DENVER, the 1909 convention city, is the metropolis of that great agricultural and mining district extending from the Missouri River on the east to the ranges of the western mountains not far distant from the Pacific coast. It is the social, political and mercantile center of Colorado, a State which is unequaled in its variety of natural resources.

Quite properly it is said that the chief assets of Colorado are its scenery and its climate. In the valleys between the hundreds of magnificent mountain peaks, occupying the entire western half of the state, are found some of the richest mines in the world, and the mining industry has recently been extended to the production of coal. In 1908 the mines of Colorado produced $42,199,804 in metals and $19,550,000 in coal. Notwithstanding these enormous figures, illustrating the extent of Colorado's mining industry, the substantial growth of Denver and other Colorado cities is accounted for even more largely by the agricultural and manufacturing output.

To the traveler from the East there exists an idea that Colorado is an entirely mountainous State. Such a conception, however, is far from true. The entire eastern portion of the State from a line drawn north and south through Denver is a comparatively level plain, the inhabitants of which are wideawake, aggressive people, interested chiefly in manufacturing and agriculture. The manufactured products of the State for 1908 were valued at $200,000,000 and the agricultural products, including beet sugar and its by-products and live-stock, totaled $136,943,000. The western slope of Colorado is one of the most fertile fruit sections of the country and in one county alone 2,000,000 acres of land, well suited to general farming, await settlement and development.

The location of Denver is ideal for a business, residence and convention city. It is situated on a level plain 20 miles east of the foothills of the Rocky Mountains. The general elevation of the city above sea level is about 5200 ft. To the east, and sloping gradually toward the Platte and Arkansas valleys, are vast plains, farming and grazing lands; to the west, and, seemingly almost within reach, is the magnificent Rocky Mountain range extending in an unbroken line north and south for 150 miles.

The valuable mining and agricultural resources of Colorado, combined with the delightful climate, have made Denver truly a city of homes. The street railway system, which so well serves this city, has scattered the residences over a large area instead of permitting congestion close to the business center. Denver has broad, level streets; good water, attractive homes and ample shade. Strict fire ordinances forbidding the erection of any but stone or brick structures have caused Denver to be as substantially built as any city. The following table presents interesting data concerning Denver:

DENVER STATISTICS

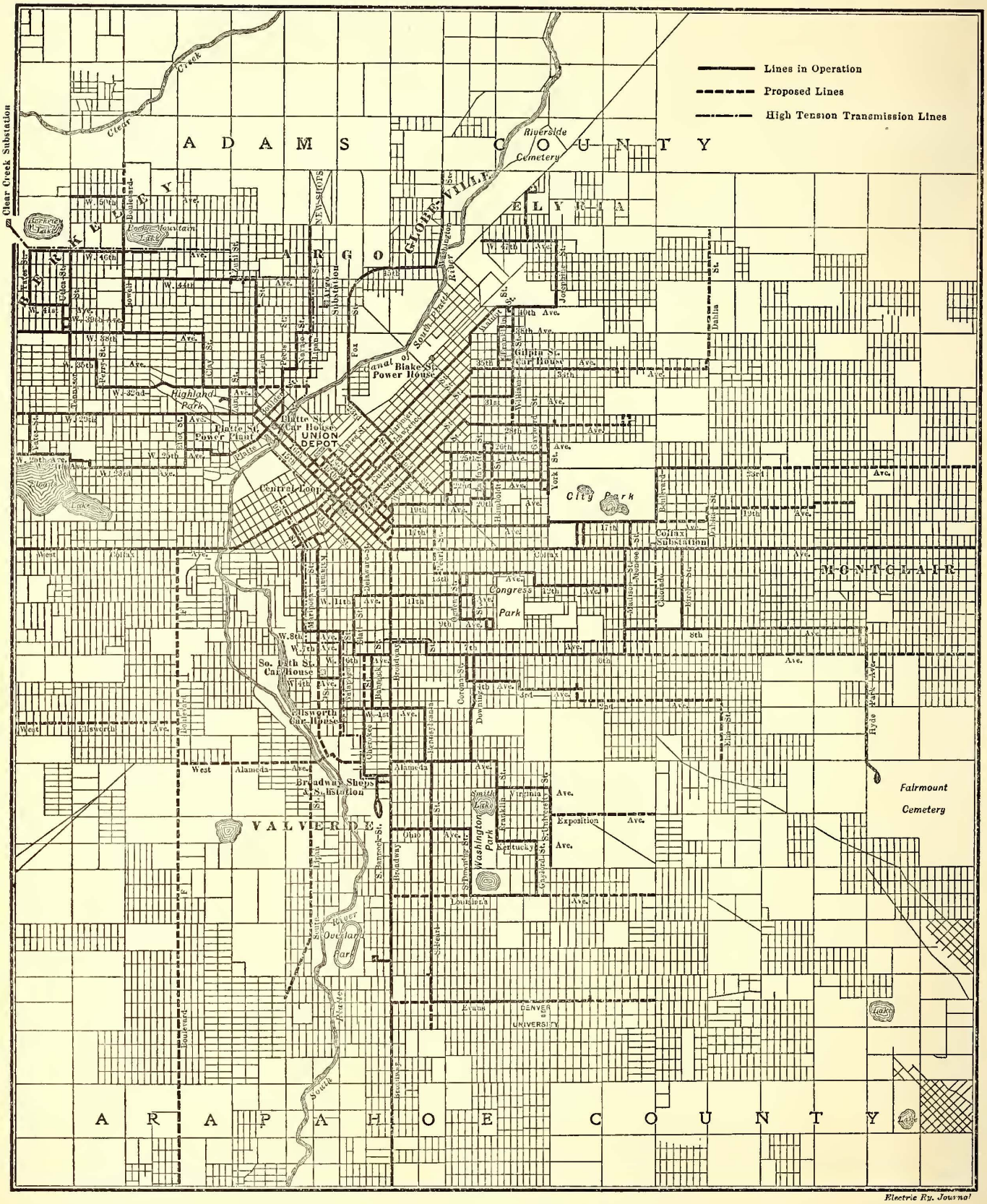
Area, square miles	54
Population	235,000
Miles of streets	1,220
Altitude above sea level, feet	5,200
Assessed valuation	$125,000,000
State Capitol, cost	3,600,000
United States Mint, cost	2,000,000
New Federal Building, cost	2,000,000
Auditorium, seating capacity, 13,000; cost	750,000
Public Library Building (100,000 volumes), cost	375,000
Young Men's Christian Association Building, cost	300,000
Young Women's Christian Association Building, cost	100,000
Public bath house, cost	75,000
Colorado Museum of Natural History, cost	100,000
Sanitary sewers, miles	300
Storm sewers, miles	85
Curbed streets, miles	250
Asphalt pavement, miles	56
Stone and cement sidewalks, miles	1,000
Electric street car lines, miles	200
Interurban electric railways, miles	125
Macadam pavement, miles	10
Stone pavement, miles	5
Surfaced streets, miles	200
Public parks (including 1200 acres)	24
Bank clearings (1908)	$411,493,943
Building permits (1908), value	10,024,000
Church edifices	180
Hospitals, homes and sanitariums	34
Banks, with deposits of $66,000,000	18
Building and loan associations	7
Newspapers and publications (five dailies)	87
Theaters and places of amusement	24
Hotels	86
Wholesale houses	100

Seventeen railroads, six being transcontinental lines; 126 passenger trains arrive and depart daily.

One of the largest and best equipped water plants in the country, furnishing daily 250 gal. of water to each inhabitant.

Excellent street and residence lighting service.

Denver has five well established electric railway systems, each serving the needs of its own particular field. The Denver City Tramway Company, including the Denver & Northwestern Railway extending to Leyden and Golden, operates 222 miles of track in the city and its suburbs. The Denver & Interurban Railway, an electrified division of the Colorado & Southern Railway system, connects Denver with Boulder and El Dorado Springs, electrically operating 58 miles of track. The Denver & Inter-Mountain Railway, a steam road recently electrified, extends from Denver to Golden, 22 miles, at the very foot of the Rocky Mountains. The Denver & South Platte Railway now has a 5-mile suburban line to Littleton in operation and is planning the construction of a 15-mile extension to reach attractive natural resorts in the foothills of the Rocky Mountains.



Denver City Tramway—Map Showing the Lines Operated and the Extensions to Be Built Within the City of Denver

THE DENVER CITY TRAMWAY SYSTEM

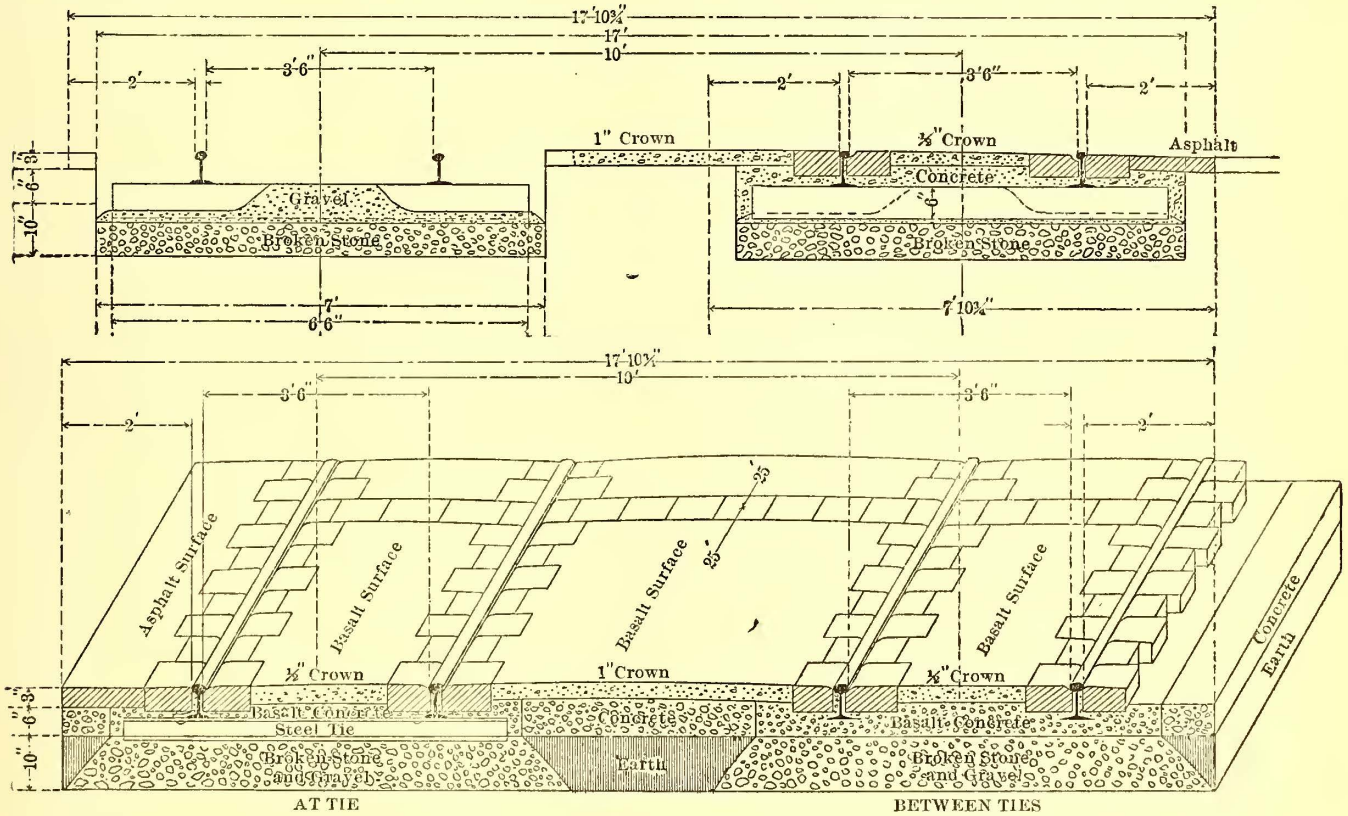
DENVER has a street railway system of which its citizens may justly be proud, and to the visitor interested in railway work the Denver City Tramway system presents a subject worthy of careful study, particularly on account of its well maintained physical property and its harmonious, well advanced operating organization. Among the many excellent features of the Denver City Tramway which are unique are the system of car dispatching by telephone, the use of trail cars for handling the rush-hour load, the light and substantial design of this company's cars, the well maintained narrow-gage T-rail track paved with solid concrete and the efficient power generation and distribution system.

Denver is a comparatively level city and the railway company's tracks have few grades. The location of the trackage within the city is shown on the accompanying map. The Denver City Tramway has 196.04 miles of track and the Denver & Northwestern, 26.19 miles—a total of 222.23 miles operated as one system. Practically all of the lines of the Denver City Tramway are double-tracked. There are 97 miles of streets occupied. With the exception of 7.06 miles all of the track is built to a gage of 3 ft. 6 in. This exception is the standard-gage double track line between the center of the business district of Denver and the suburb of Globeville, which route serves as an entrance for the passenger cars of the electrified division of the Colorado & Southern Railroad, known as the Denver & Interurban.

In May, 1906, the Denver City Tramway Company was granted franchises for the present and future expansion of its tracks. The track extensions yet to be built are indicated on the map of the city of Denver. According to the ordinance the company shall build 10 miles of extensions per year for seven years. This regular plan of extension permits the company to have a well organized track force which also is engaged in reconstructing about 5 miles per year of old cable track. The organization of the civil engineering department is headed by a chief engineer with the necessary staff of clerks and draftsmen and with an assistant engineer in charge of both maintenance and new construction of track. Under the assistant engineer are three construction foremen and two maintenance foremen. The number of gangs and laborers is varied from time to time to suit the work in hand.

TRACK AND ROADWAY

The general dimensions of the typical track structure of the Tramway company are shown on this page. It will be noted that for paved streets both steel and wooden ties are used. The steel-tie track construction has been used for 1.25 miles in the business district and, it is expected, will be found desirable for future use. Wooden ties, however, are still considered as standard for the larger part of the work.



Denver City Tramway—Track Construction with Steel and Wood Ties

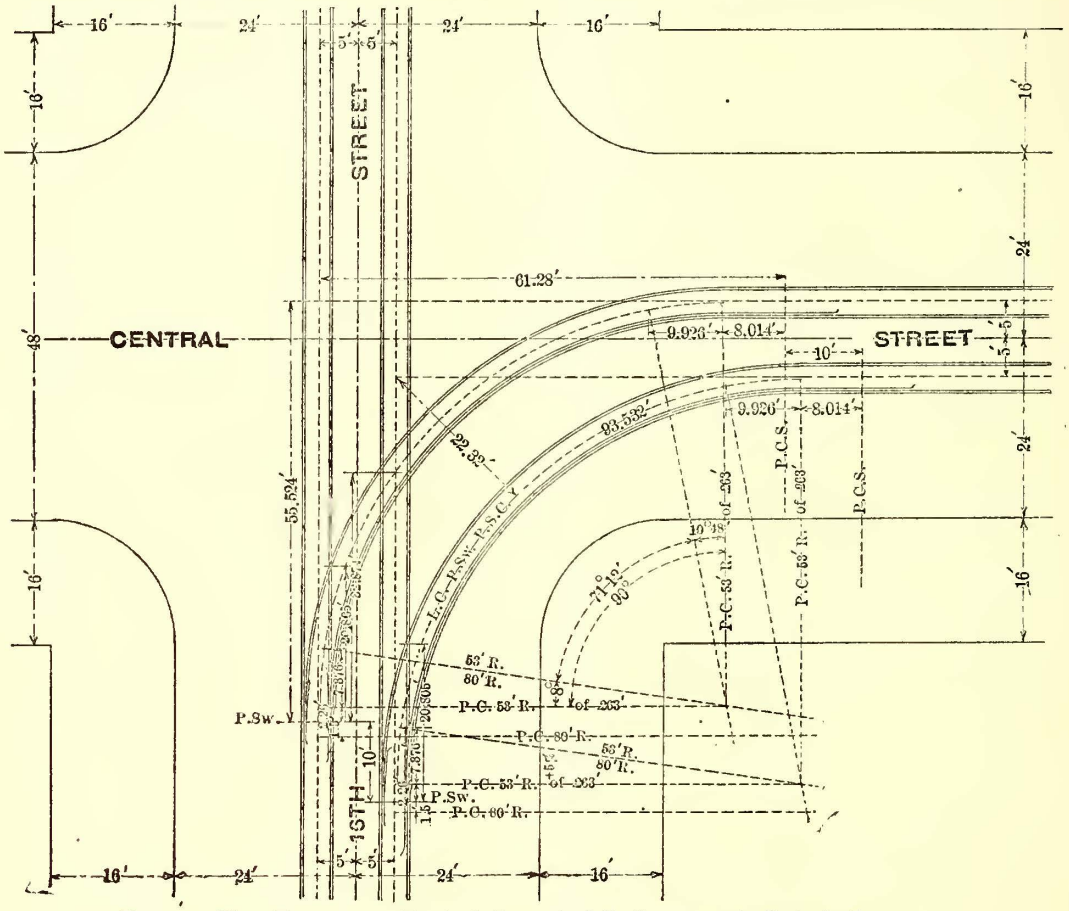
The thoroughness with which the tracks of the Denver City Tramway are built can best be shown by describing the steps followed in the execution of the work. A large part of the city track recently built has taken the place of cable track. In this reconstruction work the first step is to remove the old rails and break up the large mass of concrete forming the cable conduit and supporting the slot-rail yokes. Only one track at a time can be torn up for reconstruction. When the substructure of the cable track has been removed and the concrete broken into small parts the trench is leveled 2 ft. deep below the rail top. Into this trench is placed a bed of either broken concrete or gravel, depending upon whether or not an

old cable track is being rebuilt. For steel-tie construction the broken stone and gravel bed within the trench is made 10 in. deep. The ties and rails are next placed. Before surfacing the rails all the voids in the track foundation are filled with clean bank sand which is dumped into the trench on top of the broken stone and flushed until thoroughly packed. Wooden ties are surfaced with clean gravel, a center filling of which is brought up to the top of the ties for a width of 18 in. between the rails. The ties are then covered with a pavement foundation of concrete which is a 1:4:8 mixture of Portland cement, sand and basalt rock. Where steel ties are used they are laid directly on the broken stone or gravel subbase and are entirely enclosed in concrete, which it is thought will prevent corrosion of the metal.

In some of the asphalt paved streets, of which there are 64 miles in the city of Denver, excellent results have been obtained with a surface paving of basalt concrete placed between rails and in the devil strip. A row of beveled basalt toothing blocks 4 in. x 4 in. x 8 in. in size is placed on either side of each rail. The blocks are so cut that they fit between the head and base of the rail close to the web. These blocks are grouted with a mixture of equal parts of sand and Portland cement. The top surface of the street is then filled in with concrete made of Portland cement, sand and basalt rock in the proportions of 1:2:4. The concrete in this form of track construction is kept wet for seven or eight days while it is setting. The Denver City Tramway Company has used this concrete mixture for a paving surface between rails and tracks for seven years and the first of this work put in is still in excellent condition. It is found that the basalt surface outwears not only the toothing blocks along the rails, but the adjacent pavement put down by the city.

In part of the earlier pavement of this type cracks developed on account of lack of room for longitudinal expansion and therefore the present design of paving surface as illustrated includes a row of stone paving blocks from rail to rail on 25-ft. centers. Although these blocks are grouted and the concrete street pavement is laid against them on both sides, nevertheless their presence in the pavement seems to prevent cracking from expansion and contraction. In the railway company's quarry at Golden an unlimited supply of basalt is available for track construction. This rock is crushed at the quarry and forms a substantial ballast as well as an excellent aggregate for the concrete used in track work.

The rail used in paved streets is a 6-in. 72-lb. tee section and in unpaved streets a 65-lb. 4 1/2-in. A. S. C. E. section is used. The rail ends are connected with the Jones beveled rail joint, which has been found to offer some advantages and which differs from an ordinary four-bolt joint only in the method of cutting the rail ends. The rail ends are cut so that the inclined faces overlap and closely abut to form a tight joint. Ordinary splice bars are used. The object of this beveled joint is to provide an inexpensive means whereby weight brought to bear on one rail end will act simultaneously upon the adjacent section and prevent movement of one rail by the other, thus obviating wear on the receiving end of the joint. On double-track lines the traffic is operated against the incline ends and therefore the receiving rail in a closely butted joint transfers a part of its load to the delivering rail. About 7000 such joints had been installed in Denver up to July, 1908.

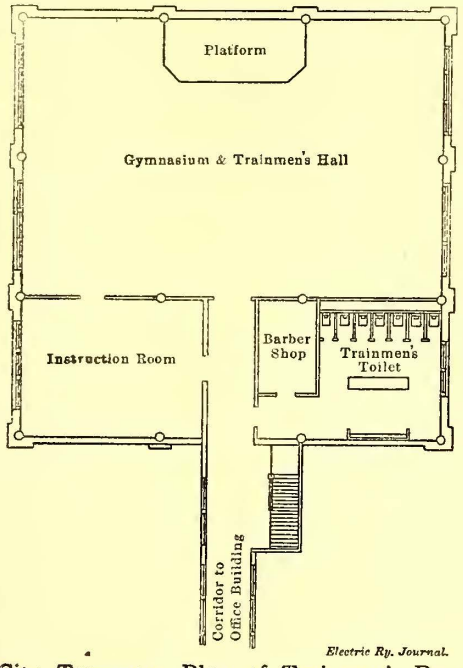


Denver City Tramway—Typical Branch-Off Curve and Switch Layout

The steel ties used in the Denver track construction weigh 14.5 lb. per foot. The design is illustrated on page 495. These ties are spaced 40 in. between centers. Wooden ties are of Texas pine 6 in. x 8 in. in cross section and are dipped in creosote. An untreated tie has a life in Denver of not more than seven years, but some treated ties which have been in use for seven years as yet show no deterioration.

An illustration presented on Plate II shows a typical special track work layout as designed and built in the company's special-work shop. Other views on Plate II show the interior of the track shop and several of its tools and also the laying-out yards close to the shop.

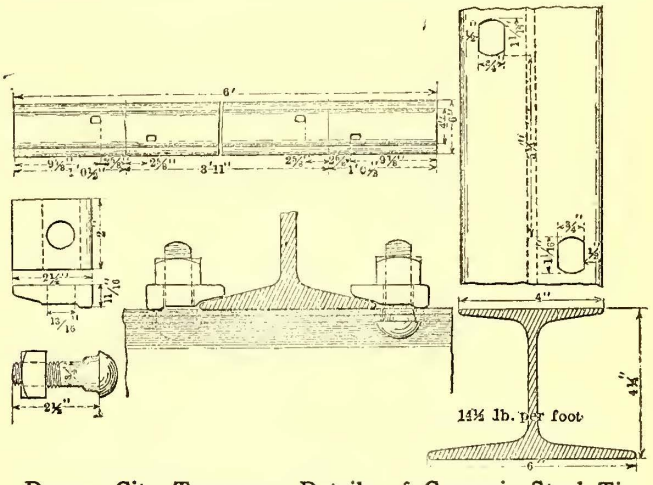
On the 72-lb. rail the joints are single bonded with 300,000-circ. mil capacity Brown standard plastic bonds. Near power stations the rails are double bonded and all special track work is jumped with two 500,000-circ. mil copper cables. Wherever a lighter rail is used the joints are bonded with American Steel & Wire pin-driven bonds extending around the joint plates, and twin-terminal No. 0000 bonds of the same manufacture. Tests made in July of the present year on the Colfax Avenue line, which was bonded in 1896 and 1897 with Brown plastic bonds, showed that out of 505 joints only 76 were defective after 13 years of severe service. In practically every case in which a bond was found to be defective the joint is said not to have failed mechanically.



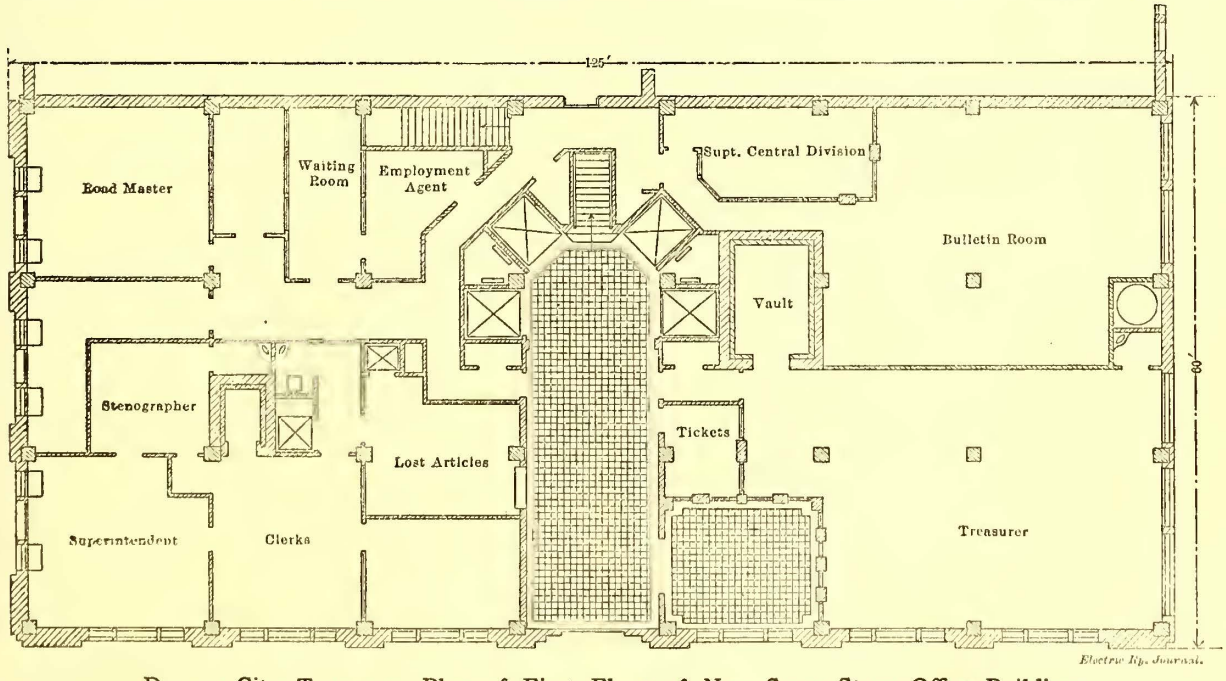
Denver City Tramway—Plan of Trainmen's Room Above Car House

Plans have recently been completed for the construction of a general office building to be used as executive and operating headquarters by the Denver City Tramway and Denver & Northwestern Railway. A new car house with storage space on two floors will be built on adjacent property and separated from the office building by fireproof partions. A difference in the street elevation at two ends of the building will permit the use of double-deck storage tracks without requiring a car elevator. The storage capacity will be for 140 cars.

The car-house section of the building will be 325 ft. long by 125 ft. wide, subdivided into two bays. One bay will have four tracks and the other five tracks. On the second floor of the car house will be three tracks in one bay and four in the other, leaving wide aisles on one side of each bay for repair and inspection work. Above the roof of the car house a gymnasium, instruction room and trainmen's quarters 75 ft. square will be erected. This superstructure will connect by a corridor with the second story of the office building.



Denver City Tramway—Details of Carnegie Steel Tie and Rail Fastening



Denver City Tramway—Plan of First Floor of New Seven-Story Office Building

The office building, seven stories in height, with a floor area 60 ft. x 125 ft., faces streets on three of its sides. On the fourth side it joins the car house. The basement of the office building has the floor on a level with the lower floor of

the adjoining car house. It will contain the boiler plant, coal storage and a general storage room with track facilities for handling heavy materials. The first floor will be subdivided into quarters for the transportation department, the treasurer and the roadmaster. The second floor will be occupied by the legal, claim, medical and tax departments and the Tramway Mutual Aid Association. The fifth floor will be subdivided for use by the auditing department, the sixth floor for the engineering department and the seventh floor for the executive department.

OVERHEAD LINES DEPARTMENT

The organization of the Denver City Tramway Company includes a department of overhead lines in charge of a superintendent. This department has charge of the construction and maintenance of all trolley lines, and outside feeders, transmission and lighting wires. It also maintains the lighting service for the entire railway, including car lighting. The superintendent of the department has a general foreman with sub-foremen in charge of trolley and overhead construction, repairs and emergency work, and a foreman in charge of lighting. The department headquarters are at the central loop where the superintendent is kept in close touch with the transportation department and also is near his emergency crews.

Whenever overhead repairs are needed the line department is notified on a blank which gives the name of the trainman or other individual reporting the defect, the line and location with pole number, and a statement of the nature of the trouble. At the lower part of the blank are lines ruled for a memorandum of the disposition of the report and for remarks. Such reports when received by the superintendent of lines are handed to the line foreman who sees that the needed repairs are made.

Each member of the line department turns in daily a blank on which he distributes the number of hours' time spent on different pieces of work. The clerk in the line superintendent's office distributes the time for all general repairs on construction work by reference to a tabulation showing the items and account numbers, as used in the company's classification. These classifications of detail accounts are reproduced herewith to show how thorough a record the Denver City Tramway Company keeps of the costs of its construction and maintenance work:

GENERAL REPAIRS.

Overhead Lines.
51—HANGERS—spans, ears, insulators, feed taps.
52—SPECIAL WORK—Curves, switches, breakers, x-overs.
53—SIGNS—on poles or span wire.
55—GROUND—Return wires and connections.
57—BROKEN TROLLEY WIRE.
58—RENEWING TROLLEY WIRE.
59—READJUSTING Alignment, plumbing.
60—POLES—Renewing, dig hole, set, release.
62—MOVING Poles, stubs, anchors.
65—INSPECTION—General.
66—ON WATCH.
67—HAULING.
68—RENUMBERING POLES, Feed or trolley.
70—REMOVING Abandoned poles, wire, etc.
72—ELECTRIC TRACK SWITCHES.
73—REPAINTING POLES.
74—CLEARANCE account storms, trees, foreign wires, etc.
76—LIGHTNING ARRESTERS.
79—FEEDERS—General—except feed taps.
Lights, Signals, Heaters, Fans, Etc.
100—HOUSE—Car Barns, Walting Rooms, Power House, Sub-Station, etc.
101—CAR—General.

THE DENVER CITY TRAMWAY CO.

*Record of Electric Line Construction Maintenance, etc., for*_____

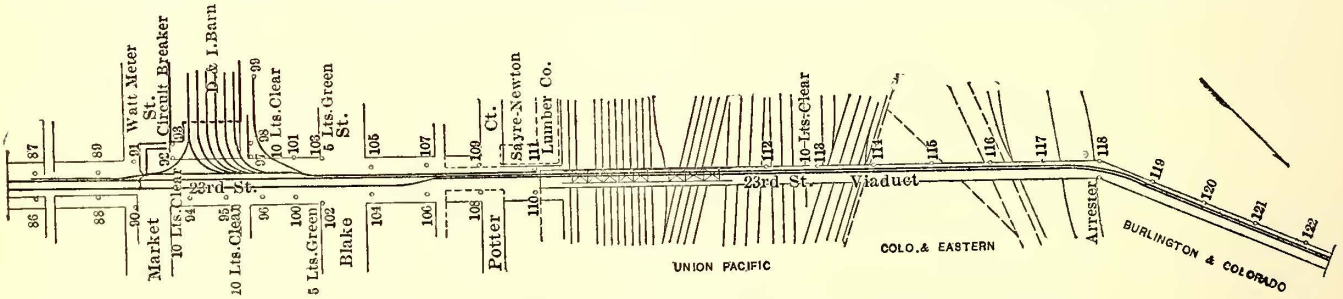
	ACCOUNT	LOCATION	WORK DONE	SUSPENSIONS: EARS	SUSPENSIONS: INSULATORS	SUSPENSIONS: HANGERS	SPAN WIRE	TROLLEY WIRE	O-H SWITCHES	O-H XINGS	O-H BREAKERS	SPLICERS	POLES	COST: MATERIAL	COST: LABOR	COST: TOTAL
				B-14 B-12 B-179 B-158 16325		15788 15789 15790	1-4 8-16 1-2	1-0 5-8 1-0 NEW	17347 17348	16392 16393	2601	1-0 404	30 35			

Denver City Tramway—Detail Record and Distribution Sheet for Line Work (Original 19 1/2 in. x 8 in.)

102—POLE LIGHTS—Clusters and arc lamps, clear or colored.
104—SIGNALS—Bells and buzzers, all kinds.
105—TROLLEY PARTY CARS—Illumination.
106—ELECTRIC FANS.
107—CAR HEATERS.
110—STATIONARY MOTORS—All kinds.

CONSTRUCTION.

Trolley Lines.
85—GUYING—Stubs, anchors, etc.
84—HAULING—General.
80—ERECTING POLES—Dig hole, raise, set, bank.
81—SPAN WIRES—Bore hole, put eye bolt, span up.
82—TROLLEY WIRES—String, pull, finish, put on ins. han. ears.
75—LIGHTNING ARRESTERS—Placing all parts.
88—SIGNS—On poles or span wire.
89—NUMBERING POLES, stencilling.
86—PAINTING POLES.
87—ELECTRIC TRACK SWITCHES—Placing all parts.
Feeder Lines.
95—HAULING.
91—ERECTING POLES—Dig hole, raise, set, bank.
93—GUYING—Stubs, anchors, etc.
92—FRAMING—Cross-arming or placing other supports.



Denver City Tramway—Section of Pole Plat Kept by Overhead Department

78—STRING WIRE—Pull, tie in, finish.
98—PAINTING—Poles or crossarms.
97—NUMBERING—Poles, stenciling.
96—DROP-OUTS—Foreign wire protectors, placing.
83—FEED TAPS or bonds between trolley wires.
99—CLEARANCE—All kinds.
Lights, Signals, Heaters, Fans, Etc.
200—HOUSE—Car Barns, Walting Rooms, Power House, Sub-Station, etc.
201—CAR.
202—POLE LIGHTS—Clusters or arc lights, clear or colored.
204—SIGNALS—Bells, buzzers, all kinds.
206—ELECTRIC FANS.
208—STATIONARY MOTORS—All kinds.

In the event of any delay caused by overhead line trouble being reported to the dispatching office, a delay report, as illustrated, is made out conveying to the line superintendent the time and location of the trouble and the number of minutes delayed. If such delay is excessive the general manager also is advised.

