand, the Scioto Valley, Stark Electric, Eastern Ohio, Cleveland & Southwestern and several roads do not believe in having the station agents pay any attention to the handling of trains, preferring to limit the transmission of messages to direct conversation between train crews and despatchers. The Cincinnati, Georgetown & Portsmouth, Cincinnati, Milford & Loveland, Cincinnati & Columbus, Interurban Railway & Terminal and several roads in the central part of the State do not require written orders. The claim is made that it takes too much time to write the orders, and that in fact written orders do not afford any greater check against the train crews, as in case of accident from mistakes orders can be altered to suit the occasion.

Verbal orders are strongly criticised by many operators, and in a number of cases unusual precautions are taken to insure a careful check on all who have any connection with the handling of orders. The Stark Electric crews take their orders in triplicate by means of carbon-backed slips, one order going to the motorman, another to the conductor and the third remaining in a book in the telephone booth. The Cleveland & Southwestern affords even a closer protection through the use of the Egery automatic register in both the despatcher's office and the telephone booth. By this method copies of the order are locked in the register in both the despatcher's office and the telephone booth, and they are accessible only to the train master or superintendent. On the Scioto Valley, Dayton & Troy and the Toledo & Indiana the despatcher keeps a record book of each order issued in addition to the usual train sheet, which is used by practically all of the roads.

Ideas as to the best method of receiving orders at passing points differ considerably. On the Stark Electric, the conductor takes the order and reads it to the motorman who must be at the booth at the time; the conductor reads it back and the despatcher in closing gives the time. Both the motorman and conductor sign the order; as stated, these orders are in triplicate. Practice on the Canton-Akron is very similar, except that the use of station booths has been abandoned and portable 'phones are carried on all cars. The Fort Wayne, Van Wert & Lima also has portable 'phones. On the Interurban Railway & Terminal, the motorman takes the order and repeats to the conductor and the conductor repeats back to the despatcher; the Dayton & Troy has a similar practice.

On the Lake Shore Electric the conductor takes the order and reads it aloud to the motorman who hangs it on a hook in front of him. On the Scioto Valley this plan is reversed; the motorman takes the order and reads it to the conductor, the idea being that the motorman is the one who should be most impressed and as he is the responsible party the order should be taken by his hand.

The kind of order issued also shows wide variation. The Western Ohio requires that calls shall be made at every passing point. The first crew arriving calls, and if there are no orders for the other car it is given the "high ball." Local cars clear limiteds by 2 minutes at sidings so that limiteds seldom have to stop for orders. Express cars run extra and clear times of passenger cars by 4 minutes. On the Eastern Ohio the order carries the car past two or three meeting points and the crew is then required to call. The numbers of cars to be passed and passing points are indicated in the order.

On the Lake Shore Electric, cars when on time are given

clearances between certain points. Limiteds call only at four points on the line, but orders may be issued to them at other points through the station agents. The form usually used is known as No. 17 in steam-road practice. Express cars when on time run as second sections of local cars and make the same schedule. When off time they are required to call at every siding. Orders are issued by number, using the train number and car number. Sidings are known by names, not by numbers; numbered sidings having been found a cause for mistakes. The Lake Shore is divided into two divisions with two sets of despatchers.

The Scioto Valley has certain calling points where all trains must report and register. The Cincinnati, Georgetown & Portsmouth has reporting points 15 miles apart. On this line all westbound trains have superior rights over east bound. On the Dayton, Covington & Piqua, written orders are issued only at the despatcher's office at the center of the line. Cars run on a time card and if 4 minutes late at a siding they call for orders. On the Stark Electric, written orders are issued at Alliance, the center of the line, giving clearance through to either terminal if the cars are on time. If 2 minutes off time, the first car reaching a regular passing point calls for orders. Orders are also issued through sub-station attendants. The company hires only steam-road despatchers of experience.

On all of the roads visited in Indiana it is the practice to run trains on despatcher's orders, these orders being given over the telephone. The method of receiving the orders and the manner in which they are given, however, differ on the several roads. Sometimes the motorman receives the order and repeats it to the conductor. On some roads, the conductor receives the order and repeats it to the motorman. Some roads are run on verbal orders, but the majority use written orders. On some of the systems attempt is made to keep the despatcher and trainmen from associating together, with the idea that the less feeling of personal friendship that there is between them, the greater will be the respect of the trainmen for the despatchers' orders

The Indiana Union Traction Company has a separate telephone line for the transmission of train orders. Two despatchers are employed, one located at Anderson and another at Tipton. Each despatcher has charge of more than 100 miles of track. An order book is used by the despatchers and all orders given are numbered and recorded. The orders are received by the motorman, are then written on order blanks by him and are then read to the conductor. The motorman's filled order blanks are turned in at night and are compared with the orders of the same number in the order book of the despatcher. If there is any discrepancy in the orders, the motorman's order is pinned over the order in the book and the discrepancy is investigated later. On the Indianapolis & Northwestern Traction Company, the conductor receives the order and repeats it to the train despatcher. On the Indianapolis & Cincinnati Traction Company, either the motorman or the conductor receives the order, but both sign it. At night the order blanks filled by the trainmen are turned in for comparison with those in the order book of the despatcher.

Verbal orders are used on the Indianapolis, Columbus & Southern system. At designated points the motorman receives the orders and at other points the conductor goes to the telephone. This practice is followed in order to save time, as at some points it is more convenient for one of the trainmen to go into the telephone booth than for the other to do so. Telephone booths are used, but telephones are also carried on the cars as a precautionary measure. At the present time one telephone line is used both for despatching and for company business, but another line will be installed shortly. Telephone jacks, to which connection can be made with the car 'phone, are installed at intervals of 1000 ft.

On the Terre Haute Traction & Light Company it is the custom for the motorman to receive the orders and to repeat them to the conductor. Both trainmen are held equally responsible.

Telephone booths are erected at all regular meeting points on the Kokomo, Marion & Western system. The usual car telephone is carried and jack boxes are located on poles at intervals of 1 mile. The motorman receives and writes the orders which he turns in to the despatcher at night. These are verified by the despatcher, who then sends the blanks to the superintendent.

On the Fort Wayne & Wabash Valley system two copies of orders are taken by the trainmen. The order is received by the motorman. One copy is signed and is given to the conductor, while the motorman holds the original copy. On heavy excursion days, the orders given by the despatcher are practically all meet orders. This avoids the necessity of the conductor being compelled to study the time-table to locate meeting points at a time when his attention is absorbed in taking care of unusually large crowds. The despatchers on this system handle the cars on 100 miles of track.

On the Detroit United Railway system, car telephones have not been found entirely satisfactory and telephone booths have been installed at all terminals and switches. This road is one of those upon which verbal orders are given. The conductor receives the order from the despatcher, but the motorman is required to be at the booth so that he can hear the conductor repeat the order to the despatcher. This practice is followed in order that if there is any doubt in the motorman's mind as to the meaning of the order, he can make his doubts known before the receiver is hung up.

A system which is probably the safest, but which consumes more time is in use on the Detroit, Ypsilanti, Ann Arbor & Jackson Railway. Verbal orders are given. The motorman goes into the booth while the conductor is required to stay at such a distance from the booth that the conversation in the booth cannot be overhead. If there are no orders, the motorman simply informs the conductor of the fact. If orders are given, the motorman receives them and then sends the conductor to the telephone while he himself goes beyond hearing distance. After the conductor has received the order, the two trainmen compare the orders given, and if they are not identical, the despatcher is again called up for further information.

EXAMINATION AND REQUIREMENTS OF TRAINMEN

Practically all of the interurban roads require trainmen to pass comprehensive examinations before they are put in charge of interurban cars. Where city lines are operated, the most promising motormen and conductors on these are selected to operate the interurban cars. For such men a short period of instruction in regard to runs, time-tables and methods of handling the cars is usually sufficient.

On the Kokomo, Marion & Western traction system, the interurban motormen are selected from those in service on the city lines. One of the best motormen decides whether or not the applicant is fitted to take an interurban run. C. A. Baldwin, superintendent of transportation of the Indiana Union Traction system, requires all applicants for positions of motormen and conductors on interurban cars to pass a thorough examination on schedules, signals, handling of cars and the meeting of emergencies. Mr. Baldwin examines the men personally. Most of the motormen in the employ of the Indianapolis & Northwestern Traction Company are old steam-road engineers. In addition to examinations on schedules, signals, and the operation of cars, the men are required to pass a very thorough examination on the electrical and air equipment of the cars. The examination with regard to car equipment and the handling of the cars is in charge of Leverett M. Clark, master mechanic of the system, who has prepared a very comprehensive set of questions for the purpose.

These questions do not go into the details of the apparatus, but are concerned almost entirely with the meeting of emergencies. Some of the questions admit of very definite answers. General answers apply to others. The list is prepared particularly to cover the operation of L4, K14 and type M control systems and automatic air-brake systems. A study of the air-brake manual with which each man is supplied aids much in acquiring the knowledge required to answer the questions with regard to air brakes, but an intimate knowledge of the apparatus is absolutely necessary. An applicant is expected to answer correctly about 90 per cent of the questions.

NOVEL METHOD OF COUNTING TICKETS

As many interurban roads have found the problem of counting city, park and other forms of tickets a rather expensive and somewhat annoying matter, there is illustrated on Plate XVI. a counting device, developed by W. A. Gibbs, general manager of the Columbus, Newark & Zanesville Traction Company.

This particular machine was designed especially for counting street railway tickets and transfers, and its method of operation is as follows: The pipes are connected to an exhaust fan or an air pump, which creates a suction in them. The dash pot shown on the front of the machine, which carries the square nozzle extending down into the ticket feed-box, is simply a means for bringing the air suction into contact with the pack of tickets in the ticket box. It is connected to the crank shaft in the machine by an arm extending back to the vertical shaft and has a reciprocating up and down motion.

The ticket is lifted off from the top of the back by the air suction and carried through separators in order to separate tickets that might be stuck together. It is taken off from the nozzle on the dash pot by the stripper, which is the sleeve shown in the engravings, through which the extension on the lower end of the dash pot passes. The stripper fits this end of the dash pot closely so that the air suction is maintained on the ticket to hold it on the lower end of the stripper, while the dash pot raises up high enough to allow the carriage time enough to pass in and out in order to take the ticket away.

The clamping arrangement shown on the front side of the machine is a gaging device, which is so adjusted that should the tickets fail to separate, they cannot be carried back by the carriage, but are held in the same position that they were lifted up in, and are carried back down through the separators until only one ticket comes up, when it will pass through the machine.

The fingers on the machine are so arranged that if a ticket is not taken off, they drop down through slots, and the machine does not register. This feature of the machine being unable to count if a ticket does not pass through it, together with the arrangement for preventing two from passing through at one time, makes the device absolutely correct in its count. It is not necessary to stop the machine in order to place the tickets or transfers in it. The machine may be operated continuously and the method of filling is simply to open the doors of the feed-box and set in as many tickets as may be desired to count at one time. The feed-box can be made of any length, so that as high as 2000 or 3000 tickets may be put in at one time if desired. It then requires no attention from anyone, as it will run the tickets off, and cease counting immediately as soon as the supply is exhausted. The machine is built in sections 8 ins. wide each. As many sections may be supplied as desired to suit various sizes of tickets. It is estimated that one person can count 50,000 tickets per hour on this machine if they are put in in packages averaging 500 tickets each.

FREIGHT AND EXPRESS

As much thought has probably been given to the working out of plans for the best methods of handling commodities as to any other subject connected with the operation of electric roads. The business, or rather two branches of business, which on steam roads has settled down to the handling of package and bulk freight on freight trains, and express matter which is cared for in express cars, usually by a company operating over a number of roads and with delivery and collection service included in the rate, has been jumbled by electric road operators in the Central West into a confused variety of methods and rates until at present hardly any two managements handle this service exactly alike. There are not less than eight distinct methods on Ohio roads at present, and, in addition, a number of roads have slight variations from what may be considered these general plans of handling the business. The majority of managers, in discussing the different phases of freight and express, maintain that the best methods of handling the business depend upon the district to be served and the local conditions surrounding it. While this is doubtless true to a certain extent, it is also a fact that certain roads have decided to handle express matter at strictly express rates, while others are handling the same matter at competitive steam freight rates in districts where the conditions appear to be almost identical.

A resume of the methods used by some of the various roads is most interesting.

First and foremost in Ohio, in bulk of matter handled and length of time it has been in the business, is the Electric Package Company, of Cleveland. The methods of this company and its equipment have been described in these columns on several occasions. A little explanation renders its position more appreciable. The name company is a misnomer. It is not a company, but an association representing five Cleveland properties. Each road furnishes its own equipment and crews and maintains them, the Package Company furnishing a messenger on each car. The Package Company operates over about 550 miles of road. It has 40 wagons in various cities and towns, and 53 agents, who either devote their time exclusively to its service or divide it between the railroad and the Package Company, and 14 messengers. The organization is managed by an executive committee of three, representing various roads, and is operated by C. A. Kenworthy, general superintendent. The earnings on each road are kept separate, and, after the operating expenses of the Package Company are deducted, the net amount goes to the road. From this net each road must pay its train-operating expenses and maintenance. The Package Company handles the baggage of the various roads, and is credited with 10 cents a trunk. On some of the roads, notably the Cleveland & Southwestern, the milk business, while handled in package cars, is unloaded on the outskirts of the city, and the entire earnings go to the road itself, and not to the Package Company. The receipts of the Cleveland & Southwestern from the Electric Package Company last year were $20,909. The operating expenses of the Electric Package Company, not including the car operation, are about 50 per cent of the receipts. The Cleveland & Southwestern's milk business of $19,441 made a gross of $61,239. The operating expenses, including the car mileage, estimated at 12 cents a mile, an arbitrary figure, as it is not known just what the cars cost to operate and maintain, give a total charge to operation of 62½ per cent, and the gross earnings per car-mile are 46 cents. On the Lake Shore Electric, while the earnings from express amounted to more than on the Southwestern, the earnings for milk amounted to very little, thus bringing the earnings per car-mile down to 42 cents, and increasing the charge for operation to 76 per cent.

Rates made by the Electric Package Company are higher than those made by electric roads elsewhere. It has two classes of rates, one covering fruit, poultry, eggs and produce, which is usually 10 cents lower than the regular rate on commodities and other goods. Its lowest rate is 30 cents a hundred for the special class within 35 miles, and its highest rate is 75 cents for Toledo, 120 miles. Its average rate is, of course, considerably higher than on the majority of roads. It handles carload stuff occasionally, but bases the rate on 50 cents a car-mile for the haul, including the return of the empty car.

By reason of high rates, the company is debarred from securing a large amount of farm produce and heavier, bulkier freight, such as are handled by other roads. The advocates of lower rates who have studied Mr. Kenworthy's methods claim that his great fault is that he tries to charge the jobber and the farmer with the cost of delivery and collection service when they do not want it, having teams of their own. Mr. Kenworthy replies that his cars run on passenger schedules, that his wagon service is equal to that of the best express companies, and that he is not catering to cheaper freight. He admits that cheaper freight might be desirable on roads traversing farming districts or going through numerous small towns, but on these systems the great majority of the towns range from 3000 to 50,000, and it is profitable to operate wagon service in nearly all of them. The company frequently interchanges business with other express companies and does a large amount of interlining with the lake boat lines. Its business has increased each year, and the territory is constantly expanding by the absorption of old lines and the building of new. The gross earnings last year were more than $200,000, and the roads in the arrangement appear to be well satisfied.

In this connection, it is interesting to note that the Lake Shore Electric Railway formerly operated a freight business on its Norwalk-Toledo division, while the Cleveland-Norwalk division was handled by the Electric Package Company. This gave an excellent opportunity to study both methods, and it has been claimed that while the freight end handled considerably more bulk and its gross earnings were larger, the net earnings were less, due to the operation of more cars, the slower speed and higher operating expenses.

Directly opposed to this experience was that of the Western Ohio and the Dayton & Troy, whose business was formerly handled by the Southern Ohio Express Company, but who recently changed to freight rates in competition with steam rates. The Southern Ohio Express Company conducts a business very similar to the Electric Package Company, but at present it operates only on the Cincinnati Northern. It is stated that last year it did a business of approximately $85,000. It has agents and wagon service in all towns, and its rates are about the same as express rates. In addition to the express business, the Cincinnati Northern does quite a freight business on a portion of its line, hauling standard freight cars with an electric locomotive.

To go back to the Western Ohio and Dayton & Troy, these roads are now engaged in building up a freight business in competition with the steam roads. They are not attempting to handle the cheaper and lower classes of goods, such as coal, ore, ice, hay, etc., but are pushing the package freight business not only for points on their own lines, but for all points in the two States where they can make arrangements with other

TABLE XI.—SUMMARY OF FREIGHT AND EXPRESS ON ROADS TREATED.