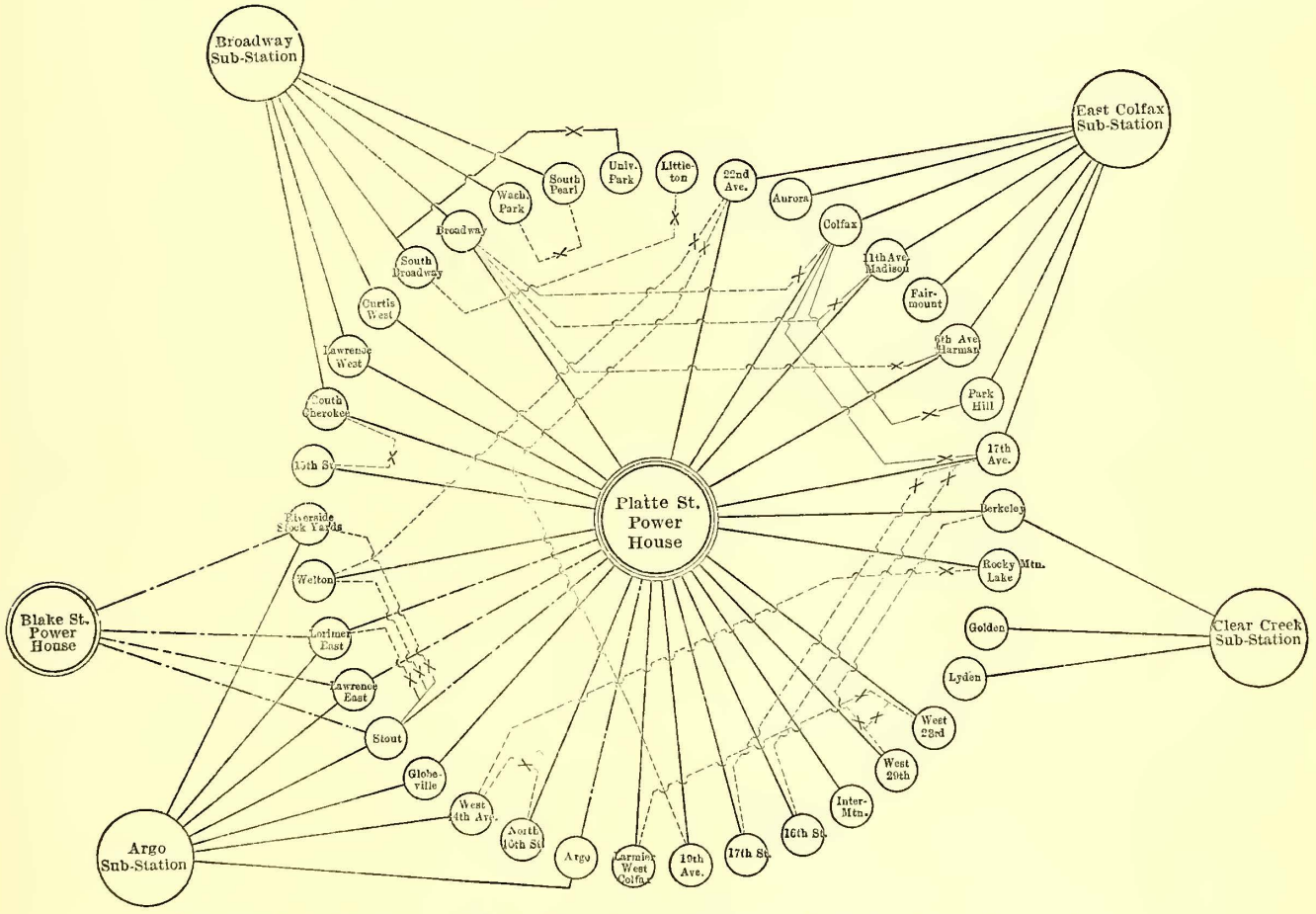
During the daytime no emergency crew is kept at the station regularly, but some member of the department is

always on duty at the central lop and one trolley repair crew, with a Trenton trolley wagon and repair materials, works within the business district, where it may be reached by the dispatcher by means of the very complete telephone system described later. The overhead maintenance force includes a night crew of two men who are on duty from the time the two day crews leave at night until they return at 7 a. m. The entire city is served from the emergency station at the central loop and emergency repairs are made either with a trolley wagon or with the very complete line car herewith illustrated on Plate VI. This emergency and construction equipment is a double-truck car provided with an elevating tower and a complete supply of trolley repair materials, including a reel of wire.

LIGHTNING PROTECTION

On account of the severe electrical storms in and around Denver the protection of the lines and cars from lightning troubles has been a problem requiring close application on the part of the line department. For that reason this department has established and maintains complete records of each burnout caused by lightning. Whenever a car is struck by lightning the crew immediately reports to the dispatcher, who fills out a blank form addressed to the superintendent, advising him of the car number, line, time and pole number at which the burnout occurred. The employees of the line department then inspect the lightning arresters on either side of the location where the car was struck and make certain that all pole arresters are in operative condition. Before May 1 of each year this department tests all lightning arresters so that the efficiency of the apparatus may be assured before the spring storms begin. A card index is kept showing the location and a complete record of the performance of each arrester.

An interesting feature of this lightning protection work is the use of a large map for exhibiting the relative location of lightning disturbances. An engraving on Plate VI shows this map as mounted on the wall of the line superintendent's office. In connection with this map stick pins of three colors are used to indicate the location of arresters, cars struck and arresters replaced. As the reports of lightning troubles are received and as the damaged arresters are repaired, new pins to indicate the changes made are placed on the map in their proper location. At a glance, therefore, it is possible to note whether trouble is more prevalent at one location than at another, and particular attention can be given to that point. Several types of arresters are used on the poles. They are spaced from 500 to 1,000 ft. apart, according to local conditions as determined by experience. Cars are protected from lightning with G. E. type M D arresters and also with water-box leakage arresters which can be cut in by the motormen during storms.



Denver City Tramway—Feeder Line Connections and Possible Cross Connections

GENERAL LINE DEPARTMENT FEATURES

The line department has a stock room at the central loop where materials are kept for all general repair work of the department. The timekeeper acts as stock clerk and keeps an accurate stock account with each repair and maintenance wagon and also with the company's general storekeeper. The records of this department include pole plats made to a scale of 100 ft. to the inch, showing the curb line, pole locations, track arrangement, pole numbers and distances. These plats are found especially useful in planning the replacement of feeders or the rearrangement of any of the overhead structure. A card index showing a complete inventory of all parts of the overhead and transmission system also is kept in the office of the department. This index, which is held in a vertical file, shows the number and size of the wire, the

location and the weight for all sections, the number and sizes of the poles, the number of incandescent lamps along the route, the location and description of lightning arresters, the location of span wire signs, stop and slow signs, telephones and the size and weight of trolley wire. Pole charts, showing the location of the different circuits on the various poles also are indexed.

In connection with the carefully kept inventory of the overhead structures the line department keeps an accurate record of the work it has done, by entering the details on the pages of a large loose-leaf record book. One page is set apart for each line and is ruled to show the account number, the location and character of the work done. It also exhibits the total quantities of the various kinds of material used. Space is provided at the right of the page as shown, for extending the items and for ascertaining the costs of the various sections of the work and the totals.

The overhead construction of the Denver City Tramway Company is No. 0 or No. 0000 trolley supported with 1/4-in. or 5/16-in. 7-strand span cable from Idaho cedar poles, brush-treated with carbolineum. The company has treated its poles by this method since 1903 and has obtained excellent results. The general details of the transmission system are described and illustrated elsewhere. At those locations where the transmission system crosses the trolley or telephone wires "drop-out" terminals are used to take the place of protection cradles. Matthews' guy anchors are used for guying.

A simple trolley feeding-in tap is being made by connecting two trolley ears with a blind stud of bronze and sol-

The Denver City Tramway Co.

Lamps Used To-day on Car Repairs

*Date*_____ *190*____

*By*_____

CAR NO.	LINE	TIME REP'R'D	CONDITION												REMARKS
			CAR				WATCH				GAUGE				
			Bur'd Out	Broken	Loose	Gone	Bur'd Out	Broken	Loose	Gone	Bur'd Out	Broken	Loose	Gone	

The Denver City Tramway Co.

Lamps Used To-day on Houses, Pole Clusters and Signals

*Date*_____ *190*____

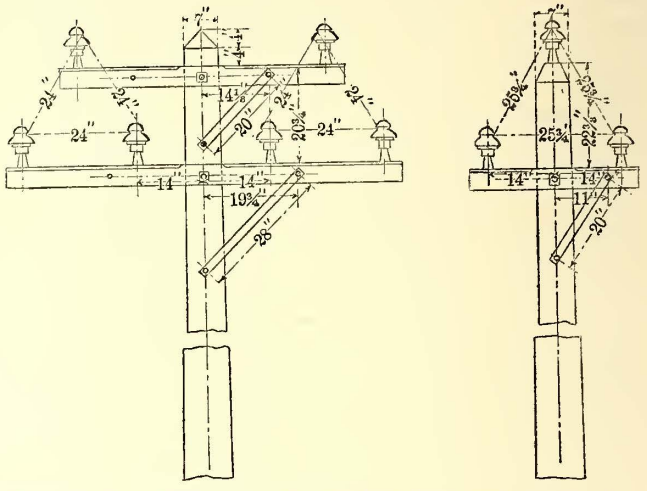
LOCATION	POLE NO.	CONDITION														REMARKS
		ED. 110				ED. 120				T.H. 110				T.H. 120		
		Bur'd Out	Broken	Loose	Gone	Bur'd Out	Broken	Loose	Gone	Bur'd Out	Broken	Loose	Gone	Bur'd Out	Broken	Loose	Gone	
	TOTALS																	

Electric Ry. Journal

Denver City Tramway—Record Forms Used in Checking Distribution of Lamps (Original 5 1/2 in. x 8 1/2 in.)

dering the joint. In this way ample electrical conductivity as well as the required mechanical strength is afforded. At turning "Y's" 18-in. steel spring-point trolley frogs have been installed so that it is only necessary for the conductor to loosen the trolley rope when turning the car, and the trolley wheel will be guided in its path by the spring points of the overhead switches. Thirty-seven electrically operated track switches have been installed. The control apparatus of these switches has been designed largely by the company's men and the results are said to have been excellent.

The views shown on Plate VI were taken in the streets of Denver and illustrate the very attractive types of poles used in certain localities. These poles are owned jointly by the Denver City Tramway Company and the city and are



Denver City Tramway—Typical Pole-Top Construction for 13,200-Volt Lines

used not only to support trolley spans, but also to carry the ornamental arc lamps for illuminating the street, and one pair of city wires. In placing these poles, set on 90-ft. centers, the Denver City Tramway Company bore the expense of removing the old trolley poles and of furnishing the interior steel tubular poles which are set in concrete and which carry the trolley span wires. The city furnished and placed the outside ornamental cases and the Denver Gas & Electric Company furnished and wired the electric lamps.

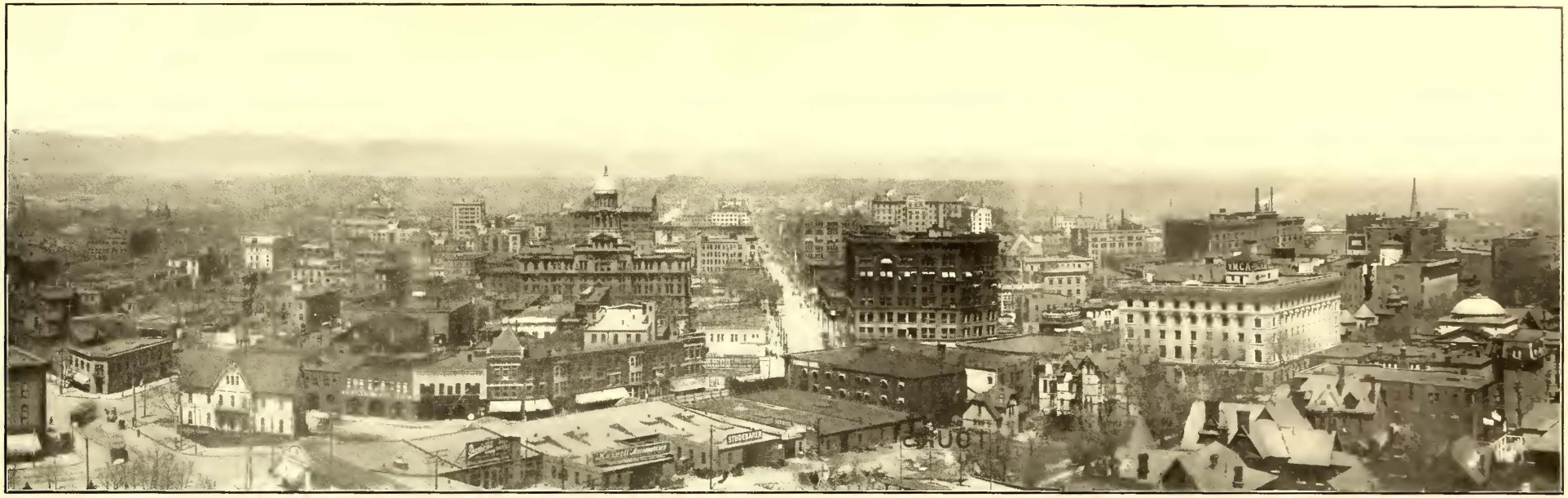
LAMP MAINTENANCE

A portion of the work of the overhead line department is the maintenance of car lighting. This department also takes care of the lamps and lighting circuits of all car houses and installs the wiring in the buildings. The department has control of the distribution of all incandescent lamps and has originated a system whereby it not only distributes lamps promptly, but sees that all useless lamps are returned.

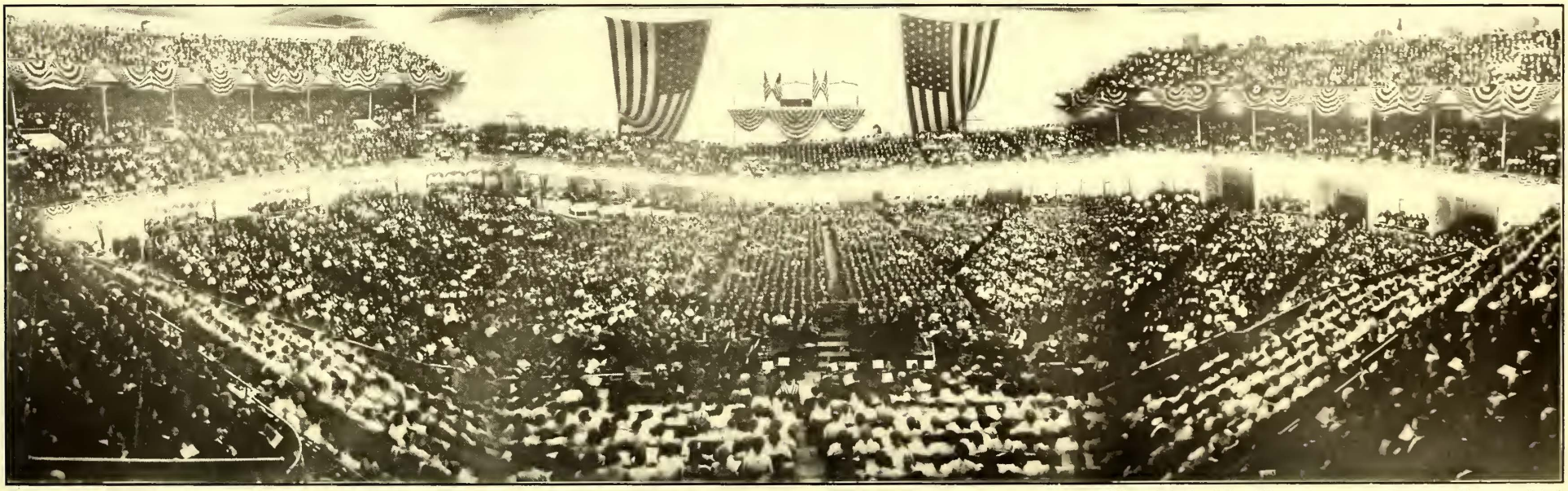
The lamps in the cars are maintained by two men who cover the entire system in the daytime, and by another man who is stationed at the central loop during the evening. This man at the central loop trims all the arc headlights and makes certain that the emergency lamp repairs on the cars are all taken care of quickly. Whenever a car crew finds that made to the dispatcher, who calls the lamp repair man on duty and tells him of the defect and advises when the car will reach the central loop. As the car passes the repair man rides along and makes the necessary repairs. When this man goes off duty at 11 p. m. the car crews may then obtain lamps from a supply box kept in the dispatcher's office at the central loop. Extra arc headlights also are kept at this central location.

A close check on the distribution and return of lamps is kept by using specially constructed storage boxes containing a temporary supply. Such boxes are placed at each car house, in each department of the shops, at each substation, and at the central loop. The boxes have two compartments, each under lock and key, one compartment contains lamps to be used by the night man and one by the day man. The lamps in these boxes are not used if the lamp repair men can make all the replacements during the daytime, and so the supply

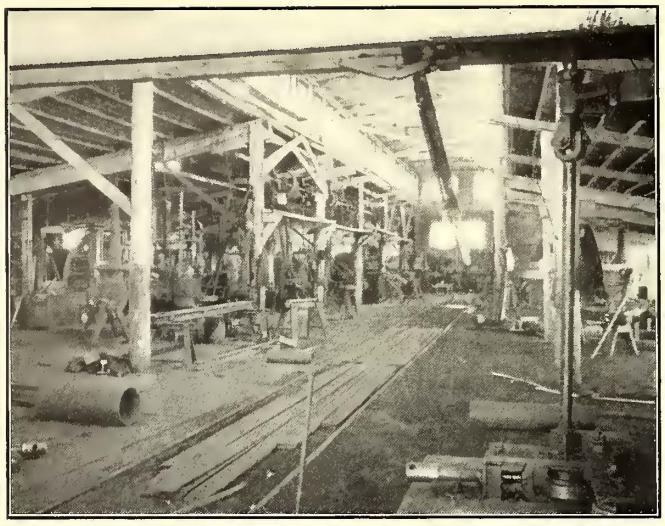
Plate I



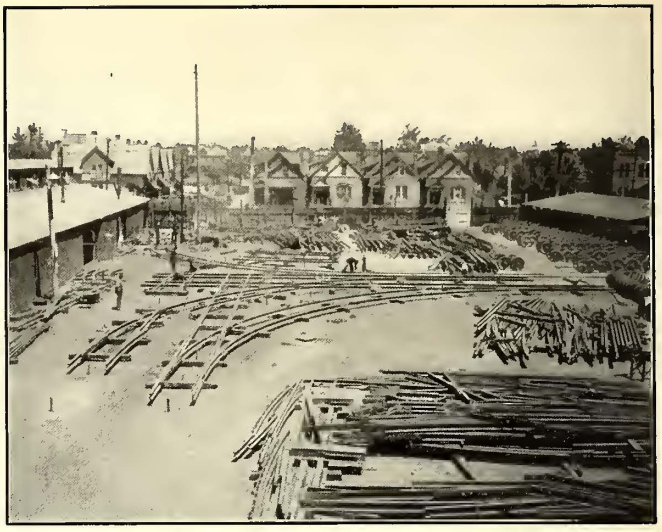
Denver City Tramway—Panoramic View of the Business Center of Denver



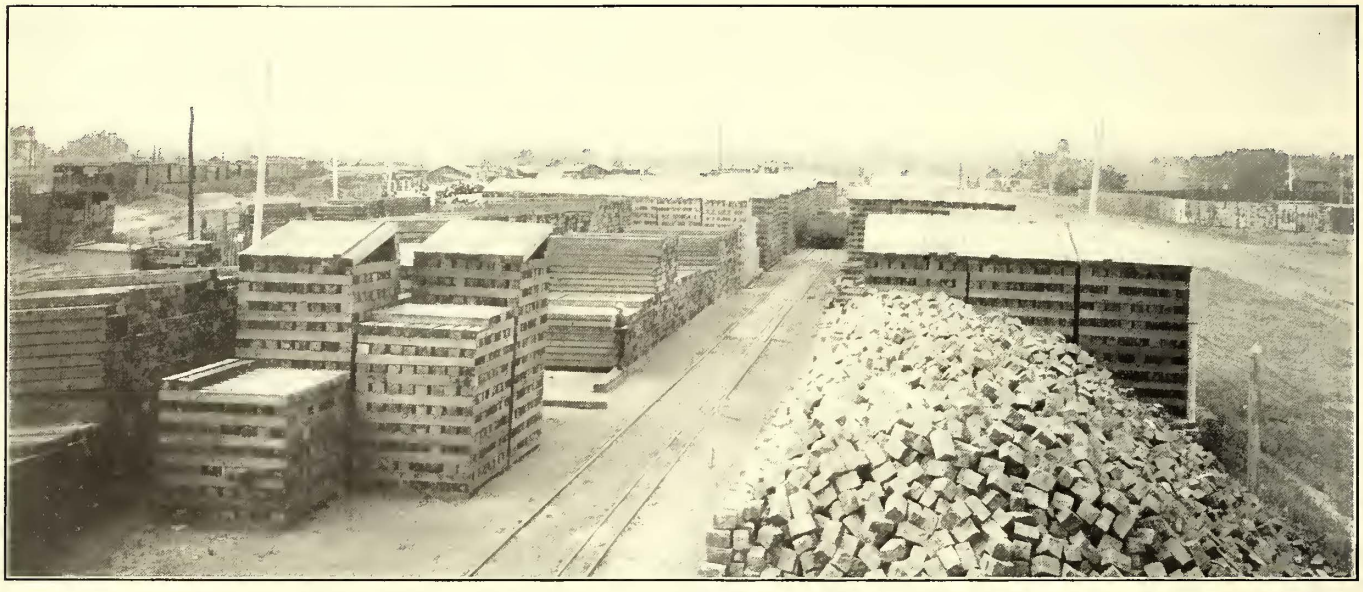
Denver City Tramway—Interior of Denver Auditorium



Denver City Tramway—Special Track Work Shop

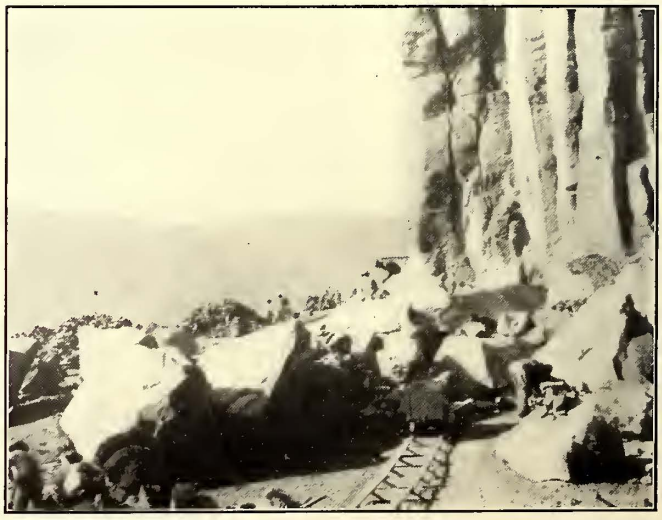


Denver City Tramway—Special Track Work Yard

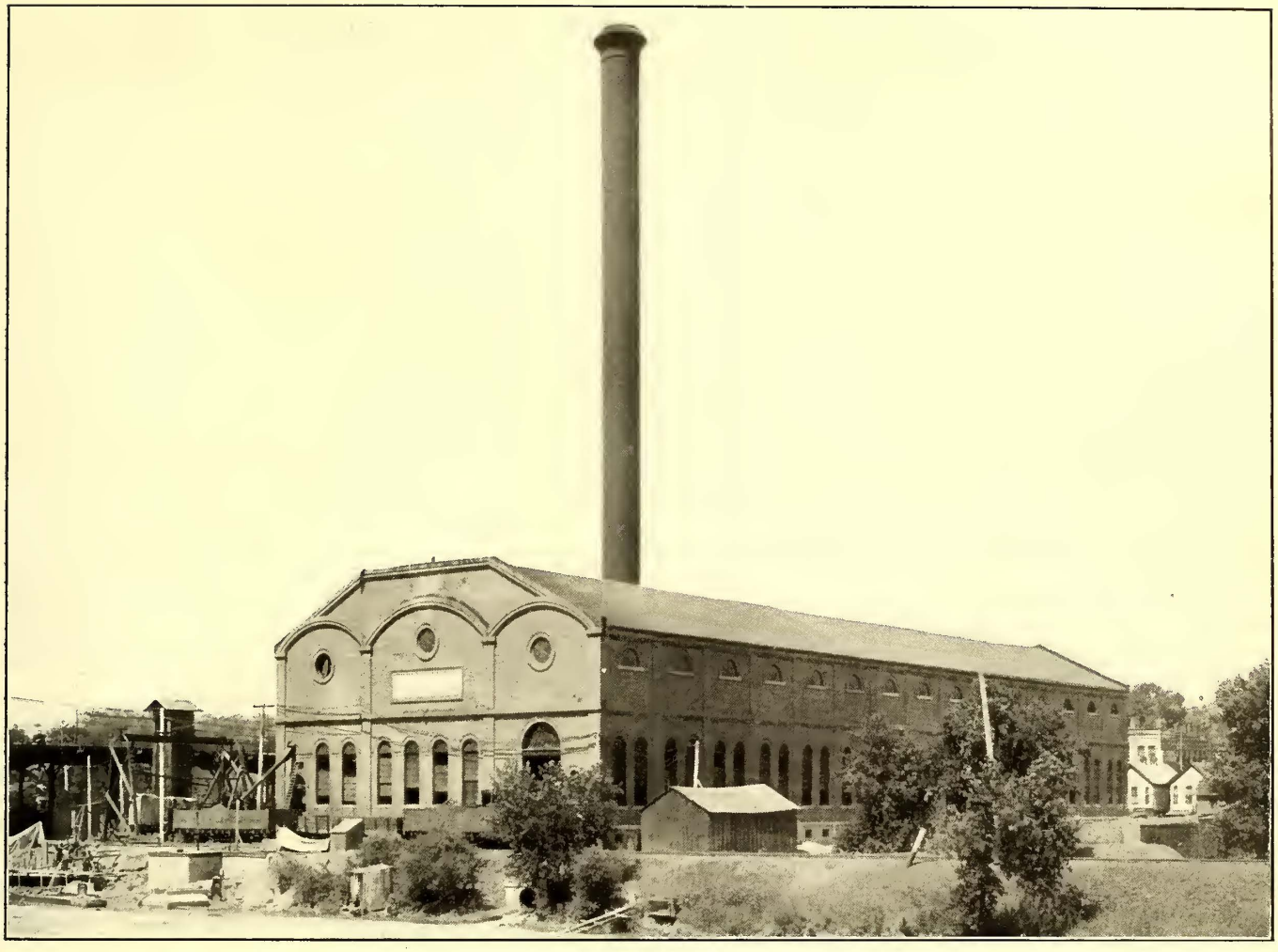


Denver City Tramway—Track Department Material Yard

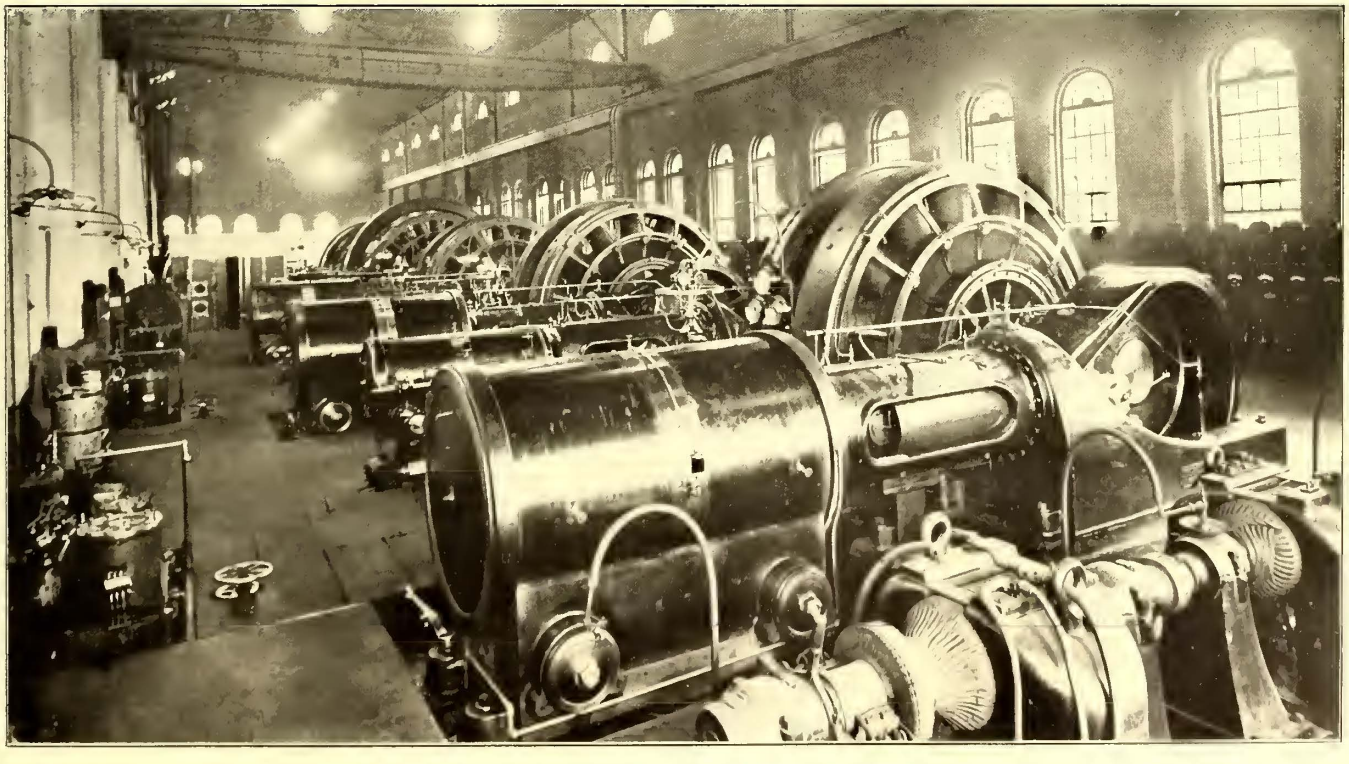
Denver City Tramway—Concrete Street Surface



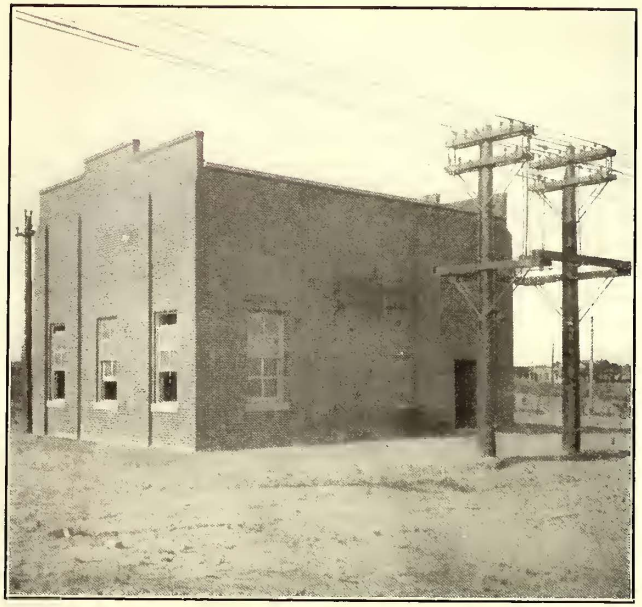
Denver City Tramway—Basalt Rock Quarries



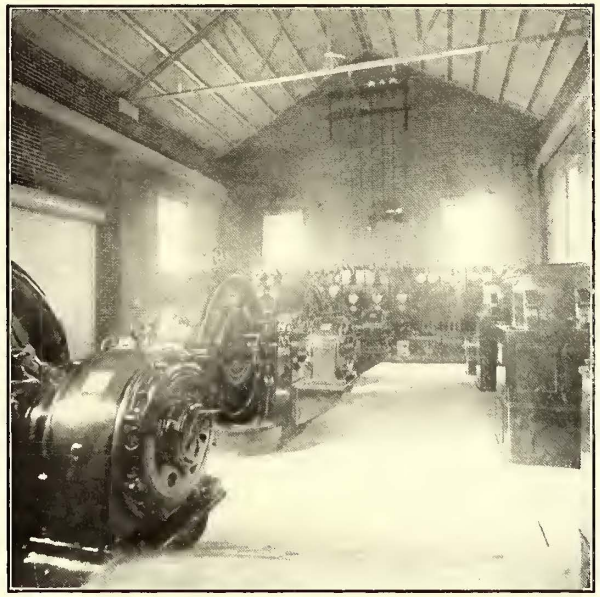
Denver City Tramway—Exterior of Main Power Station



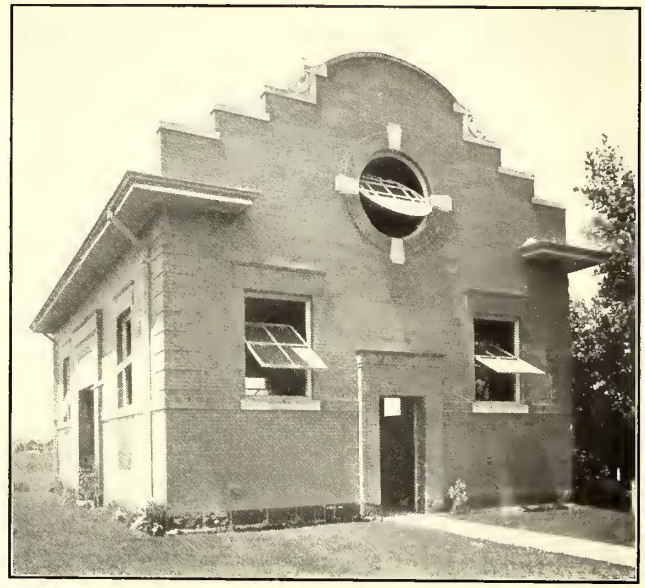
Denver City Tramway—Interior of Main Power Station