NAMES OF COMPANIES.	Character of Business, Freight or Express.	Length of Longest Run.	Wagon Service.	Range of Express Rates Per Cwt.	Range of Freigbt Rates.	Combination or Express Cars.	Haul Trailer.	Use Steam or Electric Locomotive.	Haul Standard Freight Cars.	Interchange With Steam Roads.	Pro rate With Steam Roads.
NORTHERN OHIO GROUP.											
Cleveland & Southwestern	Express (El. package)	60	Yes	30 to 60c		Combination and express	No	No	No	No	No.
Lake Shore Electric	Express (El. package)	120	Yes	30 to 75c		Combination and express	No	No	No	No	No.
Eastern Ohio	Freight	42	No		3 to 7c. car lots, 8 to 18c. broken lots.	Express	Yes	No	Yes	Yes	No.
Toledo & Indiana	Freight	56	No		4 to 10c. car lots, 6½ to 13c. broken lots.	Express	Yes	Yes	Yes	Yes	No.
Toledo & Western	Freight	58	No		2 to 6c. car lots, 5 to 17c. broken lots.	Express	Yes	Yes	Yes	Yes	Yes.
Toledo, Pt. Clinton & Lakeside	Freight	52	No		10 to 15% higher than steam rates	Combination and express	Yes	Yes	Yes	No	No.
Stark Electric	Express	35	Yes	40c.		Express	No	No	No	No	No.
	Freight		No		15c.						
Canton-Akron	Express and freight	50	Yes	30 to 40c	7 to 12½c	Express	No	No	No	No	No.
CENTRAL AND SOUTHERN OHIO GROUP.											
Western Ohio	Express	82	Yes	30 to 40c	8 to 15c	Express	Yes	No	No	No	No.
	Freight		No								
Ft. Wayne, Van Wert & Lima	..	..	..	..	..	..	..	..	..	..	..
Dayton & Troy	Freight	31	No		5 to 7½c	Express	Yes	No	No	No	No.
Dayton, Covington & Piqua	Express and freight	34	Yes	30c.	5 to 8c	Combination and express	No	No	No	No	No.
Scioto Valley	Freight	49	No		5 to 12c	Express	Yes	No	No	No	No.
Cincinnati & Columbus	Express and freight	52	No	30 to 40c	7 to 15c	Combination and express	No	No	No	No	No.
Cincinnati, Milford & Loveland	Express and freight	40	No	40c	9 to 15c	Combination and express	No	No	No	No	No.
Interurban Ry. & T. Cincinnati	Freight	35	No	20 to 25c	6 to 17c	Combination and express	No	No	No	No	No.
Cincinnati, Georgetown & Portsmouth	Express	50	Yes	20 to 45c. delivered	3 to 7c. car lots	Express	Yes	Yes	Yes	Yes	Yes.
	Fast freight		No	15 to 30c. not delivered	7 to 16c. broken lots						
INDIANA GROUP.											
Indiana Union	Express	..	No			Express				No	No.
Indianapolis & Northwestern	Express and freight	..	No			Combination				No	No.
Indianapolis & Cincinnati	Express and freight	..	No			Express				No	No.
Indianapolis, Columbus & Southern	Express and freight	..	No			Express				No	No.
Terre Haute Tr. & Lgt	..	..	No			..				No	No.
Kokomo, Marion & Western	Express	..	No			Combination				No	No.
Ft. Wayne & Wabash Valley	Express	..	No			Combination				No	No.
MICHIGAN GROUP.											
Rapid Railway System, Detroit	Express and freight	..	Cartage agent in Detroit			Express				No	No.
Detroit, Ypsilanti, A. A. & J	Express and freight	..	No			Express				No	No.

TABLE XI.—SUMMARY OF FREIGHT AND EXPRESS ON ROADS TREATED.—*Concluded.*

NAMES OF COMPANIES.	Handle Car Load Lots.	Minimum Charge for Packages.	Rates on Milk.	Income From Freight Last Year.	Income From Express.	Income From Milk.	Income From U. S. Mail.	Gross Receipts Freight Exp. and Milk.	Charge to Operation Per Cent. of Gr. Rcts.	Net Income.	Total Tonnage.	Average Rate Per Cwt.	Gross Earnings per Freight or Express Car Mile.	Cost of Handling Per Ton Mile.	Car Miles Per Day.
NORTHERN OHIO GROUP.															
Cleveland & Southwestern	Yes	$0.25	¾ to 2c.	.....	$41,818	$19,421	$1,974	$61,239	.62½	.....	.....	37½c	46c	....	369
Lake Shore Electric	Yes	.25	¾ to 2½c.	.....	51,376	1,857	1,594	53,233	.77	.....	.....	37½c	42c	....	345
Eastern Ohio	Yes	.25	$0.02	$30,306	.....	25,480	8,306	55,786	.....	.....	.....	15c	.....	....	208
Toledo & Indiana	Yes	.25	.01 3-10	.....	.....	.....	.....	35,000	.....	.....	.....	.....	75c. train mile freight, 31c. cm. express cars	....	208
Toledo & Western	Yes	.25	.....	75,399	.....	.....	3,801	75,399	.....	.....	.....	.....	85c. train mile	....	.....
Toledo, Pt. Clinton & Lakeside	Yes	.25	.01½	.....	.....	.....	.....	.....	.....	.....	.....	.....	38c	....	.....
Stark Electric	No	.25	.01½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	120
Canton-Akron	No	.25	1 to 1¼c.	.....	.....	.....	.....	20,000	.....	.....	.....	.....	.....	....	.....
CENTRAL AND SOUTHERN OHIO GROUP.															
Western Ohio	Yes	.25	.01½	.....	.....	.....	.....	.....	.....	.....	.....	.....	32c	....	.....
Ft. Wayne, Van Wert & Lima	..	..	..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	.....
Dayton & Troy	Yes	.25	.01	.....	In operation only 5 months.				.45	.....	.....	.....	38c	2c.	230
Dayton, Covington & Piqua	Yes	.25	.01	.....	.....	.....	602	15,000	.52	.....	.....	10c	42c	....	128
Scioto Valley	Yes	.25	.01½	.....	In operation 9 months.			.....	.....	.....	.....	11c	36c	....	.....
Cincinnati & Columbus	No	.25	.02½	.....	In operation 6 months.			.....	.....	.....	.....	.....	36c	....	.....
Cincinnati, Milford & Loveland	No	.25	.02	.....	In operation 9 months.			.....	.....	.....	.....	.....	31½c	....	.....
Interurban Ry. & T. Cincinnati	Yes	.25	.02	.....	.....	.....	.....	38,000	.....	.....	.....	12c	40c	....	.....
Cincinnati, Georgetown & Portsmouth	Yes	.25	.02	34,159	$11,563	.....	5,504	55,722	.68	.....	41,396	Car load freight 4.6	Express cars 34c., freight trains $1.30	$2.26	.....
INDIANA GROUP.															
Indiana Union	Yes	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	.....
Indianapolis & Northwestern	Yes	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	.....
Indianapolis & Cincinnati	No	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	.....
Indianapolis, Columbus & Southern	No	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	.....
Terre Haute Tr. & Lgt	Yes	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	.....
Kokomo, Marion & Western	Yes	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	.....
Ft. Wayne & Wabash Valley	No	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	.....
MICHIGAN GROUP.															
Rapid Railway System, Detroit	Yes	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	.....
Detroit, Ypsilanti, A. A. & J	Yes	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	.....

electric lines. Working arangements have been made between the following lines: Dayton & Troy; Western Ohio; Toledo, Bowling Green & Southern; Toledo & Indiana; Fort Wayne, Van Wert & Lima; Fort Wayne & Wabash Valley; Springfield, Troy & Piqua; Schoepf lines between Dayton and Columbus; Schoepf lines between Columbus and Zanesville; Dayton & Western; Indianapolis & Eastern; Indianapolis & Northwestern; Indianapolis Coal Traction; Indianapolis & Martinsville, and Indiana Union.

In the joint tariff sheets each road is designated by a letter, and the route sheets for agents show the through rates from the home point to the various towns touched by these roads, arranged in alphabetical order. Six classes of rates are given and the official steam road classification is used. Carload freight is handled by special arrangement only. The Springfield, Troy & Piqua, Western Ohio and the Dayton & Troy have trail cars, which they send over each other's line with carload goods. The two last mentioned roads bought some Manhattan Elevated cars and rebuilt them for the service. The other road mentioned built several trailers, following closely on steam road lines. Standard steam cars are not used. The three roads in question also operate trains over each other's lines. For instance, the service of the Dayton & Troy includes a through train from Dayton to Springfield over the Springfield, Troy & Piqua and a train to Findlay over the Western Ohio, in addition to which each of the roads has its own local cars. The Dayton & Troy has a well-equipped freight station in Dayton, which is the transfer point for goods east and west, while the Western Ohio station at Lima is a transfer point for goods north and northwest into Indiana. As soon as other roads in the district secure trailers, the interchange of carload lots will be extended, but at present the carload lots have to be transferred at the points mentioned. This through service has been in effect only since the first of the year and it has hardly developed, but the roads are getting about all they can handle with three trains a day each way over the main lines and the use of trailers on many of the runs. The Western Ohio estimates that its earnings per car-mile are about 32 cents, and the Dayton & Troy about 38 cents. The Dayton & Troy figures that it costs about 40 per cent of the gross receipts to handle the business, charging a portion of the agent's salary to freight. It is claimed that the cars themselves cost less than passenger cars to maintain and operate, as the stops are less frequent and cleaning and interior maintenance are less. The Western Ohio still continues an express business on a small scale, with wagon service in some of the larger towns and rates about equal to standard express rates.

The freight business of the Scioto Valley is referred to in detail in the special article on that road. It gives competitive rates and uses trail cars. It figures that its earnings per car-mile are about 36 cents. It has no interchange with steam roads and does not handle steam freight cars.

The freight business of the Toledo & Western and the Toledo & Indiana have been described at length in this paper. Their methods are very similar, but the territories differ considerably. The Toledo & Western extends into a rich farming district which has no other transportation facilities, therefore it gets about all the business there is in the district, while the Toledo & Indiana is closely paralleled over its entire length by the Lake Shore & Michigan Southern, one of the greatest freight-carrying roads in the country. Both of the electric lines operate standard freight trains on regular schedules handled by electric locomotives. These trains, of course, do not go into the city over the tracks of the city company, but cars are delivered to a steam belt line which encircles the city of Toledo and delivers them to other steam roads, or delivers them to its own terminal station in the center of the city. The belt line makes a switching charge for handling the cars and delivering them to steam roads, and by this means the electric lines are enabled to make through shipments to distant points and receive foreign cars. The Toledo & Western, not coming into competition with the steam roads, has pro-rate and interchange arrangements with a number of the steam roads in the district.

In addition to the standard freight trains, these roads operate package cars which run to the Toledo freight station under an alliance with other interurbans entering the city. Rates on the package cars are the same as those on the standard freight cars for broken lots. The service is, of course, faster, and no deliveries or collections are made. The Toledo & Western Company believes that its rates on the fast freight into Toledo freight station are too low to insure very much profit on this alone, but as it gives an excellent service by means of the standard freight trains between points along the line outside of the city, it does not feel inclined to throw a burden of higher rates on business between the country districts and the center of the city.

The Toledo & Western freight business for both classes last year amounted to more than $75,000, or about 40 per cent of the gross earnings of the road. Revenue earning, standard freight car lots handled last year numbered 4478, of which 725 were stone, 720 sugar beets, 525 live stock, 421 coal and coke, and 308 grain.

The two roads mentioned of course have freight stations in all towns and long sidings where a number of cars can be stored. The Toledo & Western has numerous stock pens, unloading platforms for sugar beets, and three grain elevators. A large beet-sugar plant has just been completed on its line, and this business will show a large increase in another year. The Toledo & Western's rolling stock includes 3 electric locomotives, 75 standard freight cars of various descriptions and several cabooses.

The Toledo, Port Clinton & Lakeside, which traverses a fruit and farming district, is following the example of the two roads mentioned. It is hauling standard freight cars with an electric locomotive, but as yet has no entrance to the city for these cars. During the summer months, its express cars running into the center of the city handle large quantities of fruit. It has not followed the example of the other Toledo roads in making competitive steam rates on this class of business, its rates being 10 to 15 per cent higher. Owing to its fast service, it gets a very fair proportion of the business and its net results are better. Its cars earned 38 cents per car-mile the past six months.

The Cincinnati, Georgetown & Portsmouth handles freight in an unusual manner in that it really has four classes of business, and a portion of its freight traffic is handled by steam locomotives. It has a rich farming and fruit country with practically no competition. Standard steam freight cars handle about two-thirds of the business. It has a carload lot rate and a broken lot rate for its freight trains, which operate on regular schedules. The cars are turned over to the Pennsylvania Railroad on the outskirts of the city and go to its freight terminal, or to other roads. It also operates package cars on which it gives two classes of service known as "fast freight" and "express." The express matter is delivered by its own wagons, and incidentally, it has a large automobile truck for this service, while the fast freight is delivered at its Carroll Street station only. The road has interchange and pro-rating arrangements with all steam roads and is classed as a steam road, which it was up to three years ago, when it was electrified. It operates two steam locomotives and one electric locomotive. It might be stated here that, while the management believes there is some economy in the cost of operating the electric locomotive, it does not favor its use except for through trains where there are few stops and little switching to be done. It is claimed that the electric locomotive is more cumbersome for switching, as it is necessary to

make frequent changes of the trolley, while the periods of acceleration with heavy-loaded freight cars throw an uneven and greatly varying load on the power station.

The Interurban & Terminal Railway Company, of Cincinnati, has two classes of business, one known as express, and the other as freight, but in neither case do the rates correspond with steam road rates, the freight being higher than steam freight and the express lower than steam express. The distinction between the two is that express is handled on combination cars; every other car on the system being a combination, thus giving frequent and fast service. Express rates do not include collection or deliveries, although the company has an arrangement with a transfer company for deliveries, an extra charge being made. Heavy and slow shipments are made in express cars. This business has grown tremendously on this system, and last year it necessitated the building of a freight station in Cincinnati. The building adjoins the passenger station in the center of the city, the general plans of which are shown on page 622. The company does a very heavy business in farm produce of all kinds. Something of an innovation is the extensive handling of live calves and sheep, which are shipped in crates built for the purpose at the company's shop. These are just high enough to prevent the animal from getting out, and are without tops, the animal being held in by straps passing over the back. This affords a convenient and sanitary method of handling small live stock. A supply of these crates is kept on hand at each station and are dropped off when the customer 'phones or writes for them.

The Cincinnati, Milford & Loveland and the Cincinnati & Columbus also follow the scheme of handling express matter in combination cars at frequent intervals, and freight on package cars on single daily trips. Both express rates and freight rates, however, are somewhat higher than with the other company, the express rates closely corresponding to steam express rates and the freight rates being somewhat higher than steam rates.

Radiating from Canton, the Stark Electric and the Canton-Akron lines offer both freight and express service. Both classes of goods are handled in the same cars, and the express includes deliveries and collections in the larger towns. The Canton-Akron has an arrangement with the Electric Package Company for through shipments to Cleveland and all points on the Package Company's system. Owing to the recent consolidation of the Canton-Akron with the Northern Ohio Traction & Light Company, it is probable that the freight service will soon be abandoned and the entire business turned over to the Electric Package Company, as has been done with other roads. The Stark Electric has but two rates for any distance on its line; 15 cents for freight and 40 cents for express, the latter including delivery and collection. The Stark Company has an arrangement with the Canton-Akron for joint service in Canton and for the through shipment of goods to points on the Canton-Akron system. The four roads last referred to have no interchange with steam roads and do not handle steam freight cars.

The Dayton, Covington & Piqua does quite an extensive business in both freight and express. Both classes are competitive to the corresponding rates on steam roads. The express is handled on combination cars every other trip and the freight in a special car. The bulk of the business is in farm produce, shipments to the country merchants, live stock and tobacco. The last mentioned crop furnishes a very considerable part of the business during the season. The company has stations in several towns, which are designed for tobacco warehouses, so that the producers can deliver shipments at the station as soon as they are ready and then make shipments when sales are made. Quite a little business has been worked up in the sale of ice, which is purchased from an artificial ice plant in Dayton and delivered to merchants in the towns in 100-lb. or 200-lb. cakes. A special galvanized iron platform with drainpipes has been placed in one of the cars for this service.

The Eastern Ohio Traction Company, of Cleveland, is not in the Electric Package arrangement. It traverses a dairy and farming country and has practically no steam competition, and it gives what it terms express service at freight rates. Originally the rates were as low as steam road rates, but a year ago it found that it was not making money and raised the rates, so that they are now about 25 per cent higher than steam rates, but still considerably below express rates. Goods are handled on express cars running to the Electric Package Company's station, the company having leased a portion of this station for its service. About two-fifths of its freight receipts come from milk. It also does a considerable carload lot business, transferring standard steam freight cars from connections with steam roads at several points to points on its line, using a powerful express car for a locomotive, the cars being attached on the regular runs wherever possible. For this service it makes a switching charge, having no pro-rate arrangement with the steam roads.

CONCLUSIONS

The foregoing presents in general the different operating schemes used in Ohio to derive a revenue from the handling of commodities. It will be noticed that none of the roads follow the scheme quite generally adopted by Eastern roads of dividing the business into three classes and handling it all on the same car. On these roads, the first-class rate applies to goods which are both delivered and collected, or, in other words, use the wagon service at both ends. The second class applies to goods where there is wagon service at one end only, while the third class applies to goods where there is no wagon service. The first class is insured prompt shipment on the first car leaving the station. The second class is guaranteed for delivery that day, while the third class insures no specified delivery except that it will be handled as soon as possible, and of course it is to the benefit of the company to carry out this plan. This scheme gives the shipper a wide range of rates, and the service is gaged accordingly. It does not require the man who has facilities for deliveries to pay for something he does not get, and it provides for those who want wagon service at one end only. The arrangement enables the companies to keep their cars full and gives a better average rate per car-mile or per ton-mile, than where exclusively express or freight rates are used. The exclusively express roads in Ohio seldom are enabled to fill their cars to their full capacity. They may do so occasionally, but not on the average trip. They cannot handle the low-grade commodities of the farmer, because their rates are too high. The roads which make a rate between freight and express cannot compete with the steam roads on the lower grades of stuff, and they take a lower rate on the higher grades of commodities and those requiring quick shipment than they could command if they had an express service. The exclusive freight road also misses the high rates which it might get, and it is too often the case that it gets too much of the low-grade commodity and actually loses on many carloads handled.

While the foregoing is a resume of the various methods used by Ohio roads, it is appreciated that the results shown come a long way from pointing out which road has hit upon the most profitable scheme or how much money the roads are netting on this branch of their business. As a matter of fact, the great majority of the roads do not know accurately how much money they are making on freight and express, and some of them do not even know whether they are coming out ahead or losing money in this department. A few of them attempt to figure it, but at best it is largely guesswork, and there is a wide variation in methods of figuring and allowances made for certain charges.

On a steam road, it is an easy proposition to determine the fuel

that goes into the freight locomotives, the expenses of the freight stations and station employees, and freight department forces, with a division of track maintenance along well established rules, thus entirely separating the operating expenses of the freight and passenger departments, but on an electric road it is a very different proposition. It is almost impossible to separate the power station expenses on any kind of a fair basis. Freight cars, and especially heavy freight trains operated by electric locomotives, running at irregular intervals, produce variations in the power consumption, which render it extremely difficult to figure how much should be charged to the freight service, making an allowance for the fact that the cost of power is higher and the size of the power station equipment necessarily larger than where there is a comparatively steady load, as in passenger service.