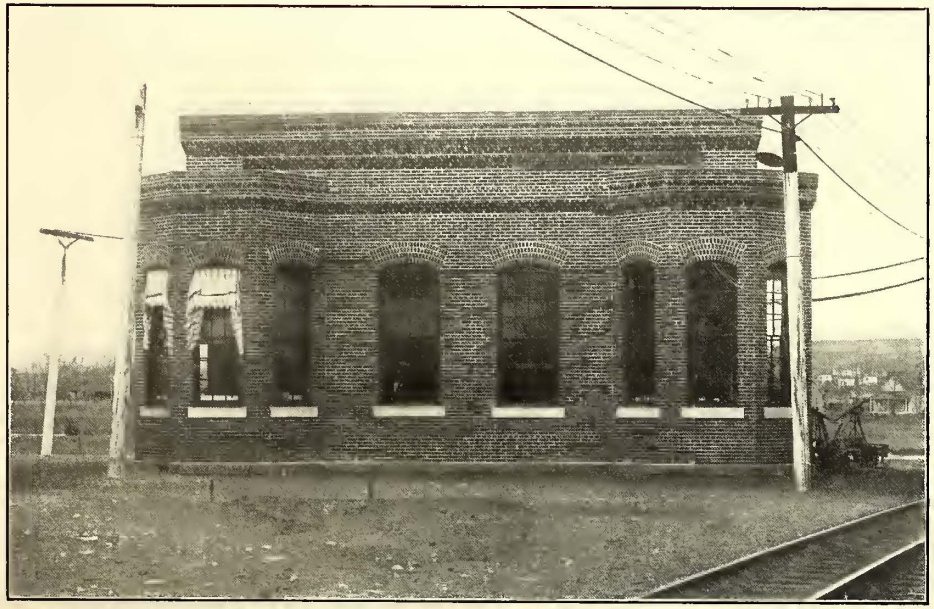
Denver City Tramway—Argo Substation



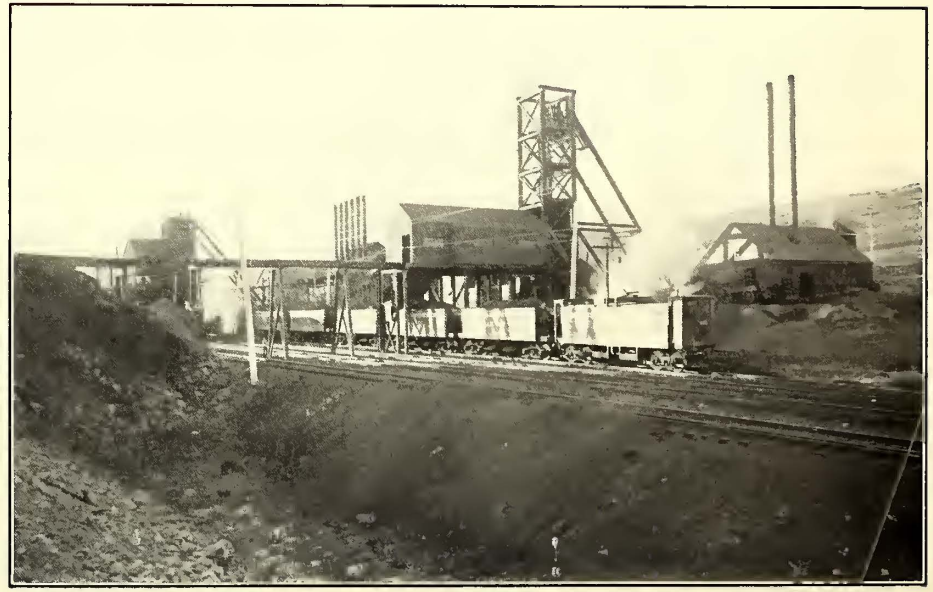
Denver City Tramway—Interior Colfax Substation



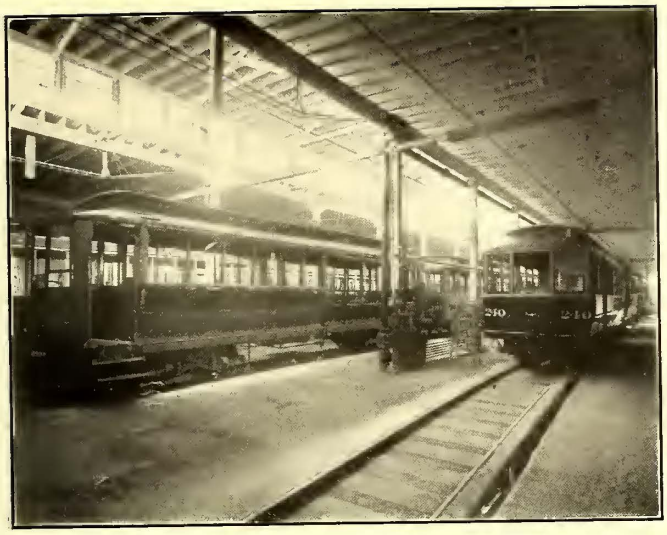
Denver City Tramway—Colfax Substation



Denver City Tramway—Clear Creek Substation



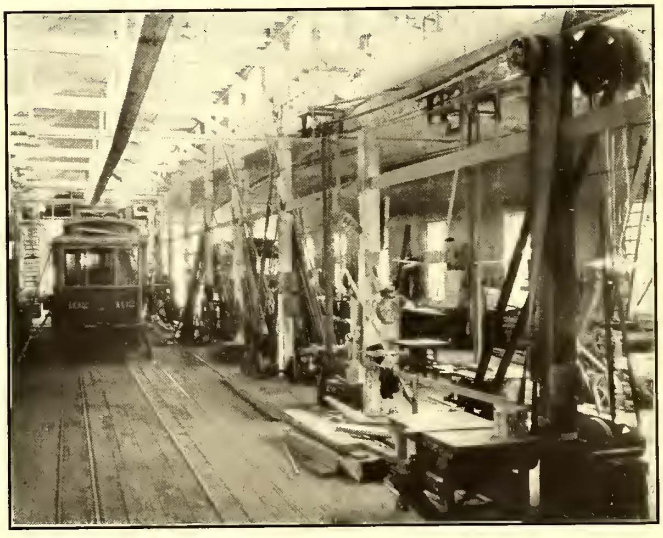
Denver City Tramway—Leyden Coal Mines



Denver City Tramway—Paint Shop

Denver City Tramway—Jacking-up Shop

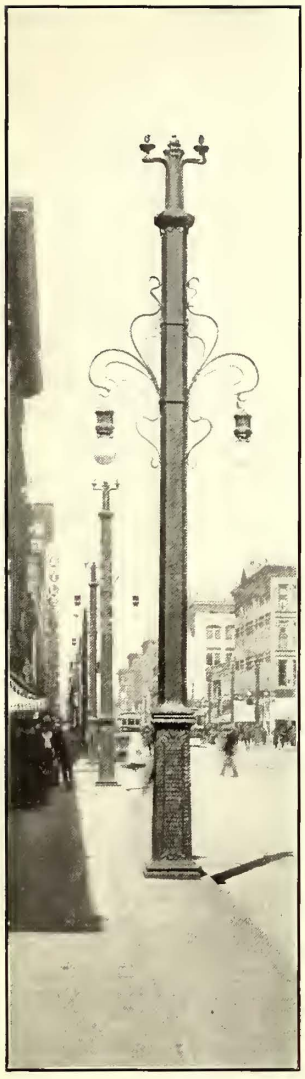
Denver City Tramway—Armature Shop

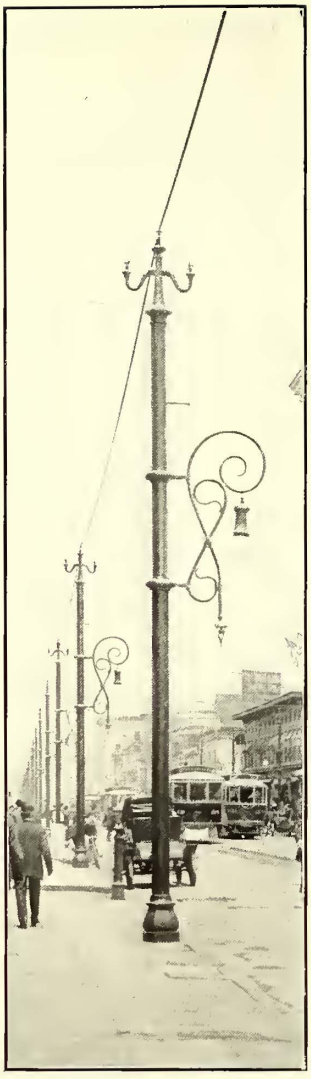


Denver City Tramway—Carpenter Shop

Denver City Tramway—Broadway Stock Room

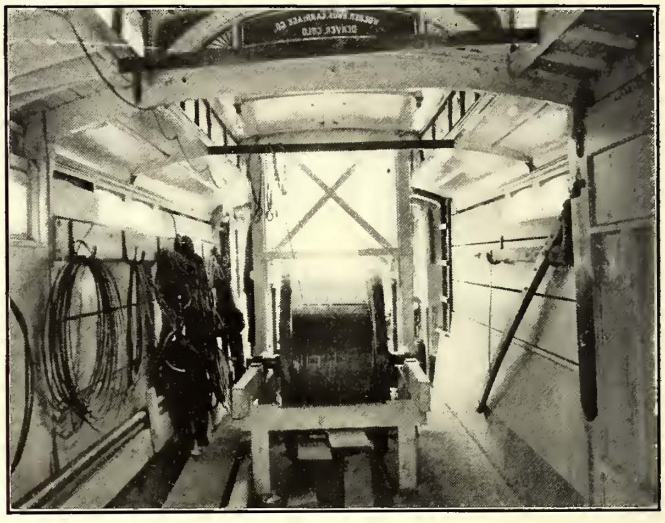
Denver City Tramway—Blacksmith Shop



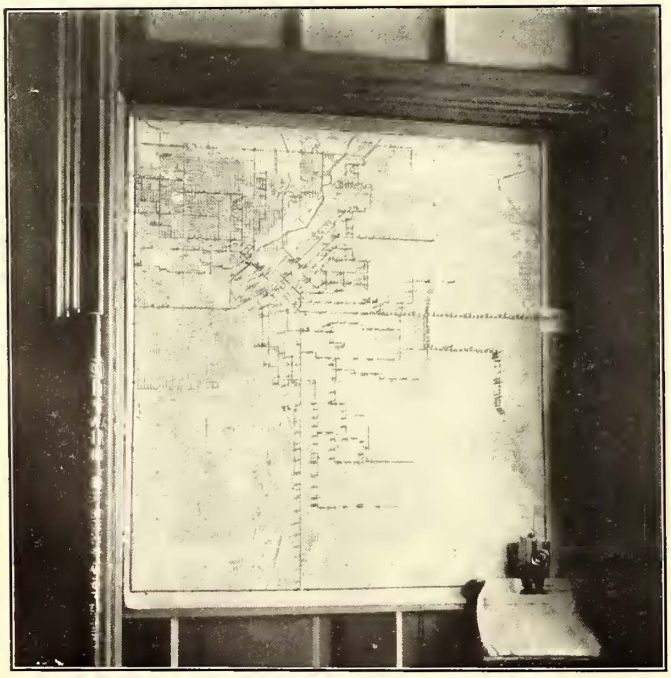


Denver City Tramway—Ornamental Trolley Poles

Denver City Tramway—Exterior of Line Car

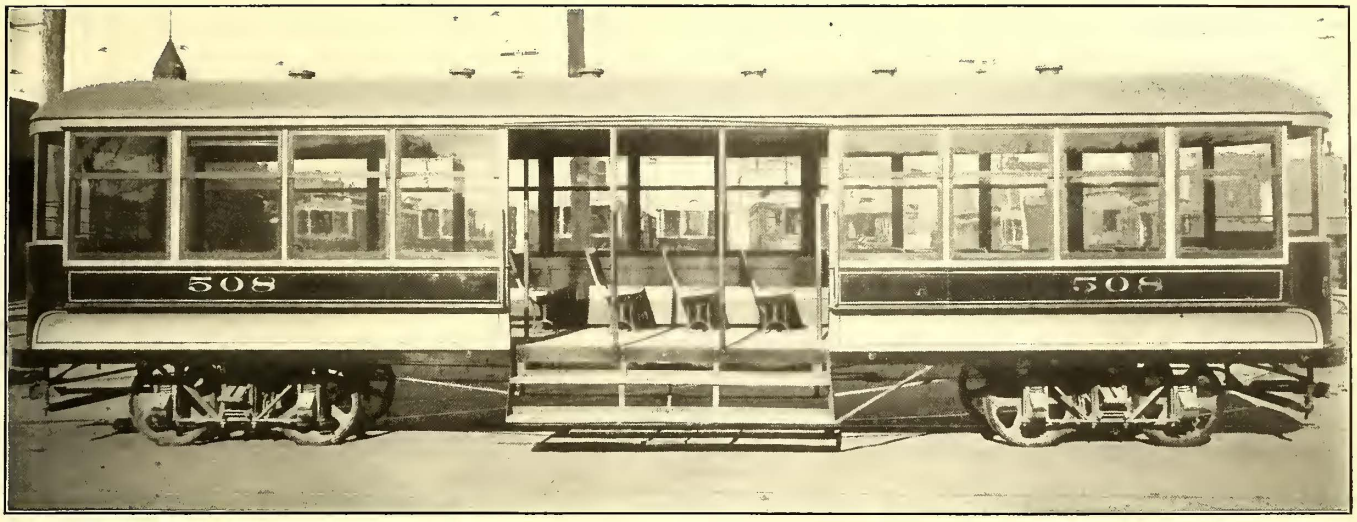


Denver City Tramway—Interior of Line Car



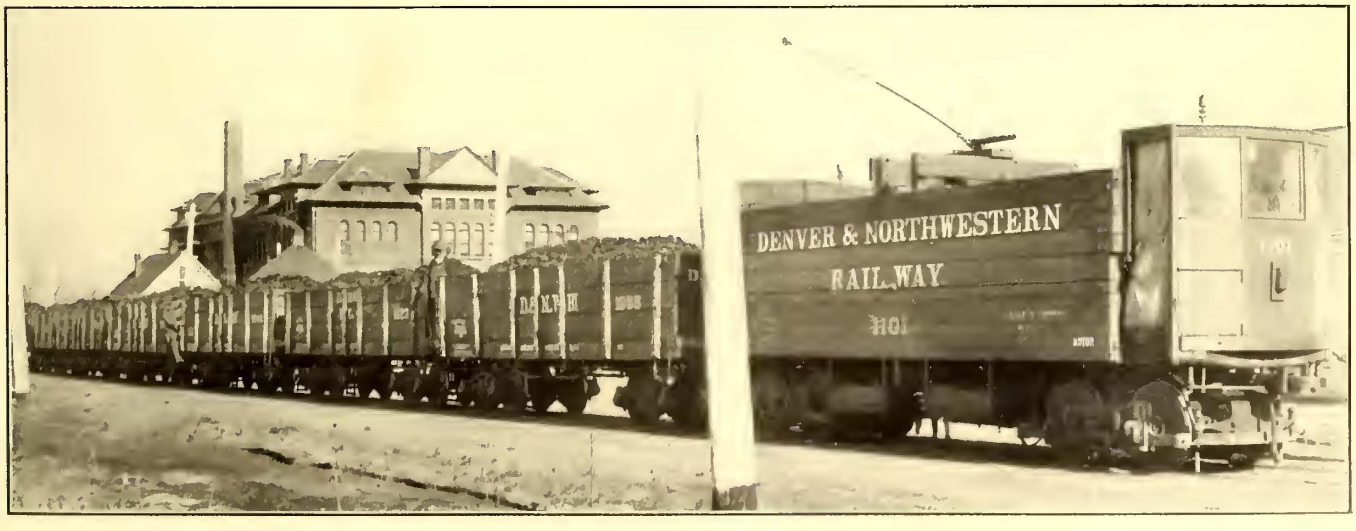
Denver City Tramway—Lightning Map

Denver City Tramway—Boiler Plant



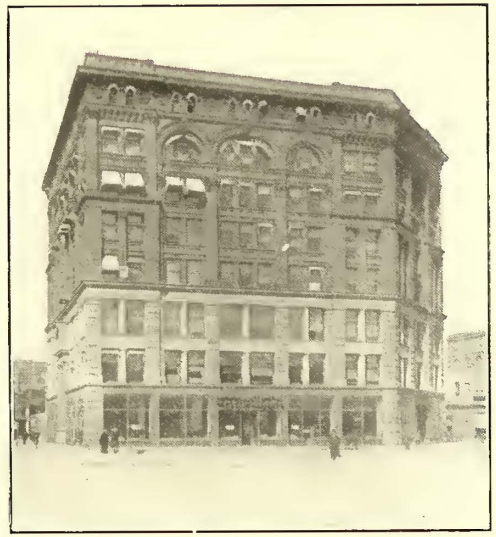
Denver City Tramway—Standard Type 13,000-lb. Trailer

Denver City Tramway—Latest Type Side-Entrance Motor Car

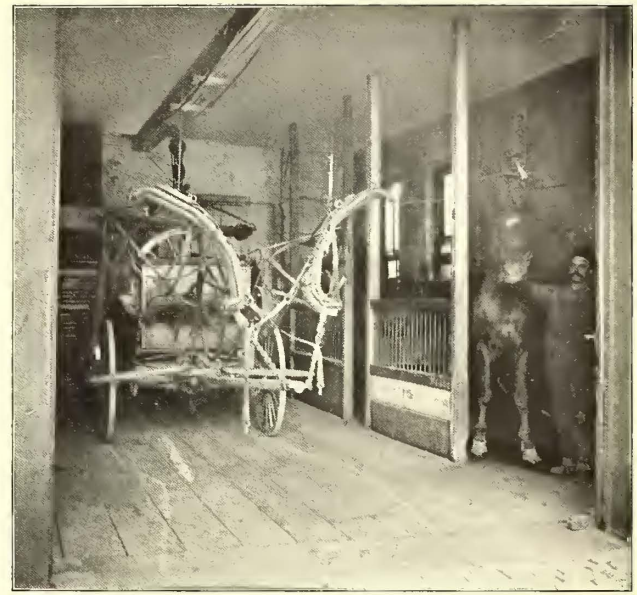


Denver City Tramway—Coal Train and Motor Car on Denver & Northwestern Division

Interior of Wreck Car

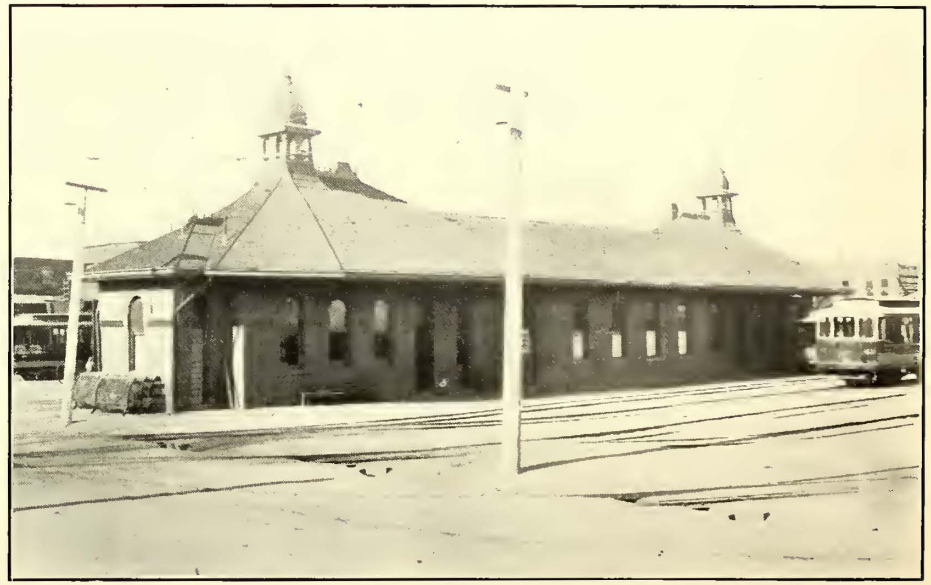


Majestic Office Building



Emergency Wreck Wagon Stable

Denver City Tramway—Central Terminal Loop



Denver City Tramway—South Broadway Trainmen's Quarters

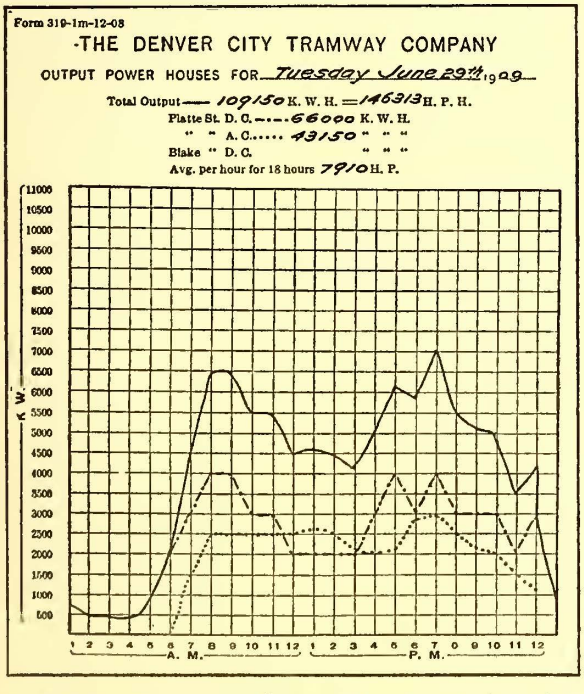
boxes serve ordinarily only as reserves. The line department has duplicate keys for the boxes, so that the renewal man on his regular trips can take out the poor lamps and replace them with good ones. As the racks in the boxes are kept full at all times it is easy to account for the total number of lamps.

In addition to the general reports of work done and material used by the department, two forms, the headings of which are shown, are used to indicate the "lamps used to-day on car repairs," and the "lamps used in buildings, pole clusters and signals."

POWER GENERATION

Power for the operation of the entire tramway system is generated in a large station located on the Platte River just north of the business district of the city. The station building is an attractive fireproof structure of brick and steel. Its location on the bank of the river and close to both steam and electric lines assures low costs for obtaining fuel and condensing water. The power station building is rectangular in plan, with a fire wall separating the interior into a boiler and an engine room. A switching house for handling the alternating current transmitted to substations is located about 30 ft. east of the engine-room side of the main station and opposite the switchboard. This power plant is of particular interest because it contains both a.c. and d.c. generating equipment operated by reciprocating engines and also steam turbines. The total capacity of the station is 7,500 kw, of which 3,500 kw are delivered to outlying substations; the remainder is fed direct to the d.c. distribution system.

It is proposed in the near future to extend the station building for the accommodation of two 2,000-kw a.c. generators to be driven either by steam turbines or vertical engines. This increase in engine capacity will call for the installation



Denver City Tramway—Curves Showing A.C. and D.C. Output of Power Station

of seven additional 850-hp boilers and additional condensing plant. In order to maintain a continuous and ample supply of condensing water it also is planned to build a concrete reservoir of 10,000,000 gal. capacity to be located at an elevation near the plant so that the water will flow by gravity to the condensers. Two 20-in. motor-driven centrifugal pumps will be used to lift the water from the river to the storage reservoir. Preliminary drawings are now being made for these improvements.

The Denver City Tramway Company and a number of capitalists interested in that company own and operate a coal mine at Leyden located on the Denver & Northwestern division of the electric railway system. Coal from this mine is handled in trains drawn by locomotives. An engraving of the elevating and loading machinery above the mine is presented on Plate IV. It is interesting to note that from the time the miners shovel the coal into the cars far below ground until it reaches the grates in the power plant the coal is handled entirely by mechanical means. The surplus output of coal from this mine which is not required at the power plant, is sold by the mining company from its yards located on the Denver City Tramway tracks in the northwestern portion of the city. The product of the mine is lignite slack, which costs $1.40 per ton delivered. With the boiler-house equipment, which includes mechanical draft, this is found to be a satisfactory fuel.

As received at the power plant in the special Denver & Northwestern coal cars, the fuel is dumped into the receiving hopper of a McCaslin conveyor which elevates and distributes it into a series of plate-steel bunkers having a total storage capacity of 1,100 tons. From these bunkers the coal is fed by gravity to Stirling chain grates. The ashes fall into hoppers built as a part of the boiler settings from which they are carried by the conveying system to cars on the siding at the south end of the building. The boiler plant includes thirteen 500-hp Stirling boilers with internal superheaters. Steam is delivered to the engines at 170 lb. pressure and 75 deg. of superheat. The exhaust gases from the furnaces pass to a large breeching which leads them to four stacks, three of which are equipped for mechanical draft. The engine and generating equipment, a view of which is presented on Plate III, includes the following units:

Three Green-Wheelock engines direct connected to G.E. 800-kw 570-volt d.c. generators.

One Allis-Chalmers cross-compound Corliss engine direct-connected to a G.E. 1,600-kw 570-volt railway generator.

One Allis-Chalmers cross-compound Corliss engine direct-connected to a G.E. 1,500-kw 2,300-volt 25-cycle a.c. generator.

One Weslinghouse-Parsons 2000-kw 13,200-volt 25-cycle a.c. turbo-generator with Worthington surface condenser.

The Corliss engine units are equipped with individual jet condensers. The alternating current generated in the 2,300-volt machine is fed to a transformer bank in the nearby switching station and stepped up to 13,200 volts, so that this unit may operate in parallel with the turbine-driven generator for feeding the outlying substations.

Distribution is made to four substations over aerial lines having a total length of about 16 miles. Where these lines emerge from the switching house at the generating station they are protected from lightning by electrolytic arresters, of the aluminum cell type. These arresters operate very satisfactorily and have greatly reduced the amount of lightning trouble formerly experienced. Similar arresters are installed at substation entrances. It has been noted in connection with the excellent service rendered by these arresters in this climate subject to severe electrical storms, that sometimes the arresters will begin to discharge fully 30 minutes before an impending storm is noticed outside.

The d.c. railway feeders of which there are 35 controlled from the main power station switchboard, are also equipped with aluminum cell lightning arresters. At the present time these feeder lines are carried from the switchboard to the street in a concrete-lined tunnel 5 ft. x 6 ft. in cross section and about 300 ft. long. The return circuit using bonded scrap rails, also is placed in this tunnel. Plans

are now being made for mounting the outgoing d.c. feeders on specially constructed steel towers, so that the concrete tunnel may be used as a discharge conduit for the barometric condensers which will serve the proposed 6,000-kw generating capacity soon to be installed.

The chart on page 497 is reproduced from a blueprint plan of the d.c. feeder system. One of these charts is posted in each of the company's generating and converting stations and shows the arrangement of the d.c. feeders and tie lines for supplying current to the various sections of the trolley network.

NEGATIVE RETURNS

An interesting bonding installation has been completed recently in the neighborhood of the main generating station with a view to minimizing the electrolytic action on neighboring waterpipes. Formerly the railway company received considerable criticism on account of the corrosion of pipes in this district, but since the installation of special negative returns the reason for criticism does not exist. The former sources of trouble were two 14-in. pipes each about 800 ft. from the station and one 16-in. pipe about 1,600 ft. from the station. From each of the pipes a 500,000-circ. mil cable has been run to connect with the negative bus within the station. An ammeter is permanently connected in each circuit at the station so that the amount of current collected from the pipes may be observed. In this connection it is noted that a nearly constant ratio exists between the station load and the current returning to the negative bus by way of the special cables connected with the water pipes. When the total d.c. output of the station is 4,000 kw the ammeter in the negative return from the 16-in. pipe, 1,600 ft. away, reads 175 amp. The station operators are familiar with the ratio between the current returning on these auxiliary negative leads and the station output, and therefore can readily note any disturbance in the negative circuit.

The connections between these large water pipes and the auxiliary negative cables were made by using large copper bands under which were compressed quantities of Brown's plastic alloy. Before placing the bands and the alloy the pipes were filed and the surfaces of both pipes and copper bands amalgamated with the alloy.

POWER RECORDS

As a means for preserving a record of the power station performance and for observing load conditions the chief engineer of the plant each day prepares three power-house reports. One of these, for the boiler plant, as illustrated, exhibits the condition of the draft on the various fires, the detail repair work done and the cleaning work done on each boiler; the temperatures in the economizers, the running time of the fan engines, the amount of coal received, amount of ash shipped and the time the conveying system was used, together with a report of the condition of the auxiliary engines and pumps in the boiler room and a miscellaneous report of repair work, etc., done during the day. The second report, for the engine room, exhibits hourly kilowatt readings, both a.c. and d.c., the period of operation of the engines, and similar details regarding condensers, vacuum, etc. The third report is an exhibit of the findings of the generator and motor inspector and a report of the work which has been done. Each day a curve is plotted showing the output of the power house, both a.c. and d.c. Copies of these curves are forwarded to the general manager daily.

Alternating current for the operation of outlying substa-

Form 406--1M--1-08--40P

ENGINE ROOM

THE DENVER CITY TRAMWAY CO. DENVER, June 29 1909

POWER HOUSE REPORT

TIME	D. C. KILOWATTS	A.C. KILOWATTS NO. 5	A. C. KILOWATTS NO. 8
Midnight	9916100	107498	9458500
6 A.M.	7400		
7 A.M.	7700		9460000
7:30 A.M.	7900		1250
8 A.M.	8100		2500
8:30 A.M.	8300		4000
9 A.M.	8500		5000
10 A.M.	8800		7500
11 A.M.	9100		9470000
12 M.	9300		2500
1 P.M.	9500		5250
2 P.M.	9700		7750
3 P.M.	9900		9480000
4 P.M.	9920200		2000
4:30 P.M.	400		3500
5 P.M.	600	107507	4250
5:30 P.M.	700	107510	9485000
6 P.M.	0900	107519	9486000
6:30 P.M.	1100	107526	9487000
7 P.M.	1300	107532	9487750
8 P.M.	1600	1,400	9490250
9 P.M.	1900		9492500
10 P.M.	2200		9494500
11 P.M.	2400		9496000
12 P.M.	9922700		9497250
	66900		38750

ENGINES CUT IN AND OUT — EXACT TIME

NO. 1	IN 2.00 P M. OUT 9.00 A M.	IN M. OUT M.	IN M. OUT M.	
NO. 2	IN 6.30 A M. OUT 9. P M.	IN M. OUT M.	IN M. OUT M.	
NO. 3	IN M. OUT 12.20 A M.	IN M. OUT M.	IN M. OUT M.	
NO. 4	IN 6 — A M. OUT M.	IN M. OUT M.	IN M. OUT M.	
NO. 5	IN M. OUT 5.35 A M.	IN M. OUT M.	IN M. OUT M.	
NO. 6	IN 11.30 P M. OUT M.	IN M. OUT M.	IN M. OUT M.	
Air Compressor	IN M. OUT 7.15 A M.	IN M. OUT M.	IN M. OUT M.	
	IN 5.35 A M. OUT M.	IN M. OUT M.	IN M. OUT M.	
	IN 4.40 P M. OUT 7 — P M.	IN M. OUT M.	IN M. OUT M.	
	IN M. OUT M.	IN M. OUT M.	IN M. OUT M.	
	IN 6.10 A M. OUT 12 — P M.	IN M. OUT M.	IN M. OUT M.	
	IN M. OUT M.	IN M. OUT M.	IN M. OUT M.	
	IN M. OUT 5.45 — A M.	IN 7.15 A M. OUT M.		
	IN M. OUT M.	IN M. OUT M.		

CONDENSERS	VACUUM				
Descr. WORK DONE ON, ETC.	8 A.M.	12 M.	4 P.M.	6 P.M.	11 P.M.
NOS. 1 & 2	22	22	22	22	22
NO. 3					
NO. 4 Cleaned	20	20	20	20	20
NO. 5				22	
NO. 6 Cleaned	22	22	22	22	22

BREAKERS OUT

TIME	CIRCUIT	CAUSE	TIME	CIRCUIT	CAUSE
1.30 A	4 - A.M. Wire	In 4.30 down	A.M.		

WORK DONE ON — REPAIRS ETC.	
Steam Piping	
Steam Separators	
Autom. Engine Stops	
Auxiliaries	
Air Compressors	

TEMPERATURE OF CONDENSER DISCHARGE	8 A.M.	12 M.	4 P.M.	6 P.M.	11 P.M.
Nos. 1 & 2 Jet					
No. 3 Jet					
No. 4 Jet				90	80
No. 5 Jet				88	88
No. 6 Surface				100	96
INTAKE					

CYLINDER OIL USED ON			
NO. 1	2-1 OTS.	NO. 4	12 — 9
NO. 2	5 3	NO. 5	3 — 1
NO. 3	2 -	Auxil's	3 - 5
ENGINE OIL IN TANKS			
ENGINE OIL ADDED TO TANKS			
TURBINE OIL PUT IN NO. 6			

REPORT ANY EQUIPMENT NOT IN PERFECT CONDITION, ALSO ALL WORK DONE ON EQUIPMENT.

Rep Sump Pump 9 Hrs. E. N. Dexter

APPROVED: D. B. Wilson, Superintendent of Power.

SIGNED: E. E. Dean, DAY ENGINEER. C. L. Ingraham, NIGHT ENGINEER.

Denver City Tramway—Daily Power Station Engine Room Report (Original 11 3/8 in. x 9 3/8 in.)

tions is transmitted at 13,200 volts on overhead three-phase transmission lines with both one and two circuits of No. 2 weatherproof wire per pole. There are four substations located as shown on the accompanying map. Two of them contain three 500-kw rotaries and two contain two 500-kw rotaries each. The interior arrangement of the substations conforms to a standard plan in so far as the location of the more important pieces of apparatus is concerned. The exteriors of the buildings are not of uniform design, but the architectural treatment of each has been adapted to the particular location in which the substation is built. Illustrations of the Argo substation, Colfax substation and Clear Creek substation exteriors are presented on Plate IV. The Argo substation is located in a sparsely populated district and therefore is not ornamental. The Colfax substation is located in a high-class residence district and is built with an attractive exterior. The Clear Creek substation is located at the junction of two diverging suburban lines. A detailed description of the East Colfax substation was presented in the ELECTRIC RAILWAY REVIEW for December, 1906, page 991. In the design of this and the other substations of the Denver City Tramway it has been the aim to have buildings and installations of machinery which will afford the greatest reliability of service; therefore, the enclosing structures are made of non-combustible materials and the apparatus is so arranged that an accident to one section will not necessarily incapacitate the others. An accompanying engraving is a reproduction of a daily substation report as made out for the information of the chief electrician of the company.

ROLLING STOCK EQUIPMENT

The rolling stock equipment of the Denver City Tramway Company is of special interest for two equally important reasons. First, the management and mechanical department have designed and had constructed types of equipment which are especially low in weight, but which have shown a low maintenance cost record. Second, the management and transportation department have developed methods for successfully operating a type of light trailer much appreciated by the riding public and effecting a considerable saving in operating cost. The detail methods of trailer operation will be described under the section devoted to the transportation department.

The equipment available for use includes the following cars: Sixty-four four-motor passenger, 215 two-motor passenger, 44 standard passenger trailers, 18 open passenger trailers, 62 miscellaneous utility cars and 106 freight cars, including motors, dump cars and gondolas used in handling coal. Illustrations are presented on Plate VII showing the more recent types of cars.

1909 TYPE CAR

During the present summer the Woeber Carriage Company of Denver has built 25 car bodies, which represent the latest type of two-motor equipment used in Denver. These cars are similar in general design to the larger part of the company's motor equipments, but they include many refinements and new improvements in minor detail. The general dimensions of the equipments follow:

	Ft.	In.
Length over bumpers	43	10
Length over vestibules	42	10
Length over end bulkheads	34	11½
Width over sills on panels	7	10
Width over belt rail	8	4
Width over water table	8	8
Height from rail to bottom sill		31
Height from rail to top of roof	11	8
Height from bottom of sill to top of roof	9	1
Height from floor to ceiling	7	11½
Height from rail to highest point on trolley base	13	2
Truck centers	24	
End overhang (front and rear the same)	9	11

Accompanying line engravings illustrate the underframe construction, brake and truck arrangement and seating plan of this type of car. A characteristic feature is the center side entrance having an opening the width of two panels, 4 ft.

THE DENVER CITY TRAMWAY CO.

BOILER ROOM — POWER HOUSE REPORTS — DENVER June 29 19 9

BOILER	DRAETS 8 A.M.	12 M.	6 P.M.	11 P.M.	CONDITION OF WORK DONE ON REPAIRING, RENEWAL, CLEANING, SEALING, ETC. BRICKWORK	STOKERS	GRATES	DRUMS	TUBES	SUPERHEATERS
1	60									
2	55									
3	50									
12	50									
13	53									

TEMPERATURES OF	8 A.M.	12 M.	6 P.M.	11 P.M.
Steam Main Header				
Economizer Intake	250	270		
Economizer Discharge				
Flue Gases	425	410		

FAN ENGINES NO.	CUT IN	CUT OUT	CUT IN	CUT OUT	CUT IN	CUT OUT
1					3.45pm	8.35pm
2			7.00am	8.10am	3.30pm	8.45pm
3					4.45pm	6.30pm

ECONOMIZERS—CONDITION, REPAIRS, CLEANED: SET | TUBES | DUST BOX

COAL: Tons on Hand 478 | Rec'd Slack | M.R. | Ash Shipped 2 cans

CONDITION, REPAIRS, OVERHAULING, ETC.,		CONDITION, REPAIRS, ETC.,	Time Operated	CONDITION, REPAIRS, ETC.	Time Operated
Fan Engine No.1		Coal Conveyor Long	13	Stoker Engine	
Fan Engine No.2		Coal Conveyor Short	7	House Pump 1	
Fan Engine No.3		Ash Conveyor	6	House Pump 2	
Fan No.1		Coal Crusher Large		House Pump 3	
Fan No.2		Coal Crusher Small		Sump Pump	
Fan No.3		Boiler Pump No.1		Tunnel Pump	
Flues		Boiler Pump No.2		Tank Pump	
Main Steam Header		Boiler Pump No.3			
Steam Piping		Boiler Pump No.4			
Steam Valves		Dampers		NO. GAUGE GLASSES BROKEN	1

REPORT IN DETAIL- ALL REPAIRING, CLEANING, BLOWING OFF, OVERHAULING, ETC., DONE DURING DAY:

REPORT HOUR AND CAUSE IF STEAM PRESSURE FALLS BELOW 165 LS. GAUGE:

Boilers blown out 4.00 am water columns blown out 8.00 am
Surface blow off blown out 11.00 pm to 1.30 am
Blow off pipe on No.2 boiler repaired boiler cut in
Owl run with No.5 boiler No. of boilers in 12

APPROVED D. H. Nelson Supt. of Power

FOREMEN H. West — SHIFT NO.1 — SHIFT NO.2 — SHIFT NO.3

Denver City Tramway—Daily Power Station Boiler Room Report (Original 11 3/8 in. x 9 3/8 in.)

11 3/4-in., with a dividing post in the middle of the entrance and three grabhandles. These handles, in connection with the 1 3/4-in. round hickory stanchion held securely in place in front of the first seat near the entrance, greatly facilitate loading and unloading. The arrangement of center entrance, with the side sill offset 7 in., affords comparatively low steps.

THE DENVER CITY TRAMWAY CO.
ELECTRICIAN'S DAILY REPORT

Sub-Station at East Colfax — 6—29—1909

Starting Rotary, No. 1, 6. A.M.
" " " 2, 6. "
" " " 3, 6.20 "
Shut Down " " 1, 12.15 P.M.
" " " 2, 12.15 "
" " " 3, 12.15 "
Fans and Motors, Condition of, O.K.

Breakers Out, Time and Cause, D. C. and A. C., None

		476,220	954,350	769,290
Condition of Breakers,	O.K.	472,860	950,980	766,010
" " Switches,	"	3,360	3,370	3,280
" " Instruments,	"			10,010 K.W.H.

Output, Average Ampere from 4 to 7 o'clock p. m., 1000
" Maximum Ampere from 4 to 7 o'clock p. m., 1800
" Average D.C. Voltage from 4 to 7 o'clock p.m., 570

Lightning Arresters, Condition of, O.K.

Number of Discharges, and on What Line, None

General Remarks:

Signed: Geiter — Day Man.
Signed: Diokey — Night Man.

Electric Ry. Journal

Denver City Tramway—Form of Daily Substation Report

At the main entrance there is a depression of 4 3/8 in. in the floor and the depressed portion is but 38 in. above the top of the rail. This rise is divided as follows:

Rail to top of first step, 14 in.
First step to top of second step, 12 in.
Second step to top of floor at entrance, 12 in.

The floor at this entrance point is covered with a 5/8-in. thickness of flexolith composition carried on 13/16-in. tongue and grooved flooring. As this floor receives the most severe wear it is desired by the use of this composition to obtain a life longer than that which might be had by the use of wood. Whenever the floor becomes unduly worn the composition can easily be repaired or replaced.

The new cars have a seating capacity for 52 passengers and weigh, completely equipped, 35,350 lb., thus showing a dead weight of a little less than 680 lb. per passenger for a two-motor car with a total of 130-hp and a length of 43 ft. 10 in. over all. The general details of the equipment include the following:

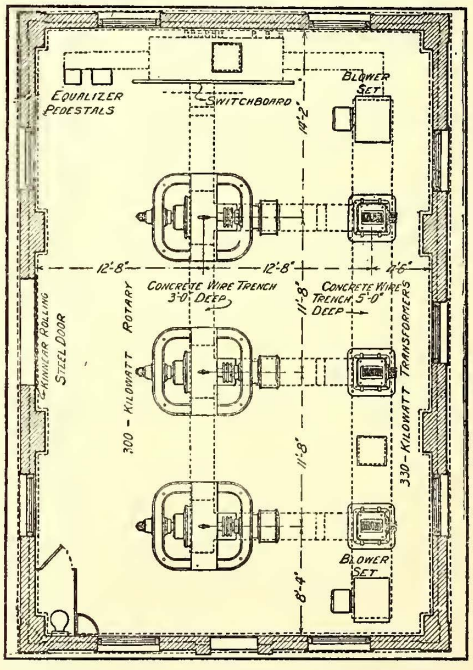
Two GE 218 65-hp interpole motors mounted on axles No. 2 and No. 3; two K-36 controllers; Brill 27 GE 1 trucks with 4-ft. 6-in. wheel base and 33-in. 500-lb. Griffin Wheel Company cast-chilled wheels; two Nichols-Lintern air sand traps mounted respectively over No. 1 wheel on the right side and No. 3 wheel on the left side; two Tomlinson couplers, type A, form 2, with spring carrier; Crouse-Hinds, type W, stationary headlight, with 32-cp incandescent lamps; Ohmer fare register and Automotoneers.

The cars are lighted by 14 16-cp lamps, hanging vertically from the ceiling in the center of the car, and four lamps used to illuminate the car steps.

ROLLING STOCK FEATURES

In 1907 30 new two-motor cars, each seating 48 passengers and weighing complete 29,000 lb., were put into service. These cars have the general design of those built during the present year, but are somewhat lighter on account of differences in the length and in the electrical and other equipment. The heaviest cars used on the system are those operating between Denver and Golden and Leyden, the termini of the Denver & Northwestern Railway. These cars are 43 ft. long and are equipped with four Westinghouse 101 F motors, mounted on 5-in. axles, carrying 33-in. rolled-steel wheels.

In connection with the problem of reducing car weights as carried out by the Denver City Tramway Company, it is not thought that the design of these cars is less substantial than that of many cars of like capacity which weigh much more. With low weight, if the design provides for reasonably low maintenance, the advantages are obvious. The extreme lightness of these cars has not been obtained by sacrificing a good factor of safety for any important structural members, but rather by carefully trimming all useless materials until there remains a mechanical structure of accepted design suitable for carrying the desired number of passengers with the lowest possible dead weight per passenger. The value of a center side entrance for cars used in city service is quite generally recognized. With the steps at the center of the car the conductor is never more than one-half the car length from the entering and leaving passengers and he is at this extreme distance only momentarily. Also, with the center entrance the load divides, part taking seats in each half of the car. In unloading the movement of the passengers is the opposite, and thus it is seen that the passengers at the extreme ends of the car are but one-half a car length from the door, which they can reach quickly. During operation the conductor's



Denver City Tramway—Floor Plan, Colfax Substation

position is close to the door where he can carefully observe all movement within the car and watch the progress of loading and unloading.

An important feature in the handling of traffic in these center side entrance cars is the placing of lamps and reflectors directly over the top step. The lamps are recessed in pockets in the deck rail. On account of the curved shape of the

reflectors these lamps illuminate the steps of the car and the street for a considerable distance away from the car, this feature being of particular value in the outlying portions of the city where the streets may be muddy and not well illuminated.

In connection with the use of step lights the company is considering the adoption of a device for cutting in and out the lamps as a car stops and starts. Such a device manufactured by the Automatic Signal Light Company, of Colorado Springs, is now being tested at Denver. The device is arranged to make and break the circuit which feeds the step lights so that the lamps will burn when the car is slowed down to about 4 miles per hour and remain burning during the stop, to be cut out when the car has again reached a speed of 4 miles an hour. All of the Denver cars are equipped with motormen's mirrors and the motormen state that with the automatically operated light the sudden reflection on the mirror forcibly attracts their attention, causing them to be more vigilant in watching the steps.

TRAIL CARS

A few years ago 44 trail cars, which exhibit an especially interesting type of construction, were put into service. The standard trail car is 38 ft. long over all and 8 ft 2 in. wide. The center entrance has a width of three window sashes, 8 ft. 2 in. in all. This extra width over that of the motor car entrance was given the trailer entrance with a view to facilitating the loading so that when stops were made passengers on the trail car would not delay the starting of the train. The car roof is built without the use of a monitor and considerable weight is thus saved. The seating capacity of this standard type of trailer is 46 passengers, and when equipped with hand brakes and Westinghouse schedule S M E air brakes, the car complete weighs but 13,000 lb.

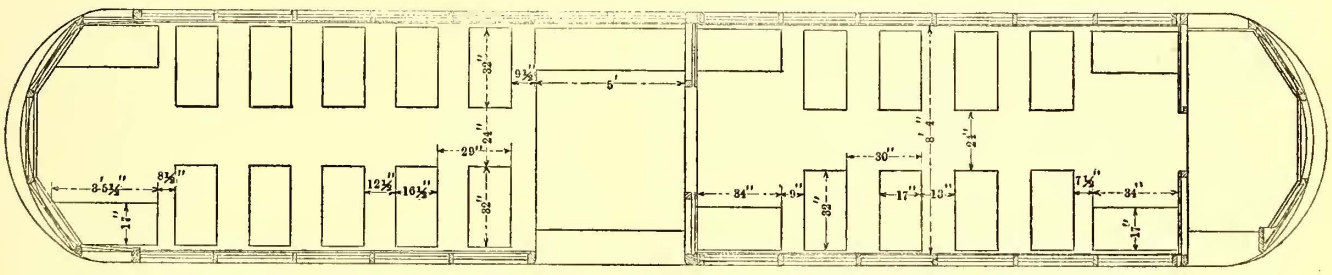
Some of the car bodies operated in Denver are mounted on a truck of entirely new design, evolved in the engineering department of the Tramway Company. The principal members of this truck are built of channel sections and the arrangement of parts conforms in general to the M. C. B. type of truck. The design has been carefully worked out with a view to obtaining minimum weight consistent with the necessary strength to support the motors and the car bodies. This type of truck has a wheel base of 4 ft. 10 in. and the cast-iron wheels used are 33 in. in diameter and weigh 475 lb. each. The driver axles are 4 1/2 in. and the idler axles are 4 in. in diameter. Without motors two trucks complete with wheels and fittings ready to run weigh 9400 lb.

With the exception of the 19 short, two-motor cars of Brill manufacture, operating on the Union Depot loop, all the cars in Denver are single-ended. Controllers and hand-brake handles, however, are placed on the rear end for emergency and switching use.

The special equipment operated by the company includes a double-end wrecking car, two "chartered" cars and a hearse car. The wrecking car is a substantially built, double-end, 35-ft. equipment, with four GE 58 motors and Brill trucks. This car weighs 18 tons without its load of emergency materials and appliances. It is provided with four push-pole pockets and a heavy underframing so that it may be used for wrecking purposes. Entrance to the body, which is undivided, may be had through two large sliding doors. The window sashes are filled with sheet steel, except at the vestibule ends. Inside of the car body is to be found a very complete equipment of tools, blocking tackle, etc., carefully placed on frames and racks. One end dash is provided with a movable panel so that poles or large timbers may be loaded into the body. The control equipment comprises two K-6 controllers with a specially high resistance so that the car may be operated slowly. Attachments are provided for mounting snowplows on either end, these attachments being designed to provide for the easy raising or lowering of the plows from within the car body. Braking power is had with a Peacock hand brake equipment.

The following tools and equipment are ordinarily carried on this car:

Double blocks with 200 ft. of 2-in. rope, 100 ft. of 2-in. rope, three blocks used for snubbing, 150 ft. of 1½-in. rope for loop to handle upset car or wagon, five No. 19 15-ton Barrett jacks, three No. 18 10-ton Barrett jacks, two small screw jacks, five 25-ft. chains with ⅝-in. links, one 15-ft. chain with ⅝-in. links, one 10-ft. chain with ½-in. links, one 8-ft. chain with ⅜-in. links, 10 grab chains with harps 4 ft. long. The car carries the latest type of replacers, beveled dutch-boards and large home-made dutch boards, also a stock of ties and 30-ft. rails with "stay-rods," 25 tunnel plank and a large quantity of blocking, two push-poles for moving wagons or cars, one wagon wheel with extra bushing in hub to fit any axle, four crowbars, four large chisel-bars, six small chisels, two sledges, three small hammers, one wood saw, one ax, one hack-saw (24 blades), one spike maul and spikes, one wire cutter, three monkey wrenches, two screwdrivers, wire jumpers, extension wire 50 ft. long on wooden pole, used for trolley in case car is beyond the reach of regular trolley pole, one track gage, one extra trolley base, stand and pole with rope, two "pick ups" for broken trolley wire, switch brooms, three shovels, two picks, four different types of king bolts, as well as a variety of other bolts, bolted clamp used for picking up broken iron axles on wagons, one extra cluster of 15 lamps with pole to hang on trolley wire in case of long detainment. Other illumination sources consist of 2-gal. kerosene torches. A "dolly" truck with a temporary track is carried. This is raised or lowered by blocks and small chain.



Denver City Tramway—Seating Plan of 1909 Type Car

An illustration is presented on Plate IX, showing the emergency car truck built at the company's shops and so designed that it can be coupled to the wrecking car and drawn to the scene of an accident and quickly used to replace a broken truck.

SHOP FACILITIES

The shopping and car-house facilities include a main repair shop plant known as the Broadway shops, a paint shop rebuilt from an old car house, and storage car houses at the operating centers of the north, east and west divisions. All car cleaning and inspection work, including light repairs and armature replacements, is carried on at the outlying car houses, but other shop work and all manufacturing of car parts are done at the Broadway shops.

On account of the rapid increase in the rolling stock equipment, necessitated by the growth of the city and the extension of lines to the new suburban districts, the railway company has outgrown its repair shop facilities. The best possible use is being made, however, of the limited quarters, and plans have about been completed for the construction of a modern shop plant to be located in the Argo subdivision north of the business district and within the city limits. The present shop includes many late designs of machine and other tools which can be moved to the new shops. With this equipment the Broadway plant, although crowded, is successfully fulfilling its part of the work by maintaining the company's cars in uniformly good condition.

The shop subdivisions are located in several adjoining buildings and the departments are organized as ordinarily found in railway plants which must maintain in the neighborhood of 400 cars. One bay of the main shop is set apart for truck overhauling work. In this bay are four 3000-lb. and two 1000-lb. air lifts, serving the five tracks. Repair work also is done in the open air over pits also equipped with air hoists.

There are five tracks in the wood shop, with entrances at either end of the bay. The equipment here includes the following tools, group-driven by electric motors:

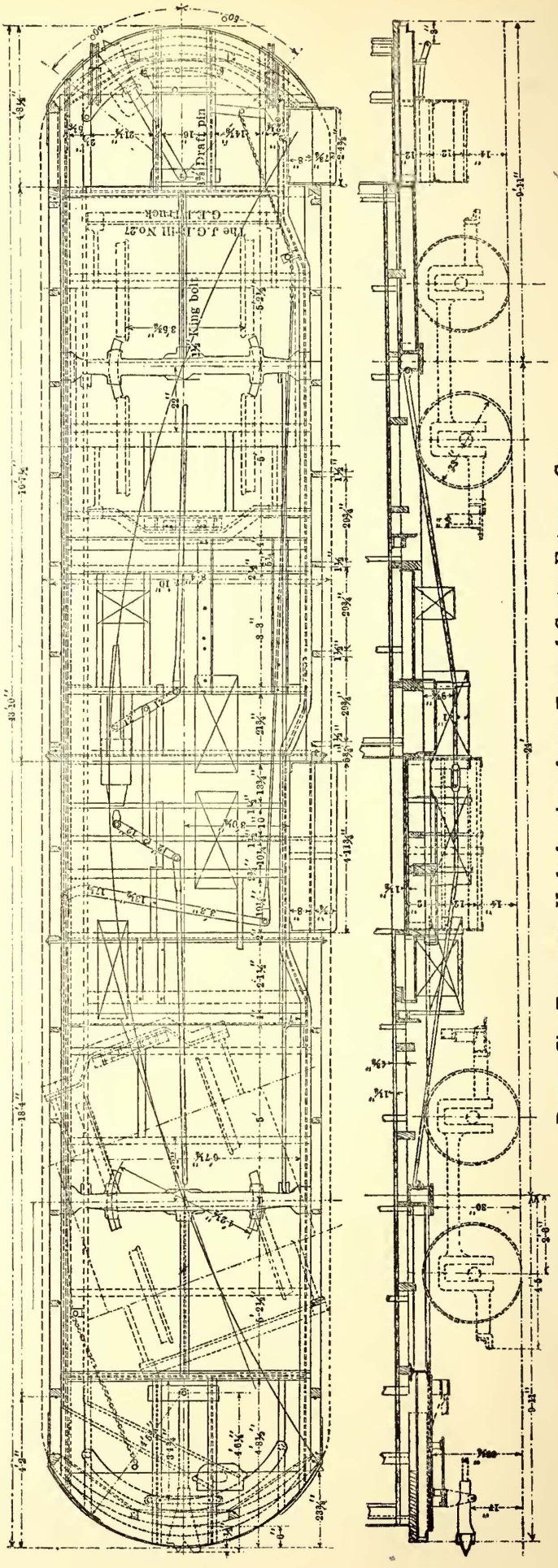
Fay & Egan double surfacer No. 140.
Fay & Egan 16-in. jointer.
Fay & Egan rip saw.
Hall & Brown 36-in. band saw.
Fay & Egan sand drum.
Motor-driven drill press.
Emery grinders.
Wood-turning lathes.
Double spindle shaper.
Mortiser.

The blacksmith shop has an especially modern equipment, including the following:

Williams, White & Company motor-driven double-punch and shear; capacity to shear 1½ x 10 in., capacity to punch 2½ x 1½ in.
2000-lb. Niles steam hammer.
1100-lb. Niles steam hammer.
350-lb. steam-operated hammer with foot-control attachment.
Air-operated bulldozer with 14 x 26-in. cylinder.
Two coke furnaces.
Six forges.

It is the usual practice to purchase old axles from the Pullman Car Company's plant in Denver and use the metal in these to make all forgings needed by the special track work construction shop of the tramway company located nearby. Some of the axles used on the company's cars also are hammered from old Pullman axles. A brass foundry with complete equipment for making all the castings used by the company forms one division of the shops.

The electrical department of the shop is housed in a brick building and has a complete equipment, including a system of overhead trolley hoists for handling electrical repair work. The company does all its own motor repairing and rewinds and manufactures its armature and field coils. Armature coils are wound on four Ford-Oliver winding stands and field coils on either of two American General Engineering Company's field coil stands or one that is homemade. Coils are insulated by submersion in an 18-in. x 24-in. tank filled with insulating compound. This tank has a strong cover so that when the coils are placed therein the shop air pressure of 80 lb. per square inch may be applied to the surface of the liquid, thus serving to impregnate the coils thoroughly. Field coils are baked before and after the application of the insulating compound in a bake oven built of brick standing on the shop floor. This oven is large enough to allow the workmen to walk inside and give the coils close attention. Heat is supplied by car heaters mounted below an iron checker-plate



Denver City Tramway—Underframing of 1909 Type of Center-Entrance Car

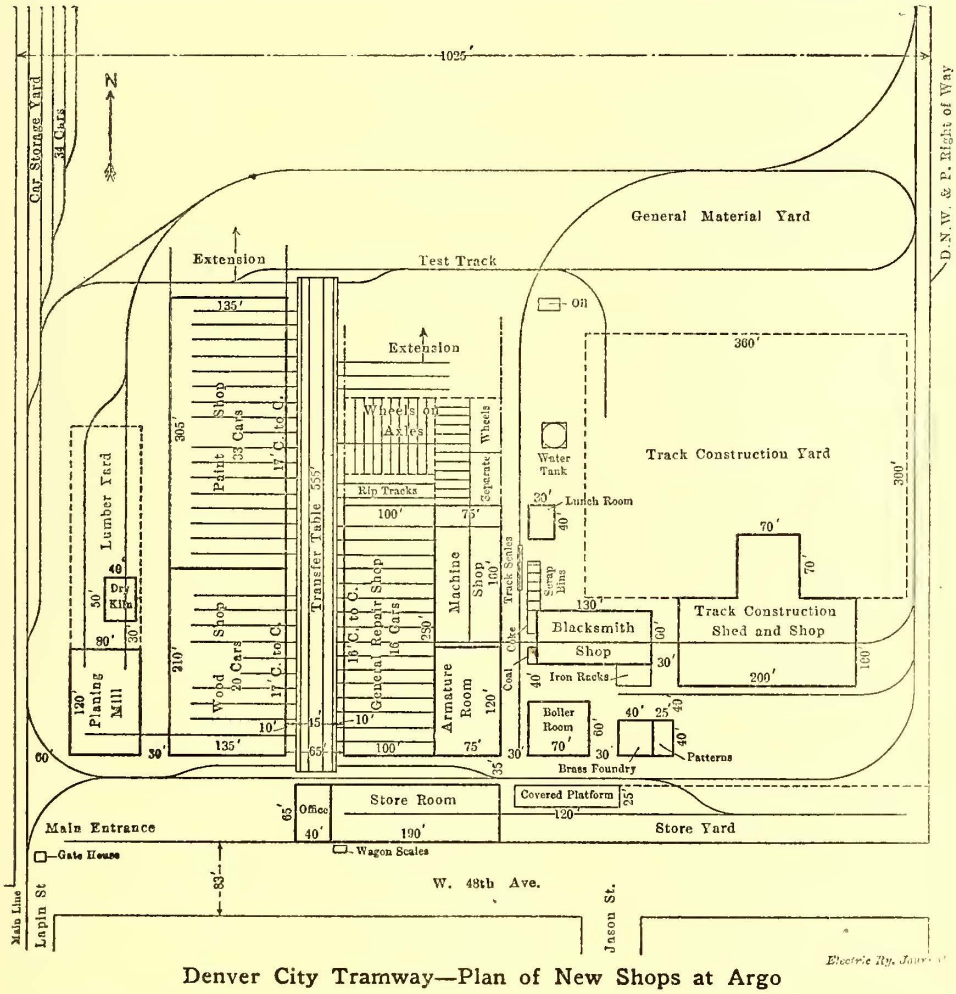
floor and vent pipes are provided to carry off waste gases. A temperature of 175 deg. is maintained within the bake oven. The supply of compound for dipping coils is kept in a tank enclosed in a house built of transite board and angle irons. This house is located outside of the electrical shops. Additional equipment in the electrical shop includes two good lathes on which the commutator and bearing work is done, an American General Engineering Company's banding machine, and a coil taping machine.

STOREKEEPING DEPARTMENT

The five car houses and shops located throughout the city of Denver together with the power houses and track construction work are all supplied with stores from a central stockroom and yard located at the Broadway shops. The method of distributing stock is as follows: On Monday of each week requisitions are made for supplies withdrawn from the small local stocks during the previous week. These requisitions are filled and the materials delivered on Thursday of the same week, the deliveries being made on flat cars pulled by work cars ordinarily used in handling track construction. The supplies needed for special jobs and for keeping complete the stock in the central store room are ordered of the purchasing agent on a requisition blank which includes spaces ruled for indicating quotations made by various supply dealers.

Shipments of supplies received at the stock room are acknowledged by a "goods received" slip made out in triplicate, the storekeeper's office retaining one copy, the delivery man a second and the third being kept in a book as a stub for reference. A record of all materials thus received is kept in a book 22 1/2 in. x 18 in. ruled to indicate the source of supply and to automatically distribute the cost in accord with the shop accounting system. A very complete description of the accounting methods of the storekeeping department was presented in the ELECTRIC RAILWAY REVIEW for Jan. 12, 1907, page 40. This system is such that each month an intelligent statement of all the business done by the storekeeping department can be rendered by it to the auditor. The statement makes available the stores accounts, distributed as to operating expense, construction expense, balance on hand, etc. When the information thus exhibited is checked by the auditor the storekeeping department balances its ledger in which all materials received are debited to the material and stores account and all disbursements are credited to the same account, the balance thus showing the stock on hand. A special book is kept for recording the material used for and costs of articles manufactured in the company's shops. By carefully entering up the items of material and labor in this book the net costs are obtained for goods returnable to the store room stock.

For several years past the expense of maintaining the storekeeping department, including the costs of the office work and the handling and care of the materials, has averaged about 1 per cent of the total value of the materials handled by the department. During the past 10 years it is said that the semi-annual inventories have each balanced within $200 of the correct amount as shown on the auditor's books, and three such inventories have shown such a slight variation that no adjustment was necessary in the auditor's office.



Denver City Tramway—Plan of New Shops at Argo

TRANSPORTATION FEATURES

The Denver City Tramway has in daily operation 242 regularly scheduled cars and also operates 28 trippers, hourly interurban cars to Leyden and Golden, two sightseeing cars and a funeral train. The immediate control of the operation of all cars is centralized at a loop station located in the heart of the business district of Denver. On the property adjoining this station are buildings containing the offices of the superintendent of transportation and his assistants, the train dispatching office, headquarters of the overhead line department, emergency houses, lost and found department, and the transfer issuing and receiving stations. The careful detail with which this system of operating practically all cars through a "central loop" has been developed is especially worthy of the consideration of those not acquainted with the excellence of Denver's electric railway service. The headway through this station is 15 seconds.

The facilities at the central loop include a long ornamental shelter shed with loading tracks on either side. Each of these tracks branches two ways at each end and switches also lead to side tracks so that disabled cars may quickly be shunted over an emergency repair pit and the headway not be disturbed.

DISPATCHING

During the past 17 years a system of dispatching street cars by telephone from the central station has been successfully followed out in Denver. On account of the arrangement of central-loop tracks and nearby through tracks in the business center of the city the lines of the Denver City Tramway Company are particularly well adapted to being handled by a dispatcher, with his office located at the central loop. The telephone dispatching system affords the superintendent the greatest facility for keeping in touch with every detail of the operation of the cars. Should an accident occur the particulars are communicated at once to the dispatcher and no time is lost in summoning the necessary officials, city ambulance or wrecking crew. In case a car should become disabled the crew can immediately notify the dispatcher and ascertain means for obtaining the quickest remedy. The flexibility of the car service and the rapidity with which it enables the dispatcher to adjust the headway on any line are the strongest points in favor of this telephone system. In every city the condition of travel demands the addition of extra cars on most lines at certain periods of the day, usually in the morning and late afternoons. By means of the telephone system the dispatcher can so space his cars that trippers can be put out without confusion and at night when the extras are withdrawn the dispatcher again can equalize the spaces between cars as fast as the trippers go to the depots. Any congestion of cars caused by accident or blockade also may be adjusted without difficulty in the same manner.

The Denver City Tramway has a regular method of "pulling down" the lines at night, but if the dispatcher finds that the travel on any line is such as to demand increased service he may hold the full quota of cars and if necessary use cars which are not needed on other lines. In this way through the agency of but one man, who is enabled to keep fully alive to the needs of the patrons on all lines, the service is reduced to a minimum.

A view of the dispatching station located in the group of buildings at the central loop is shown on Plate XI. The dispatching circuits are operated in the same way as a party line, each circuit having from two to four reporting telephones of different car lines. There are 30 lines in all and care has been taken not to put two busy telephones on the same circuit.

A train sheet 26 x 24 in. in size is used. This sheet is ruled with spaces for the car numbers of all lines and for noting the leaving time of each car from the reporting stations. After a car has been switched at the end of the line the conductor calls the dispatcher from a nearby telephone instrument and tells him the number of his car and the name of the line on which he is running. Aided by his familiarity with the running time and his experience in making quick computations the dispatcher announces without hesitation the proper leaving time of the car. The motorman then repeats this time and receives the dispatcher's O.K. before departing. At the same time the dispatcher records on the train sheet opposite the car number the time of leaving. The running time of all lines and the time allowed for running between given points along the line, are published for the benefit of all trainmen. As soon, therefore, as the motorman receives the leaving time at one terminal from the dispatcher and the conductor, he knows at what time his car is due at the other terminal and just when his car should pass the "time points" along the route.

The records of the train sheet prove valuable in many ways especially when it is necessary to gather information regarding an alleged accident. The train sheets are also valuable for use in the auditing department.

TRAIL CAR OPERATION

The successful operation of trail cars in Denver clearly illustrates that during rush hours there appears a marked advantage as regards freedom from accidents to passengers and employees. This freedom undoubtedly is largely due to the use of a uniform number of car units on the street during the entire day. During the rush-hour period the uniform headway is especially noticeable in contrast with the plan of single-unit operation when the downtown districts of most cities are crowded with single cars running on much shorter headway than exists during the middle part of the day. By using trailers to accommodate the peak traffic with trains on the same headway that exists during the entire day all cars are operated by motormen well acquainted with their work and the usual plan for meets and stops is not interfered with. Again, there is only one train unit (consisting of two cars) to move through a crowded street in contrast with two units, the second one of which frequently is manned by an inexperienced crew. Thus the regularity of headway and the use of experienced crews helps materially to lessen the accident costs. The total accident and claim cost of the Denver City Tramway does not exceed 1.4 per cent of the yearly gross receipts.

The use of trail cars introduces a much desired economy in the original cost of rolling stock and in its maintenance costs when the design of motor and trail cars are satisfactory. In Denver the motor cars seating 52 passengers, cost about $6,000 each and the trail cars, seating 46 passengers, cost $2,000 each. Thus, if the road has a sufficient number of motor cars to fulfill its regularly midday schedules a considerable original investment is avoided by the purchase and use of trail cars so designed that they can be operated behind the regular motor cars. Insurance charges also are lessened, which saving, combined with the reduction in interest charge on idle investment, make a sum worthy of consideration.

It is stated that the Denver trail cars although practically always fully loaded when in operation, and although stored out of doors at other times, cost less than one-tenth as much to maintain as do motor cars. This advantage is largely brought about by the especially low weight of 282.6 lb. per unit seating capacity of the Denver type trailers.

About two years ago the engineering department in Denver made a detailed investigation of the power consumption required for operating certain lines with single motor cars and with motor cars hauling trailers during the rush hours. The approximate load at the switchboard as determined for the three types of cars used in Denver was as follows:

	Kw-hour per car-mile.
Two-motor car, seating 48 passengers	2.0
Four-motor car, seating 52 passengers	3.5
Trailer car, seating 46 passengers	1.25

Accompanying these figures, which were published in the Electric Railway Review for May 4, 1907, was a statement that during a full year the average power consumption per car-day for the entire system, including all cars, was 405 kw-hours. The average consumption for the same period was at the rate of 2.32 kw-hours per car-mile and the cost of current at the power-station switchboard was 0.66 cent per kw-hour. This detailed investigation of power costs extending over a period of 30 days and including readings on a large number of cars, showed that the use of trail cars, for handling double the load carried by motor cars, required but from 27 to 41 per cent additional power. Thus it is seen how effective the use of trail cars may be in reducing the peak load on power generating equipment.

The use of trail cars also reduces the cost for platform ex-

pense. In Denver the average cost for platform employees on a motor car is 50 cents per car-hour. With the addition of a trailer the passenger carrying capacity may be doubled at an increase of but 25 cents per hour.

METHOD OF TRAILER OPERATION

The regular rush-hour schedules require the use of 25 trailers. During the middle of the day these trail cars are stored in trains at the car houses which happen to be situated at about the midpoints on the lines on which trailers are used. Just before the rush-hour period a train of trailers is taken to a siding close to the line on which the motor cars are operated so that when the loads on the motor cars increase and instructions are given, the trail cars can be attached quickly to the motor cars as they pass. This work of coupling has so been systematized that it is found that trail cars can be attached to motors on lines having four-minute service without any derangement of the headway and with no additional time allowance. All motor and trail cars are equipped with Tomlinson radial couplers and Westinghouse schedule S M E air brakes.

The flexibility of this system of trailer operation is further illustrated by the statement that on some of the long city lines the motor cars haul trailers for only a portion of their routes and on one line in particular, through the medium of the telephone dispatching system, the service is adjusted to satisfy the needs of the traffic by using six trail cars in connection with ten motor cars.

SCHOOLROOM

All motormen before being placed on a car are given a course of instruction in a schoolroom located in the group of buildings at the central loop. The course of instruction includes training a man to understand his duties as fully as possible before he is sent out on the road with an instructing motorman. The equipment of the schoolroom includes dummy car fronts with complete control, brake, headlight, cut-out and lighting apparatus. All the important parts of the overhead circuits also are mounted in the room. In the course of his instruction the best methods of avoiding accidents are discussed with the student and he is shown how to use the brakes and sander most effectively and also how to quickly trip the fender. The principle underlying the instruction given in this school is calculated to impress upon the learner the practical workings of the machinery and apparatus under his charge and the necessity for strict economy in its operation. He is made to understand, also, that his first thought must be for the safety and comfort of his passengers and that he must exercise gentlemanly courtesy toward all. After a course in the schoolroom under a competent teacher the man is placed under the guidance of an experienced motorman on a car and he is invited and expected to return to the instruction room for information on any subject which may come to his notice during his working experience.

SPECIAL CARS

A hearse car is operated in connection with one of the motor parlor cars owned by the company. The running time to the city cemetery is about 30 minutes from the loop and the charges made for funeral and special car service are given on the accompanying table.