The majority of roads employing station agents divide the expense of the agent equally between freight and passenger accounts, which is seldom a fair proposition, because an agent will spend more time handling a heavy shipment of freight bringing perhaps $1 than he will in selling a number of $1 tickets. The division of office help is also a hard point to settle. The majority of roads have small office forces, and as a rule it takes more time to look after the details of a lot of freight and express shipments, bringing in a small amount of money, than does the accounting of the larger passenger receipts. Where combination cars are used, it is a much mooted question as to how to separate the earnings of the compartments. The Lake Shore Electric in charging car-mileage on combination cars, figures one-quarter against the express and three-quarters against the passenger, although the passenger compartment may be full and the express compartment have nothing in it. The question of track and overhead maintenance are of course difficult to adjust. Some claim the freight cars do more damage to the track, because of their greater loads, while others believe they do less damage on account of their slower speeds and less frequent stops. Repair shop expenses are also difficult to adjust, owing to the failure of the majority of roads to keep mileages on various parts. The companies know that so many gears, trolley wheels, armatures and wheels wear out in the course of a year, but few of them know which cars they should be charged to.

The Lake Shore Electric makes an estimate that its express cars cost about 12 cents per car-mile to operate, due to less frequent stops and smaller interior maintenance. As stated in the reference to the business of the Electric Package Company, the operating expenses of the company, exclusive of car operation, are 50 per cent of the receipts. At 42 cents a car-mile estimated earnings, this would make the receipts of the company 21 cents a car-mile, or 9 cents a car-mile after paying operating expenses, interest and taxes.

The Cleveland & Southwestern, on the same basis, shows net earnings for freight cars of about 11 cents a car-mile.

The Scioto Valley Traction Company has estimated that freight cars consume about 5 kw-hours per car-mile, as compared with 3.1 kw-hours for passenger cars. If current delivered at the car costs 1 cent per kw-hour, which is considered a fair rate for large stations in this district, the cost of power would be 2 cents more than for regular passenger cars. The company knows the consumption of current on passenger cars from experience before the freights were placed in operation, and by making a careful estimate of other expenses it is able to satisfy itself that it is making a good profit on this department. Unfortunately, it is unwilling to go into the details, beyond saying that the cars earn an average of 36 cents a car-mile.

The Toledo & Indiana has found that its electric locomotive consumes 4 kw-hours per car-mile. Each loaded car adds 2 kw-hours per car-mile. Current at the car costs about 1 cent per kw-hour. The freight trains make 100 miles a day, and average five cars to the train, but all the cars do not cover the entire length of the road. The cars average 30 miles each way, or 60 miles per car, equivalent to 300 car-miles per day, or 7500 car miles per month. The trains earn an average of $75 per day, or $1,875 per month, equivalent to gross receipts of 24 cents a freight car-mile. However, the earnings per freight train-mile are 75 cents, because the train itself makes the full mileage. The earnings of express cars running into Toledo are $1,750, and the cars make 5600 miles per month, so that the earnings per car-mile are 31 cents.

There is a very good profit in this one train, but it would be impossible to operate several of these trains a day without interfering with the fast passenger service and necessitating much larger equipment in the power station. The Toledo & Indiana package cars which operate into the city last year handled 4,600,000 lbs. of freight matter, of which 3,800,000 lbs. was outbound, and 800,000 lbs. incoming. This indicates that the bulk of this class of business is in goods shipped by the city jobbers to the country merchants, rather than incoming produce.

In this connection it might be stated here that the idea that the traction lines are taking the place of the farmer's wagon and are hauling his goods to the city is somewhat of a fallacy. While a number of roads undoubtedly secure a large amount of this business, the trend of traffic is in the other direction, i. e., from the big city to the country stores. The tendency of the roads that secure a lot of this business is not to stop at the farmer's door and take on a load of his produce, but to induce the farmer to go to the nearest town and sell to a shipper. This serves the double purpose of giving the road large shipments and with no delays to pick up small lots, and it also keeps the merchants in small towns in a better frame of mind, because they want the farmers to come to town.

The experience of the Toledo & Western with trainload lots is very similar to that of the Toledo & Indiana. It averages more cars to the train, and its earnings per train-mile are 85 cents. Its locomotives are heavier and probably consume somewhat more than 4 kw-hours per car-mile.

The Cincinnati, Georgetown & Portsmouth reports $1.30 gross earnings per train-mile, and 34 cents per car-mile for express cars. It figures operating expenses on both classes at 68 per cent, and does not attempt to separate them.

It is more difficult to obtain figures from roads handling freight at freight rates in single cars or two-car trains. The Dayton & Troy estimates earnings at 38 cents per car-mile and operating expenses at 45 per cent. The Dayton, Covington & Piqua figures its earnings at 42 cents per car-mile and operating expenses at 52 per cent. The other roads of this class make no attempt to separate the freight operation from the passenger. Car-mileage earnings of several roads are shown in Table XI.

MILK

The interurbans in Ohio are constantly increasing their milk business. The fast and frequent service and the usually convenient location of the lines, and their willingness to stop for small quantities, induce the farmers to turn the business over to the electrics. There would be a milk famine in Cleveland were the package cars to stop running. The Eastern Ohio, which traverses a rich farming district, handles 5000 to 6000 gallons daily, and its receipts from milk last year were $25,480. The company makes a flat rate of 2 cents a gallon for any distance, which places the farmers 40 miles away on an equal footing with those nearby, thus increasing the bulk of the business. Cans are returned free. The company encourages farmers to build milk platforms and will stop for any number of cans above three. Tickets are sold and must be attached to cans.

The Cleveland & Southwestern comes a close second to the Eastern Ohio, hauling an average of 800 cans a day. Milk receipts last year were close to $20,000. The bulk of this is delivered to wagons at the city limits, which gives the company all

the receipts. Rates vary from ¾ cent to 2 cents, according to distance. A higher rate is charged for cream, as it was found some time ago that farmers were separating the milk from the cream and shipping the cream, the milkman making it back into milk after it got to the city.

The Toledo & Indiana gets an unusually large amount of milk which it takes to two large condensing plants on its line. It makes a rate of 1.3 cents per gallon to these plants.

The Toledo, Port Clinton & Lakeside and the Toledo & Western handle large quantities of milk into Toledo, while the Interurban Railway & Terminal, Cincinnati, Georgetown & Portsmouth, Cincinnati, Milford & Loveland and the Cincinnati & Columbus assist greatly in serving Cincinnati. Their rates are shown in Table XI.

Practically all of the roads visited in Indiana and Michigan handle more or less milk, but statistics on the general freight business of these roads are not so complete as to allow an analysis such as given of the Ohio freight traffic. The milk handled varies from a few cans a day on some roads to such a quantity as to require special milk trains, as on the Detroit United Railway system. There is no uniformity as to basis for charges. Some roads base their charges on the distance and the size of the cans. Others charge the same price for all sizes of cans and for long or short hauls. The Indiana Union Traction Company handles milk on a three-part ticket as does also the Indianapolis & Northwestern Traction Company. One part of the ticket is torn off by the conductor, another serves as a receipt for the consignee and the third portion is for the return of the empty can. On the Indianapolis & Northwestern system, about 1000 gallons of milk are handled per day. A charge of 1 to 3 cents per gallon is made, the charge increasing with the distance. At the present time, the cans are hauled in the baggage compartment of the regular passenger cars, but within a short time a special milk train will most probably be put on.

A charge of 1½ cents per gallon is made by the Indianapolis & Cincinnati Traction Company for handling milk. This charge is made regardless of the distance hauled. Three-part tags are sold for cans of three, four, five and eight gallons capacity. Tags for cans of different capacities are distinguished by different colors. These tags are sold to farmers in quantities of not less than $3 worth at a time. Loading platforms are built at all the towns where the shipments justify the expense. Private loading stations are erected by the shippers. All the milk is carried in express cars.

About 2000 gallons of milk are handled per day by the Indianapolis, Columbus & Southern Traction Company. For hauls less than 10 miles, a charge of 1 cent per gallon is made. Above this distance 1½ cents are charged. This charge includes the return of the empty can. Cans of five, eight, seven and one-half and twelve gallons capacity are handled. Shippers are compelled to buy 100 tickets at a time and are requested to erect their own platform. These may be erected at any point on the line.

For shipments of milk over the lines of the Terre Haute Traction & Light Company no tags are employed. Milk is billed in the same manner as is freight. Farmers are supplied with blank bill heads which they fill out for each shipment. Settlement is made at the office of the company on Saturdays when the farmers come to the city. A charge of 1 cent per gallon is made for carrying milk.

The Kokomo, Marion & Western Traction Company has handled some milk, but as there are no large cities on the line, there is very little shipped. A three-part tag is sold in quantities of fifty at one time.

About 500 gallons of milk are handled by the Fort Wayne & Wabash Valley system per day. The shipper makes out a bill of lading and leaves it on the shipping platform with the can. The train crew picking up the can make out the way bill. Monthly settlements are made with shippers, the charges being 10 cents per full can and 2½ cents for the return of the empty can. This charge is made regardless of the distance hauled.

A milk train is operated on each of the interurban divisions of the Detroit United Railway system. Milk is also carried in the early morning baggage cars. A motor car and a trailer make up the milk train on the Flint division. The cars are especially fitted for carrying cans, racks being built on each side of a central passageway. The charge per gallon is based on the length of the haul and varies from 6 to 10 cents for a ten-gallon can. The same price is charged for smaller cans. A two-part tag is used. One part is taken from the full can by the conductor, while the remaining part is left on the can and serves for its return when empty. Creamery companies which buy up milk throughout the country are the purchasers of a large quantity of tickets. To private shippers any number of tickets will be sold at one time, but usually the purchases are in from $2 to $5 lots.

About 250 cans of milk are handled each morning by the Detroit, Ypsilanti, Ann Arbor & Jackson Railway. A two-part ticket is employed and cans are carried in freight or express cars. A charge of 10 cents per can regardless of the distance hauled is made.

EXPRESS CARS

As has already been intimated, the idea of handling express and freight matter on combination cars is on the decline, except in the case of a few roads which distinguish between freight and express and do a small amount of fast express business on the combination cars. Practically all the roads now have special express cars for this service. Ideas as to the best design of car for the service differ almost as much as in passenger cars.

One of the most substantial cars in service is that of the Cleveland & Southwestern. It is 54 ft. long, built with very heavy floor framing and bumpers and is designed to carry 20 tons. It has two double doors on each side and doors at each end, which are very convenient for loading long, bulky articles, such as poles, scenery, etc.

The Dayton, Covington & Piqua Traction Company has a 56-ft. express car of exceptionally strong and heavy construction, and in addition to being of large capacity and very serviceable, it is fitted with an adjustable platform on the roof so that it may be used as a line car.

The various branches of the Indiana, Columbus & Eastern have several 60-ft. express cars with large carrying capacity. The express motor cars built for the Scioto Valley Traction Company are but 45 ft. long and they were equipped with 125-hp motors and train-braking system for handling one or more trailers. The trail cars used for this service are described in another column, as are also the Manhattan elevated cars transformed into freight trailers by the Western Ohio and Dayton & Troy lines; a very convenient auxiliary equipment which costs but little. The express cars of several roads are illustrated on Plates L. and LII.

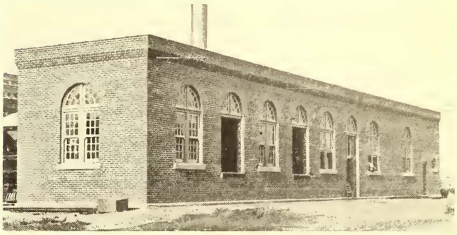
U. S. MAIL

Nearly all the roads in Ohio handle mail in bags and derive some little income from the Government on a basis of a fixed amount per mile per sack. Three roads, the Eastern Ohio, the Cincinnati, Georgetown & Portsmouth and the Toledo & Western, which cover districts not touched by steam roads have contracts for regular mail-car service. They furnish a special compartment of 10 ft., which is fitted up for the distribution of mail en route, and for this they receive 7½ cents per car-mile, and 3 cents per mile per sack for pouch mail. The Toledo & Western and the Eastern Ohio carry the mail on a passenger car, while the Cincinnati, Georgetown & Portsmouth has a 56-ft. express car with one end partitioned off for the mail. Traction lines generally are endeavoring to secure more of this business and incidentally they think they ought to get better rates. It appears, however, that the entire appropriation to electric railways is a ridiculously small amount, and it is difficult to persuade the Government to raise it.

FREIGHT PLATFORM OF STATION AT TIPTON, INDIANA
UNION

TYPICAL FREIGHT STATION IN SMALL TOWNS, WESTERN
OHIO

FREIGHT STATION AT ANDERSON, INDIANA UNION



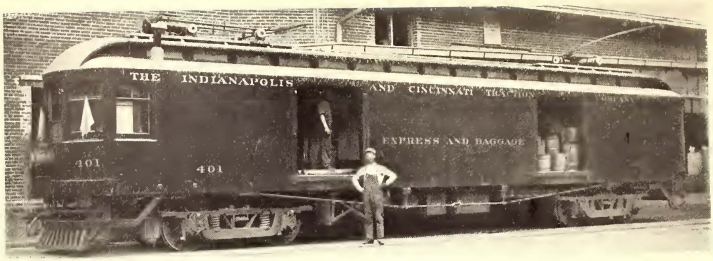
FREIGHT STATION AT RUSHVILLE, IND., INDIANAPOLIS &
CINCINNATI TRACTON

SIDE VIEW, INTERURBAN FREIGHT STATION AT
INDIANAPOLIS

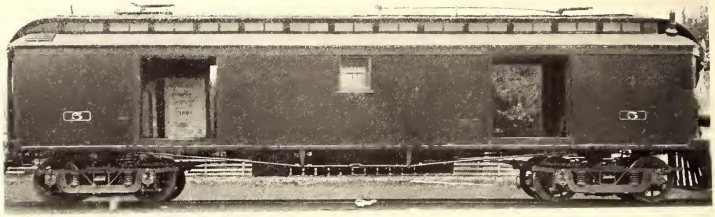
TYPICAL SCENE, INTERURBAN FREIGHT STATION,
INDIANAPOLIS

FREIGHT TERMINALS AT COLUMBUS, SCIOTO VALLEY

TERMINAL STATION, ELECTRIC PACKAGE COMPANY,
AT CLEVELAND



STANDARD FREIGHT CAR, INDIANAPOLIS & CINCINNATI TRACTION



EXPRESS CAR, INDIANAPOLIS & NORTHWESTERN

STANDARD FREIGHT CAR, INDIANAPOLIS, COLUMBUS & SOUTHERN

EXPRESS CAR, LAKE SHORE ELECTRIC

OLD MANHATTAN ELEVATED CAR REBUILT FOR EXPRESS AND FREIGHT SERVICE, WESTERN OHIO RAILWAY

INTERURBAN ELECTRIC RAILWAY ECONOMICS

The gross receipts per mile of track and the gross receipts per inhabitant (or per capita) in the district served are the units generally used in comparison of the earning power of electric roads. To the mind of the banker or financier, the operating expenses are of secondary consideration, because by proper management they can be reduced to a fairly fixed quantity, depending on the service given. But the gross receipts reflect primarily the judgment of the promoters in locating the line and the riding proclivities of the people in the territory through which the road runs.

From statistics, the patronage to be expected by a city railway can be approximated very closely, and it is safe to say that with an interurban railway proposition some rules can be evolved, but the conditions make the process more difficult. Thus in the city property, the rides per inhabitant have been found to increase pretty constantly in a certain ratio, depending on the population, and the figures on population can easily be obtained from the census. With an interurban railway it is safe to assume that the traffic increases with the population served, but it is a very much more difficult undertaking to determine satisfactorily the number of people who are served by the road. The first obstacle is in connection with the terminal city. Most interurban lines have one large community at their termini and this fact has a large influence on the traffic, on account of the people in the country who wish to visit the city and those in the city who ride out into the country. Both statistics and common sense show, however, that it is improper to consider that the entire population of the terminal city is being served by an interurban railway extending from one direction only out of the city, or if so included and counted in the tributary population, they should not be given the same weight as the residents of the smaller communities directly on the line of the road. Again, it is difficult to obtain any exact enumeration of the tributary interurban population. Strictly speaking, the facility with which people living along the line use the road is in inverse proportion to the distance at which they live from the line. Practically the usual way is to include all of the population within 2½ miles of the line. To this there is again a practical obstacle unless a house to house canvass is made, because the population is irregularly distributed throughout the different townships. Part of it is in towns and villages whose population is given in the governmental census reports, and part of it is in scattered houses of whose inhabitants there is no enumeration outside of those covering the entire township. As a result, a variety of practices is followed among those who, like consulting engineers, have been obliged to make investigations into the probable earning capacity of interurban railways.

None of the largest engineering or financial houses, so far as is known, counts in the entire population of the terminal city invariably in any estimate of the population served. Some include in the entire population of the terminal city if it is below 50,000. Above this figure they credit the terminal city with the number 50,000 plus a gradually decreasing percentage of additional inhabitants. Others follow the same plan but have a different limit. Still others, and these are probably greater in number, seemingly have become so discouraged in endeavoring to find a satisfactory law for the extent to which the terminal city should be included, that they boldly throw out the population of the terminal city altogether. There is, it is true, an argument for this course. Advocates of this plan claim, first, that all interurban roads have a terminal city, so that in one sense a comparison would not be incorrect if the population of this terminal city was ignored. The second point made is that while the terminal city is on the route, the traffic under ordinary conditions comes mostly from the inhabitants along the line visiting the terminal city rather than vice versa. Of course an amusement park on the line of the road would make an important exception, as this park would be visited principally by city residents, but if a special allowance is made for the traffic to this park, the ordinary traffic can be figured exclusively from the population along the line.

The interurban electric railways in Ohio and Indiana have been in operation for a longer period than those of any other section of the country, and interurban railroading has received its highest development there. In this form of road Ohio led, and in the early history of interurban railroading it was gravely asserted in many quarters that the conditions for this class of road in Ohio were so peculiarly favorable that a road built in that State would earn from 20 to 25 per cent more per mile than one in the neighboring States of Indiana or Pennsylvania under the same conditions. The reason given was that Ohio was more of a manufacturing State than any of its neighbors, and that its in-

TABLE XII.—SHOWING EARNINGS, ETC., FOR TWENTY OHIO ROADS FOR THE YEARS ENDING APRIL 30, 1905 AND 1906.