RATES FOR FUNERAL AND SPECIAL CARS—CITY SYSTEM

Funeral Car—Maximum time for trip, 3 hours, $12.
Funeral Train—Maximum time for trip, 3 hours, $25.
Overtime, $4 per hour.
Special Car—First hour, $6; and $4 per hour thereafter.
For any car run after midnight, minimum price is $10. Waiting time of $2 per hour will be charged for car laying over.
Illuminated Car—First two hours, $12, and $4 per hour thereafter.
Charges are computed from time car is ordered at starting point until surrender at final destination.
To Littleton or vicinity, single car, round trip, $20. Train, $30.
If cars are held awaiting return of party, charge of $2 per hour per car, or $3 per train will be made.
Funeral Car or Train, same as above, except that no waiting time will be charged while party is conducting burial service.

INTERURBAN SYSTEM

	Car.	Train.
Funeral Cars:		
Denver or Leyden, to Olivet	$25	$35
Arvada or Golden, to Olivet	20	30
Golden or Leyden, to Denver	25	35
Arvada, to Denver	20	30
Special Car or Train, Denver to Golden, Leyden or for any 3-hour trip	25	35
Running Time, exceeding 3 hours	4	7
Waiting Time, if time of trip consumed more than 3 hours	2	3

In all cases not enumerated above, the charge for trailer should be 60 per cent of the motor-car charge.

The emergency equipment kept at the central loop includes the wrecking car previously described, a wrecking wagon and a fire wagon.

The wrecking wagon is used in the city for quick calls, such as those resulting from cars off the track or disabled in any way, wagons broken down or stuck on the track. It is equipped with drop harness, making the process of hitching very rapid and easy. The horses stand in stalls facing the pole at all times. The wagon is built very strongly, weighing about 1800 lb. empty and about 4000 lb. when loaded. It has two side boxes for tools, replacers and chains. The center of the wagon box is used for carrying jacks and blocking. A wagon wheel equipped with a false bushing to fit any axle from 1 1/2 in. to 3 3/4 in. in diameter is secured in a pocket on the front end.

The fire wagon is 11 ft. long, 4 ft. 6 in. wide and weighs about 1800 lb. It carries four bridges at all times, six others remaining in reserve at the barn—sufficient equipment to bridge 20 hose lines in case of big fire. The wagon is equipped with quick touch, drop harness. Alarms are transmitted to the company's fire crew by the dispatcher, who gets the signal simultaneously with the fire departments over the city's system.

DENVER TRAMWAY MUTUAL AID ASSOCIATION

The Tramway Mutual Aid Association of Denver was organized through the efforts of the officers of the Denver City Tramway Company and its employees in July, 1903. The object of the association is to provide life insurance and aid the unfortunate employees of the company who are disabled through sickness or accident.

During the first 30 days of the organizing period 411 employees became members of the association without having to pass a physical examination. Since that time the membership has increased to 798. On July 1, 1909, the total insurance carried by the members was $615,375, which amount was fully guaranteed by the Denver City Tramway Company. The company also pays all of the running expenses of the association and annually pays into the disability fund a sum equal to one-fourth of the amount of money collected as dues from the men.

The membership of this association is divided into three classes. The class to which an employee is eligible is regulated by the salary he receives, the only exception to this rule being that relating to trainmen who, at the time of joining the association, may elect the class to which they desire to become members. The following are the classes:

Class 1—This class is made up of employees who receive

a monthly salary of $80 or over. The monthly dues for this class are $1 and in case of disability the members receive a benefit of $6 per week. In case of death $1,000 is paid to the heirs.

Class 2—This class is made up of employees who receive a monthly salary of $60 and less than $80. The monthly dues for this class are 75 cents and in case of disability the members receive a benefit of $4.50 per week. In case of death $750 is paid to the heirs.

Class 3—This class is made up of employees who receive a monthly salary of less than $60. The monthly dues for this class are 50 cents and in case of disability the members receive a benefit of $3 a week. In case of death $500 is paid to the heirs.

The benefits referred to in these three classes are applicable only to employees who become members before they are 41 years of age. Employees who join the association between the ages of 41 years and 51 years are allowed 75 per cent of the death benefit. Members who join after they are 51 years of age are allowed 50 per cent of the death benefits of their class.

Members may double the death benefit by paying double the monthly dues for their class. This, however, does not double their disability benefit.

The annual report of the association issued on June 30, 1909, showed the membership of the three classes and the insurance carried by each class to be as follows:

Class 1—428 members, insurance	$415,750
Class 2— 73 members, insurance	52,875
Class 3—297 members, insurance	146,750
Total, 798 members, insurance	$615,375

The annual statement for the year ending June 30, 1909, shows the association to be in a satisfactory financial condition. The statement follows:

Receipts—		
From members	$7,761.95	
From the Tramway company	1,939.60	
From interest on bond investment	779.17	
		$10,480.72
Disbursements—		
Disability benefits	$2,232.06	
Five death benefits	4,250.00	$6,482.06
Net gain for year		$3,998.66

The *Tramway Bulletin*, a small magazine published by the Denver City Tramway Association, is the official organ of the Tramway Mutual Aid Association.

PENSION DEPARTMENT

The Denver City Tramway Company has an employees' pension department. Any employee who gives his entire time to the service of the company is eligible to a pension. The pensions as provided for are divided into four classes as follows:

1. All officers and employees who shall have attained the age of 70 years, and who shall have been 25 years or more in the service.
2. All officers and employees, 65 to 69 years of age, inclusive, who shall have been 25 or more years in the service, and shall, in the opinion of the board of officers, have become physically disqualified.
3. All present employees of the company who shall attain the age of 70 years, and who shall have been 15 years or more in the service, and shall, in addition, be members in regular standing of The Tramway Mutual Aid Association.
4. All officers and employees 65 to 69 years of age, inclusive, who shall have been 15 years or more in the service, and shall, in addition, be members in regular standing of The Tramway Mutual Aid Association, and who, in the opinion of the board of officers, have become physically disqualified.

The pension allowances paid monthly are on the following basis:

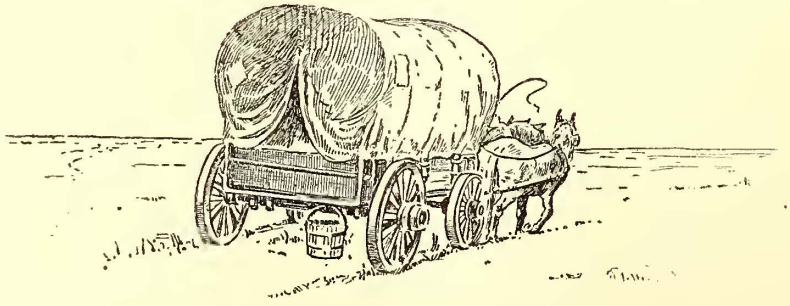
Twenty-five dollars a month pension to all uniformed em ployees in the regular train service of the company.

Twenty-five dollars a month pension to all employees who shall have received average monthly wages of $80 or more, during the 10 years immediately preceding application or recommendation for retirement.

Twenty dollars a month pension to all employees who shall have received average monthly wages of $60 or more, to $79, inclusive, during the 10 years immediately preceding application or recommendation for retirement.

Fifteen dollars a month pension to all employees who shall have received average monthly wages of less than $60 during the 10 years immediately preceding application or recommendation for retirement.

The authorized amount of money to be spent in any one year has been fixed at $18,000.

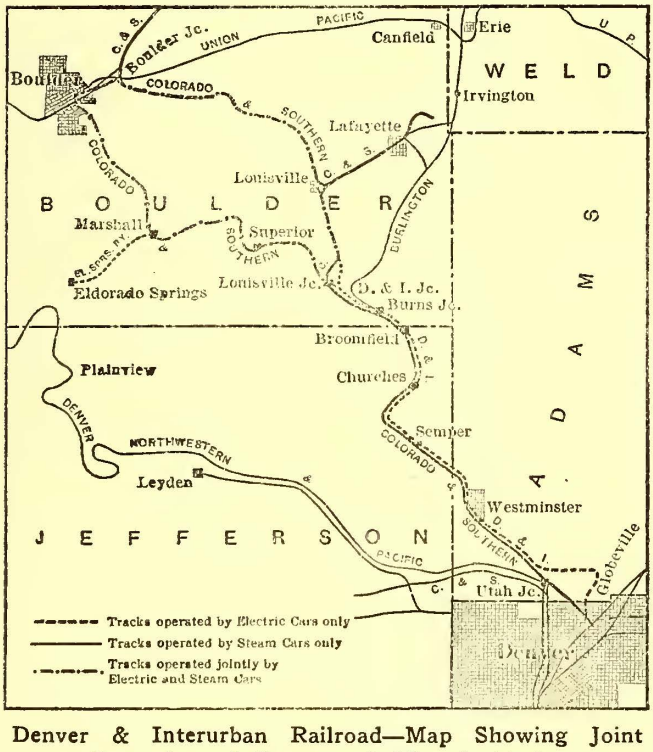


INTERURBAN ROADS OF COLORADO

THE DENVER & INTERURBAN 11,000-VOLT RAILROAD

THE Denver & Interurban Railroad is an electrified division of the Colorado & Southern Railway system between Denver and Boulder, Colo., which has been equipped for operation with 11,000-volt. alternating current. A general description of the methods used in the catenary trolley construction on this road appeared in the ELECTRIC RAILWAY JOURNAL for Sept. 5, 1908, page 595. Some of the more novel and interesting operating features to be found on this property will be described in the following pages.

Electric operation over this line was begun on June 23, 1908. Prior to that time the Colorado & Southern Railway,



Denver & Interurban Railroad—Map Showing Joint Operation of Steam and Electric Trains

which is affiliated with the Burlington system, operated frequent steam train service between Denver and Boulder, Colo. These trains were operated over a single track from Denver to Louisville Junction, and from there over either of two tracks to Boulder. A branch line from the southern one of these two routes between Louisville Junction and Boulder extended 3 miles southwest to El Dorado Springs, where a popular watering place and summer resort has been developed at the mouth of South Boulder Canyon.

During the work of electrification that section of the road between Globeville, at the north city limits of Denver to Louisville Junction (see map) was double tracked, and one of these tracks equipped for electric service. From Louisville Junction northwest the tracks divide to follow two routes which are jointly used by the electric passenger trains and the steam passenger and freight trains to Boulder. From Globeville the electric trains reach the Denver terminus at Sixteenth and Arapahoe Streets over standard-gage city tracks of the Denver City Tramway Company. The distance from the city terminal to Globeville is 4.26 miles and from Globeville to the junction point from whence the two routes extend to Boulder, 15.23 miles. From this junction point to Boulder via the southern or Marshall route, the distance is 13.24 miles and via Louisville, the northern route, 13.04 miles. The El Dorado Springs branch leaves the through line at Marshall and is 3.3 miles long. The through electric passenger trains are routed from Denver to Boulder over one route going and over the other returning. The entire line from Globeville to the city limits of Boulder is operated with 11,000 volts on the trolley. The section of the route through the built-up portion of Boulder, 1.78 miles long, is fed with 500-volt direct current and direct current is also used within the Denver city limits. In one round trip a car operates for 54.97 miles on 11,000-volt trolley and for 10.3 miles on direct-current trolley.

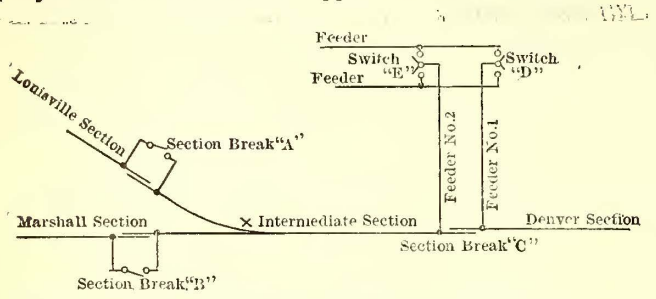
The track construction throughout is according to the standards used for the Colorado & Southern Railway and is laid with 70-lb. and 80-lb. steel rails electrically connected with No. 0000 Protected rail bonds. On account of joint operation with heavy steam passenger and freight trains, both narrow and standard gage, the track is well maintained. Views on Plate XII show the character of the roadbed. The ties for the entire distance are ballasted with slag which was blasted from the waste pile of the Globeville smelter. In the 13 miles from Globeville to Louisville Junction there are 102 crossings with irrigation flumes or pipes. The maximum grades on the main line are about 1.25 per cent., while the branch line to El Dorado Springs, which has an elevation of 6,000 ft., is nearly all on a grade of 2 per cent, compensated on curves.

POWER DISTRIBUTION

The power distribution system is the most interesting feature of the Denver & Interurban Railroad. Power for the operation of all the cars is furnished by the Northern Colorado Power Company from its steam generating station at Lafayette, near Louisville. Two feeders connect the generating station with the feeding-in switches located near the center of the route and at the point where the line from Denver divides to follow two routes to Boulder. Switching arrangements are provided so that either or both of the two feeders may be used to supply current to one or all of the three trolley legs.

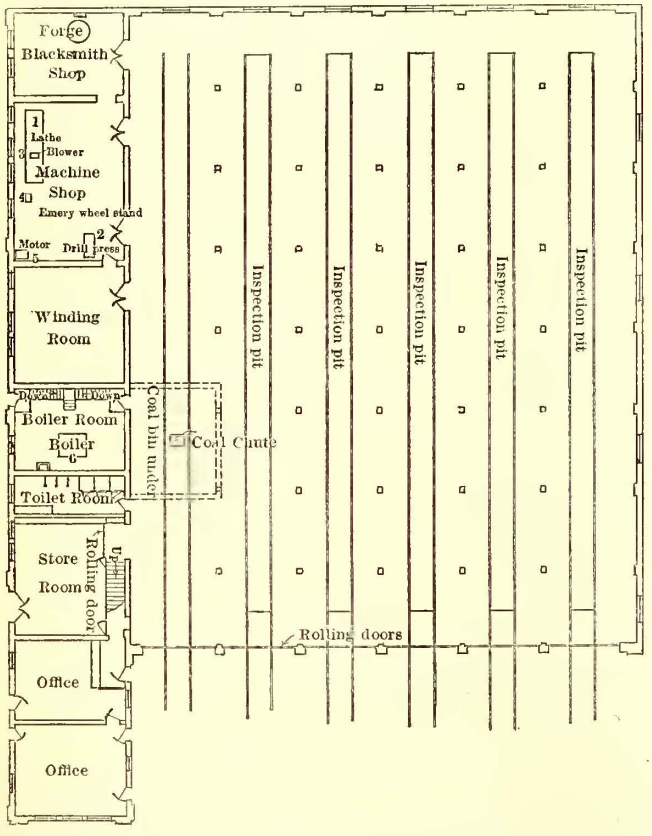
The 11,000-volt 25-cycle operating current is fed to the cars through a catenary supported No. 0000 "phono-electric" trolley wire carried 22 ft. above the running rail and supported by a Bessemer steel cable 7/16 in. in diameter. No additional feeders are required. The messenger cable is carried on Thomas porcelain insulators supported by angle-iron brackets. The poles are spaced 120 ft. apart on tangents and guyed to Matthews' anchors. On curves the poles are set sufficiently close so that pull-offs need not be used. Porcelain insulation is provided in spans and strand wires wherever used. A ground wire consisting of 7/16-in. stranded galvanized steel cable is strung over the pole tops for the entire length of the line. This ground wire affords a cheap and convenient means for grounding the brackets, it affords effective lightning protection and serves as a continuous return circuit in addition to the bonded and cross-bonded

track rails. The overhead ground wire is connected to the tracks at every fifth pole and the track is provided with ground plates. Westinghouse, Church, Kerr & Company were the contractors on the catenary construction and also built the power plant of the Northern Colorado Power Company from which current is supplied to the railroad.



Denver & Interurban Railroad—Diagram of Switching Connections at Feeding Point on 11,000-Volt Trolley

A map is presented showing the trolley wire and feeder layout. The switching scheme at the junction point where the feeder lines from the power plant are connected with the trolley wires is shown in diagram. Section-breaks are placed at an average distance of 3 miles and are located at passenger stations where someone is always on duty. The a.c. line is subdivided into 12 sections by these breaks. Special a.c.-d.c. section breaks are installed at Globeville and at Boulder, where the 11,000-volt a.c. catenary trolley joins

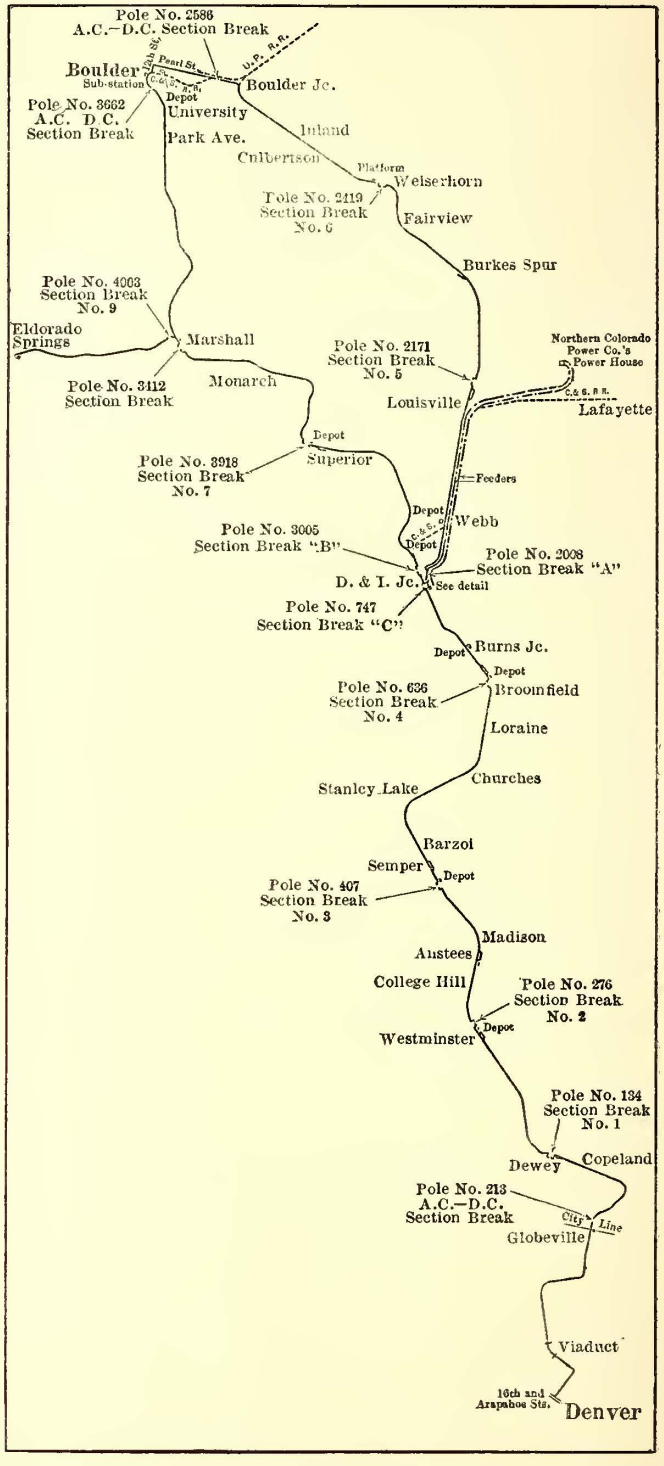


Denver & Interurban Railroad—Floor Plan of Denver Car House

the 550-volt d.c. trolley. At the a.c. section breaks the trolley wires overlap so that there is no interruption in current fed to a car under normal conditions.

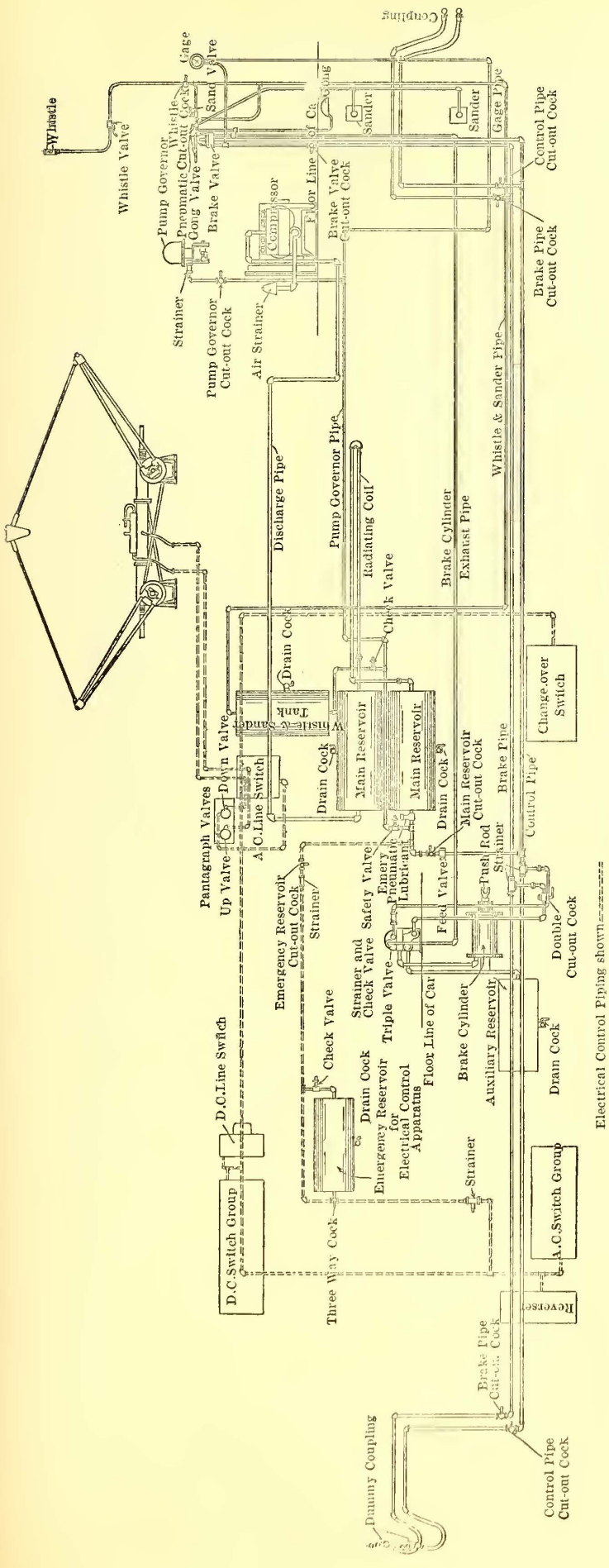
Specially constructed trolley derailers form a part of the overhead structure at the ends of the d.c. sections. These trolley derailers are so designed and placed that should the car crew neglect to pull down the trolley pole as a car enters the d.c. section the wheel would be thrown from the wire and the pole automatically lowered by the retriever before it could come in contact with the 11,000-volt catenary.

Local conditions made it necessary to operate the cars with direct current for 1.78 miles through Boulder and a motor-generator substation is provided to supply the power. The



Denver & Interurban Railroad—Map Showing 11,000-Volt Trolley Sections

substation equipment is installed in a substantial fireproof building located close to the track in the western edge of the city. The equipment of the substation includes a 300-kw General Electric synchronous motor-generator set with a compensating transformer which receives current through a feed wire connecting with the 11,000-volt trolley and delivers it at 2300 volts to the synchronous motor.



Electrical Control Piping shown

Denver & Interurban Railroad—Diagram of Air Piping for Motor Car

ROLLING STOCK

The rolling stock equipment of the Denver & Interurban includes eight motor cars, four trail cars with bodies of the same design as the motor cars and two Colorado & Southern passenger coaches used as trailers. The interurban passenger car bodies were built by the St. Louis Car Company and are mounted on especially heavy trucks built by the American Locomotive Company. These trucks which have a load-carrying capacity of 38,000 lb. at the center plate, were illustrated and described in the ELECTRIC RAILWAY JOURNAL for Oct. 3, 1908.

The motor car bodies are 55 ft. 6 in. long, 10 ft. wide and seat 60 passengers. The trailer cars are 53 ft. 10 in long, 10 ft. wide and seat 58 passengers. The weight of a motor car body without load is 46,000 lb. The underframing is of structural steel and the body framing of wood. The structural steel underframe is entirely covered with a floor of steel plates which are used as a protection against fire. The roof of the car is covered with sheet metal which is electrically grounded to serve as a protection against fire in event of low trolley wire. The interior of the car bodies is trimmed with mahogany.

The car bodies are subdivided into a motorman's cab, a baggage compartment and a general passenger compartment. End doors are provided for train operation. The motorman's cab has a side window. Located in this cab, in addition to the electrical and brake control apparatus, is a switch cabinet and the 1/6-hp 110-volt a.c. 14-volt d.c. dynamotor for charging the control storage battery while operating on a.c. trolley. The a.c.-d.c. motor-driven air compressor also is located in the cab. Above the motorman's head is a rack containing red and green fusees, flags, four marker lanterns, two red and two white hand lanterns, two extra lantern lenses and a supply of torpedoes.

Washburn M.C.B. type couplers are provided on all motor and trailer coaches. The platforms of the steam railroad coaches used as trail cars have been extended so that they have round ends and these couplers are installed with radius bars to support them when rounding city curves. On a portion of the equipments the multiple-unit train-line coupler head is carried on top of the coupler knuckle.

In the rear of the cab is a baggage compartment with a large door on either side of the car. This compartment is finished in mahogany and has drop seats which will accommodate eight people. A swinging door leads from the baggage compartment to the smoking compartment in which are four fixed and four reversible green Pantasote upholstered seats with mahogany arm rests. Another swinging door leads from the smoking compartment to the main compartment, which has four fixed and ten reversible seats of the same type. A toilet room is provided at one end. The aisle space is covered with heavy rubber floor mats. The step openings on the platforms are covered during running with spring-actuated trap doors.

The electrical equipment of these cars is of particular interest because it is the first used in the West for operating with both 11,000-volt alternating current and 550-volt direct current. Each motor car has four Westinghouse 148-A 125-hp motors with a control equipment for train operation. Current is collected from the 11,000-volt line with a Westinghouse air-operated pantograph and from the d.c. line with an ordinary trolley wheel and pole. The control equipment was supplied by the Westinghouse Electric & Manufacturing Company and in general conforms to its electro-pneumatic unit-switch system.

The 11,000-volt current is taken from the pantograph trol-

ley to an oil-insulated double-break electrically operated line switch and thence to the primary of an auto-transformer carried under the car and thence to ground. From the secondary of the auto-transformer eight taps are taken to supply running current at graded voltages. This current, before being fed to the motors, is passed through preventive coils and through the group of unit switches. Separate switch groups are provided for the a.c. and d.c. motor control. The train-line cable carries 12 wires.

The air-brake equipment for these cars is the schedule AMM of the Westinghouse Traction Brake Company, which includes automatic features for train operation. An engraving presents the details of the piping layout for the air-brake apparatus. In the lubrication of the moving parts of the air-brake system of these cars and the moving parts of the unit-switch system excellent results are said to have been had by the use of the Emery pneumatic lubricator, which is manufactured by the Emery Pneumatic Lubricator Company, St. Louis, Mo.

This lubrication system consists of a receptacle fitted into the pipe system in the outlet pipe from the main reservoir containing a stick of lubricant having its lower end exposed to the action of air passing into the pipe system. The composition of the stick of lubricant is such that it is gradually dissolved by the moisture contained in the compressed air and thereby is carried through the entire pipe system, reaching and lubricating all bearing surfaces of feed, brake and triple valves and brake cylinders. The lubricating stick is placed in a tube having its lower end composed of brass wire netting and the amount of surface of the lubricant exposed to the air can readily be adjusted. The stick feeds by gravity, being controlled by the frequency of brake applications and the amount of moisture contained in the compressed air, as well as the amount of exposure to the air current.

In connection with the electric-pneumatic control system for operating the multiple unit there are 28 valves and 22 cylinders on each car, and while the service is very severe, including many stops and covering 5000 to 6000 miles per car each month, there are said to have been no failures whatever in regard to automatic lubrication.

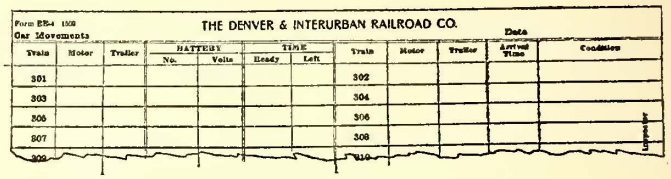
The principal features of the motor cars of the Denver & Interurban Railroad Company are as follows:

Length, 55 ft. 6 in.
Width, 10 ft.
Seating capacity, 60
Body, wood
Underframe, steel
Interior trim, mahogany
Air brakes, Westinghouse A M M
Axles, 6 1-2 in.
Bolsters, cast steel
Brakeshoes, Diamond S flanged
Control system, Westinghouse electro-pneumatic
Couplers, Washburn
Curtain fixtures, Forsyth
Curtain material, Pantasote
Door hangers, Duner
Hand brakes, Peacock
Heating system, Consolidated electric
Headlights, Crouse-Hinds a.c.-d.c.
Journals, 1-2 in. x 9 in.
Journal boxes, Franklin
Motors, four Westinghouse 148-A
Pilot, locomotive type
Registers, Ohmer
Roof, sheet metal
Sanders, Lintern
Seats, St. Louis Car Company
Seat material, pantasote
Springs, Railway Steel Spring Company
Step treads, Mason safety
Trolley retrievers, Lord No. 4
Trolley base, Nutall and pantograph
Trucks, American Locomotive type A
Wheels, Standard rolled steel, 38-in.

Weights—
Car body light 46,000 lb.
Air and electrical equipment (except motors), 15,000 lb.
Trucks without motors, 13,900 lb.
Total weight without passengers, 117,000 lb.
Total weight trailer without passengers, 66,250 lb.

The inspection and repair shop, where all car work is done, is located in Denver and comprises a rectangular shaped building with a row of shop rooms and offices on one side and a general inspection and repair bay with six tracks, five of which have pits and all of which are of sufficient length to accommodate two cars. The building is of brick with a concrete floor and a mill-type roof. Yard tracks are provided for storing the trailers. The car-house door openings are fitted with Kinnear rolling steel doors.

The southern section of the building is entirely enclosed and subdivided with brick partitions. The subdivisions are used as follows: Offices of electrical engineer and trainmaster; store room, toilet room, boiler room, winding room, machine shop and blacksmith shop. The coal bin for the boiler room extends below one of the car-house tracks and a chute is provided so that fuel may be unloaded by gravity from hopper-bottom coal cars.

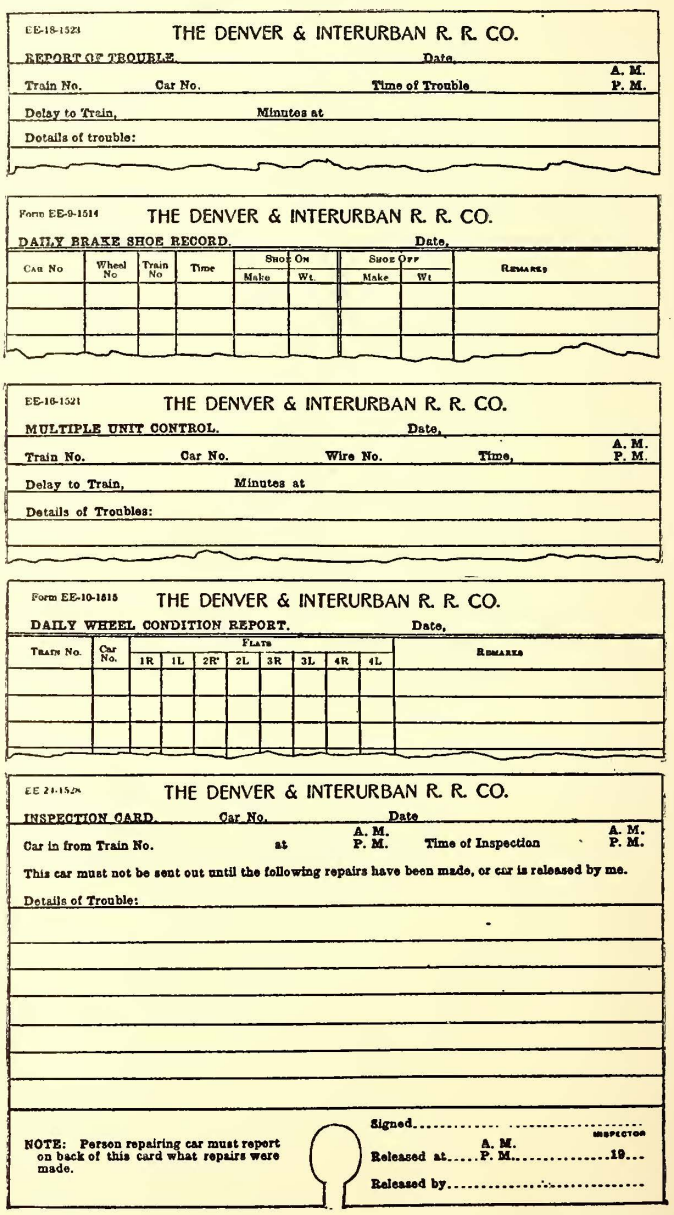

THE DENVER & INTERURBAN RAILROAD CO.

Car Movements

Date

Train	Motor	Trailer	Battery No.	Battery Volts	Time Ready	Time Left	Train	Motor	Trailer	Arrival Time	Condition
301							302				
303							304				
305							306				
307							308				
309							310				

Denver & Interurban Railroad—Car Movement Record (Original 8 in. x 5 in.)


EE-18-1523 THE DENVER & INTERURBAN R. R. CO.

REPORT OF TROUBLE. Date,

Train No. Car No. Time of Trouble A. M. P. M.

Delay to Train, Minutes at

Details of trouble:

Form EE-9-1514 THE DENVER & INTERURBAN R. R. CO.

DAILY BRAKE SHOE RECORD. Date,

Car No	Wheel No	Train No	Time	Shoe On Make	Shoe On Wt	Shoe Off Make	Shoe Off Wt	Remarks

EE-16-1521 THE DENVER & INTERURBAN R. R. CO.

MULTIPLE UNIT CONTROL. Date,

Train No. Car No. Wire No. Time, A. M. P. M.

Delay to Train, Minutes at

Details of Troubles:

Form EE-10-1515 THE DENVER & INTERURBAN R. R. CO.

DAILY WHEEL CONDITION REPORT. Date,

Train No.	Car No.	Flats 1R	1L	2R	2L	3R	3L	4R	4L	Remarks

EE 21-1520 THE DENVER & INTERURBAN R. R. CO.

INSPECTION CARD. Car No. Date

Car in from Train No. at A. M. P. M. Time of Inspection A. M. P. M.

This car must not be sent out until the following repairs have been made, or car is released by me.

Details of Trouble:

NOTE: Person repairing car must report on back of this card what repairs were made.

Signed..... Inspector

Released at.....A. M. P. M.....19...

Released by.....