COMPANY	Capital Stock (Issued).	Bonded Indebtedness (Issued).	City Mileage.	Interurban Mileage.	Total Mileage.	Passenger Earnings, Year Ending April 30, 1905.	Passenger Earnings, Year Ending April 30, 1906.	Freight and Express Earnings, 1905.	Freight and Express Earnings, 1906.	Other Earnings, 1905.	Other Earnings, 1906.	Total Earnings, 1905.	Total Earnings, 1906.	Car Miles.
Cincin., Milford & Loveland Trac. Co.	$1,650,000	$300,000	7.	32.	39.	.....	.....	.....	.....	.....	.....	.....	.....	.....
City Railway Co., Dayton	2,597,100	65,000	28.75	.....	28.75	$419,936	$470,727	.....	.....	$ 22,238	$22,935	$442,174	$493,662	.....
Cleveland Electric Ry.	23,400,000	8,026,000	235.	.....	235.	4,838,085	5,425,515	$28,054	$33,316	29,854	58,919	4,895,993	5,517,751	21,832,363
Cleveland, Painesville & Ashtabula	1,000,000	850,000	2.	26.	28.	83,809	99,387	.....	1,550	927	566	84,736	101,504	355,976
Cleveland, Painesville & Eastern	1,606,000	1,402,000	4.	41.43	45.43	204,201	223,994	*11,003	10,229	15,203	19,511	230,407	253,735	870,786
Columbus Ry. & Light	12,400,000	7,479,000	28.	79.	107.	1,366,361	1,487,549	6,209	5,282	344,256	350,754	1,716,826	1,843,585	6,037,949
Dayton, Covington & Piqua	1,100,000	510,000	2.	32.	34.	73,675	‡87,845	11,825	13,674	137	801	85,637	102,324	¶452,245
Eastern Ohio Traction Co.	2,500,000	2,500,000	0.	82.79	82.79	160,944	163,852	54,047	64,115	6,287	9,853	221,278	237,820	272,000
Lake Shore Electric Ry.	7,500,000	4,897,000	13.	137.	150.	663,354	770,718	23,559	‡33,245	12,427	19,647	699,340	823,611	.....
Lorain Street Ry.	750,000	550,000	.....	.....	10.	105,849	132,442	1,441	11,628	950	464	108,240	134,534	.....
Ohio River Elec. Ry. & Power Co.	300,000	315,000	.....	.....	12.02	38,546	44,325	5,107	5,737	3,611	5,772	47,264	55,836	300,486
Springfield Ry. Co.	1,000,000	500,000	28.71	.....	28.71	212,002	§230,539	.....	.....	837	740	212,839	231,280	1,264,441
Springfield & Xenis Ry.	600,000	.....	1.4	18.	19.4	54,425	58,925	1,677	2,370	822	666	56,744	61,991	247,778
Tiffin, Fostoria & Eastern	350,000	.....	2.	13.	15.	46,257	49,292	3,108	4,754	760	602	50,115	54,648	.....
Toledo, Fostoria & Findlay	450,000	443,000	.....	33.	33.	45,609	58,862	3,038	3,244	1,196	2,951	49,832	65,057	301,333
Toledo & Indiana Ry.	1,500,000	1,500,000	3.	57.	60.	68,279	151,327	10,472	39,727	45	.....	78,796	191,054	750,000
Toledo Railways & Light Co.	1,200,000	10,866,000	112.37	.....	112.37	1,215,147	1,337,649	3,605	.....	530,888	588,622	1,749,640	1,926,272	.....
Toledo Urban & Interurban	1,000,000	800,000	.....	.....	60.	.....	240,844	.....	20,349	.....	62,763	.....	323,957	.....
Youngstown Park & Falls Street Ry.	200,000	194,000	2.	1.6	3.6	.....	70,418	.....	.....	.....	1,049	63,908	71,467	300,000
Youngstown & Sharon	712,500	662,500	2.2	11.23	13.43	93,901	135,138	6,996	10,093	.....	473	100,897	145,704	436,562

* Net from operating express company. † Year ending June 30. ‡ Include mail earnings. § Including freight and express. ¶ Including 40,012 freight car-miles.

habitants were more inclined to travel than the agricultural population of Indiana. This idea has disappeared with the rapid development of the Indiana interurban railways, seeming to prove that a prosperous agricultural population is as ready to use transportation as one devoted to manufacturing.

A student of economy values is handicapped in studying electric transportation problems in both of these States, as compared with electric railroading in most of the Eastern States, from the fact that comparatively few of the companies in either State make public their complete annual reports. For a number of years the Ohio railroad companies have been obliged to file with the Secretary of State at Columbus certain figures relating to their gross receipts, but the systematic and itemized statements required by the Railroad Commissioners in such States as the New England States, New York and Pennsylvania are not obligatory. The fiscal year for these Ohio reports hitherto required is that ending April 30. During the past year, however, a change has been made in the Ohio law by which these reports are no longer filed with the Secretary of State, but with the Commissioner of Railroads and Telegraphs. Owing to this fact, there has been a delay in issuing the proper blanks to the street railway companies, and as a result these figures for the fiscal year ending April 30, 1906, are not available for publication in most cases. Through the courtesy of a number of companies, advance copies of the reports which have been or will be filed with the Commissioner, but which have not yet been made public, are presented in Table XII., together with the 1905 figures.

INDIANA STATISTICS

Certain reports are required of the Indiana electric railway companies by the State Auditor, but up to the present, none has been available in published form outside of the report of the Indiana State Board of Tax Commissioners, which gives the assessed value of main trunk, second track, side track, rolling stock and improvements on right of way of the different electric railway companies, but no figures on gross receipts. During the last year, however, reports have been required from the State Bureau of Statistics of all of the roads in Indiana, and while individual figures have not been made public, the totals are available through the courtesy of Joseph H. Stubbs, State Statistician of Indiana. These figures are presented in Table XIII.:

Table XIII., showing statistics of all of the electric lines in Indiana for the year ending June 30, 1905:

EARNINGS AND EXPENSES

Gross earnings	$6,757,730.22
Grand total expenses	4,679,027.57
Gross income	$2,078,702.65

EARNINGS IN DETAIL

From passengers	$6,308,653.95
From freight	120,770.37
From express	66,522.48
From mails	3,741.17
From rents	82,033.60
From all other sources	176,008.65
Grand total earnings	$6,757,730.22

EXPENSES IN DETAIL

Maintenance of way and structures	$405,039.43
Maintenance of equipment	369,265.60
Conducting transportation	1,798,928.91
General expenses	1,078,236.19
Additions and betterments	1,027,557.44
Grand total expenses	$4,679,027.57

DISBURSEMENTS IN DETAIL

Total expenses as above	$4,679,027.57
Interest on funded debt	2,078,302.01
Taxes for Indiana	294,619.00
Taxes for other States	55,748.17
Rentals	267,001.68
Grand total disbursements	$7,374,698.43

PASSENGER AND FREIGHT BUSINESS

Total number of passengers carried	112,838,065
Total tons of freight and express	33,216

MILES OF TRACK

Number of miles of main track in Indiana	847.49
Number of miles of side track in Indiana	34.25

WAGES—1905

Employees in Indiana	Number Employed	Total Yearly Compensation
General officers	51	$115,141.83
Other officers	38	65,875.68
General office clerks	140	70,889.64
Station agents	66	23,255.00
Other station men	29	13,340.00
Motormen	806	489,291.35
Conductors	803	489,235.38
Other trainmen	119	90,351.74
Machinists	33	23,093.61
Carpenters	39	26,231.54
Other shopmen	265	151,490.16
Section foremen	90	51,991.99
Other trackmen	524	199,271.05
Flagmen and watchmen	16	8,040.55
Operators and despatchers	23	13,315.20
All other employees	295	172,346.30
Totals	3,337	$2,003,161.02

ACCIDENTS

	From Causes Beyond Their Own Control, Killed	Injured	From Their Own Carelessness, Killed	Injured
Passengers	0	38	10	1,869
Employees	0	12	3	129
All others	1	10	26	2,288
Totals	1	60	39	4,286

DAMAGES

The amount paid in damages during the year 1905 for accidents was $96,061.30.

OHIO STATISTICS

In view of the impossibility of obtaining figures from all or a greater part of the Indiana roads, it was deemed preferable to devote the analysis of the gross receipts of the electric railway companies in the district under consideration to those in Ohio, and several diagrams are presented herewith. For the purpose of this analysis, twenty-eight roads were selected. Of these, five have their chief terminal in Cleveland, six in Columbus, seven in Dayton, four in Toledo, and six have been selected at large through the State from among those roads which do not directly enter one of the very large cities of the State. The figures on population have been taken from the latest Governmental Census Report, which is that of 1900, and the figures on earnings are given in column 2, and are either for the year ending Dec. 31, or, where these figures were not obtainable, are for the year ending April 30, 1905.

An explanation should also be given of the method of securing the figures on tributary population. While not entirely satisfactory, it is probably the best available outside of an enumeration of the houses along the line. It was assumed first that the contributing territory to be taken should be that approximately 2½ miles on each side of the route of the railway. This distance was adopted partly because it is the figure often employed in calculations by financial houses, and partly because of the fact that the townships in Ohio, as a rule, are 5 miles square, so that the figure lent itself very easily to the approximations on population. Where a line extended through the center of a township, therefore, its entire population was taken as the number of people served. Where a line extended through only the corner of a township, a different plan had to be followed. In this case the number of inhabitants in the towns on the line of route were first added to the population served. The populations of these towns were then deducted from the population of the township. If there were any large communities in the township which were not served by the railroad, their populations

were also deducted from the total population of the township. It was then assumed that the remaining population was equally distributed throughout the township, and the proportion which the area of a strip 2½ miles each side of the track in the township bore to the whole population of the township was then taken as the proper proportion of the residual population of the township served by the interurban railway.

Tables XIV. to XVIII. have been compiled for each of the main groups of roads in Ohio. As will be seen, earnings per mile of track have been given for both passenger earnings and total earnings. The average passenger earnings have also been calculated per inhabitant in three ways, viz.: (1) including the terminal cities; (2) excluding the main terminal city, and (3) excluding both terminals where the road connects two large cities. The gross earnings have also been estimated on the basis of the inhabitants served, inclusive of the terminals. The roads have been divided into groups so that those roads entering the same city, and hence operating under the same conditions so far as main terminal city is concerned, could be compared more closely than would otherwise be possible. To understand the local conditions under which each of these lines operates, the following summary is given:

CLEVELAND GROUP

Lake Shore Electric:—The main line extends to Toledo with branches to Sandusky, South Lorain, Gibsonburg, and a line from Norwalk to Sandusky. It touches Lorain, 30,000; Elyria, 15,000; Sandusky, 20,000; Norwalk, 7000; Fremont, 8000; Cleveland, 500,000; Toledo, 225,000. It has a very large amount of through passenger traffic, and in summer an extensive park travel to no less than thirty resorts along the lake shore and the islands near Sandusky. Its express business is quite an important item. The company also operates city lines in Sandusky and Norwalk, but their earnings do not constitute a very important proportion of its gross. The company's gross earnings per mile of track during the calendar year of 1905 were $4,927 and this year will probably reach $5,625.

The system of the Cleveland & Southwestern has two main divisions which extend out of Cleveland to the south and west. The southern division goes to Medina, 2500; Seville, 1500, and Wooster, 2500. The western division extends through Elyria, 15,000, and Oberlin, 3500, to Norwalk, 7500. It also has branches to Lorain, 30,000; North Amherst, 1500; Grafton, 1500, and Wellington, 2500. It gets considerable through travel between the terminal points and has a large express and milk business. It owns Puritas Springs and enjoys considerable summer traffic. The earnings per mile of track for the last calendar year were $4,024, and this year will probably reach $4,825.

The system of the Eastern Ohio Traction Company also has two divisions, both of which extend out of Cleveland. The Eastern division goes to Chardon, 2000, and has a branch to Middlefield, 1800; the Garrettsville division goes to Chagrin Falls, 2000; Hiram, 1500, and Garrettsville, 2000. This district is a rich farming and dairy country and there is no competition to Cleveland. Freight and milk business is very heavy. The traffic to Gates Mills, a summer town for wealthy Clevelanders, is very heavy, and the company gives a half-hourly service to this point. The earnings per mile of track for the calendar year of 1905 were $2,681.

Northern Ohio Traction & Light Company:—The lines of this company touch Cuyahoga Falls, 2500; Akron, 5000, with a branch line to Barberton, 7000, and another branch to Kent, 1500, and Ravenna, 2500. The through travel between Cleveland and Akron is very heavy and the line is double track with half-hourly service. The company also operates 20 miles of city lines in Akron with local service to Cuyahoga Falls. It does an extensive express and milk business, and there are several resorts on the line which attract the summer travel.

Cleveland, Painesville & Eastern:—The line of this company extends easterly out of Cleveland in two divisions as far as Willoughby, with one line on to Painesville, 30 miles. The main line goes out Euclid Avenue, which is lined with homes of citified farmers to Willoughby. The Shore Line follows the Lake Shore through Collinwood, 7000, passes a number of lake resorts and derives large travel from hampers and those who have summer homes on the lake front. Milk and express amount to quite an item. Since the first of the year the company has been operated in connection with the Cleveland, Painesville & Ashtabula, and through cars are now operated between Cleveland and Ashtabula, 60 miles, The road is handicapped considerably by having a haul of nearly 9 miles on city track, from which it derives very little revenue.

TABLE XIV.—SHOWING STATISTICS OF THE INTERURBAN ELECTRIC RAILWAYS CENTERING IN CLEVELAND.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	COMPANY.	Fiscal Year Ending During 1905.	City Mileage.	Interurban Mileage.	Total Mileage.	Passenger Earnings Per Mile of Total Mileage.	Population Per Mile Including Terminals.	Passenger Earnings Per Inhabitant, Col. 7 ÷ Col. 8.	Population Per Mile Excluding Main Terminal.	Pass. Earn. Per Inhab. Ex. Main Terminal, Col. 7 ÷ Col. 10.	Population Per Mile Excluding Both Terminals.	Pass. Earn. Per Inhab. Ex. Both Terminals, Col. 7 ÷ Col. 12.	TOTAL EARNINGS.	
													Per Mile of All Track.	Per Inhab. Including Term., Col. 14 ÷ Col. 8
	CLEVELAND.													
A	Lake Shore Electric	Apr. 30	15	145	160	$4,146	3,750	$1.15	541	$7.66	541	$7.65	$4,370	$1.16
B	Cleveland & Southwestern	Apr. 30	..	133	133	3,302	3,428	.91	707	5.65	579	5.65	$3,744	1.08
C	Eastern Ohio	Apr. 30	..	81	81	1,987	4,544	.41	112	17.70	112	17.70	2,732	.56
D	Northern Ohio	Apr. 30	30	68	98	7,453	4,570	1.61	674	11.03	238	31.19	9,118	1.95
E	Cleveland, Painesville & Eastern	Apr. 30	1	42.8	43.8	4,662	9,243	.50	529	8.83	529	8.83	5,260	.57
	Average	.....	..	....	103.2	$4,310	5,107	.91	512	10.17	399	14.2	$5,045	1.06

Examining again Table XIV. and referring to the different roads by their distinguishing letters to avoid repetition, it will be seen that the passenger earnings per mile vary between $3,300 and $4,660, with the exceptions of road D, which is considerably higher than the average, largely on account of its Akron system, and road C, which is considerably lower than the average on account of its comparatively low population per mile of track outside of Cleveland. If, however, we examine the total earnings per mile of track as given in column 14, this percentage of variation is much decreased on account of the large freight and milk business on road C. In population per mile of track including terminals (column 8) the figure for road E is considerably higher than the average, because it is a short line and the population of Cleveland is consequently a large factor in the total population. This is shown in the Cleveland curve in Fig. 1, in which the populations are plotted as ordinates and the earnings per mile of track as abscissae. The form of the curve is quite irregular, as C and E are lower than the average for the reasons mentioned, and D is considerably above the line.

Column 10 in Table XIV. gives the population per mile, excluding Cleveland, except that in the case of the Lake Shore

Railway (road A) the population of Toledo has also been taken out for the reason that this city might be considered as bearing the same relation to the traffic that Cleveland does. We then get passenger earnings per inhabitant varying from $5.65 to $17.70, and the Cleveland curve shown in Fig. 2, in which the points have a much more rational distribution than in Fig. 1. The principal exception is D, which is much above the average for the reasons already outlined. In column 12, the population of both terminals has been excluded. Here, A, C and E have the same figures as in column 10, because Toledo has already been deducted from A, and C and E have no other large terminals. The tributary population B has been reduced by the omission of Lorain, and D by the omission of Akron. Column 12 shows that with both terminal cities omitted, three of the roads, A, B and E, have population figures very closely approximating each other. It is interesting to note in diagram Fig. 3, in which these values are plotted, that with the exception of D, which is extraordinarily high, the figures are within a comparatively narrow triangle whose apex is at the origin. In the group B and E are especially close together.

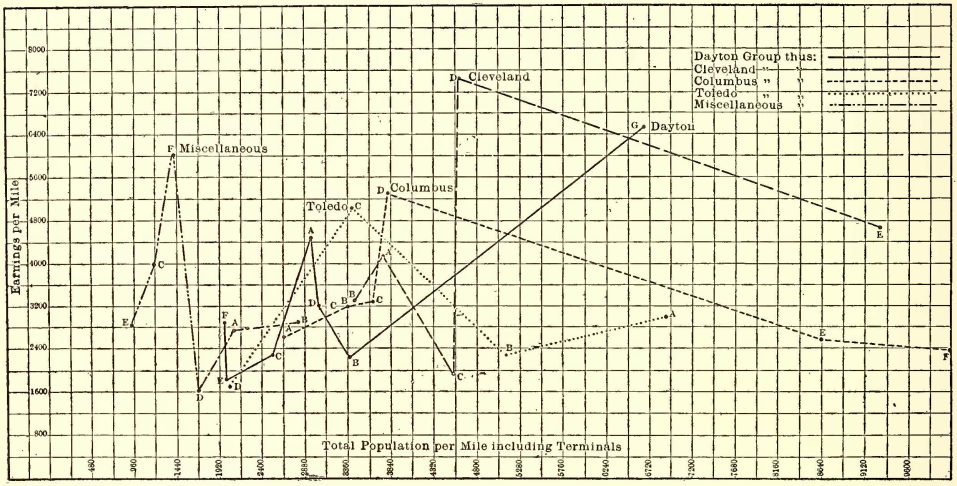


FIG. 1.—RELATION BETWEEN PASSENGER EARNINGS PER MILE AND TRIBUTARY POPULATION, INCLUDING BOTH TERMINALS

COLUMBUS GROUP

Corresponding figures to those shown for the Cleveland district in Table XIV. are presented in Table XV. for the Columbus district. Here the roads represented are six in number and are as follows:

Columbus, Delaware & Marion:—The line of this company extends north from Columbus through Worthington, 1500; Delaware, 8000, and Prospect, 1500, to Marion, 13,000. The latter is a good manufacturing town and the road gets considerable through business. The express business is very heavy, much farm produce being handled. Small local service given in Delaware and Marion. The company operates three parks and caters to the excursion business. It also has a heavy commuter business in and out of Columbus.

Columbus, London & Springfield:—This road has been purchased by the Schoepf syndicate and is now a part of the Indiana, Columbus & Eastern system. It passes through London, 3700, to Springfield, 40,000; traverses a good farming district and receives much through business to Springfield and to Dayton over connecting lines.

Scioto Valley Traction Company:—This line now has 81 miles of track and, as described elsewhere, is operated by the third rail. It extends from Columbus in a southerly direction, the main line going through Circleville, 7500, to Chillicothe, 14,000, while a branch goes to Lancaster, 11,000. The main line traverses a very rich farming district and gives better time than the parallel steam roads between terminals. The earnings given in the table are almost exclusively passenger. A freight business was started Dec. 1 last year, and the traffic is proving surprisingly heavy. The earnings for this year will be largely in excess of those given for 1905.

Columbus, Buckeye Lake & Newark:—This road has also been made a part of the new Indiana, Columbus & Eastern system. Newark has 20,000 population and the road gets the bulk of business. The line traverses a good farming country and has a large express business. There is a branch line to Buckeye Lake, a famous camping, fishing and hunting resort. The company operates a park and hotel and summer traffic is very heavy.

Columbus Grove City & Southwestern:—This line is now a part of the Indiana, Columbus & Eastern system and goes through a farming district with no steam competition.

Columbus, New Albany & Johnstown:—The line of this railway extends out of Columbus in a northeasterly direction into a territory which has no steam railroad transportation. The electric line gets all the business there is, both passenger and freight, and the latter is quite an item.

An examination of column 5 shows that the roads composing this group correspond much more closely in length than in those of the Cleveland district, and the passenger earnings per mile, with the exception of D, are quite close to the average of $3,200. To the large park business of road D is undoubtedly in large part due its high earnings per mile of track. The population

figures given in column 8 are very much higher for the last two roads than for the rest, on account of the shortness of these two lines and consequent preponderance of the population of the city of Columbus, but in reality the tributary population is smaller, as shown in column 10. An examination of column 8 and the Columbus group in Fig. 1 shows A, B and C close together, D very much higher on account of its large business, and E and F at the end of the scale on account of the large population per mile due to Columbus. In the population per mile, exclusive of main terminal as given in Fig. 2, we find E and F now near the origin, A, B and C in practically a straight line, and D much above the others in the group.

Taking up now, population, excluding both terminals, the population of Marion has been omitted from line A, Springfield from line B, Chillicothe from line C, and Newark from line D. This gives the populations presented in column 12 and the points in Fig. 3.

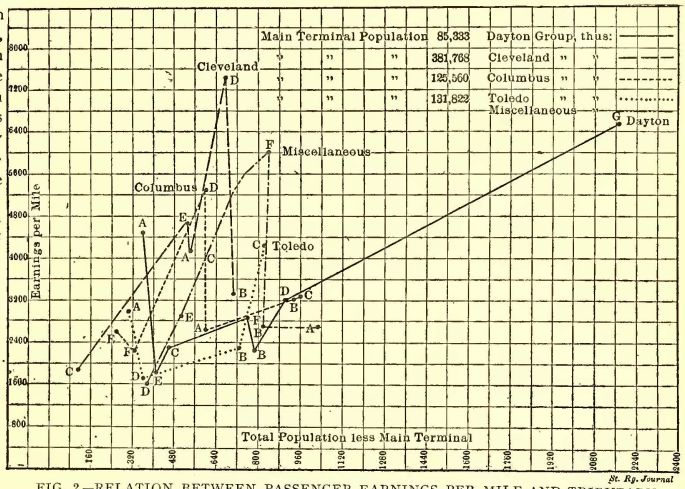


FIG. 2.—RELATION BETWEEN PASSENGER EARNINGS PER MILE AND TRIBUTARY POPULATION, EXCLUDING LARGEST TERMINAL

DAYTON GROUP

The roads composing the Dayton group are seven in number and are as follows:

Dayton & Troy:—This road goes north through Tippecanoe, 1500, and Troy, 6000, to Piqua, 8000, and does extensive interline business with the Western Ohio for Lima, Findlay and Toledo. It started a freight business about the first of the year and is now doing extensive interline freight. It is thought that the earnings this year will reach $5,800 per mile.

Dayton, Covington & Piqua:—The line of this railway also extends north from Dayton, traversing the Stillwater Valley, a very fertile district. It touches West Milton, 1500; Covington, 1500, and Piqua, 8000. It gives faster time than the parallel steam road and consequently gets the bulk of the local business. Farm products and tobacco furnish quite a profitable freight traffic. The company operates a park near West Milton and pushes the excursion business.

Dayton & Northern:—This road has also been purchased by, and is now a part of, the Indiana, Columbus & Eastern system. It extends out of Dayton in a northwesterly direction through Brookville, 1500; Arcanum, 1500, to Greenville, 6000. It traverses a good farming district and connects with the Dayton & Muncie, giving through service to Muncie.

Dayton & Western:—The line of the Dayton & Western Company extends west from Dayton through Eaton, 4000, to Richmond, Ind., 12,000, and has a branch line to New Paris, where there is a noted summer resort. The line is a part of the through line to Indianapolis and obtains considerable through travel to that city and intermediate points. The freight business also furnishes good revenue.

Dayton & Xenia:—The Dayton & Xenia Traction Company operates two electric lines between Dayton and Xenia, 9000, with a branch to Spring Valley, 2500. The farming country through which it runs is very prosperous and the through travel between Dayton and Xenia is quite large. The comparatively low earnings per mile of track are due to the fact that it consists of two lines which were consolidated. Infrequent service is given on one of them with hourly service on the other.

Dayton, Springfield & Urbana:—This is another property which now forms part of the Indiana, Columbus & Eastern system. The earnings shown include those of an extension known as the Urbana, Bellefontaine & Northern, recently constructed and not making a very heavy showing. The main line is located between Dayton, Springfield & Urbana and is one of the most prosperous lines in the State. Springfield has a population of 40,000. There is a great deal of travel between Spring-

TABLE XV.—SHOWING STATISTICS OF THE INTERURBAN ELECTRIC RAILWAYS CENTERING IN COLUMBUS.

1	2 COMPANY.	3 Fiscal Year Ending During 1905.	4 City Mileage.	5 Interurban Mileage.	6 Total Mileage.	7 Passenger Earnings Per Mile of Road.	8 Population Per Mile Including Terminals.	9 Passenger Earnings Per Inhabitant, Col. 7 ÷ Col. 8.	10 Population Per Mile Excluding Main Terminal.	11 Pass. Earn. Per Inhab., Ex. Main Terminal, Col. 7 ÷ Col. 10.	12 Population Per Mile Excluding Both Terminals.	13 Pass. Earn. Per Inhab., Ex. Both Terminals, Col. 7 ÷ Col. 12.	14 Total Earnings. Per Mile of All Track.	15 Per Inhab. Including Term., Col. 14 ÷ Col. 8
	COLUMBUS.													
A	Columbus, Delaware & Marion	Nov. 30	5	56	61	$2,623	2,664	$ .98	606	$4.32	411	$6.37	$3,116	$1.07
B	Columbus, London & Springfield	Apr. 30	..	52	52	3,183	3,341	.95	925	1.06	191	3.43	4,307	1.28
C	Scioto Valley	Apr. 30	..	47	47	3,274	3,641	.89	970	3.50	694	4.90	3,404	(b) .93
D	Columbus, Buckeye Lake & Newark	Apr. 30	..	39.1	39.1	5,306	3,817	1.39	606	8.75	142	37.29	6,366	1.66
E	Columbus, Grove City & S. W	Apr. 30	..	15	15	2,592	8,630	.30	259	9.99	259	9.99	3,111	.36
F	Columbus, New Albany & Johnstown	Apr. 30	..	8.6	8.6	2,236	14,929	.15	329	6.80	329	6.80	2,673	.17
	Average	.....	..	....	37.2	$3,202	6,170	.78	616	5.84	337	11.46	$3,829	.92

(b) Based on prorata earnings for year.

field and Dayton. This section will be double-tracked next year. There is also a branch line to New Carlisle, 1500. The company operates a park and secures considerable summer traffic. The express business is very good though undeveloped.

Cincinnati-Northern Traction Company:—The main line of this company extends from Cincinnati through Hamilton, 25,000; Middletown, 12,000; Miamisburg, 4000, to Dayton, 90,000. There are a large number of small towns along the line and its route traverses the most densely populated section of the State. A considerable portion of the line is double-tracked. The company operates the city lines in Hamilton, and has touching the suburbs and a number of small towns tributary to Toledo. There is a large resident population, and much of the business is derived from pleasure riders desiring to visit a number of points of historic interest near Maumee, also because of the beautiful river ride.

Toledo & Indiana:—The tracks of this company parallel the main line of the Lake Shore & Michigan Southern Railway (a steam railroad), and touch Holland, 1200; Swanton, 1200; Delta, 1500; Waseon, 2500; Stryker, 1500, and Bryan, 3500. It traverses a good farming district and operates standard freight trains by electric locomotives, in addition to

TABLE XVI.—SHOWING STATISTICS OF THE INTERURBAN ELECTRIC RAILWAYS CENTERING IN DAYTON.

1	2 COMPANY.	3 Fiscal Year Ending During 1905.	4 City Mileage.	5 Interurban Mileage.	6 Total Mileage.	7 Passenger Earnings Per Mile, Total Mileage.	8 Population Per Mile Including Terminals.	9 Passenger Earnings Per Inhabitant, Col. 7 ÷ Col. 8.	10 Population Per Mile Excluding Main Terminal.	11 Pass. Earn. Per Inhab. Ex. Main Terminal, Col. 7 ÷ Col. 10.	12 Population Per Mile Excluding Both Terminals.	13 Pass. Earn. Per Inhab. Ex. Both Terminals, Col. 7 ÷ Col. 12.	14 Total Earnings. Per Mile of All Track.	15 Total Earnings. Per Inhab. Including Term., Col. 14 ÷ Col. 8
	Dayton.													
A	Dayton & Troy	Apr. 30	3	30	33	$4,480	2,951	$1.52	366	$12.24	366	$12.24	$4,669	$1.58
B	Dayton, Covington & Piqua	Apr. 30	..	33	33	2,232	3,371	.66	785	2.84	386	5.77	2,595	.76
C	Dayton & Northern	Apr. 30	..	40	40	2,281	2,519	.87	461	4.72	461	4.72	2,641	.99
D	Dayton & Western	Apr. 30	..	40	40	3,205	3,036	1.05	902	3.55	447	7.18	4,286	1.57
E	Dayton & Xenia	Apr. 30	..	53	53	1,827	2,022	.90	412	4.43	412	4.43	2,074	1.00
F	Dayton, Springfield & Urbana	Apr. 30	..	73	73	2,880	1,959	1.47	762	12.07	239	12.07	3,163	1.61
G	Cincinnati & Northern	Apr. 30	5	68	73	6,540	6,634	.98	2,169	3.01	1,000	6.53	6,963	1.04
	Average	.....	..	....	49.3	$3,349	3,213	1.06	836	6.12	473	7.56	$3,770	1.22

* For 1904.

TABLE XVII.—SHOWING STATISTICS OF THE INTERURBAN ELECTRIC RAILWAYS CENTERING IN TOLEDO.

1	2 COMPANY.	3 Fiscal Year Ending During 1905.	4 City Mileage.	5 Interurban Mileage.	6 Total Mileage.	7 Passenger Earnings Per Mile, Total Mileage.	8 Population Per Mile Including Terminals.	9 Passenger Earnings Per Inhabitant, Col. 7 ÷ Col. 8.	10 Population Per Mile Excluding Main Terminal.	11 Pass. Earn. Per Inhab. Ex. Main Terminal, Col. 7 ÷ Col. 10.	12 Population Per Mile Excluding Both Terminals.	13 Pass. Earn. Per Inhab. Ex. Both Terminals, Col. 7 ÷ Col. 12.	14 Total Earnings. Per Mile of All Track.	15 Total Earnings. Per Inhab. Including Term., Col. 14 ÷ Col. 8
	Toledo.													
A	Maumee Valley	Apr. 30	..	20	20	$2,980	$6,897	$ .43	306	$9.73	306	$9.73	$3,296	(a)$ .47
B	Toledo & Indiana	Apr. 30	..	30	30	2,276	5,123	.44	729	3.11	729	3.11	2,627	.51
C	Toledo, Bowling Green & Southern	Apr. 30	5	46	51	4,225	3,408	1.24	823	5.13	478	8.80	4,502	(a) 1.30
D	Toledo & Western	Apr. 30	..	78.5	78.5	1,729	2,045	.84	365	4.72	365	4.72	2,604	1.21
	Average	.....	..	....	48.7	$2,802	4,368	.74	556	5.67	469	6.59	$3,257	.87

(a) Excluding light and power.

branches to Mt. Healthy and Germantown. Its express business is probably the largest in the State. There are several parks on the route and a summer Chautauqua brings it heavy business at certain times. It also has large commuter business.

The earnings per mile of track of the roads in this group correspond fairly closely with the exceptions of A, E and G, the latter very high because it operates the city system in Hamilton. The population per mile is high because both Dayton and Cincinnati are included. The Dayton group in Fig 1 shows an irregular curve with A, F and G along one line, and B, C and E along another line. Taking the population per mile, excluding Dayton, we have figures from 366 to 2169, and receipts varying from $2.84 to $12.24, with an average of $6.12. In this curve and in column 10, Cincinnati is deducted from line G, instead of Dayton, as Cincinnati is the larger city. The population per mile, exclusive of both terminals, has been obtained by deducting Piqua from the line B, Richmond from line D, Springfield from line F, and Dayton from line G. The diagram Fig. 3 shows a fairly regular curve outside of points A and F.

THE TOLEDO GROUP

The Toledo group contains the four following roads:

Maumee Valley Railway & Light:—The lines of this company form a kind of belt on both sides of the Maumee River, package cars. It gives a fast limited service and gets considerable through business.

Toledo, Bowling Green & Southern:—The lines of this railway extend due south from Toledo through Maumee, 3000; Perrysburg, 1500; Bowling Green, 5500; North Baltimore, 1800, to Findlay, 20,000. It furnishes the most direct route from Findlay to Toledo, and there is a large amount of through travel. It traverses an oil district, from it derives a large freight and passenger business. This is one of the best purely interurbans in the State from the standpoint for earnings per mile of track, and due to the connection recently made with roads south for through business from Dayton to Toledo, the earnings are increasing rapidly.

Toledo & Western:—This line, the longest of the Toledo group of roads, extends westward from Toledo, traversing a very fertile farming district, which has no other means of transportation. A branch line extends north to Adrian, Mich., a prosperous city, which gives considerable through business to Toledo. About 40 per cent of the receipts of the company are in freight, handled largely in standard freight trains. As there are few towns, the passenger business is smaller than the average.

With the exception of road C, the passenger earnings per mile of the Toledo group are lower than any of the other groups,

largely on account of the absence of practically all city business and also because of the great length of line D. By the development of freight business, however, this latter company has been able to increase largely these earnings per mile, as shown in column 15. The population, including terminals (column 8), varies inversely according to the length of the line, but with the deduction of Toledo the order is radically changed. Line A gives it considerable additional summer revenue. The line traverses a productive oil district.

The Springfield & Xenia extends from Springfield, 40,000, to Xenia, 9000, and is the only direct route connecting these two county seats. It has an arrangement with the Dayton & Xenia for through business to Dayton and derives considerable summer traffic from a park on its line.

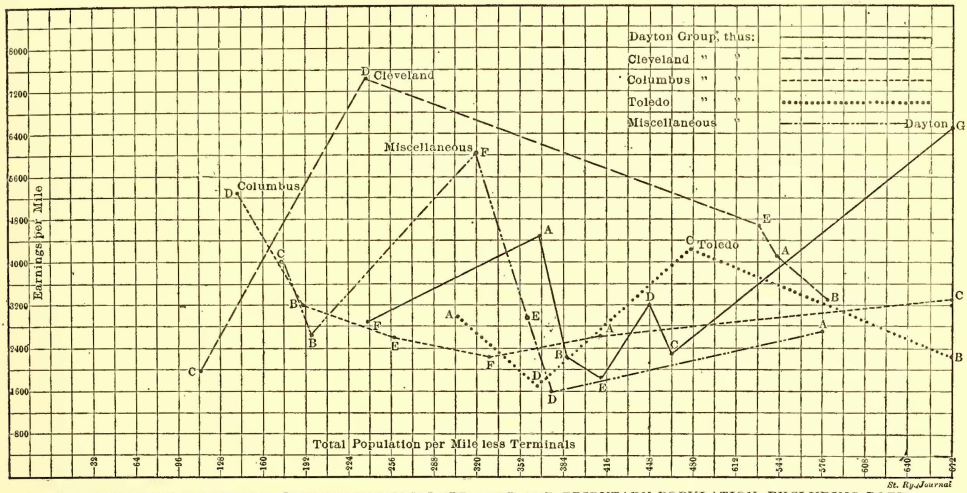


FIG. 3.—RELATION BETWEEN PASSENGER EARNINGS PER MILE AND TRIBUTARY POPULATION, EXCLUDING BOTH TERMINALS

has the lowest population per mile, excluding Toledo (column 10), but the highest receipts per capita (column 11), and this throws its point on the curve in Fig. 2 considerably higher than the others. The population per mile, excluding both terminals, is obtained by deducting Findlay from line C in the values given in column 10, and leaving the others the same, as there are no large terminals except Toledo on these lines. Fig. 3 shows A and E in one line, and B and D in another line.