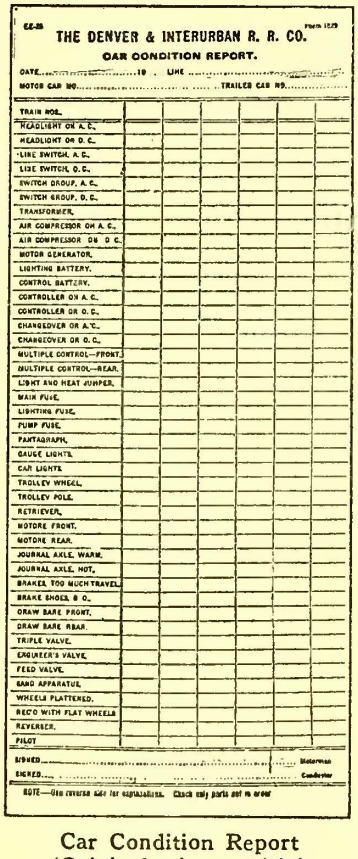
Denver & Interurban Railroad—Group of Blank Forms Used in Recording Maintenance Data (Originals 6 in. x 4 in.)

The shop machine equipment now installed includes the following:

Machine	Maker's Name
24-in. engine lathe with 92-in. centers	American Tool Works Company
Vertical drilling machine with 12-in. spindle traverse	Rockford Drilling Machine Company
No. 1 forge blower	Buffalo Blower Company
Emery wheel stands for two 12-in. x 2-in. wheels	Glizbe Manufacturing Company
10 h.p., three-phase motor	Westinghouse Electric & Manufacturing Company
Ideal steam heater No. S-36-8	American Radiator Company

MAINTENANCE RECORDS

A very complete record of the defects and maintenance work on the rolling stock equipment is being kept by the electrical engineer, who is responsible for its condition. Accompanying engravings show the blank forms which exhibit the maintenance records. The "car condition" report and the report of trouble are filled out by the car crews and turned in with the equipment. The "car movement" card serves to show the numbers of the trains in which the various cars were operated and is kept by the hostler. The inspection report is made out by the carhouse inspectors and unless it is properly signed by the inspector in charge the car cannot be used by the transportation department. The additional record cards bear information regarding train delays, brakeshoe life, multiple-unit control performance, motor operation, wheel condition and car body defects. These latter cards are filed according to the vertical system and present a complete record of the performance obtained from the equipment. Since operation was begun in June, 1908, the motor cars have been making an average of 318 miles per day. A list of the officials of the Denver & Interurban Railroad Company follows: A. D. Parker, president; J. D. Welsh, general superintendent; H. W. Cowan, chief engineer; F. W. Mahl, mechanical engineer and purchasing agent; J. H. Bradbury, auditor; F. W. Darlington, electrical engineer; S. S. Morris, superintendent; W. B. Grenamyre, trainmaster.



THE DENVER & INTERURBAN R. R. CO.
CAR CONDITION REPORT.

DATE.....19 . LINE .....
MOTOR CAR NO..... TRAILER CAR NO.....

TRAIN NOS.							
HEADLIGHT ON A. C.							
HEADLIGHT ON D. C.							
LINE SWITCH, A. C.							
LINE SWITCH, D. C.							
SWITCH GROUP, A. C.							
SWITCH GROUP, D. C.							
TRANSFORMER.							
AIR COMPRESSOR ON A. C.							
AIR COMPRESSOR ON D. C.							
MOTOR GENERATOR.							
LIGHTING BATTERY.							
CONTROL BATTERY.							
CONTROLLER ON A. C.							
CONTROLLER ON D. C.							
CHANGEOVER ON A. C.							
CHANGEOVER ON D. C.							
MULTIPLE CONTROL—FRONT.							
MULTIPLE CONTROL—REAR.							
LIGHT AND HEAT JUMPER.							
MAIN FUSE.							
LIGHTING FUSE.							
PUMP FUSE.							
PANTAGRAPH.							
GAUGE LIGHTS.							
CAR LIGHTS.							
TROLLEY WHEEL.							
TROLLEY POLE.							
RETRIEVER.							
MOTORS FRONT.							
MOTORS REAR.							
JOURNAL AXLE, WARM.							
JOURNAL AXLE, HOT.							
BRAKES TOO MUCH TRAVEL.							
BRAKE SHOES, B. O.							
DRAW BARS FRONT.							
DRAW BARS REAR.							
TRIPLE VALVE.							
ENGINEER'S VALVE.							
FEED VALVE.							
SAND APPARATUS.							
WHEELS FLATTENED.							
RECO WITH FLAT WHEELS							
REVERSER.							
PILOT.							

SIGNED..... Motorman
SIGNED..... Conductor

NOTE—See reverse side for explanations. Check only parts not in order

Car Condition Report
(Original 4 in. x 9½ in)

An hourly service consisting of two and four-car trains is given between Denver and Boulder. The one-way rate is 70 cents and the round-trip rate, weekdays, $1.25, and Sundays, $1; family and individual commutation tickets also are sold at reduced rates. The running time for the 29 miles between Denver and Boulder is 1 hour and 7 minutes via Marshall and 1 hour and 15 minutes via Louisville. The operation of the trains conforms strictly to the rules of the Colorado & Southern system, except within the city limits of Denver while the cars are on the Denver City Tramway Company's tracks.

DENVER & INTER-MOUNTAIN RAILROAD

THE Denver & Inter-Mountain Railroad was built in 1890 and operated with steam locomotives until February, 1909, when it was equipped for electrical operation. Since the change of motive power a considerable increase in traffic has been brought about by the more frequent and more regular electric service. As the route of this railway traverses an attractive suburban district, the growth in traffic which electrification has brought about will undoubtedly continue.

The principal sources of passenger traffic of this road are, in the order of their distance from Denver, the Colorado Golf Club, Colorado State Rifle Range, a shooting park; Colorado State Industrial School, Colorado State School of Mines and the thriving town of Golden at the base of the foothills of the Rockies. There are many interesting trips for the tourist, which can be made from Golden, and, therefore, it is expected that a substantial amount of pleasure traffic can be built up.

The Denver terminus of this road occupies part of a city block, between Fourteenth and Fifteenth Streets, on Arapahoe Street, in the center of the businss district and across the street from the central terminal loop property of the Denver City Tramway. The Denver & Inter-Mountain has an attractive brick terminal station and office building, 62 ft. 6 in. x 125 ft. in ground dimensions.

The route of the line from the terminal station includes a run of one mile over tracks laid in the city streets, and thence for two miles on a private right of way to the city limits. The private right of way is 50 ft. wide and is continuous to the terminal in Golden, 13.1 miles from the end of the city track in Denver. In addition to the Denver-Golden main line, a 3-mile branch is operated to Barnum, a suburb of Denver. The total trackage is 22 miles.

Golden has an elevation about 500 ft. higher than Denver, and in reaching Golden the line surmounts a ridge 600 ft. higher than the elevation at Denver. Thus a car in running west from Denver to Golden has a steady climb with grades ranging from 1.25 to 1.75 per cent for 11 miles to the summit and then down grade at an average of 1 per cent for two miles into Golden. As the road was originally built for steam operation, it has long easy curves and a good substantial roadbed. The track is laid with 70-lb. steel on sawed ties. The joints are made with six-hole angle plates and are bonded with No. 0000 American Steel & Wire soldered bonds.

Power for the operation of the line is generated in a d.c. plant owned by the company and located 4.5 miles west of the Denver terminal station. The equipment of this plant includes two Allis-Chalmers 925-hp Corliss engines, each belted to a 500-kw General Electric railway generator, and four 200-hp railway generators, which can be utilized at times of overload. Good boiler feedwater is obtained from an artesian well 744 ft. deep, the flow from which is delivered to a 40,000-bbl. storage tank by a Fairbanks-Morse deep-well pump.

The output of the power plant is distributed to the trolley wire by supplementary feeders. One No. 0000 bare copper feeder extends west to the summit of the grade 2 miles east of Golden, and a 500,000-circ. mil feeder extends 2 miles east of the power house to the city limits of Denver. Standard overhead construction is used, the parts of which include No. 0000 grooved trolley span-supported with Ohio Brass Company fittings from 35-ft. Idaho cedar poles. The butts of all poles were treated with preservative compound, and each

span pole is back-guyed to a Matthews' anchor. The trolley wire is protected from lightning by Garton arresters spaced one-half mile apart.

The repair shops are located at the western city limits of Denver. The group of buildings includes an engine house, electrical repair shop and car house equipped with the usual complement of tools for the maintenance of interurban cars and the steam locomotives used in freight service.

The rolling stock equipment owned and operated by the company includes the following:

Three 48-ft. passenger cars, one equipped with four, and two equipped with two 50-hp General Electric motors; one combination baggage and passenger car equipped with four 50-hp General Electric motors; four city cars with Westinghouse 12-A and W P. 50 motors; two express cars with W.P. 50 motors; two steam passenger coaches; two Baldwin 10-wheel locomotives; forty-six gondola cars, 60,000 lb. to 80,000 lb. capacity; five box cars and one caboose.

Illustrations are presented on Plate XIV, showing the 48-ft. passenger cars which were built by the McGuire-Cummings Manufacturing Company, and are mounted on McGuire-Cummings No. 10-A trucks with 6-ft. 3-in. wheel-base and 24-ft. truck-center distance.

The underframing of these cars consists of two center sills built up of 6-in. 14.75-lb. I-beams and side sills reinforced with 8-in. x 5-in. steel plates. The center sills are continuous from bumper to bumper. The car bodies are 8 ft. 5 in. wide and were built according to the standards of the manufacturing company for substantial interurban equipment. The interior fittings of these cars include Hale & Kilburn seats, Peter Smith hot-water heaters, Ohmer fare registers and continuous parcel racks. The combination baggage and passenger car conforms in size to the straight passenger cars. The cars used on the Denver-Golden service are all equipped with Westinghouse air brakes.

FREIGHT AND PASSENGER SERVICE

The regular week-day schedules include passenger cars from Denver to Golden on an hourly headway, and between Denver and Barnum on half-hour headway. On Sundays and holidays the Denver-Golden service is operated on half-hour headway. The running time from Denver to Golden is 45 minutes, and from Denver to Barnum 25 minutes. The one-way fare from Denver to Golden is 25 cents. Round-trip tickets are sold for 40 cents. As the Barnum service is entirely within the city limits, a fare of 5 cents is received for a maximum ride of three miles. Ticket stations are maintained at the terminals, where the standard form of one-way and round-trip tickets are sold. All fares collected on cars are rung up on Ohmer registers. For special car service between Denver and Golden a round-trip rate of $25 is made with no limit as to the number of passengers carried. All trains are ordinarily operated by schedules, but when a schedule cannot be followed the cars are dispatched by telephone. A set of Western Electric telephone instruments is installed at each of the five sidings between Denver and Golden.

A considerable portion of the revenue of the Denver & Inter-Mountain Railroad is derived from freight traffic. This traffic includes the handling of clay between the pits located along the route and the brickyards in Denver, the delivering of coal and the handling of general merchandise, lumber, etc. The tariffs of the road, both local and foreign, are published in the form prescribed by the Interstate Commerce Commission. An average of about 25 carloads of freight are handled each day, 20 of which are delivered to connecting steam lines. The freight equipment is handled by steam locomotives after midnight.

A regular express service of two round-trips a day between Denver and Golden is operated. The rate for handling express packages is 25 cents per 100 lb. All less-than-carload freight is handled on the freight trains at night at a rate of 12 cents per 100 lb.

The officials of the Denver & Inter-Mountain Railroad Company are: George W. Hutton, president, Chicago; Caldwell Yeaman, first vice-president; Charles F. Probst, second vice-president; James E. Gaule, secretary; F. L. Butler, superintendent, and William F. McDermott, auditor, Denver.

The controlling interest in the road is owned by John J. Cummings, president, McGuire-Cummings Manufacturing Company, Chicago, Ill.

COLORADO SPRINGS & INTERURBAN RAILWAY

COLORADO SPRINGS, Colorado City and Manitou are furnished electric railway service by the well constructed, 39-mile property of the Colorado Springs & Interurban Railway Company. A suburban line to the company's amusement resort—Stratton Park—at the mouth of the Cheyenne Canyon, also is operated. Five miles of extensions have been built during the present year.

TRACK WORK

The track throughout the entire line is laid with standard 65-lb. T-rail on native red spruce ties, purchased locally, and laid to standard gage. All main lines are doubled tracked on 11-ft. centers.

The rails are electrically bonded with American Steel & Wire Company's No. 0000 twin-terminal bonds. Before installing these bonds, which are placed on the head of the rail, the terminals are amalgamated. This improves the contact between the copper and the steel, filling any voids that may remain after the bonds have been driven home. An amalgam, for this purpose, is made as the work progresses. In making the amalgam tinfoil is first dissolved in mercury and then when it is desired to coat the bonds sodium is added to the mixture. The sodium drives off the water and evaporates, thus leaving a pure amalgam of tinfoil and mercury. The bond terminals and the holes are carefully cleaned with cotton waste, then the inside of the holes is tinned with the mixture and the bond terminals likewise are tinned and driven home. This method of bonding has given exceptionally good results.

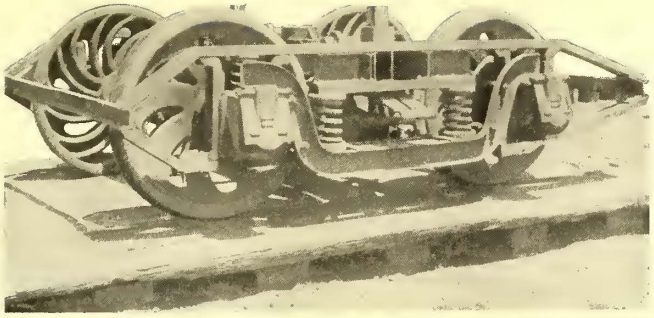
POWER STATION

Current for the operation of the road is generated in a steam plant located within the city. The following figures will illustrate the efficiency of this plant, which uses lignite, containing less than 10,000 b.t.u. per pound. On account of scarcity of water it is necessary to operate the plant non-condensing. These figures represent the actual cost of operation during the full year of 1908:

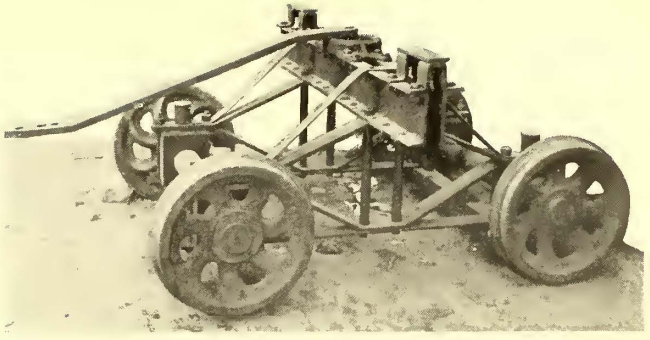
Coal per kw-hour	7.623	lb.
Cost of coal per kw-hour	0.51293	cent
Cost of labor	0.2	"
Shop labor, repairs and supplies	0.09462	"
Total cost of current per kw-hour	0.80755	cent

The plant operates with a railway load only and averages 20 hours' run per day. The total kw-hours generated during the year 1908 was 5,236,655. The daily average for 20 hours was 14,308 and the hourly average 715.4 kw-hours.

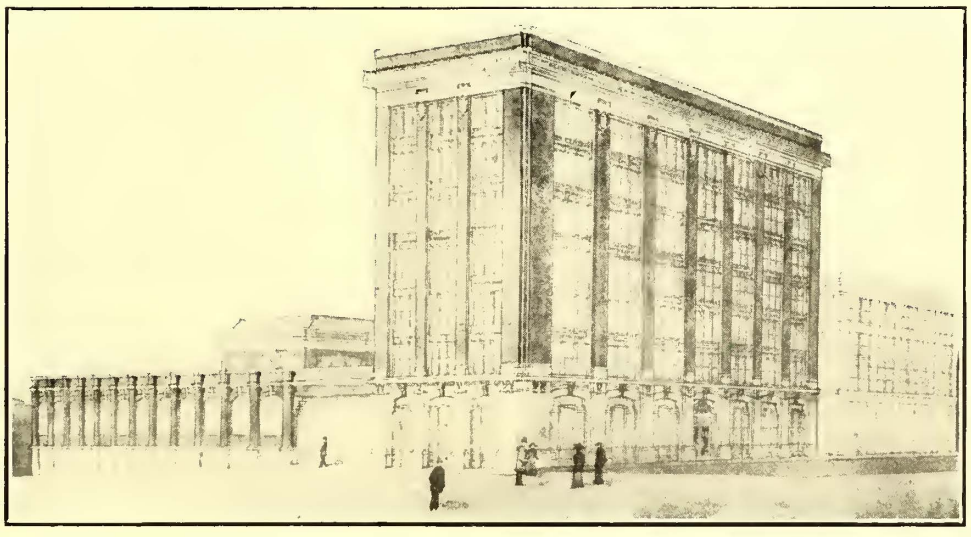
Ten men, besides the power-house superintendent, are required regularly for the operation of the plant—three in the engine room, five firemen, one conveyor man and one utility man.



Denver City Tramway—Channel Iron Motor Truck



Denver City Tramway—Emergency Truck



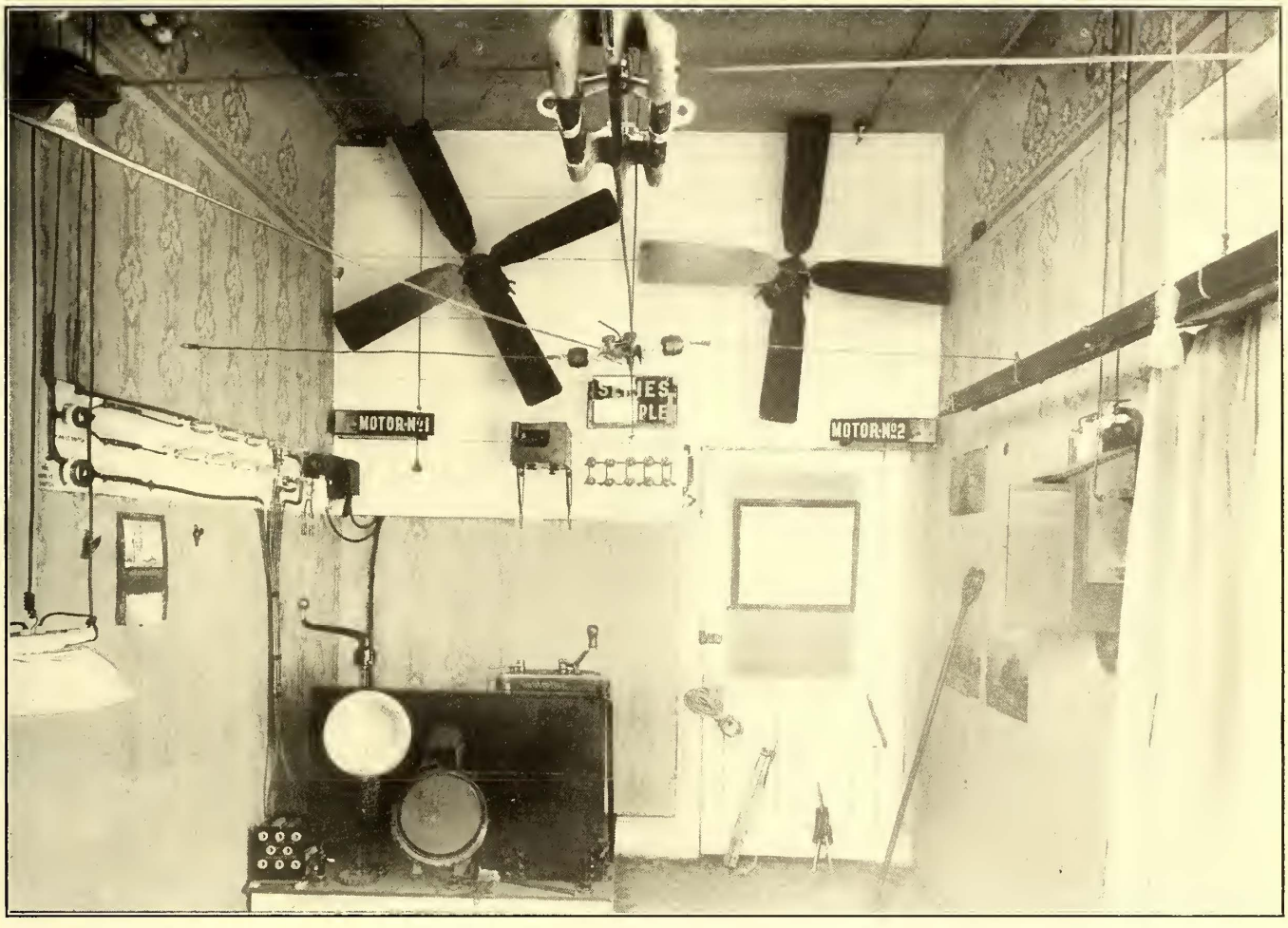
Denver City Tramway—Sketch of New Office Building and Car House

Denver City Tramway—Interior 1909 Type Motor Car

Denver City Tramway—Concrete Mixing Car

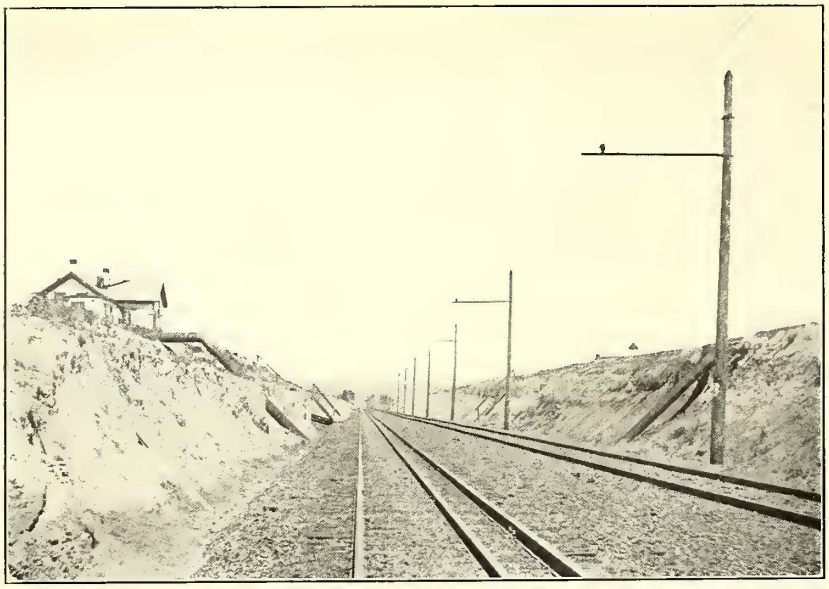
Denver City Tramway—South Broadway Trailer Storage Yard

Denver City Tramway—Passenger Depot at Golden

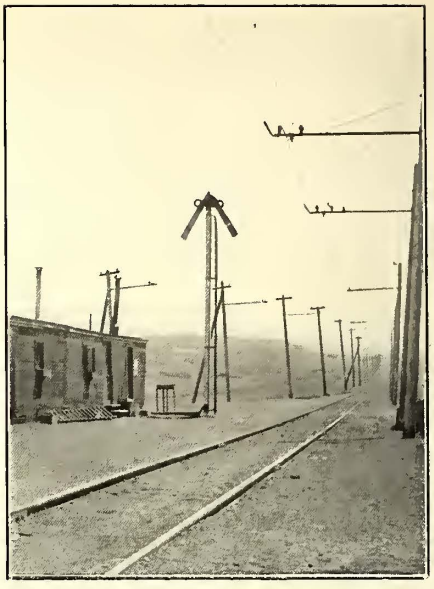


Denver City Tramway—Interior of Instruction Room

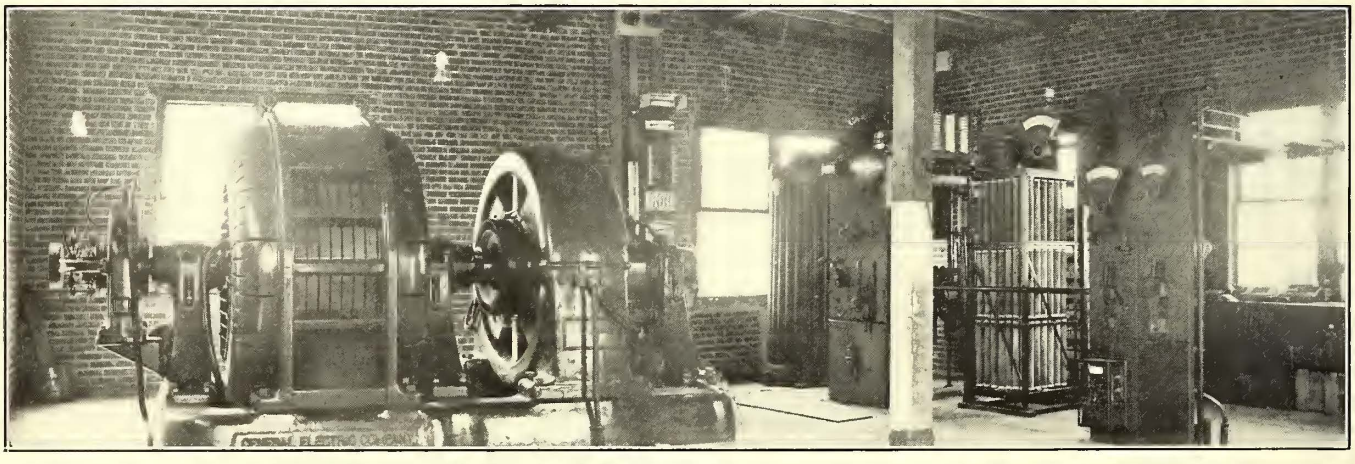
Denver City Tramway—Central Car-Dispatching Office



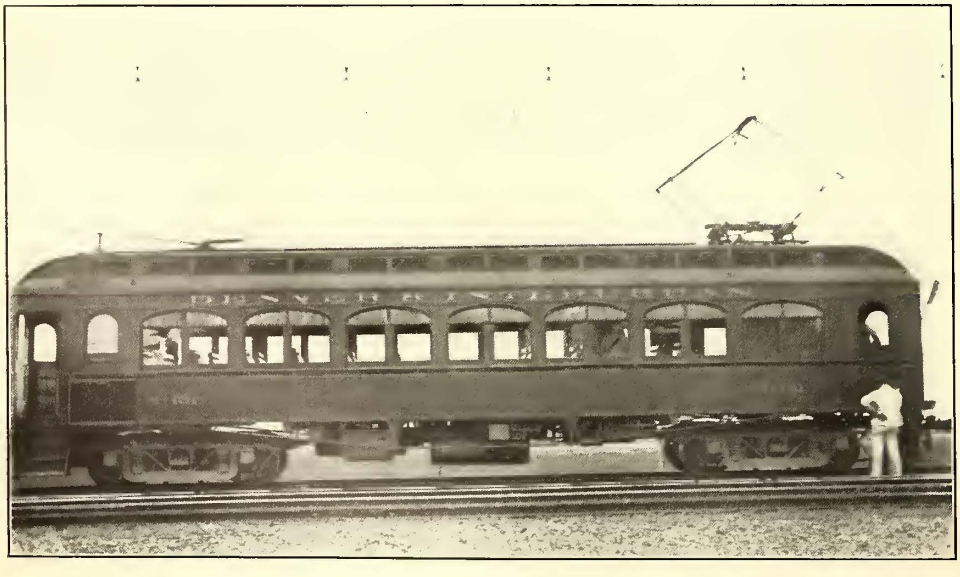
Denver & Interurban Railroad—Electric Track and Double-Gage Steam Track



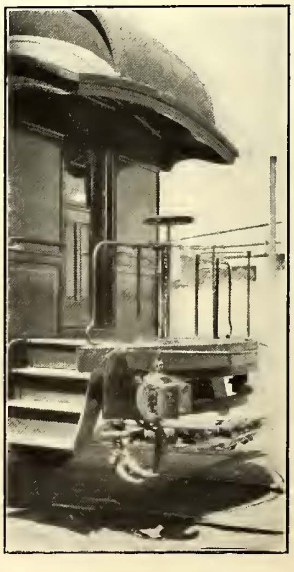
Typical Section Break



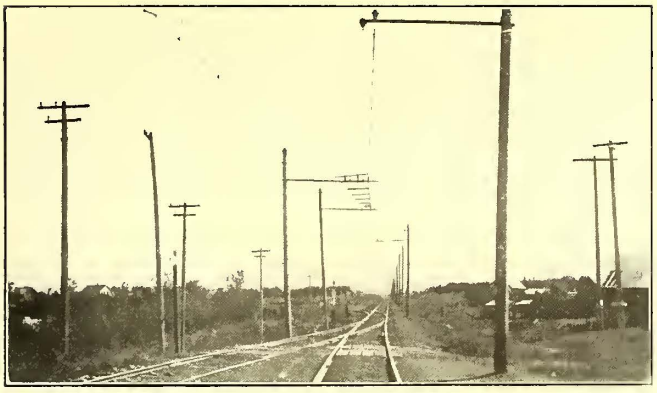
Denver & Interurban Railroad—Interior Motor-Generator Substation at Boulder



Denver & Interurban Railroad—Motor Coach



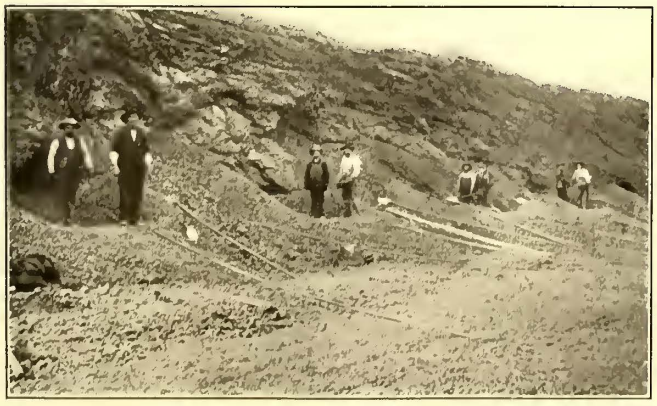
Radial Coupler



Denver & Interurban Railroad—Deflector at Switch

Denver & Interurban Railroad—Denver Shops

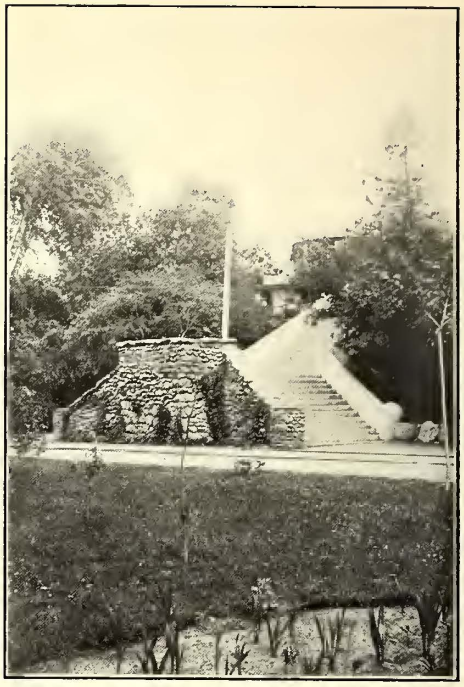
Colorado Springs & Cripple Creek District Railway—Birdseye View of Route



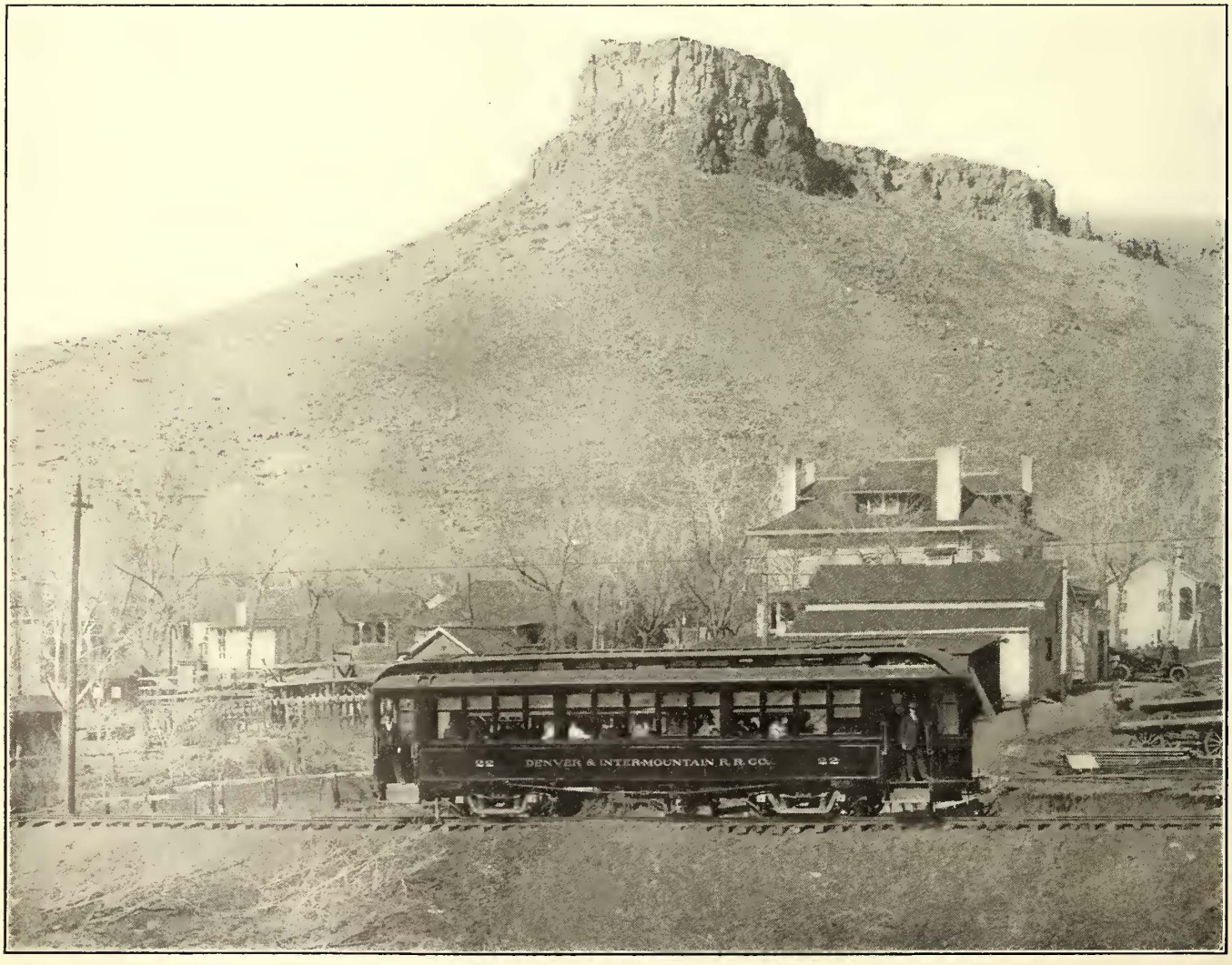
Denver & Interurban Railroad—Smelter Slag Ballast

Denver & South Platte Railway—View in Park

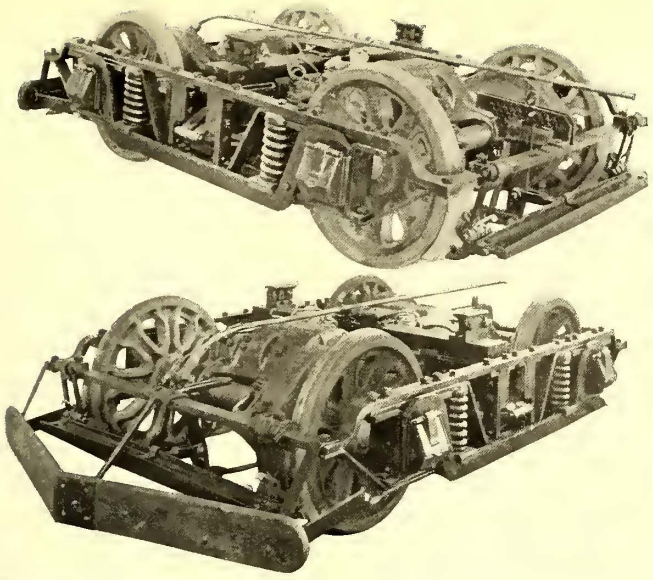
Denver & Inter-Mountain Railway—Interior of Passenger Coach



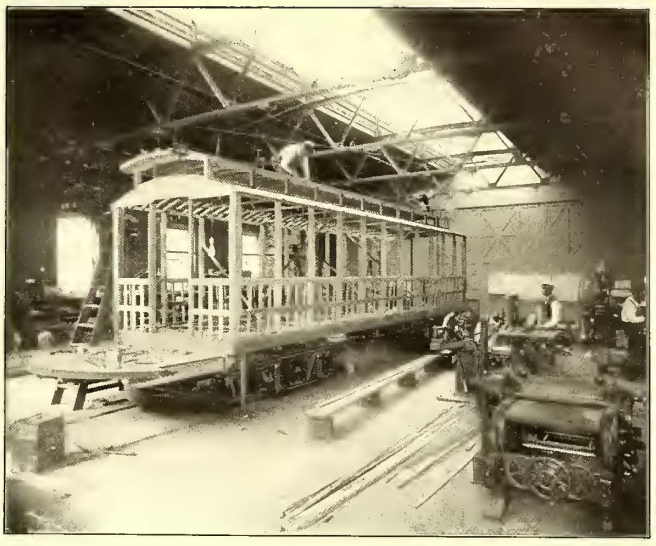
Stratton Park at Colorado Springs



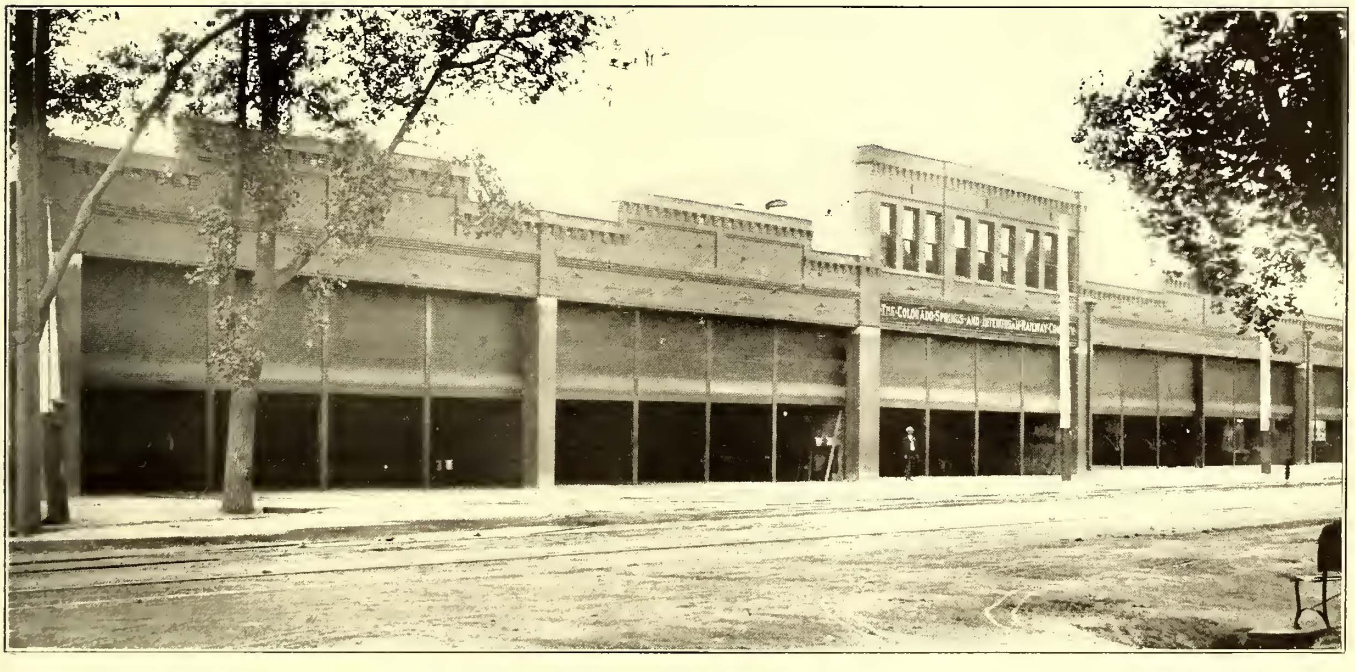
Denver & Inter-Mountain Railway—View of Car and Castle Rock near Golden



Colorado Springs & Interurban—Home-Built Trucks with Special Brake Rigging

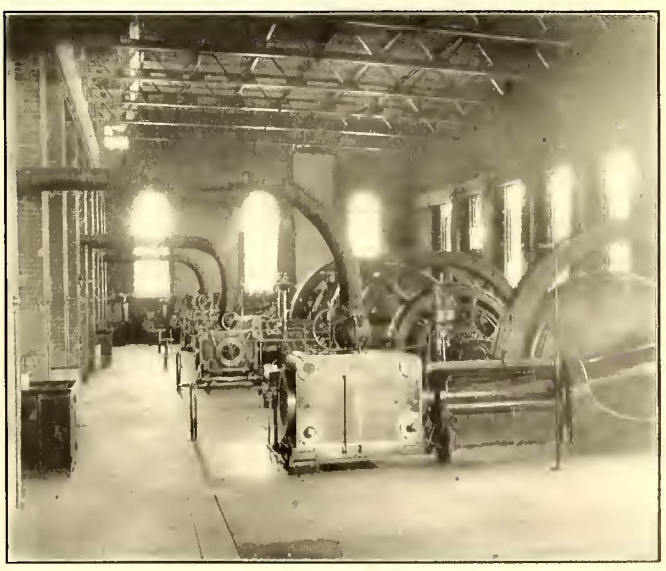


Colorado Springs & Interurban—Interior of Shop with Car Under Construction

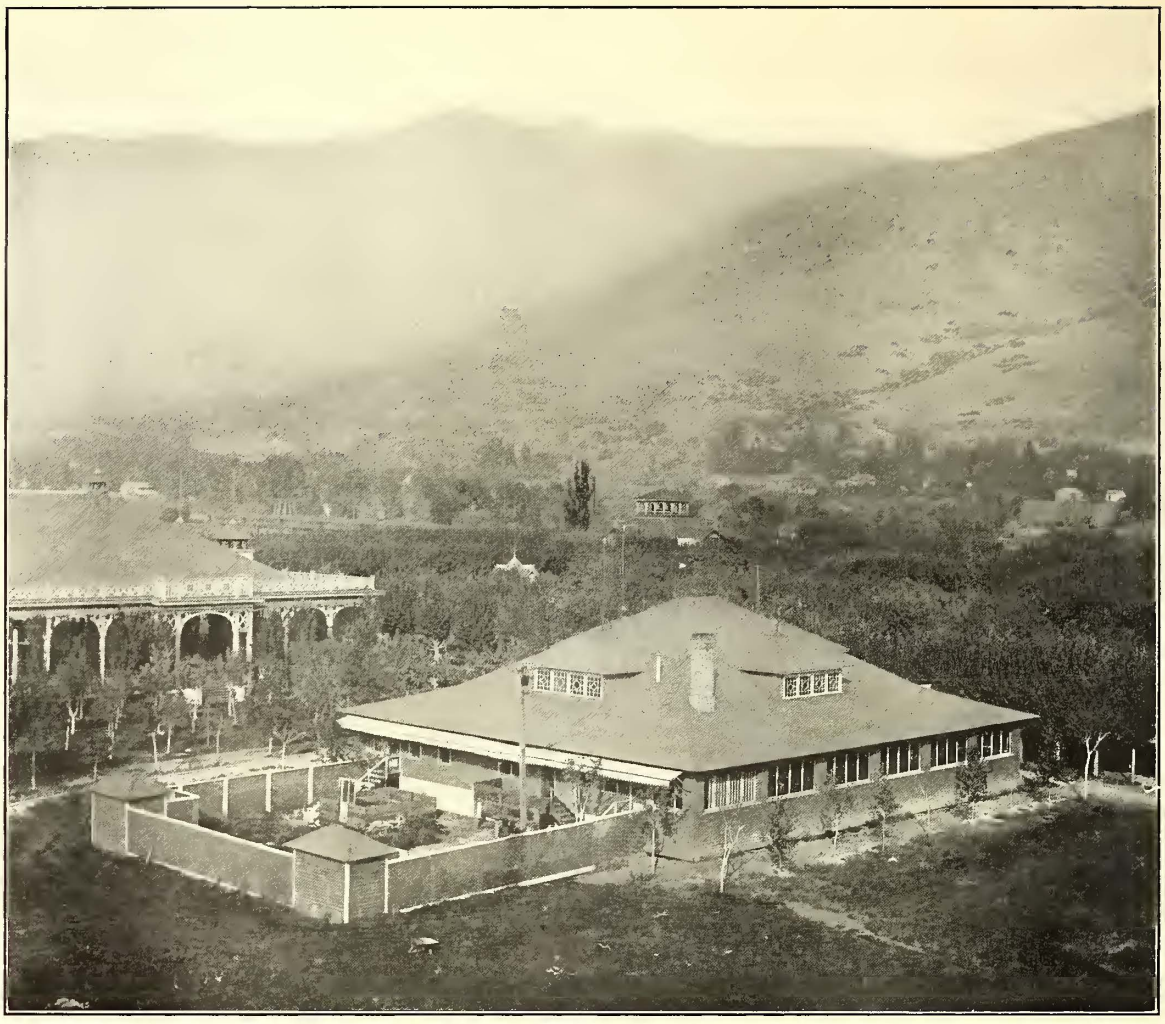


Colorado Springs & Interurban—Central Car House and Operating Headquarters

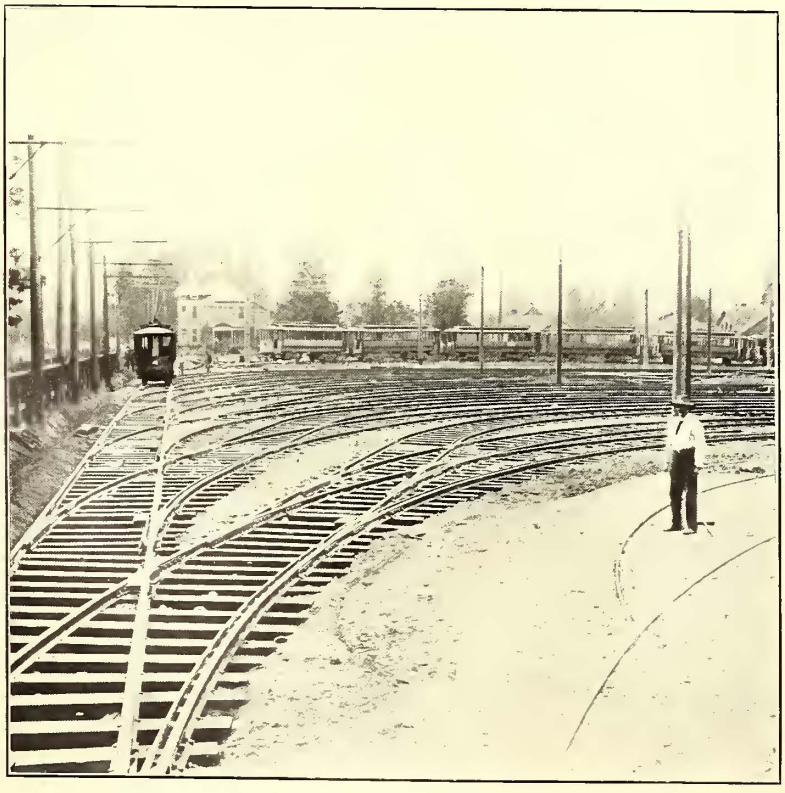
Colorado Springs & Interurban—Exterior of Power Station



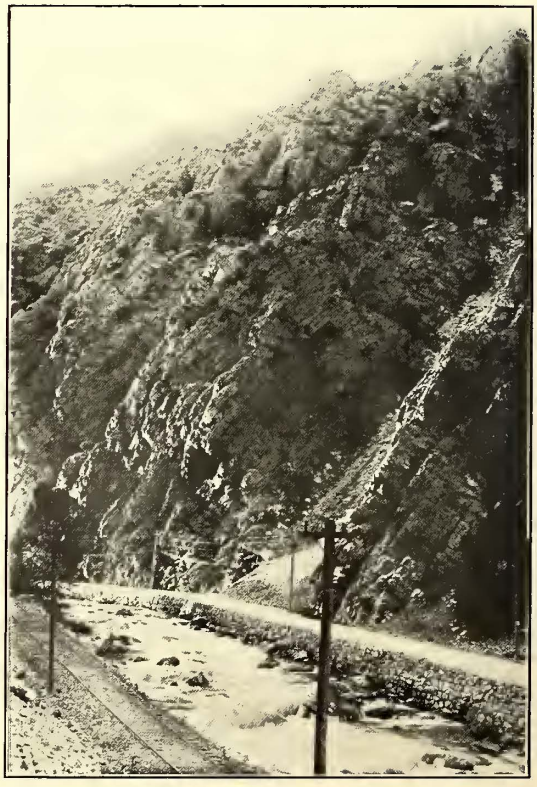
Colorado Springs & Interurban—Interior of Power Station



Salt Lake & Ogden Railway—General View of Lagoon Park



Utah Light & Railway—Yards of New Car House



New Electric Road in Ogden Canyon

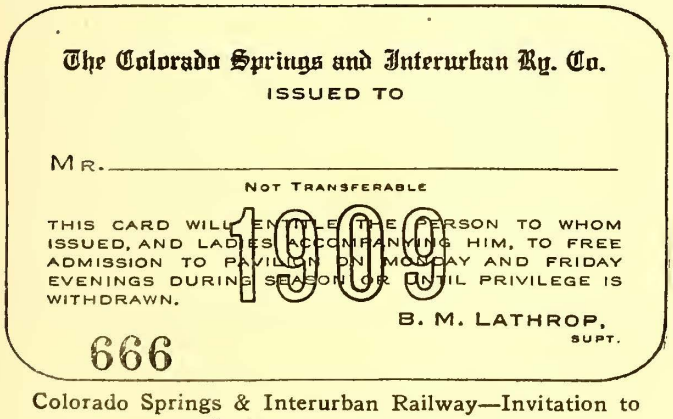
The boiler-house is equipped with a continuous conveyor for coal and ash handling. Whenever mine-run coal is obtained it is crushed to the size of slack so that uniform firing conditions are secured. The boiler equipment is made up of four 300-hp and two 400-hp B. & W. type boilers. One of the 400-hp boilers has an extension Dutch oven firebox, supplied by the Johnson Furnace & Engineering Company, of Colorado Springs.

The generating equipment includes two Allis-Chalmers Corliss engines, driving 500-kw General Electric generators; one Allis-Chalmers Corliss engine driving a 300-kw General Electric generator; and one Wisconsin Engine Company's Corliss engine, driving a 500-kw Allis-Chalmers-Bullock generator. A 30-ton overhead crane serves the entire engine room. The engines are all operated non-condensing and the generators are all standard, direct-connected, d.c. machines. A portion of the exhaust steam from this plant is piped one-half mile to the car houses, shops and offices, where it is used for heating.

On account of severe lighting conditions the regular line arresters are supplemented with a tank arrester, built behind the railway feeder switchboard at the power-house. As installed, the tank arrester consists of a water-box with a row of carbon pencils extending just above the surface of the water. Each pencil is connected with one of the outgoing feeder lines and when a storm is in progress the pencils are inserted in the water to give a leakage path for lighting direct to ground through the resistance of the carbon pencils.

SHOPS

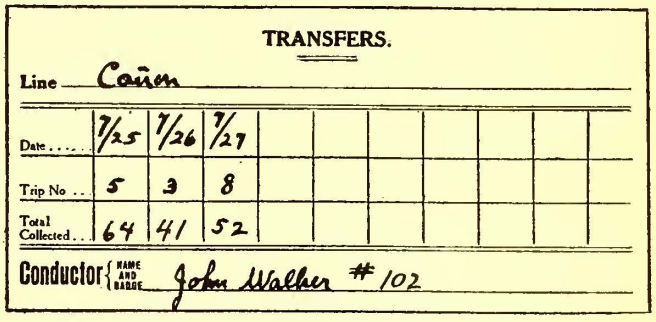
The railway company has a very complete shop plant located on the same property with its operating offices and car houses, a view of which is shown on Plate XV. All of the cars required by the company for several years have been constructed in these shops. On account of the difference in the winter and summer schedules it is necessary, ordinarily, to make a considerable change in the number of men employed for operating cars, and instead of discharging these men each fall particular care is taken when new men are employed to get workmen skilled in some trade which forms a part of car-construction. The men serve on the car platforms during the summer and in the winter are transferred to the shop force,


The Colorado Springs and Interurban Ry. Co.
ISSUED TO
MR.
NOT TRANSFERABLE
THIS CARD WILL ENTITLE THE PERSON TO WHOM ISSUED, AND LADIES ACCOMPANYING HIM, TO FREE ADMISSION TO PAVILION ON MONDAY AND FRIDAY EVENINGS DURING SEASON OR UNTIL PRIVILEGE IS WITHDRAWN.
1909
B. M. LATHROP, SUPT.
666

Colorado Springs & Interurban Railway—Invitation to Series of Park Dances

which is engaged in building new cars for use the following summer.

A view is presented on Plate XV, showing the interior of the wood-working shop and a new car in course of erection. Another view shows the design of truck equipment built in the company's blacksmith and machine shops. These trucks, which are of the M.C.B. type, have brake-rigging similar to that used on steam railroad freight cars, but adapted to electric double-truck service. The brake-rigging is easily adjusted on the road if necessary. Braking pressure is applied to the shoes by an I-beam with a floating lever which has the pulling rod connected to its top, passing over the motors and the tie rod between the two ends of the truck connected at its lower end and passing beneath the motors. At


TRANSFERS.

Line	Cañon									
Date	7/25	7/26	7/27							
Trip No.	5	3	8							
Total Collected	64	41	52							
Conductor (NAME AND BADGE)	John Walker #102									

Colorado Springs & Interurban Railway—Conductor's Envelope for Depositing Transfers

the inside end of the truck the brake-beam lever is supported on a bracket, drilled with two rows of staggered holes. The easy adjustment of the positions of the brake-shoes is made by moving from hole to hole the single pin against which the brake lever rests.

TRANSPORTATION FEATURES

In the regular winter schedule 25 cars are operated. In summer this number is increased to 30 cars. Additional rush-hour business or special business is handled with extra cars sandwiched in so as not to disturb the regular schedule. A supply of these cars is kept at the central operating loop in the business district where they can be dispatched quickly to handle peak loads.

A special method is used in handling transfers. This method reduces the number of transfer envelopes required to one-tenth of that needed ordinarily. The transfer envelopes, which are 6 1-2 in. x 3 3-5 in., in size as illustrated, are printed with rows of spaces for entering information on 10 different days. The conductor uses these envelopes in the ordinary way for delivering transfers, filling in one column each day that the envelope is used. In this column he notes the date, the trip number and the total number of transfers collected. The first time he uses the envelope he indicates the name of the line in the space at the top and signs his name and badge number on the line at the bottom.

When the transfer envelopes are collected each day they are checked, and those signed by each man are held together in a bunch with a rubber band and put in a box in the transportation headquarters. Before starting out on the second day the conductor gets his supply of envelopes from this box and thus uses on the second and successive days up to 10, envelopes which he has used before. The information required in turning in the transfers on the succeeding days is entered as on the first day the envelope was used. When the auditing office removes the transfers from the envelopes and checks them, different marks are used, not only by different checkers, but for different days. These marks are always the same for the same conditions and serve for future reference as to who checked any envelope on any day.

During the past year a method of checking the money turned in by the conductors has been put into use. This method obviates all quibbling between the conductors and the accounting department and saves many arguments that might arise on account of a mistake on the part of either the conductors or the checker in the count of tickets, cash, trans-

fers, etc. It was the practice formerly to check one day and balance the next, but this arrangement brought about many petty differences and has been changed. Conductors turn in their receipts in money sacks numbered with figures corresponding to their badge numbers. A complete set of sacks, consecutively numbered, one for each conductor, and 20 sacks numbered specially for extra men, are put into the conductors' room each night. The conductor in turning in his daily receipts picks out that sack which is numbered to correspond with his badge number and uses this sack for depositing his tickets, transfers and cash in the receiver's safe. Each morning two men are present when the safe is opened. One of these men is provided with a mimeographed sheet exhibiting all the conductors' badge numbers and numbers X-1 to X-20 for the extra men. After the safe has been opened one of the men removes the bags from the safe and as he takes each one out he announces to the other the number on that bag. This number is checked on the printed list held by the second man, who puts a blue mark opposite the number on the printed list corresponding to the number on the bag. Then the numbers of the unused sacks are similarly checked in order and when all the sacks have been handled over all the numbers on the printed list should be checked, either with a blue mark, indicating a bag with receipts in it, or a red mark indicating an empty bag. Thus the receiver knows that all the sacks used on the previous day have been turned in and the presence of two men to open the bags assures a complete check.

Formerly it was the practice to check conductors' receipts each day and balance with the conductors on the second day. To reduce the number of petty arguments over little differences and the time required to adjust these differences, it was determined to make settlement but once in two weeks at the time of issuing pay checks. However, if there is a difference of $1 or more the conductor in whose account the error occurs is sent a notice to call at the office the following day and adjust the account. If the amount is less than $1 it is entered on a record card and a notice of the amount is mailed to the conductor. These record cards are balanced once in two weeks and a cash settlement made at the time of paying off. Because the shortages and overages usually balance very closely a considerable amount of the dissatisfaction ordinarily experienced is done away with. The settlements for $1 and over are made at once, thus preventing the men from holding out a portion of the receipts, using the money for a few days and then turning it in as an overage in their receipts.

STRATTON PARK

Stratton Park, which is operated by the Colorado Springs & Interurban Railway, is located near the entrance to Cheyenne Canyon at the foot of the Rocky Mountains. This park is 80 acres in extent and has been highly developed by careful gardening and by the construction of simple amusement devices for children and a large pavilion. It is served by two lines of the railway, each double tracked, terminating at opposite ends of the park near attractive passenger stations. The distance to the park from Colorado Springs is 4 miles and a fare of 10 cents each way is received.

The main amusement pavilion at Stratton Park was built at a cost of approximately $24,000. It is a steel-supported structure with a large stage at one side. The pavilion is used three nights each week for select dances. In connection with these dances the company reserves the right to permit no gentleman on the floor unless he has been given an invitation card of the form shown herewith. The issuing of these cards has been the means of maintaining a very high character to the patronage of the dances. While the company does not require the presentation of cards at the doors of the pavilion the representatives in charge of the dancing floor may call for them in event of ungentlemanly conduct. The floor of the dance hall will accommodate 1,000 couples and the pavilion is well lighted, tastefully decorated and has a seating capacity around the edge of the dance floor sufficient for all the dancers and a large number of spectators.

Concerts by a band of 40 pieces are given three days each week, from June to October, in a specially constructed bandstand. After the close of the regular season concerts of an exceptionally artistic character are given at intervals in the pavilion by a large orchestra of accomplished musicians. These concerts and the dances are free to the public.

COLORADO SPRINGS & CRIPPLE CREEK DISTRICT RAILWAY COMPANY

THE Colorado Springs & Cripple Creek District Railway, which is said to be constructed at a higher altitude than any other electric railway in this country, connects ripple Creep with Victor, Goldfield, Independence and many smaller towns located in the mining district of Colorado. The company was chartered in April, 1897, when the first work was done toward building this railway system, which now consists of 18.5 miles of electric line and 58 miles of steam railroad.

The electrified portion of this company's railway is divided into two divisions. One of these, known as the "low" line, which connects Cripple Creek and Victor, is 6 miles in length. The other line, known as the "high" line, follows a more circuitous route through the Rocky Mountains for a distance of 12.5 miles, and eventually reaches the city of Victor, where connection is made with the "low" line division. These two divisions of the railway form a loop which affords the miners of that district excellent transportation between the mines, their homes and the leading cities of the territory. Hourly service is operated on the high line and 30-minute headway on the low line.

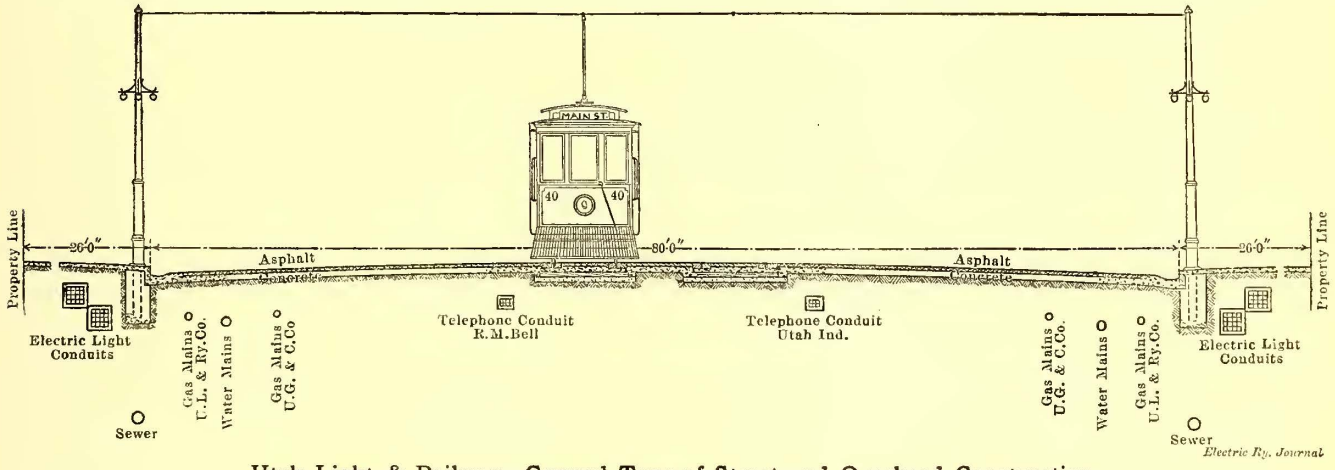
Although the lines operated by this company pass through one of the most rugged districts of the Rocky Mountains, the tracks are laid with maximum curves of 24 deg. outside of the city streets, and maximum grades of 8 per cent. The average grade for the entire length of the railroad is 3 per cent. The tracks are built to standard gage. The cost of constructing the roadbed was about $25,000 per mile.

A part of the power for operating cars over these lines is generated hydraulically at Canon City, a distance of nearly 50 miles from Cripple Creek and is transmitted at 20,000 volts to the company's reserve steam power plant at Cameron. It is here converted and delivered to the trolley as direct current at a line pressure of 580 volts. The cars operated by the company are of the interurban type. They are 41 ft. long and weigh about 30 tons. Each car is equipped with Westinghouse automatic air brakes, four GE 57 motors and McGuire-Cummings No. 57 trucks.

REHABILITATION OF THE UTAH LIGHT & RAILWAY PROPERTY

ABOUT three years ago the City Council of Salt Lake City granted the Utah Light & Railway Company a new 50-year franchise, and shortly thereafter control of the property passed to the Harriman interests. Since the change in ownership a plan of general reconstruction has been followed and a considerable portion of the rehabilitation is now completed.

The Utah Light & Railway Company has 100 miles of track, practically all within the corporate limits of Salt Lake City. This track, before reconstruction, was not in the best condition, because it had been built originally for much lighter cars than have been operated during the last few years. The track now being laid is of the latest approved type with high T-rails and concrete substructure. During the past three years the track has been rehabilitated as follows:



Utah Light & Railway—General Type of Street and Overhead Construction

1907	28.84 miles
1908	29.25 miles
1909 (to October)	20.00 miles

All of the work of track construction is done by company forces except the street paving, which is laid by the city contractor. The type of track structure adopted as standard for the Utah Light & Railway is made up of 7 in. 80-lb. T-rails in 62-ft. lengths laid on sawed carbolineum-treated ties spaced 16 and 13 ties to the rail. Two ties are used under each joint. The ties are ballasted with gravel, supported on a 6-in. concrete bed, and the foundation for asphalt paving is a layer of concrete beginning 6 in. below each rail and carried up to a height of 3 in. between the rails completely covering the ties. The following table shows the volumes of concrete, gravel and excavation per lin. ft. of double track, with 16 and 13 ties to each 62-ft. rail length:

Gage Lines.	Volume of Concrete Ties 4-ft. Centers.	Ties 5-ft. Centers.
7 ft.	.6516 cu. yd.	.6566 cu. yd.
6 ft.	.63306 cu. yd.	.63804 cu. yd.
	Volume of Gravel	
7 ft.	.1987 cu. yd.	.2022 cu. yd.
6 ft.	1987 cu. yd	.2022 cu. yd.
	Volume of excavation	
7 ft.	1.14228 cu. yd.	
6 ft.	1.1296 cu. yd.	

The concrete used in the track construction comprises a 1:3:7 mixture of cement, sand and gravel. Gravel for this track work is obtained from a large pit of the Oregon Short Line located on an extension of the electric railway just north of the city. This gravel is hauled in side-dump cars by electric locomotives for distribution along the streets. On the same line with the gravel pit is a stone quarry from which the principal portion of the crushed rock for street work is obtained. The rock also is hauled electrically and is locally distributed with dump wagons. The wagons for street distribution are loaded from a portable bunker which is set up on the street near the center of distribution. This bunker is made of timbers, each of which is numbered and so bolted together that they may be taken down and moved as the center of distribution changes. The cars carrying the stone are run over the bunker on a portable electric railway track from where they are automatically dumped into the large storage bin. Wagons are driven under the bin and loaded by gravity.

The joints in the 80-lb. track rails used in paved streets are made either with thermit welds or with continuous plates. In the latter case the rail ends are electrically connected with 300,000-circ. mil pin-driven American Steel & Wire 1-in. terminal bonds.

The streets in Salt Lake City are exceptionally wide, 132 ft., and the blocks unusually long, being 660 ft. from curb to curb, or 792 ft. from street center to street center. There are approximately seven blocks to the mile. The tracks are laid in the center of the streets and there is ample room for special trackwork with large-radius curves. On account of the large amount of curved rail needed for the reconstruction of the entire track layout in Salt Lake City, the engineering department has installed a rail-bending and cutting plant at the yards of the new shop property. The special-work track layouts are made with frogs and switches in which manganese steel rail and hard centers are used. This special work is supplied by the Pennsylvania Steel Company and William Wharton, Jr., & Company. The electric railway company bends its own curves in its rail shop, the equipment of which includes a large power-driven rail saw, bending rolls and a complement of forges, drill presses and smaller tools.

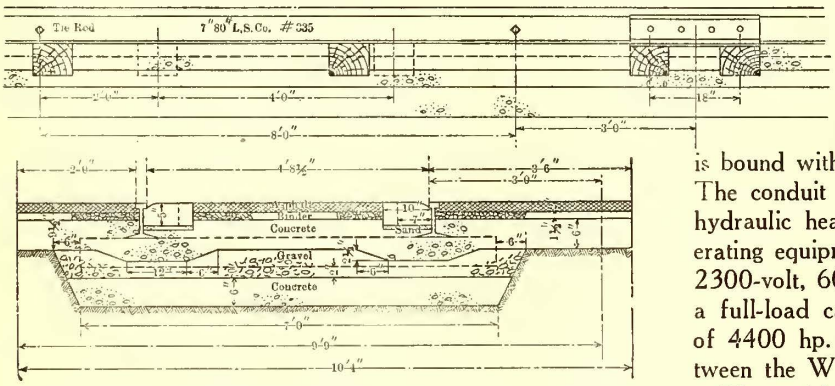
TROLLEY CONSTRUCTION

On all of the paved streets of Salt Lake City the center-pole type of trolley construction formerly used is being removed and the trolley wires supported by spans from poles set on the curb line. The very wide streets ranging from 60 ft.

to 92 ft. between curb lines and the resulting long spans, necessitated the use of 12 standard sizes of steel poles. On some of the streets these poles carry a few of the company's lighting and feed wires. Of these 12 standard sizes there are only four or five main sizes that are generally used. The poles range from 8-7-6 in to 10-9-8 in., vary in height from 28 ft. to 32 ft. and in weight from 650 lb. to 1575 lb. They are set in concrete and are given a backward rake of about 7 or 8 in. The steel poles are painted a red shop coat and finished with two coats of dark olive green.

Three poles are set on each corner of a wide street intersection. Where there is an extensive special track work layout a 10-in. pole is set at the curb intersection and 8-in. poles are set 27 ft. along the curb in each direction. A part of the strain from the corner pole is transmitted to the auxiliary poles through heavy anchor cables. In the commercial district where the blocks are 660 ft. long between curbs the steel poles are set 107.17 ft. apart between the nearest of the group of three corner poles and are 18 in. back of the curb line. At grand union crossings the center bull ring, to which the curve pull-offs are attached, is supported by four heavy steel strand cables which in turn are supported by the poles at the curb intersections. An engraving shows the arrangement of pull-offs and the location of the overhead special work at such a crossing.

Ornamental cast-iron bases which are 30 in. high and 21 in. in diameter at the ground are placed around the butt of each



Utah Light & Railway—Standard Roadbed in Asphalt Pavement

of the steel poles within the commercial district. A lead ring is poured around the tops of these bases to provide a tight connection. These cast-iron pole bases were required by the city. Outside of the business district the center-bracket poles are being replaced with wooden poles painted green.

As the new tracks are laid throughout the city this pole reconstruction is completed and the existing No. 2 and No. 4 copper trolley wires heretofore used are replaced with No. 00 round wire supported by 5-16-in. stranded steel spans. These spans are insulated at the steel poles with Brooklyn insulators and at the wooden poles with 8-in. wood breaks. The trolley wire is connected to the span by the use of Ohio Brass, General Electric or H. W. Johns-Manville insulated hangers.