TABLE XVIII.—SHOWING STATISTICS OF VARIOUS INTERURBAN ELECTRIC RAILWAYS IN OHIO, NOT INCLUDED IN THE PREVIOUS GROUPS.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	COMPANY.	Fiscal Year Ending During 1905.	City Mileage.	Interurban Mileage.	Total Mileage.	Passenger Earnings Per Mile, Total Mileage.	Population Per Mile Including Terminals.	Passenger Earnings Per Inhabitant, Col. 7 ÷ Col. 8.	Population Per Mile, Excluding Main Terminal	Pass. Earn. Per Inhab. Ex. Main Terminal, Col. 7 ÷ Col. 10.	Population Per Mile Excluding Both Terminals.	Pass. Earn. Per Inhab. Ex. Both Terminals, Col. 7 ÷ Col. 12.	TOTAL EARNINGS. Per Mile of All Track.	TOTAL EARNINGS. Per Inhab. Incl. Terms., Col. 14 ÷ Col. 8
	GENERAL.													
A	Toledo, Fostoria & Findlay.....	Apr. 30	..	16.8	16.8	$2,738	2,085	$1.30	1,031	$2.61	576	$4.70	$2,961	$1.42
B	Springfield & Xenia.....	Dec. 31	..	20	20	2,712	2,726	1.00	813	3.33	197	1.38	2,712	1.00
C	Columbus, Newark & Zanesville....	Apr. 30	8	34	42	3,955	1,166	3.41	606	6.57	174	22.90	4,295	3.68
D	Springfield, Troy & Piqua.....	Dec. 31	..	29	29	(b) 1,505	1,693	.94	374	4.26	374	4.26	1,760	1.04
E	Cleveland, Painesville & Ashtabula..	Apr. 30	..	29	29	2,889	955	3.02	508	5.67	356	8.58	2,922	3.05
F	Canton, Akron—New Philadelphia..	Apr. 30	18	60	78	6,013	1,395	4.31	840	7.15	319	15.63	6,614	4.74
	Average.....	.....	..	....	35.8	$3,322	1,666	2.33	695	4.93	333	9.57	$3,542	2.49

(b) Based on pro rata earnings for year.

OUTSIDE LINES

In addition to the figures already given, six lines in Ohio which do not belong in any of the groups mentioned have been selected for this comparison as follows:

Toledo, Fostoria & Findlay:—This is the shortest of those selected. Its line extends from Findlay, 20,000, to Fostoria, 15,000, with a northern extension to Pemberville, which was completed this year, and affords connection for Toledo over the Lake Shore electric. Reeves Park, owned by the company, a noted college town. There is a great deal of picturesque scenery along the route and several summer resorts.

Springfield, Troy & Piqua:—This is another Springfield road. Its line extends northwest from Springfield to Troy, 6000, where it connects with the Dayton & Troy for Dayton, Lima and Toledo. It derived considerable through business by means of this connection and operates through freight cars from Springfield to Dayton. It gets considerable carload freight from the farming district traversed.

Cleveland, Painesville & Ashtabula:—The line of this company extends from Painesville to Ashtabula and is now operated in connection with the Cleveland, Painesville &

Columbus, Newark & Zanesville:—The line of this company is also now a part of the Indiana, Columbus & Eastern system. The main line is an extension of the Columbus, Buckeye Lake & Newark to Zanesville, 25,000, and the road gets considerable through business to Columbus. The system includes the city lines in Newark and a branch line to Grandville,

Eastern, from which it derives considerable through business through Geneva and Ashtabula. Its business in summer is very heavy to many resorts along the lake.

Canton-Akron-New Philadelphia:—This railway extends from Akron, 50,000, through Conton, 40,000; Massillon, 15,000; Beach City, 1500, and Canal Dover, 7000, to New Philadelphia, 8000, and city lines in Canton and Massillon. The property has recently been consolidated with the Northern Ohio Traction & Light Company. The northern section traverses a good farming district, while the line to the south is through the coal district. The company operates park and summer theater near Canton and derives considerable business from this source,

None of these lines has any large terminal and the average passenger earnings per mile of track are considerably lower than that of any of the other groups. The tributary population, including terminals, is also lower, but excluding terminals is higher. In this group the population, excluding main terminal, that is the difference between column 8 and column 10, has been obtained by deducting Findlay from line A, Springfield from line B, Zanesville from line C, Springfield from line D, Ashtabula from line E, and Akron from line F. The figures given in column 12 have been obtained by also subtracting Fostoria from Line A, Xenia from line B, Newark from line C, Painesville from line E, and Canton from line F.

SUMMARY

Tables XIX. and XX. summarize the earnings of the roads in the different groups according to the passenger earnings and total earnings per mile of track.

Table XIX. shows only four roads with earnings over $5,000 per mile of track. These roads are the Northern Ohio; Columbus, Buckeye Lake & Newark; Cincinnati Northern and Canton-Akron-New Philadelphia. With the exception of the second each of these lines, it will be remembered, possesses considerable city mileage, while the Columbus, Buckeye Lake & Newark has an exceptional park traffic. Looking now at Table XX., which includes freight earnings, it will be found that with but one other exception these four lines are still the only ones showing gross earnings of over $5,000 per mile of track.

Looking now at lowest figures for earnings per mile of track, Table XIX. shows that there are only four roads of the twenty-eight which have passenger earnings of less than $2,000 per mile of track, and that when the freight earnings are added, as in Table XX., this minimum earning capacity is reduced to one road. This road is really not an exception because, as stated previously, it is a comparatively new proposition and its earnings are based upon a portion of the year only. Table XX. also shows only one other road has gross earnings of less than $2,500 per mile of track, and if the local conditions of this road, mentioned in the previous text, are recalled, that is, that it consists of two consolidated lines, upon one of which infrequent service is given, the reason can be understood. In other words, Table XX. shows that under ordinary conditions, and without city systems, the interurban railways of Ohio have been earning gross between $2,500 and $5,000 per mile of track, and that the greater proportion of them show for 1905 gross earnings of about $3,500 per mile.

Referring now to the different diagrams, Fig. 2, or that in which the tributary population is taken after deducting that of the main terminal, seems to give on the whole the most logical distribution of points. Line D in the Cleveland group, the Northern Ohio Traction Company, is far above the average zone, for the reasons mentioned; while line G of the Dayton group is far to the right on account of the inclusion of Dayton and also for the reasons mentioned previously in this article. All the other roads group themselves approximately closely along a line drawn at an angle of about 45 deg. from the axis of abscissae, with some of the older and more prosperous lines above and some of the later roads below this assumed average line.

No attempt has been made in this article to reproduce diagrams showing the relations between gross earnings per mile and population, but it is thought that if such a diagram should be drawn with the population of the main terminal omitted in making up the figure for rides per inhabitant, the points would group themselves even more closely around a central line. This is indicated from column 14 in the different tables, which shows that those roads which on account of length or comparatively low tributary population are low in passenger earnings per mile of track are the ones which have been best able to develop a good freight business.

TABLE XIX.—DIVISION OF ROADS SHOWING PASSENGER EARNINGS PER MILE OF TRACK.

Passenger Earnings Per Mile of Track.	Cleveland Group.	Columbus Group.	Dayton Group.	Toledo Group.	Miscellaneous.	Total.
Under $2.000.....	1	0	1	1	1	4
$2,000 to $2,500....	0	1	2	1	0	4
2,500 to 3,000....	0	2	1	1	3	7
3,000 to 3,500....	1	2	1	0	0	4
3,500 to 4,000....	0	0	0	0	1	1
4,000 to 4,500....	1	0	1	1	0	3
4,500 to 5,000....	1	0	0	0	0	1
Over $5,000.....	1	1	1	0	1	4
Total.....	5	6	7	4	6	28

TABLE XX.—DIVISION OF ROADS SHOWING TOTAL EARNINGS PER MILE OF TRACK.

Total Earnings Per Mile of Track.	Cleveland Group.	Columbus Group.	Dayton Group.	Toledo Group.	Miscellaneous.	Total.
Under $2.000.....	0	0	0	0	1	1
$2,000 to $2,500....	0	0	1	0	0	1
2,500 to 3,000....	1	1	2	2	3	9
3,000 to 3,500....	0	3	1	1	0	5
3,500 to 4,000....	1	0	0	0	0	1
4,000 to 4,500....	1	1	1	0	1	4
4,500 to 5,000....	0	0	1	1	0	2
5,000 to 5,500....	1	0	0	0	0	1
Over $5,000	1	1	1	0	1	4
Total.....	5	6	7	4	6	28

SOME OF THE APPARATUS IN USE IN THE CENTRAL WEST

The Power Specialty Company, of New York, has equipped the power plant at Terre Haute with the Foster superheater, and the Kent wing-wall furnace is used with success at the Muncie, Ind., power plant.

The Trolley Supply Company, of Canton, Ohio, supplies some fifty companies in Ohio and Indiana with the Knutson trolley retriever. This device is used by practically all the electric roads around Columbus, Dayton, Cincinnati, Cleveland, Lima, Springfield, Toledo, East Liverpool, Norwalk, Anderson, Evansville, Ft. Wayne, Indianapolis, Terre Haute, South Bend and other interurban centers.

The General Electric Company reports the following list of apparatus supplied in the Columbus district:

Scioto Valley Traction Company.—Complete General Electric switchboard apparatus in power house; three G. E. sub-station equipments, each consisting of one 400-kw, 600-volt, 25-cycle, three-phase rotary converters; seventeen quadruple GE-66 motor equipments with type "M" control. Columbus, Urbana & Western Electric Railway Company.—Two GE-800, two-motor equipments with K-9 controllers, and one GE-1000, two-motor equipment with K-10 controller. Columbus, Grove City & Southwestern Railway Company.—Two GE-54 motor equipments with K-12 controllers, and two GE-73 two-motor equipments with C-6 controllers. Central Market Railway Company, Columbus, Ohio. —One 250-kw, 425 r. p. m., 500-volt, belt-driven generator; two 300-kw, 500 r. p. m., 600-volt, 25-cycle rotary converters; six 110-kw, 370-26,400-volt transformers. Columbus, Newark & Zanesville Traction Company.—Two 800-kw, 94 r. p. m., 13,200-volt, 25-cycle alternators; one 1500-kw, 94 r. p. m., 13,200-volt, 25-cycle alternator; one 35-kw, 125-volt, engine driven exciter; one 35-kw, 125-volt motor generator set; six 120-kw transformers; eight 300-kw, 500 r. p. m., 600/370-volt, 25-cycle rotary converters; eight 120-kw transformers; thirteen quadruple GE-73 equipments with type "L" control; five double motor GE-75 equipments with K-6 controllers; four quadruple GE-57 equipments with B-8 and K-14 controllers; two quadruple GE-67 equipments with K-6 controllers; ten double motor GE-67 equipments with K-10 controllers; two double motor GE-1000 equipments with K-10 and B-8 controllers; one double motor GE-800 equipment with type "K" controller.

Columbus, London & Springfield Railway Company.—Fifty quadruple GE-54 equipments, with K-12 controllers; twenty double motor GE-54 equipments, with K-10 controllers; fifteen quadruple GE-73 equipments, with type "M" control; two double motor GE-73 equipments with K-6 controllers; three quadruple GE-57 equipments, with D-8 controllers. Columbus, Delaware & Marion Railway.—One 2000-kw, 750 r. p. m., 25-cycle, 2300-volt Curtis turbines; one 800-kw, 1500 r. p. m., 25-cycle, 2300-volt Curtis turbine; two frequency changers, consisting of two ATB 10-200-750-2300-volt generators; one motor generator exciter, consisting of one 45-kw, 750 r. p. m., 125-volt generator, direct connected to an "L" 4-75-750-2300-volt induction motor; one 25-kw Curtis steam turbine exciter; one 400-kw, 150 r. p. m., 550-volt, generator; one 400-kw, 860 r. p. m., 550-volt generator; three 110-kw transformers; three 600-kw transformers; four 300-kw, 500 r. p. m., 600-370-volt, 25-cycle rotary converters; eight 220-kw transformers; eleven GE-73 quadruple equipments, with type "M" control; three quadruple GE-1000 equipments, with K-6 controllers; three double motor G. E. 800 equipments, with K-2 controllers.

Columbus Railway & Light Company.—Five quadruple GE-67 equipments; 143 double motor GE-67 equipments; twenty double motor GE-52 equipments; forty-nine double motor GE-54 equipments; thirty-five double motor GE-800 equipments. Equipments at Station No. 1.—Two General Electric generators, type M. P., class 14-1000-100, form H, amps. 1739, speed 100, voltage 525-575; one generator (booster), type M. P., class 6-150-500, form L, amps. 500, speed 500, voltage 300; one generator, type M. P., class 12-850-100, form A, amps. 1518, speed 100, voltage 500-560; two generators, type M. P., class 10-500-110, amps. 910, speed 110, voltage 500-550; two alternating-current generators, type ATB, class 4-500-1800, form T, amps. 72, speed 1800, voltage 4000; one generator (steam-driven exciter), type M. P., class 6-30-305, form A, amps. 240, speed 305, voltage 125; one generator (motor-driven exciter), type M. P., class 4-35-720, form H, amps. 280, speed 720, voltage 125; one generator (new steam-driven exciter), type M. P., class 6-50-280, form L, amps. 400, speed 280, voltage 115-125; one generator (300-kw M. G. set), type M. P., class 8-300-400, form H, amps. 522, speed 450, voltage 525-575; one generator (500-kw M. G. set), type M. P., class 8-500-400, form H, amps. 870, speed 400, voltage 525-575. Equipments at Station No. 2.—One double-current generator, type A. C. T., class 20-480-150, form B, speed 150, continuous current, 1600 amps., 300 volts, alternating current, cycles 25, volts 185; two generators, type D. D., class M. P., 14-200-120, amps. 1303, speed 120, volts 150; one double current generator, type A. C. T., class 20-480-150, form A, speed 150, continuous current, 1600 amps., 300 volts, alternating current, 25 cycles, 786 volts; one generator, 18 poles, 1000 kw, 100 revolutions, 3640 amps., 275 volts; two generators (No. 8 M. G. set), type M. P., class 8-200-514, form L, amps. 1480, speed 514, voltage 118-210; two generators (No. 9 M. G. set), type M. P., class 8-200-400, form L. amps. 1480, speed 400, voltage 135; one generator (motor-driven exciter), type C. E., class 4-15-1200, form A, amps. 120, volts 125, speed 1200; one generator (booster), type M. P., class 4-40-850, form H, amps. 200, speed 850, voltage 200. Central Market Station.—One generator, type M. P., form H, class 6-250-425, amps. 455, speed 425, voltage 500-550; one generator, type M. P., form L, class 6-45-600, amps. 750, speed 600, voltage 60-130.

The Electric Storage Battery Company, of Philadelphia, has been very successful in introducing batteries for interurban and city roads in Ohio and Indiana. In addition to the installations mentioned elsewhere in this issue the following installations of "Chloride Accumulators" may be mentioned:

In Dayton, the City Railway Company operate a 550-volt battery rated at 265 kw. Since this installation was made the company has been able to run the station with the operation of one 500-kw unit less than before. The saving in coal has been large. The ultimate capacity of this battery is 350 kw.

The Peoples' Railway Company, Dayton, also operates a battery for power house regulation rated at 390 kw, with an ultimate capacity of 660 kw.

The installations of the Cleveland Electric Railway are particularly interesting. There are four of these in all. The first is a battery of 1536-kw capacity, installed in the Cedar Avenue power station. This operates to remove fluctuations during the larger portion of the day, and also assists in taking two peaks, one in the morning and one in the afternoon, thereby saving the operation of a large unit during these periods. The other three batteries are for an entirely different purpose, being installed far out on the lines of the company, where there are heavy loads to be dealt with at certain times of the day. One of these batteries is at Windemere, with a present capacity of 660 kw and an ultimate capacity of 880 kw; one at Harvard Street, with a capacity of 1435 kw, which may be increased to 1700 kw later, and one at Detroit Street, with an initial capacity of 840, which may be increased to 1050 kw later. These batteries remove fluctuations from the line during ordinary conditions of load, thereby evening up the demand on the power house, and they each also supply current for a heavy local load of short duration, which would otherwise come back on the power house at the time when it was carrying heaviest load.

The Springfield Railway Company operates a 264-kw battery, with an ultimate capacity of 390 kw for power house regulation.

At Steubenville, a line battery with a capacity of 250 kw is used to maintain a constant voltage on the lines to the company's park. The lighting of the park is very satisfactorily accomplished from the railway feeders, owing to the regulating effect of the battery.

A system somewhat similar to the one in Columbus, described elsewhere, has been installed for the Toledo Railways & Light Company, where there are two batteries. One of these, with a capacity of 880 kw, is used normally to regulate the railway fluctuations. A second battery, with a capacity of 1200 kw, is

normally used to carry the peaks of the lighting load. The whole system is, however, so arranged that either battery or both batteries may be used in emergency to assist either the lighting or the railway system.

The Youngstown & Sharon Street Railway Company operates two batteries, one with a capacity of 96 kw and the other with a capacity of 144 kw to regulate the loads on the sub-stations. These batteries remove fluctuations, leaving a constant load for the rotaries.

The Pennsylvania & Mahoning Valley Railroad also operates sub-station batteries for similar work at Youngstown and Niles. These batteries have an initial capacity of 350 kw and an ultimate capacity of 440 kw.

The Gould Storage Battery Company, of New York, has a number of important battery installations for interurban work in the district. The Dayton & Muncie has Gould batteries at each of the following stations: Greenville, Winchester, Union City and Selma. The maximum battery discharge at these plants ranges from 630 amps. to 650 amps. Each installation consists of 304 type S-609 elements, and each operates in connection with a C. E. M. F. 44-kw differential booster. These batteries are located in sub-stations for the purpose of keeping the load on the rotaries practically constant. The regulation obtainable is variable at the will of the attendant. The booster regulator may be set so that the d. c. output from the rotaries is consant within limits of 6 per cent plus or minus of any average desired, that is, the variations of load on the rotaries may be made as small as 6 per cent while the average load on the rotaries may be set at any desired value. These plants were installed August, 1905.

The Dayton & Northern has a 500-amp. (maximum outfit) Gould battery, consisting of 266 elements of the O-513 type, operating with line type shunt booster. The battery is located at Fairview Hill, on the road from Dayton to Greenville, and supplies current to the cars climbing the heavy grade, at the same time maintaining the voltage on the line at a higher and more constant value and making the load on the rotaries supplying this section of the road far more constant. The booster is located at the power house at Brookville, about 9 miles from the battery, and is used to raise the voltage on the feeder leading to the battery. The current fed from Brookville to the battery may be varied as desired to suit different schedules. This plant was installed July, 1906.

The Dayton & Western has a 500-amp. (maximum outfit) battery of the same type at each of its sub-stations at New Hope and Snyders. These batteries are located at a distance from the power house at West Alexandria, and are used to maintain the voltage on the lines at a high and steady value. The booster is a 3-unit outfit, and raises the voltage on feeders leading from the power house to the batteries. The current fed to the batteries may be varied to suit different schedules. These plants were installed June, 1905.

The Van Dorn & Dutton Company, of Cleveland, is furnishing a large proportion of the roads in this district with its gears and pinions.

The Niles-Bement-Pond Company, of New York, has supplied its machine tools to interurban and city repair shops generally throughout Ohio and Indiana.

The Niles Car & Manufacturing Company, of Cleveland, Ohio, has furnished a large number of interurban cars operating in the district. Reference to several of these is made in the chapter on rolling stock design and equipment in this issue. The J. A. Hanna Company, of Cleveland, has charge of general sales for this company.

The Heine Safety Boiler Company, of St. Louis, has equipped a number of plants in the Central West with its boilers. A partial list of the companies with the horse-power capacity installed follows: Michigan City Electric Company, Michigan City, Ind., two 130 hp; Cincinnati, Lawrenceburg & Aurora Electric Company, Cincinnati, Ohio, four 250 hp, installed in 1899; Canton & Akron Railway, Canton, Ohio, two 300 hp, installed in 1904; Cleveland & Southwestern Traction Company, Elyria, Ohio, three 500 hp, installed in 1902; Columbus, Delaware & Marion Railway Company, Delaware, Ohio, two 267 hp, and four 366-hp units, two of which are just being installed, and the other two will be delivered soon; Mahoning Valley Railway, Youngstown, Ohio, two 400 hp, installed in 1900; Toledo Railways & Light Company, Toledo, Ohio, eight 500 hp, installed at intervals between 1895 and 1901; Zanesville Railway & Light Company, Zanesville, Ohio, two 370 hp.

The Creaghead Engineering Company, of Cincinnati, has sold Creaghead flexible brackets to a number of interurban roads in the district, prominent among which may be mentioned the Interurban Railway & Terminal Company, at Cincinnati; the Dayton & Xenia Transit Company, and Dayton, Springfield & Urbana Electric Railway.

The Babcock & Wilcox Company, of New York, gives the following list of plants in Ohio and Indiana where Babcock & Wilcox boilers will be found: Toledo, Fremont & Norwalk Electric Railway Company, Fremont, Ohio, 1500 hp; Columbus, Buckeye Lake & Newark Traction Company, Hebron, Ohio, 1208 hp; Lorain Street Railway Company, Lorain, Ohio, 1014 hp; Sandusky & Interurban Electric Railway Company, Sandusky, Ohio, 1208 hp; Springfield, Troy & Piqua Interurban Railway Company, Springfield, Ohio, 1200 hp; Indianapolis & Northern Traction Company, Anderson, Ind., 5200 hp; Central Market Street Railway Company, Columbus, Ohio, 500 hp; Columbus Railway Company, Columbus, Ohio, 3500 hp; Cincinnati Traction Company, Cincinnati, Ohio, 6291 hp; Dayton, Springfield & Urbana Street Railway, Medway, Ohio, 2470 hp; Indianapolis Traction & Terminal Company, Indianapolis, Ind., 4000 hp; Indianapolis Street Railway Company, Indianapolis, Ind., 3400 hp; Indianapolis & Cincinnati Traction Company, Rushville, Ind., 2800 hp; Winona & Warsaw Railway Company, Winona Lake, Ind., 642 hp; Winona Interurban Railway Company, Winona Lake, Ind., 1200 hp; Indiana Union Traction Company, Anderson, Ind., 1200 hp; Ft. Wayne & Wabash Valley Traction Company, Ft. Wayne, Ind., 4000 hp; Cleveland Electric Railway Company, Cleveland, Ohio, 1021 hp.

The Green Fuel Economizer Company, of Mattewan, N. Y., has installed economizers in the power stations of the Columbus Railway & Light Company, the Cincinnati Street Railway Company, the Terre Haute Railway & Light Company, and also at Findlay, Ohio, and Grand Rapids, Mich.

The National Brake & Electric Company, of Milwaukee, has installed in the Milo sub-station of the Columbus Railway & Light Company an interesting motor generator set, which is described in the article on the electric railway systems of Columbus elsewhere in this issue. The Columbus Railway & Light Company has also installed a National induction motor generator set in a new sub-station at the corner of High and Town Streets, for use on the underground Edison lighting system.

The Brown Hoisting Machinery Company, of Cleveland, in addition to other apparatus supplied in the district has installed an interesting single-rope Brown patent grab bucket for unloading cars at one of the stations of the Cleveland Electric Railway Company. The company states that with this bucket it has unloaded broken stone, swinging the stone from one car to another, at a cost of $.008 per ton. Many of the interurban roads use Brown hoists, traveling cranes, jib cranes, etc.

The Kinnear Manufacturing Company, of Columbus, has supplied a number of its well-known rolling doors for car houses in the Central West. Two interurban railways entering Columbus, namely, the Columbus, Delaware & Marion Electric Railway and the Columbus, London & Springfield Traction Company have installed the Kinnear door, and the Columbus Railway & Light Company uses a large number. The Dayton City Railway has twenty-six Kinnear doors on its car house, and the Indianapolis Traction & Terminal Company uses fifteen doors in its car houses and eleven at its freight and express station. These are but a few of the Kinnear Company's many customers in this district.

The Locke Insulator Manufacturing Company, of Victor, N. Y., has supplied the following equipment to interurban roads in this district: High-tension insulators to the Indianapolis, Columbus & Southern Traction, Cleveland & Southwestern Traction, Rapid Railway System of Detroit, Toledo & Western Railway, Stark Electric, Western Ohio, Lake Shore Electric, Detroit, Ypsilanti, Ann Arbor & Jackson, Cincinnati, Milford & Loveland, Cincinnati & Columbus, Ft. Wayne, Van Wert & Lima, Ft. Wayne & Wabash

Valley, Indianapolis & Cincinnati, Scioto Valley, Columbus, London & Springfield, Indianapolis & Northwestern, Canton-Akron, Cincinnati, Georgetown & Portsmouth, Eastern Ohio and others. Strain insulators to the Columbus, Delaware & Marion and Scioto Valley; wall insulators to the Cincinnati, Milford & Loveland, Toledo, Port Clinton & Lakeside, Indiana Union, and Ft. Wayne & Wabash Valley.

The Westinghouse Company makes the interesting statement that it has sold to electric lines in Ohio approximately 5500 motors, with an aggregate of 300,000 hp, and to the electric lines in Indiana approximately 1075 motors, with an aggregate of 59,000 hp. Many of the Westinghouse power house and substation installations in the district are referred to elsewhere in this issue.

The Heywood Brothers & Wakefield Company, of Wakefield, Mass., states that it has furnished its Wheeler type of seats and its spring seating for the following roads in Ohio and Indiana: Columbus, Buckeye Lake & Newark Traction Company, Pennsylvania lines west of Pittsburg, Columbus Railway & Light Company, Toledo, Fostoria & Findlay Railway Company, Columbus, Newark & Zanesville Electric Railway, Toledo & Western Railway Company, Toledo Railways & Light Company, Youngstown & Sharon Street Railway, Indianapolis & Northwestern Traction Company, and Terre Haute Traction & Light Company, Terre Haute, Ind.

The Baldwin Locomotive Works, of Philadelphia, states the following electric railways in the States of Indiana and Ohio are either wholly or in part equipped with Baldwin trucks: Cleveland & SouthWestern Traction Company; Columbus, Delaware & Marion Railway Company; Muncie & Portland Traction Company; Detroit, Monroe & Toledo Traction Company; Dayton & Northern Traction Company; Ft. Wayne & Wabash Valley Traction Company; Ft. Wayne & Springfield Railway Company; Cleveland Electric Railway; Ft. Wayne, Van Wert & Lima Traction Company; Indiana Union Traction Company; Indianapolis & Western Traction Company; Indianapolis & Eastern Traction Company; Indianapolis & Cincinnati Traction Company; Lake Shore Electric Railway Company; Lima & Toledo Traction Company; Toledo & Chicago Interurban Railway Company; Terre Haute Traction & Light Company; Western Ohio Railway Company; Winona Interurban Railway Company; Youngstown & Southern Railway; Youngstown & Ohio River Railway & Light Company. With the exception of those in city service all these trucks are of the regular Baldwin M. C. B. double-bar equalized type for interurban service, and the surface equipments are modified from this standard only so far as short wheel base and outside hung motors make necessary. All of the interurban trucks are equipped with either Standard Steel Works steel-tired wheels or with solid rolled forged steel wheels made by the same company.

The Curtain Supply Company, of Chicago, states its curtains and fixtures are in use on practically all of the interurban roads in the district.

The Lord Electric Company, of Boston, has furnished Thomas soldered rail bonds to the following companies: Cincinnati, Georgetown & Portsmouth Railway Company; Tuscarawas Traction Company; Keystone Construction Company; Louisville & Southern Indiana Traction Company; Indianapolis & Eastern Railway Company; Indiana Union Traction Company; United Gas & Electric Company; Calora Coal Company. The Lord Company has also supplied Shaw non-arcing lightning arresters to the following: Columbus Railway & Light Company; Mt. Vernon Electric Railroad Company; Lake Shore Electric Railway Company; Stark Electric Company; Jamestown Electric Light Company; Cleveland Electric Railway Company; Steubenville & Wheeling Traction Company; East Liverpool Traction & Light Company; Mahoning Construction Company; Southern Railway Company; Indianapolis & Cincinnati Traction Company; Evansville Gas & Electric Company.

W. N. Matthews & Bro., of St. Louis, Mo., states the Columbus Railway & Light Company uses the Kearney cable clamp. The Scioto Valley Traction Company has used 8-in. (about 300) anchors for anchoring its poles throughout its construction work. This company also has its shops equipped with the "Hold Fast" lamp guard. The Columbus, London & Springfield Railway Company is also using the "Hold Fast" lamp guard.

The National Lock Washer Company, of Newark, N. J., reports its lock washer is in service on many of the electric roads in Ohio and Indiana for many years, as are also its curtain fixtures and sash lock and sash balance.

C. H. Hoyt, of Cleveland, State agent for the Detroit Graphite Manufacturing Company, writes that this company has supplied to the Columbus, Delaware & Marion Railway a special graphite paint for car roofs. It is claimed this paint remains always elastic, keeps the canvas roof waterproof and prevents cracking of the canvas. The same paint is also used for preventing rust on poles and bridges. C. H. Hoyt is also agent for the Carbolineum Wood Preserving Company, and states that the disinfectant oil supplied by this company for preserving wooden pins, cross-arms, poles, ties, trestles, etc., is used by the Scioto Valley Traction Company on its chestnut poles.

The Macon-Evans Varnish Company, of Pittsburg, supplies insulating varnishes to the Columbus Railway & Light Company, the Cleveland Electric Railway Company and many other roads in the district.

The National Brake & Electric Company, of Milwaukee, has supplied air-brake apparatus to the following roads in Columbus: Columbus Railway & Light Company; Columbus, London & Springfield; Columbus, Buckeye Lake & Newark; Columbus, Grove City & Western; Columbus, Delaware & Marion, and Columbus, New Albany & Johnstown. Among recent orders for electrical apparatus the company has lately installed for the Columbus Railway & Light Company two motor generator sets, one consisting of a synchronous set of 500-kw capacity, and one consisting of an induction motor generator set of 250-kw capacity.

The Blake Signal & Manufacturing Company, of Boston, Mass., during the past year has completely equipped with its signals the interurban lines of the Illinois Traction System, supplying over fifty signals on 150 miles of interurban track, and now has in its shop further orders from this system for equipping additional interurban lines as they go into service. During the past three months the Blake Company has equipped portions of the East St. Louis & Suburban Railway, and the Indiana Union Traction, and has its shops well filled with orders for many lines, both in New England and the Middle West.

The J. G. Brill Company, of Philadelphia, has furnished rolling stock to the following interurban roads: Akron, Bedford & Cleveland Railway, ten 31-ft. cars; Painesville, Cleveland & Eastern, ten 31-ft. cars; Lorain & Cleveland, eight 31-ft. cars; Pennsylvania & Astabula, three 30-ft. 8-in. cars, two 31-ft. 8-in. passenger and baggage cars; Mahoning Valley Railway, ten 31-ft. 8-in cars; Lake Shore Electric Railway, ten 30-ft. 7-in. cars. All of these are closed interurban cars of the drop-sash type, mounted on Brill trucks. The Brill Company has also furnished practically the entire rolling stock for the city of Columbus, Ohio, the cars measuring 28 ft. over the bodies and mounted on Brill maximum traction trucks.

The Ohio Brass Company, of Mansfield, Ohio, states that its overhead material is standard upon the lines of the following leading roads in Indiana and Ohio: Indiana Union Traction Company; Muncie, Hartford & Ft. Wayne Railway Company; Ft. Wayne, Van Wert & Lima Traction Company; Ft. Wayne & Bluffton Traction Company; Marion, Bluffton & Eastern Traction Company; Ft. Wayne & Wabash Valley Traction Company; Indianapolis Traction & Terminal Company. Ohio Brass overhead material is used extensively by every road in and running from the cities of Indianapolis, Ft. Wayne, Terre Haute, Evansville, and in fact by the principal lines in Indiana. In Ohio the company mentions the Cleveland Electric Railway Company, all of the roads in and emanating from the cities of Toledo, Cleveland, Akron, Dayton (except one), Columbus, and a large majority of the other roads in Ohio, as its customers. Referring particularly to the city and interurban systems centering in Columbus, the Central Market Street Railway Company is equipped with Ohio Brass hangers and clamps, as are also all of the intercompany is now expecting an order for sufficient Nichols-Lintern sanders and Aikman annunciators to equip the cars of the Dayton, Springfield & Urbana and the Columbus, London & Springfield

Railway Company's lines. These two, as well as the Scioto Valley Traction Company, are also using the "Genuine Bell Metal Motor Bearings," as are most of the other Columbus roads. The Scioto Valley Traction Company's private car is equipped with the "Aikman Pressure Annunciator," and should be quite an attraction to the visitors to the convention. The Columbus, Newark & Zanesville Traction Company, the Columbus, London & Springfield, the Columbus, Buckeye Lake & Newark Traction Company, and the Indiana, Columbus & Eastern Traction Company are using the "Armstrong Oilers," for which the Ohio Brass Company is the agent. Several of the cars to be shown at the Columbus convention are equipped with this company's Nichols-Lintern air sanders and Aikman pressure annunciators.

The American Blower Company, of Detroit, Mich., sends the following particulars concerning its installations in Ohio and Indiana: Muncie, Hartford & Ft. Wayne Electric Railway—At this plant are installed six Jones underfeed stokers and two 9 x 7 automatic engines for driving a 90-in. full housed, steel plate blower. Eastern Ohio Traction Company, Chardon, Ohio—At this alpnt was installed nine Jones underfeed stokers to operate which was furnished one 100-in., three-quarter housed steel plate blower, driven by one 8 x 10 horizontal automatic engine. Toledo, Bowling Green & Southern Traction Company, Findlay, Ohio—Here were installed twelve Jones underfeed stokers and two 100-in. three-quarter housed steel plate fans. Lima Electric Railway & Light Company, Lima, Ohio—At this plant were installed fourteen Jones underfeed stokers. South Covington & Cincinnati Street Railway Company, Newport, Ky.—At this plant was installed six Jones underfeed stokers. The company has installed a heating plant at the Avondale car houses, Cincinnati, Ohio. These car houses are heated by the fan system, consisting of a heater made up of six sections, having a total capacity of 4950 ft. It has also sold the Cincinnati Traction Company one heater having 900 ft. in three sections, another of 850 ft. in two sections, and one 90-in. full housed steel plate fan with overhung wheel and fan. It has also furnished engines and generators to the Winona Interurban Railway Company, Winona Lake, Ind. At this plant was furnished a 5 x 5 type "A" vertical, automatic, inclosed, self-oiling engine to drive a 7½-kw, 120-volt NI Bullock generator. The engine is attached direct to the dynamo shaft, and both are mounted on a cast iron sub-base.

The American Blower Company has standardized some forty different makes of generators for its engines. The engine is fully inclosed and is lubricated by a novel pump oiling system, the oil being distributed by gravity from an oil reservoir at the top of the frame, which latter is filled by a pump located at the base of the engine. The oil is filtered at three different points in its circuit, and the method of introducing the oil to the bearings is new and novel. Every engine installed has a record of running at least three months before requiring any additional oil or any adjustment.

The Armstrong Oiler Company, of Philadelphia, has introduced its journal oiler on a number of roads in Ohio and Indiana.

The General Fire Extinguisher Company has its fire protection apparatus in all the car houses of the Cleveland Electric Railway Company. These installations and various tests made on them have been described in the columns of the Street Railway Journal.

The Lagonda Manufacturing Company, of Springfield, Ohio, has furnished its boiler cleaners to all the stations in Columbus.

The Central States Bridge Company, of Indianapolis, Ind., built practically all of the bridges on the majority of lines entering Dayton and also Indianapolis, together with the structural steel for the power houses. It also designed and built two viaducts for the Dayton & Western Traction Company, aggregating about 1200 ft.

The Green Engineering Company, of Chicago, has sold Green traveling link grates for 3000 hp of boilers in the Spring Street station of the Columbus Railway & Light Company.

The Bellamy Vestlette Manufacturing Company, of Cleveland, Ohio, is supplying its "Vestlette" to the Columbus Railway & Light Company; Dayton City Railway Company; nearly all of the interurban lines running into Columbus; the city lines in Indianapolis, Toledo, Cleveland and the interurban roads running out of these cities, as well as to many other roads in Ohio and Indiana.

The Chase-Shawmut Company, of Newburyport, Mass., has supplied a large number of rail bonds to the different roads throughout Ohio and Indiana. These bonds have all been of the soldered type, in forms that were suitable for application on the bottom of the rail and on the web of the rail under the plates. Among the roads supplied have been the Cleveland & Southwestern Traction Company; the Cincinnati, Lawrenceburg & Aurora Electric Street Railway Company; Ohio Central Traction Company; Mansfield, Crestline & Galion Railway Company; the Indiana Union Traction Company, and the Terre Haute Railway & Light Company. The Cleveland & Southwestern was one of the first large systems to look into and adopt soldered rail bonds, it having had them in use for five years or more. The Chase-Shawmut Company has also recently closed a contract for the complete bonding of the tracks of the Cleveland, Ashland & Mansfield Traction Company's tracks.

The Southern Exchange Company, of New York, furnished the poles used in the entire construction of the Columbus, London & Springfield Railway; Columbus, Buckeye Lake & Newark Railway; Columbus, Delaware & Marion Railway; Columbus, Urbana & Western Railway. These roads have used many thousand of the Southern white cedar poles of which the Southern Exchange Company makes a specialty. In the State of Ohio the following companies constructed their lines of the same material: Zanesville Railway, Light & Power Company; Springfield & Xenia; Springfield & Piqua; Cleveland & Southern Railway; Cleveland, Painesville & Ashtabula; Pennsylvania & Ohio; Toledo & Western, and Toledo & Indiana.

The Harrison Safety Boiler Works, Philadelphia, submit a partial list of interurban electric railways in Ohio and Indiana using Cochrane heaters: Akron Street Railway & Illuminating Company; Canton & Akron; Cincinnati & Eastern; Cincinnati, Milford & Loveland; Cincinnati Traction; Cleveland, Painesville & Ashtabula; Dayton & Northern; Dayton, Xenia & Bellbrook; Findlay Street Railway; Indiana Northern; Indianapolis, Lebanon & Frankfort; Indianapolis & Martinsville; Indianapolis, Shelbyville & Southeastern; Indianapolis & Union; Kokomo Railway & Light; Lima Electric; Loraine Street Railway; Muncie, Hartford & Fort Wayne; National Transit; Northern Ohio; Ohio Traction; Rapid Transit; Toledo & Chicago; Toledo & Indiana; Toledo & Western; Wabash River; Youngstown Consolidated; Winona & Interurban.

The Buckeye Engine Company, of Salem, Ohio, has equipped a number of the power stations installed in and near Dayton, Ohio, as follows: Dayton & Xenia Traction Company, two cross-compound engines, 600 hp each; Dayton & Northern Railway Company, two cross-compounds, 400 hp each; Dayton & Troy Electric Railway, two cross-compounds, 625 hp each; Dayton, Covington & Piqua Traction Company, two cross-compounds, 600 hp each; Indiana, Columbus & Southern Traction Company, one cross-compound and one simple, 1175 hp; Dayton & Western Traction Company, two cross-compounds, 350 hp each; Interurban Railway & Terminal Company, two cross-compounds, 700 hp each, and two exciter engines; Union City, Winchester & Muncie Traction Company, two cross-compounds, 800 hp each, and two exciter engines. The company also furnished Buckeye engines for the Dayton Electric Light Company aggregating 3300 hp; also four tandem compound engines to the City Railway Company, of Dayton, 545 hp each; also for the Indianapolis Street Railway, three cross-compounds of 2000 hp, for the Indianapolis Street Railway Company, for both city and interurban work. It has also equipped many smaller stations, such as the Indiana Railway Company, at South Bend, with 2000 hp, etc.

The O. M. Edwards Company, of Syracuse, N. Y., calls special attention to the limited cars of the Fort Wayne & Wabash which are equipped with a special design of Edwards extension platform trap-door fixtures for the trap doors of the observation platforms. These platforms are covered with rubber block tiling, and are large and roomy, and finely equipped and appointed. These coaches were built by the Cincinnati Car Company, and are exceptionally handsome and attractive in appearance.

The Jewett Car Company, of Newark, Ohio, has built cars for the following roads: Columbus, Buckeye Lake & Newark; Central Market Street; Columbus, London & Springfield; Columbus, Delaware & Marion; Cincinnati & Columbus Traction; Cleveland & Southwestern; Cleveland, Painesville & Ashtabula; Cambridge & Byesville; Canton & Akron; Canton & New Philadelphia; Columbus, Newark & Zanesville; Columbus, New Albany & Jamestown; Cleveland Electric; Cincinnati, Lawrenceburg & Aurora; Canton & Massillon; Canton Street Railway; Camden Interstate; Interurban Railway & Terminal Company; Lake Erie, Bowling Green & Napoleon; Little Miami Traction; Norwalk & Southern; Newark & Granville; Ohio Valley Traction; Sandusky & Interurban; Steubenville, Mingo & Ohio Valley; Toledo & Monroe; Toledo & Maumee Valley; Toledo & Western; Toledo, Findlay & Fostoria; Toledo, Bowling Green & Southern; Toledo & Indiana; Zanesville Railway, Light & Power; Zanesville & Southeastern; Chicago & South Shore; Indianapolis & Northwestern; Indianapolis & Martinsville; Indianapolis & Greenfield; Indianapolis, Columbus & Southern; Indianapolis, Greenwood & Franklin; Kokomo, Marion & Western; Lake Cities Railway; Winona Interurban; Wabash Valley Traction; Wabash River Traction.

The American Brake-Shoe & Foundry Company furnishes the following list of roads and type of brake-shoes furnished in Ohio and Indiana: Cincinnati, Lawrenceburg & Aurora, "U" Diamond "S"; Cincinnati, Georgetown & Portsmouth, Streeter wire back; Citizens' Railway & Light, Diamond "S"; Cleveland Electric, Streeter; Columbus, Delaware & Marion, Diamond "S"; Columbus, London & Springfield, Diamond "S" and Streeter; Columbus, Newark & Zanesville, Diamond "S"; Columbus Railway & Light, Diamond "S"; Dayton, Springfield & Urbana, Streeter and Diamond "S"; East Liverpool & Rock Spring, Diamond "S"; Eastern Ohio Traction, Streeter; Evansville, Suburban & Newburg, Streeter steel back; East Liverpool Traction, Corning and Diamond "S"; Fort Wayne & Wabash Valley, Streeter; Indianapolis Traction & Terminal, Corning; Indiana, Columbus & Eastern, Diamond "S"; Mansfield Railway, Light & Power, Diamond "S"; Mount Vernon Electric Railway, Streeter; Muncie, Hartford & Fort Wayne, plain; Oakwood Street Railway, Diamond "S"; Richmond Street & Interurban, Streeter; Scioto Valley Traction, Diamond "S"; Steubenville Traction & Light, Diamond "S"; Toledo, Bowling Green & Southern, Corning; United Power, Streeter; Youngstown Park & Falls, Diamond "S"; Youngstown & Sharon, Corning.

The Fyricide Manufacturing Company, of New York, has its fire extinguishers on many of the roads in the district.

The New York Car & Truck Company, of Kingston, N. Y., reports that Peckham trucks are in use in the district as follows: Indiana Union Traction, eight No. 11; Indianapolis, Columbus & Southwestern, twelve pairs No. 36-B; Fort Wayne & Springfield, four pairs No. 40-A; Fort Wayne & Wabash Valley, sixteen pairs No. 14-A-X-S; Fort Wayne & Southwestern, two pairs No. 14-A-X; Muncie, Hartford & Fort Wayne, four pairs No. 26; Indianapolis & Cincinnati, two pairs No. 26; Indianapolis & Martinsville Rapid Transit, one pair No. 32, twenty pairs No. 14-A-X-X; Indianapolis & Northwestern, twenty-three pairs No. 36-B; Kokomo, Marion & Western, eight pairs No. 25, five pairs No. 7-D; Kokomo Railway & Light, two pairs No. 7-D; Chicago & South Shore, one pair No. 14-B-3, one pair No. 26; Dayton & Muncie Traction Company, thirteen pairs No. 36; Canton & Akron, two pairs No. 36-A, six pairs No. 14-B-3-X; Northern Ohio Traction & Light, eleven pairs No. 40-A, ten pairs No. 36-B; Stark Electric, four pairs No. 40, one pair No. 14-A-X-X; Cleveland, Painesville & Ashtabula, eight pairs No. 40; Lake Erie, Bowling Green & Napoleon, one pair No. 36; Chillicothe Electric Railway, Light & Power, four pairs No. 7-B; Cincinnati-Columbus Traction, eight pairs No. 40-A; Cincinnati, Georgetown & Portsmouth Traction, two pairs No. 14-B-3-X; Cleveland & Southwestern Traction, one pair No. 46; Cleveland Electric, two pairs No. 25, thirty-eight pairs No. 14-B-3, twenty-four pairs No. 10; Lake Shore Electric, two pairs No. 40-A, three pairs No. 14-A-X, two pairs No. 26; Columbus, Newark & Zanesville, five pairs No. 36-A; Toledo, Bowling Green & Southern, eleven pairs No. 26, twelve pairs No. 14-B-3; Western Ohio Railway Company, forty-five pairs No. 14-A-X-X; Columbus, London & Springfield, four pairs No. 46, ten pairs No. 14-B-3; Springfield-Xenia, one pair No. 14-A-X-X, fifteen pairs No. 26; Steubenville Light & Traction, one pair No. 25, seven pairs No. 14-B-3; Cincinnati Traction, forty-six pairs No. 14-B-3-X; Columbus, Delaware & Marion, eight pairs No. 14-A-X.

The Macdonald Ticket & Ticket Box Company, of Cleveland, Ohio, reports the Macdonald holders are in use upon the following roads centering in Columbus: Columbus, London & Springfield Railway Company; Dayton, Springfield & Urbana Electric Railway Company; Columbus, Grove City & Southwestern Railway Company; Urbana, Bellefontaine & Northern Electric Railway Company; Columbus, Buckeye Lake & Newark Traction Company; Columbus, Newark & Zanesville Electric Railway Company; Columbus, Delaware & Marion Railway Company.

The International Fence & Fireproofing Company, of Columbus, Ohio, states its special interurban right-of-way fence is in use on many of the lines throughout Ohio and Indiana. Among those better known in Columbus might be mentioned the Columbus, Delaware & Marion. Both sides of the right of way on this road is fenced from Columbus to Marion with the particular fence referred to. The Columbus, London & Springfield, Dayton, Springfield & Urbana, and many other prominent roads throughout Ohio are also using this special fencing. The company's system of reinforced concrete has also been used extensively in power houses for the different electric lines in Ohio.

The Belknap Hardware & Manufacturing Company, of Louisville, Ky., has furnished in the district a large number of scrapers, picks, shovels, brackets, cross arms, braces, guide rods, axes, handles and other construction tools and appliances, as well as bolts, nails, screws and other hardware.

The Standard Steel Works, of Philadelphia, has its steel-tired and rolled steel wheels on interurban roads generally throughout Ohio and Indiana.

The T. H. Symington Company, of Baltimore, maker of the Symington journal box and Baltimore ball-bearing center and side bearings, reports its devices are in use on the following roads in the Central West: Indianapolis & Northwestern Railway; Indianapolis, Columbus & Southern Railway; Indiana & Cincinnati Traction Company; Cincinnati Traction Company; Cleveland Electric Company; Cleveland, Painesville & Eastern; Canton & Akron Railway; Lake Shore Electric Company; Detroit United Railways; Illinois Traction Company; Columbus, London & Springfield; Columbus, Delaware & Marion; Columbus, Buckeye Lake & Newark.

The Ohmer Fare Register Company, of Dayton, reports that the Indiana Union Traction Company, operating approximately 340 miles of track, is one of the largest users of the Ohmer register. All the interurban cars of this company are equipped with the larger style machines and the city lines are equipped with the smaller register. A few of the other important roads in Ohio and Indiana using Ohmer equipments are as follows: Scioto Valley Traction; Northern Ohio Traction & Light; Canton-Akron Railway; Cleveland & Southwestern Traction; Cleveland, Painesville & Ashtabula Railroad; Hocking Valley Railroad; Fort Wayne & Wabash Valley Traction; Fort Wayne, Van Wert & Lima Traction; Indiana, Columbus & Eastern, and the Muncie, Hartford & Fort Wayne Railway.

The Stromberg-Carlson Telephone Manufacturing Company, of Rochester, N. Y., has supplied telephone apparatus for despatching and other purposes to many roads in the Central West, including the Muncie, Hartford & Fort Wayne; Louisville & Southern Indiana Traction; Cleveland, Painesville & Ashtabula; Lake Shore Electric; Interurban Railway & Terminal Company; Columbus, Delaware &Marion; Columbus, Urbana & Western; Scioto Valley Traction; Toledo & Western.

The Globe Ticket Company, of Philadelphia, has sold both its hand power and power ticket destroyers quite generally throughout the district. It has also during the present year put on the market several new forms of patent transfers and cash-fare receipts for which several millions are used by the interurban roads in the Central West.

The W. T. Van Dorn Company, of Chicago, has furnished practically all of the roads that run into Columbus with various

styles of couplings. The majority of these roads use couplers of heavy types. The Columbus Railway & Light Company uses a number of Van Dorn couplers on its two-car trains operated with multiple-unit control for city service, reference to which is made elsewhere in this issue. Most of the interurban roads running into Indianapolis are equipped with No. 11 or No. 11½ drawbars, and one or two use the No. 15 coupler. The Lake Shore Electric is equipped with one of the heaviest types made by the Van Dorn Company, namely, the No. 18, which has the Van Dorn Solid connection to the car body.

The Climax Stock Guard Company has sold Climax cattle guards to a large number of interurban roads in the Central West.

The United States Metallic Packing Company, of Philadelphia, reports that among other stations its packings are used in the power houses of the following roads: Columbus Railway & Light Company; Toledo Railways & Light Company, and Terre Haute Traction & Light Company.

The Bayonet Trolley Harp Company sends the following list of electric railway systems in Ohio and Indiana using Bayonet detachable harps: Indiana, Columbus & Eastern Traction Company; Columbus, New Albany & Johnstown Traction Company; Cincinnati, Georgetown & Portsmouth Railroad; Cincinnati, Milford & Loveland Traction Company; Cambridge Power, Light & Traction Company; Dayton & Western Traction Company; Hocking Valley Railway Company (Jackson-Welston Belt Line); Mahoning & Shenango Railway & Light Company; Springfield Railway Company; People's Railway Company; Stark Electric Railway; Steubenville Traction & Light Company; Springfield, Troy & Piqua Railway Company; East Liverpool Traction & Light Company; Mt. Vernon Electric Railway Company; Lake Erie, Bowling Green & Napoleon Railway; Youngstown Park & Falls Street Railway Company; Southeastern Ohio Railway, Light & Power Company; Indianapolis & Eastern Railway Company; Richmond Street & Interurban Railway Company; Indianapolis & Martinsville Rapid Transit Company.

The R. D. Nuttall Company, of Pittsburg, submits the following list of prominent Ohio and Indiana Electric Railways using Nuttall gears and trolleys: Columbus, Urbana & Western Electric Railway; Columbus, Buckeye Lake & Newark Traction Company; Northern Ohio Traction Company; Richmond Street & Springfield Railway Company; Columbus, Delaware & Marion Railway Company; Eastern Ohio Traction Company; Cincinnati, Dayton & Toledo Traction Company; Cincinnati Traction Company; Northern Ohio Traction Company; Richmond Street & Interurban Railway; Louisville & Southern Indiana Traction Company; Indianapolis & Eastern Railway Company; Indiana Union Traction Company.

The Star Brass Works, of Kalamazoo, Mich., is supplying many roads throughout Ohio and Indiana, among which are the following: Northern Ohio Traction & Light Company; Stark Electric; Pennsylvania & Ohio; Canton-Akron Railway; Cincinnati & Columbus Traction; Cincinnati, Lawrenceburg & Aurora Electric Railway; Cincinnati, Milford & Loveland Traction; Cincinnati Traction and all roads connected therewith; Eastern Ohio Traction; Columbus, London & Springfield Railway; Columbus Railway & Light Company; Columbus, Delaware & Marion; all roads entering Dayton except the Oakwood Railway and People's Railway; the Toledo, Bowling Green & Southern Railway; Western Ohio Railway; Lorain Street Railway; Mansfield Railway, Light & Power Company; Columbus, Newark & Zanesville; all roads entering Springfield; Toledo & Indiana; Toledo & Western; Youngstown & Sharon and other smaller roads. In Indiana it sells the Indiana Union Traction Company; Ft. Wayne & Wabash Valley Traction; Indiana & Cincinnati Traction; Indianapolis & Eastern; Indianapolis & Martinsville Rapid Transit; Indianapolis & Northwestern Traction; Madison Light & Railway Company; Muncie, Hartford & Ft. Wayne, Muncie & Portland; Evansville & Princeton; Richmond Street & Interurban Railway; Northern Indiana Railway Company, and the Terre Haute Traction & Light Company.

Merritt & Company, of Philadelphia, gives the following list of the various electric companies in Ohio and Indiana which have recently purchased its lockers: Cincinnati Gas & Electric Company; Cleveland Electric Illuminating Company; Columbus Railway & Light Company; Mansfield Railway, Lighting & Power Company; Marion Heat & Lighting Company; Warner Electric Company; South Bend Electric Company.

The Murphy Iron Works, Detroit, Mich., furnished an installation of eight furnaces for one of the Columbus power houses. It also recently sold a number of furnaces to the Cincinnati Street Railway Company for installation in the Hunt Street station. The Cincinnati company has been using these furnaces for a number of years and has a total of twenty-eight installed. Among other roads in the territory that are using Murphy furnaces may be mentioned the Lorain & Cleveland with four; the Lake Shore Electric with seven, and the Cleveland Electric with twenty-one.

The Traction Equipment Company, of Brooklyn, N. Y., has supplied ventilated spiral resistances to the following roads: Indianapolis Traction & Terminal; Indianapolis & Martinsville Rapid Transit; Ft. Wayne & Wabash Valley Traction; Indiana Union Traction; Cleveland Electric; Lake Shore Electric, and Toledo, Bowling Green & Southern Traction.

The H. W. Johns-Manville Company advises that the following electric roads are using "J-M" overhead line material: Vincennes Citizens; Indiana Railway; Indianapolis Light & Power; Indianapolis Northern Traction; Ft. Wayne & Wabash Valley; Indianapolis Traction & Terminal; Indianapolis & Martinsville; Washington Street Railway, of Washington, Ind.; Indiana Union Traction; Evansville & Mt. Vernon; Columbus Railway & Light; Northern Indiana, and many other roads in Ohio. "Noark" fuse devices and roofing materials, as well as "J-M" overhead line material, are used by these and other companies in the territory.

The Consolidated Car Heating Company, of New York, N. Y., reports that its electric heating equipments are in use on a large number of street railway systems in Ohio and Indiana. The cars of the Scioto Valley Traction Company are entirely equipped with the Consolidated double coil cross-seat heaters, thirty heaters per car, and arranged for four gradations of heat. The Cincinnati Traction Company's recent cars are equipped with 12-heater equipments of the truss plank type and 12-heater equipments of a new panel type. The company's portable vestibule heater, recently designed, has already been sold for a large number of cars for use in Ohio, Indiana and Illinois, particularly in Ohio, where a recent law has been passed requiring the heating of motormen's vestibules.