The removal of practically all transmission wires in the business district of Salt Lake City necessitated placing the railway feeders underground. The new feeders have been installed in vitrified clay ducts. These feeders vary in size from 500,000 to 1,500,000 circ. mils, and on the more important streets are laid so that there are three in parallel. Facilities are provided in conduit manholes so that in event of trouble to any portion of the feeders the damaged cables can be disconnected from the circuit and power fed with those cables which are in operating condition. A new system of negative buses has been installed in conduit on the streets surrounding the block containing the central power station, which is within the business district. This negative collection bus has cross sections equivalent to 6,000,000 and 3,000,000 circ. mils of copper and is connected to the tracks at frequent intervals.

POWER IMPROVEMENTS

The power generating equipment of the Utah Light & Railway Company includes both steam and water-power-driven generators. The water-power plants are located in the Wasatch range of mountains just east of the city. In the Cottonwood canyon, 16 miles southeast of Salt Lake City, the company's water-power plant has a capacity of 2000 hp, which is transmitted at high voltage to a receiving station in Salt Lake. A second plant in Cottonwood canyon has 4000-hp capacity, and a plant at the mouth of Ogden canyon, 37 miles northeast of Salt Lake City, has 5000-hp capacity. A 1500-hp reserve steam plant is located within the commercial district in Salt Lake City, and power is purchased from the transmission systems of the Telluride Power Company and from the plant of the Utah Sugar Company, located 85 miles north of the city. The switching of current from these several sources and the synchronizing of the company's water-power plants is controlled from a main receiving station in Salt Lake City equipped with water-cooled transformers and oil-break high-tension switches.

Construction work is now well advanced on a 4000-hp water-power plant which the company is building in Weber canyon, 14 miles east of Ogden. A hollow reinforced concrete dam 66 ft. long has been built across the canyon at this point. Water from the dam is conveyed to the power plant through a 72-in. wood-stave pipe 7050 ft. long, and 2000 ft. of 8-ft. concrete conduit. The wood-stave pipe is bound with 3-4-in. round steel hoops, placed 3 in. apart. The conduit is 9 in. thick and is heavily reinforced. The hydraulic head at the power plant is 180 ft., and the generating equipment consists of one 2500-kva Western Electric 2300-volt, 60-cycle alternator driven by a Pelton wheel with a full-load capacity of 3500 hp and a maximum capacity of 4400 hp. Duplicate transmission lines will be built between the Weber canyon plant and Salt Lake City.

The rapid increase in the number and size of the cars operated in Salt Lake City has made necessary several changes in the relay steam plant and the substation in Salt Lake City. During the past year two 1500-kw Allis-Chalmers motor-generator sets have been installed in the central station. Each of these units comprises a 4000-volt 60-cycle 3-phase motor direct connected to a railway generator. The installation of the two motor-generator sets at this plant has released two 450-kw rotary converters from railway service, and these are now used to supply power to the three-wire d.c. 250-500 volt commercial power circuit.

If the present rate of increase in the power demand continues it is expected that another railway substation will soon be needed in the southeast portion of the city. The company is now extending its tracks 12 miles south to Bingham Junction, and plans are under way for the construction of a railway substation to be located at Murray, which will feed this suburban division. The normal railway load has increased during the last two years from about 1500 kw to 2900 kw. The total rated capacity of the railway power supply without steam is 2500 kw, and with steam, 3050 kw.

ROLLING STOCK

The regular schedules require the operation of about 100 cars in summer. The total number of cars available is 144, of which about 15 are held in for inspection each day. During the last year the company has purchased 50 new semi-

convertible cars, which are now in use on the principal lines of the city. These cars are equipped with four 40-hp motors and air brakes. They have 6-ft. platforms and are 30 ft. long over corner posts and 44 ft. long over bumpers. The seating capacity is 44. The maintenance of equipment is carried on systematically. All cars are inspected every night, and after five days, or when, approximately, 1000 miles have been run, each car is taken off the road and given a general inspection during the daytime so that such repairs as are necessary may be made. It is planned to put each car through the shop for a general overhauling once each year.

The present shop facilities of the company have been in use for a long time, and plans have been made and work soon will be started on the erection of a large modern shop plant to be located on the same property with the new car house described later. The shop facilities will include the following:

Machine shop, 140 ft. x 160 ft.
Blacksmith shop and foundry, 140 ft. x 48 ft.
Carpenter shop, 120 ft. x 112 ft.
Paint shop, 120 ft. x 32 ft.
Store house, 120 ft. x 44 ft.

A transfer table 50 ft. wide and 280 ft. long will serve these buildings. Additional room is available for the future erection of buildings, which room is now in use as a material yard.

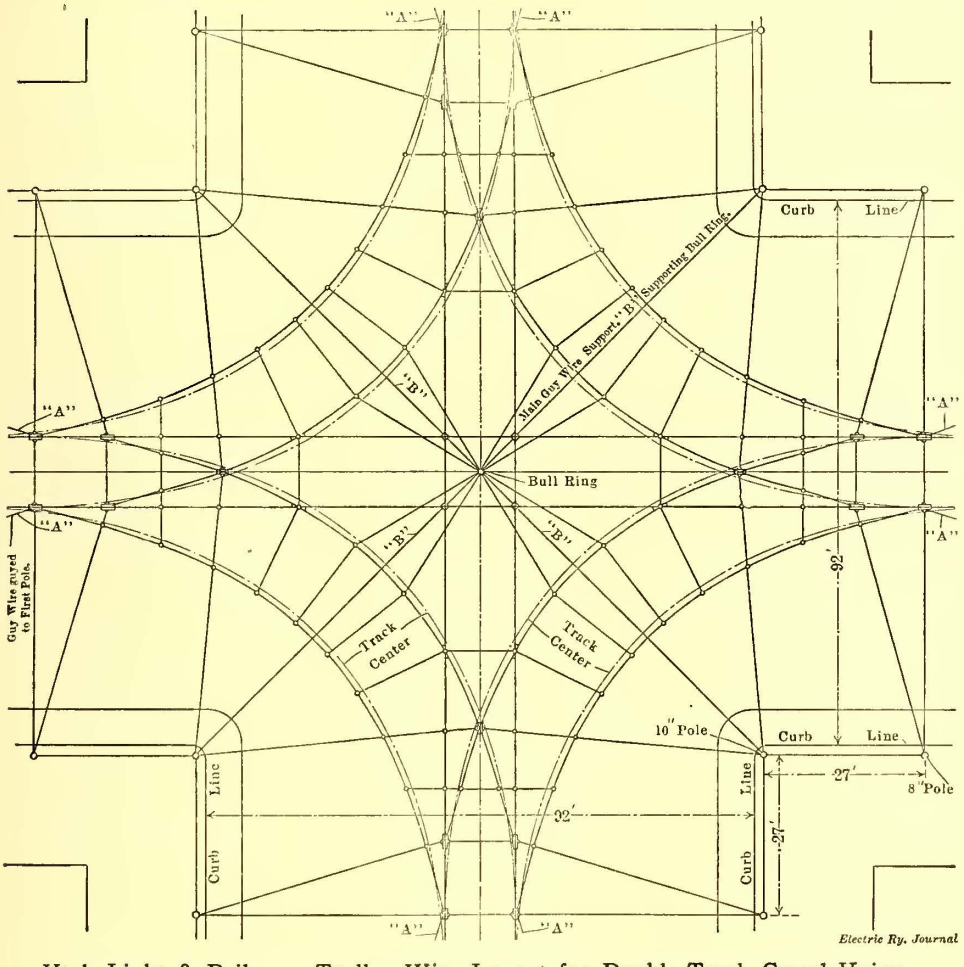
NEW CAR HOUSE

A new fireproof car house with a capacity for 144 double-truck cars has just been completed. This structure and the shop buildings soon to be erected will occupy an entire block 680 ft. square located six blocks east and five blocks south of the business center of the city. The new car house is 430 ft. long by 229 ft. wide, and has 16 through tracks laid on a 1 per cent grade sloping toward the rear of the building. At the front of the building these tracks join in a ladder leading to a double-track line on Seventh East Street. This special track work, which is illustrated, was largely built in the company's plant earlier mentioned. It is made up of 65 lb. rails and Wharton manganese steel frogs. At the rear of the car house the 16 tracks are connected, eight with each of two ladder tracks leading to the lines on Fifth South Street. This arrangement of double-ladder tracks will permit the handling of two cars at a time between the car house and the street, or will permit the simultaneous movement of one car between the car house and the street and another between the car house and the shop transfer table. The track layout as shown in the ground plan is such that three cars may be sent out to service in either direction at three corners of the shop and car house property.

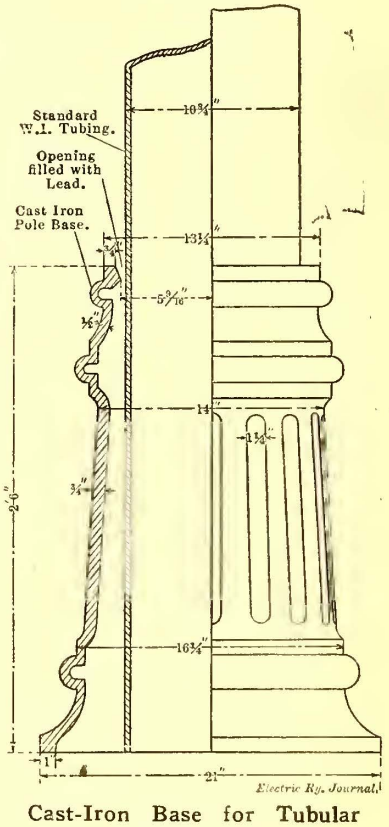
Within the car house the tracks are laid on concrete pit walls for a length of 220 ft. The pit floors have a 1 per cent grade and are of concrete construction with depressed troughs on either side, which are designed to collect drippings from snow brought in by the cars and quickly lead them to the sewers, thus affording a dry floor. All of the pits are piped for hot-water heating. The pit space is illuminated with 16-cp lamps set 10 ft. apart, staggered on opposite walls.

The car-house superstructure is subdivided into four 4-track bays with concrete floors. The floor of one bay is 2 ft. below the level of the track rails to provide for the convenient inspection of trucks. Each bay is divided at its midpoint between the inspection and storage ends of the building by a row of Kinnear rolling steel doors, thus separating the fire risks The front and sides of the building are laid with pressed brick and cement mortar.

All foundations for the end and side walls were made of concrete strengthened with American Steel & Wire reinforce-



Utah Light & Railway—Trolley Wire Layout for Double-Track Grand Union Crossing with 92-ft. Roadway

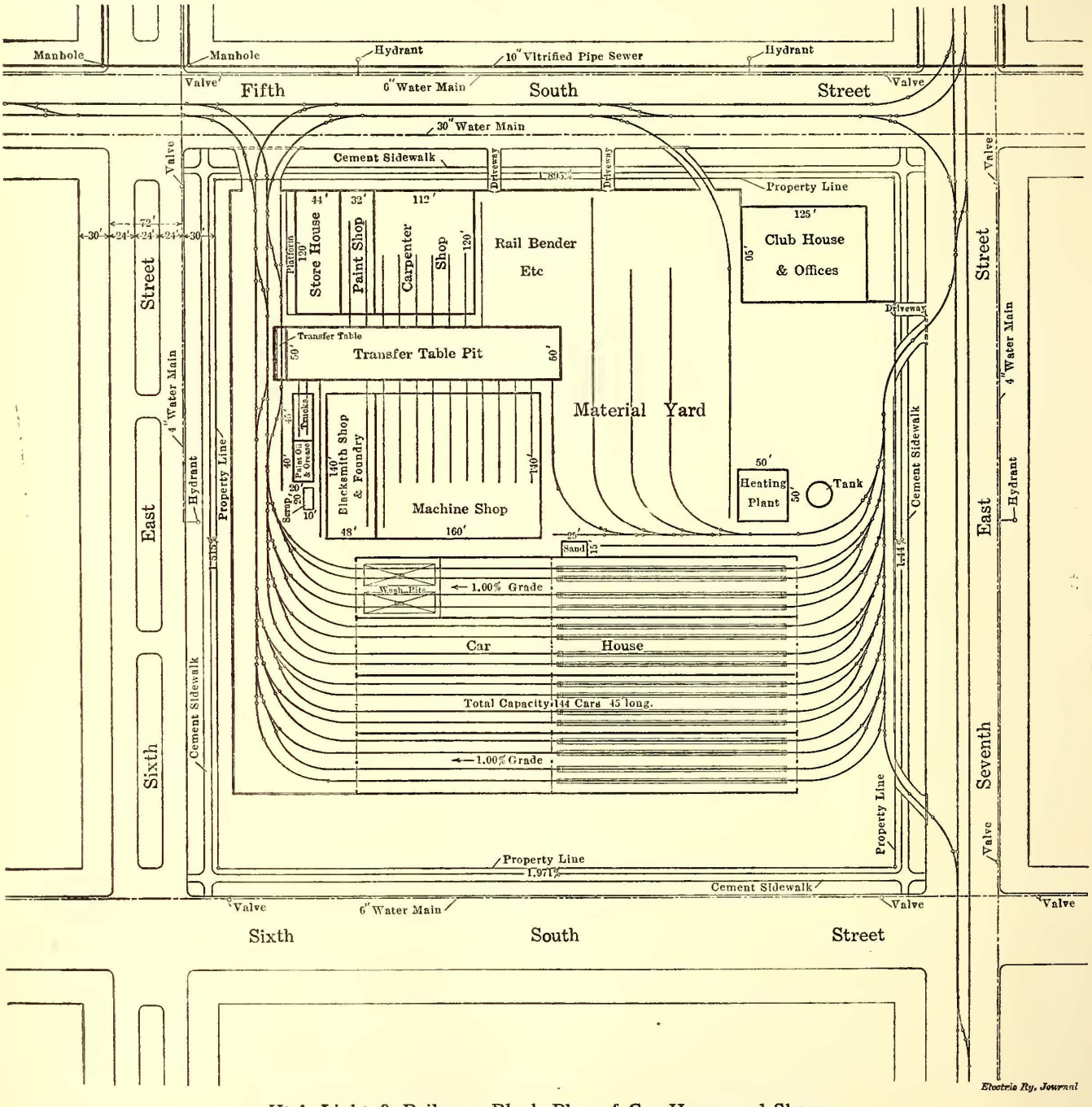


Cast-Iron Base for Tubular Trolley Pole

ment, and the concrete work throughout the structure was laid against galvanized iron forms and therefore presents a smooth surface. The walls are surmounted by concrete copings and pilasters to support the structural steel roof trusses.

The front of the building, which is designed in "Mission" style, is a series of reinforced concrete arches supported by brick piers and structural steel posts enclosed in concrete, protected on the outside by cast-iron boxes. Each of the arches spans two tracks and supports the brick end wall. These arches are made up of two 18-in. 55-lb. I-beams 28 ft. long, from which a curved steel plate ribbed with angles is supported by 5-8-in. hook bolts. The entire structural steel work of the arches is enclosed in a body of concrete 21 in. thick and 34 in. deep at the crown. In the end wall of each bay over the pier supporting the pair of arches is the monogram of the railway company. These monograms are 6 ft. x 6 ft. in size, and were cast of concrete and set in the 13-in brick wall. The opening under each arch is fitted with a Kinnear rolling steel door equipped for operation by an electric motor.

The roof of this car house has 83,600 sq. ft. of waterproofed surface and 204 skylights, each 16 ft. x 8 ft. in size. The skylights are filled with wire glass 1-4 in. thick fitted in galvanized iron frames. The roof, which is supported by structural steel trusses spanning each four-track bay, is a concrete slab 3 in. thick reinforced with 6-in. Kahn mesh. The surface of the roof is water-proofed with four-ply Carey-magnesia roofing. This roof construction cost 25 cents per sq. ft. and the skylight construction 61 cents per sq. ft. The inside of the roof and the end walls of the car house are cal-



Utah Light & Railway—Block Plan of Car House and Shops

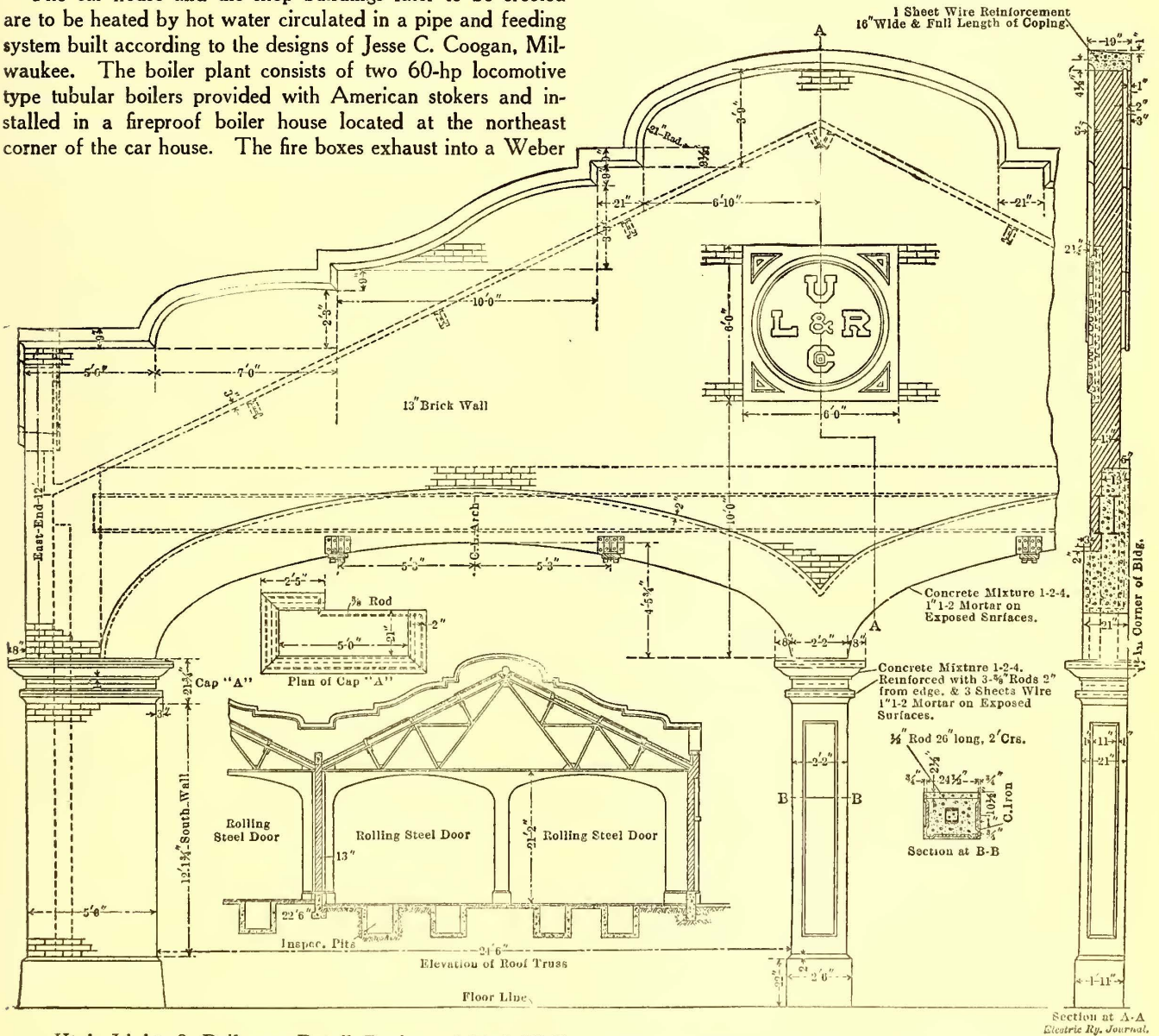
cimined cream color down to the height of 6 ft. above the floor. The wainscot is painted black.

Over each track current is fed to the cars through a trolley trough made of 4-in. 5 1-2-lb. channel irons with the edges turned down. These channel irons are put up in lengths of 31 ft. 9 in. and are held together with cast-iron clips. They are electrically bonded and are insulated from the steel roof structure with wood. By the use of the channel irons it is practically safe to run cars in either direction within the car

house without turning the poles, which hardly would be possible otherwise on account of the close proximity of the aisle sprinklers.

The entire interior of the car house is protected from fire with an installation of dry-pipe sprinklers made by the International Sprinkler Company. The valves controlling the admission of water are so equipped that they can be opened from several points throughout the car house by pressing electric contact buttons. Sprinkler lines are installed under the roof directly over each track, and there are also six lines of aisle sprinklers in each four-track bay with the sprinkler heads so located that the water will strike the top sash of a car window. A reserve supply of water is held in a 50,000-gal. tank erected by the American Bridge Company. The top of this tank is 97 ft. above the car house tracks.

The car house and the shop buildings later to be erected are to be heated by hot water circulated in a pipe and feeding system built according to the designs of Jesse C. Coogan, Milwaukee. The boiler plant consists of two 60-hp locomotive type tubular boilers provided with American stokers and installed in a fireproof boiler house located at the northeast corner of the car house. The fire boxes exhaust into a Weber



Utah Light & Railway—Detail Design of End Wall Arches and Elevation of Roof Trusses of Car House

reinforced concrete stack 100 ft. high. A thermostatic regulator controls the dampers on the boilers so that the temperature of the circulating water may be regulated automatically. This arrangement permits the circulation of water at 100 deg. in very mild weather, and also permits the raising of the temperature of the circulating water to 300 deg. in cold weather. Inasmuch as this possible variation in the temperature of the circulating water can be controlled continuously and the amount of coal burned also cut down in direct proportion to the rise in outdoor temperature, a considerable economy is said to result over the use of live steam, which would require sufficient fire at all times to keep the piping under pressure and afford circulation. It is expected that it will be possible to heat the entire plant in all except the most severe weather with the use of only one of the 60-hp boilers.

The front half of the car house, which is occupied by 16 pits, each 210 ft. long, is heated by a continuous coil of two pipes on each side of each pit. These coils are fastened to the concrete side walls with hangers which permit expansion movement. Series of coils are supplied with water from flow and return mains enclosed in a concrete trench, which extends from the boiler house across the full width of the building. The rear section of the car house, which will be used for storage, has a similar installation of supply mains and each of the four divisions in this end of the building is to be warmed by series of radiation coils, each 200 ft. long, supported on the side and division walls.

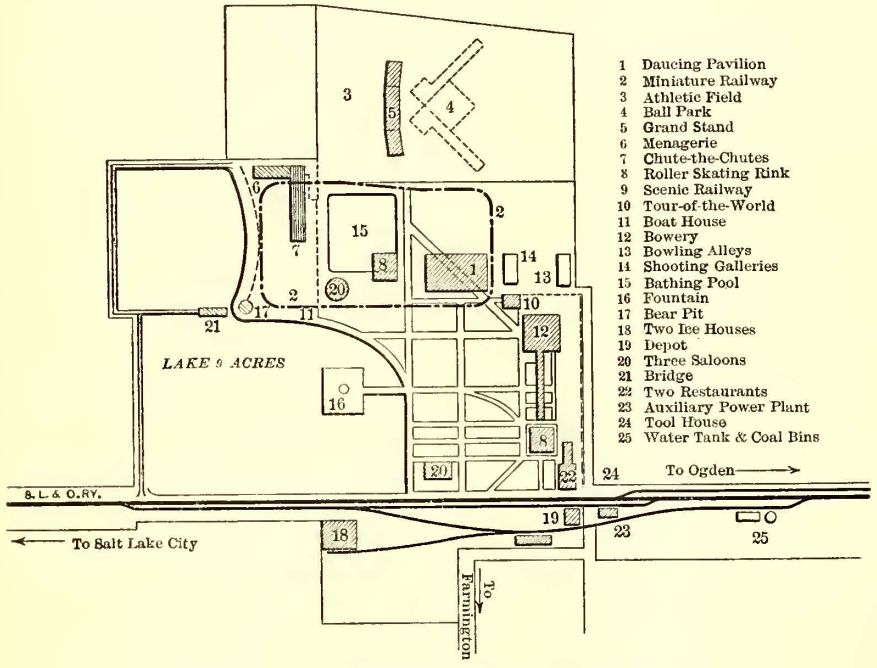
In the boiler house a Coogan turbine pump driven by a 3-hp motor circulates the hot water through the entire piping system. It is said that the load on this motor will be 1 1-2 hp for the entire plant. The small pump and its driving motor are the only mechanical devices, except stokers, used in the heating plant.

ELECTRICAL EQUIPMENT OF THE SALT LAKE & OGDEN RAILWAY

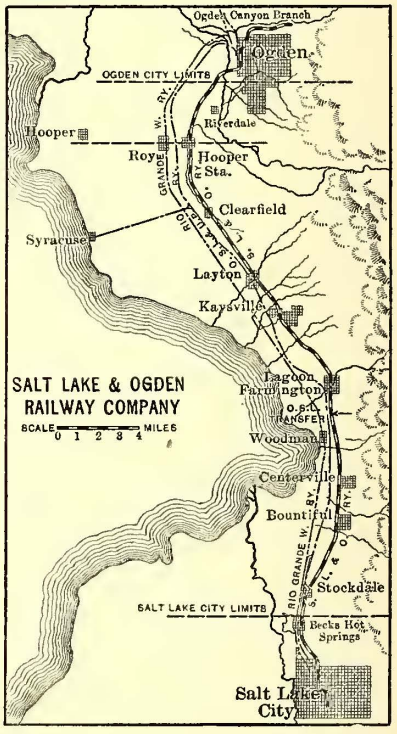
ELECTRIFICATION work on the line of the Salt Lake & Ogden Railway has progressed satisfactorily during the summer, and it is announced that electric cars will be running over the entire line from Salt Lake City to Ogden, Utah, by Jan. 1, 1910.

The Salt Lake & Ogden Railway began operating steam cars over its line between Salt Lake City and Layton, Utah, in 1892. Since that time the freight and passenger business has developed to such an extent that about two years ago it was found advisable to make provisions for facilitating the handling of this traffic. Accordingly H. A. Strauss, vice-president of the Falkenau Electrical Construction Company, Chicago, Ill., was engaged to act as consulting engineer, and after making a study of traffic conditions and the terminal facilities he recommended that the line be rebuilt and equipped for electrical operation.

Early in 1909 the active work of rebuilding the system was begun. The work now under way includes the construction of a new roadbed and track from Layton north into Ogden, a distance of 16 1-4 miles, also the regrading of many parts of the existing track and roadway, elimination



Salt Lake & Ogden Railway—Plan of Lagoon Park



Map of Route

of short-radius curves, lowering of heavy grades, relaying of tracks with heavier steel, bonding of rails, stringing of feeder and trolley wires and rearranging of the city terminals. The plans also called for the purchase of electric motor cars, rebuilding steam railway passenger cars for electric railway train operation, building substations and making arrangements for an adequate supply of electric power.

The Salt Lake & Ogden Railway has its two terminals located in the principal cities from which it derives its name. The corporate limits of these two cities, Salt Lake City and Ogden, are 29.5 miles apart. The tracks connecting these cities, together with the branch lines and the lines that have been provided in the city streets, aggregate nearly 40 miles. The road is built on private right-of-way averaging 66 ft. in width between terminals. At both Salt Lake City and Ogden excellent terminal facilities are owned.

The line, which runs in a general north and south direction, traverses a fertile belt lying between the western slope of the Wasatch Mountains and the eastern shore of Salt Lake. The track, which has a maximum grade of 1.1 per cent and maximum curves of 6 deg. outside of the cities, is laid with 85-lb. steel and is bonded with No. 0000 twin terminal bonds. Franchises owned by the company provide for the operation of cars in Salt Lake City over 4 miles of track occupying some of the important streets of that city and around a block adjoining the Federal Building, near the center of the business section of the city. Part of these tracks will be used jointly with the Utah Light & Railway Company. The company also owns several pieces of property fronting on the streets traversed by its tracks, which will be utilized as needed for an additional car shop and storage tracks and for freight and passenger stations and other terminal purposes. At Tenth North Street the company's tracks cross the lines of the Oregon Railway & Navigation Company and the Rio Grande Western Railroad Company, with which roads the Salt Lake & Ogden Railway has definite arrangements for the interchange of freight. This crossing is one of the important junctions from which a large amount of business is derived.

Within the city of Ogden at the northern end of the railroad, the company owns a private right-of-way to a depot on the main street. From here the electric cars will operate along the public streets to a terminal loop located opposite the Federal Building of that city. Branch lines connect with the main line at Stockdale, Bountiful and Kaysville. These spur lines are from 1-4 to 1 3-4 miles long and each serves brick and stockyards, which originate a substantial amount of freight traffic.

For the present, heavy freight will be handled over the electrified road by steam locomotives, which will be run only at night. The freight traffic during the past year exceeded 190,500 car-miles. This figure, however, includes practically 90 car-miles per day of light freight, which will be handled by electric cars. A substantial milk, perishable freight and express business has been developed and soon will be handled on the electric cars.

The track has been rebuilt for high-speed operation. An hourly local service with running time of 1 hour and 45 min-

utes between terminals will be maintained. In addition to local trains a limited train will leave each terminal every three hours during the day and is scheduled to cover the distance between terminals in 70 minutes, making only three stops en route. It is planned to operate single motor cars during the hours of light traffic. Trail cars will be added, however, to suit the needs of the traffic and also additional motor cars with train control when required.

At Farmington the company controls a summer resort known as "The Lagoon," which is freely patronized by the residents of the entire State of Utah and has been self-supporting for several years. This resort includes 40 acres of land situated between the Wasatch Mountains and the great Salt Lake. Among the many amusements provided here are the following: Dance pavilion, miniature railway, athletic field, ball park, menagerie, shoot-the-chutes, roller skating rink, scenic railways, boats, 9-acre lake, bowery, bowling alleys, shooting galleries, bear pits, etc. During the year 1908 there were about 250,000 admissions to the park. As soon as it is possible to give a more frequent service on the line leading directly to the gates of this resort it is expected that these figures will be surpassed.

POWER SUPPLY

Power for the operation of the line will be supplied either from a power house to be built by the company or from the high-tension lines of a hydro-electric power company, which run almost parallel with the railroad. Four substations, which are being built at intermediate points along the line, will be equipped each with two 400-kw rotary generator sets and the necessary auxiliary equipment. Direct current at 700 volts will be distributed to the cars by two No. 0000 grooved trolley wires supported on 3-8-in. Siemens-Martin steel-strand spans from poles back-guyed to St. Louis malleable iron guy anchors. One line of poles will be 35 ft. high and the other 30 ft. The poles are being treated with carbolineum at the butts and set 6 ft. in the ground. They are protected at the ground surface by a collar of concrete 23 in. deep extending 5 in. above ground to form a water table. A supplementary copper feeder of 750,000 circ. mil cross-section is being erected on one line of poles over the entire distance. The overhead fittings for this trolley and feeder installation were supplied by the Westinghouse Electric & Manufacturing Company, and the pole hardware by the Western Electric Company.

ROLLING STOCK

Ten motor cars have been built by the Jewett Car Company for use on this railroad, and 40 steam railroad passenger coaches will soon be rebuilt at the company's shops for electric train operation. The motor cars, which have a seating capacity for 60 passengers, are designed to conform as nearly as possible to standard M.C.B. specifications. The following are the dimensions of the cars:

Length over buffers	56 ft. 6 in
Length over corner posts	44 ft. 0 in.
Length from center to center of trucks	35 ft. 0 in.
Width over all	9 ft. 0 in.
Width over side sills	8 ft. 2 1-4 in.
Width, inside measurement	7 ft. 11 1-4 in.
Height from top of rail to center of drawbar	0 ft. 34 1-2 in.
Height from bottom of sill to top of car	9 ft. 7 in.
Wheel base	6 ft. 6 in.

The interiors of the cars are finished in solid mahogany with full-vaulted Empire ceilings. The main compartment has 15 reversible and four stationary seats of the Hale & Kilburn No. 199 type. The smoking compartment has four reversible and four stationary seats.

The baggage compartment occupies a space 11 ft. long at the front end of the car, and has two sliding side doors. This compartment is lined on the sides and ends with 2-in. ash strips. Two folding seats are placed along the side walls. The vestibules, which are 4 ft. 6 in. long, have end doors for use during train operation. The front end of the car is set off as a motorman's cab. The cars are built for single-end operation, but are equipped for double-end control. They are lighted by 16-cp frosted globe incandescent lamps, arranged as follows: Two lamps in the vestibule; 19 lamps on the deck rail, and 12 lamps on the ceiling of the main compartment; two ceiling lamps in the toilet room and eight deck and three ceiling lamps in the smoking compartment. Combination arc and incandescent headlights will be used. The lamps are grouped in circuits to allow for partial lighting, if desired.

The cars are equipped with Janney radial M.C.B. couplers and McConway & Torley draft gear adapted for train operation in heavy interurban service. Other equipment installed on these cars includes: Baldwin class 78-30 trucks, Symington ball-bearing centerplates, Woods roller side bearings, Keystone air sanders, Edwards window fixtures, Curtain Supply Company's ring curtain fixtures, Duner toilet fixtures, Westinghouse AMM brake equipments, General Electric 205-B motors, General Electric type M automatic control and Peter Smith hot-water heating system.

NEW OGDEN CANYON LINE

THE Ogden Rapid Transit Company operates a 12-mile street railway line within the city of Ogden, Utah, and is just completing a scenic suburban extension up the deep canyon of the Ogden River, 3 miles, to a popular hotel and resort called "The Hermitage." The road, which is built against the base of the mountainside, has largely been cut out of solid rock. The roadbed is just above a tumbling stream, on the opposite side of which is a highway. An illustration on Plate XVI shows a portion of the roadbed, the stream and the highway. This view was taken before the trolley wire had been placed. The cost for constructing the three miles of roadbed in this canyon was $85,000.

EMIGRATION CANYON RAILROAD

A FREIGHT and passenger road extending from the southeastern part of Salt Lake City to quarries located 14 miles away recently has been equipped for electrical operation by the Emigration Canyon Railroad Company. In the length of this line the road climbs to an elevation of 7000 ft. in the Wasatch Mountains. This trip affords many beautiful views of rugged mountain scenery. The original reason which called for the building of the road was the transportation of lime and sandstone from quarries in the mountains to Salt Lake City, where these materials are used for building purposes. The electrification of this road has brought about the location of many summer homes along the canyon and steadily-increasing passenger traffic. Power for the operation of the line is obtained from the Utah Light & Railway Company as high-tension alternating current and is converted at a sub-station located about the midpoint of the line. The rolling stock equipment includes two Washington type motor cars and two 40-ft. 6-in. open trail cars with canopy tops, manufactured by The J. G. Brill Company. The closed motor cars are designed for all-the-year service and have sufficient motor capacity to haul the trail cars for handling the heavy summer traffic.

ELECTRIC RAILWAYS IN AND ABOUT SPOKANE

STREET AND INTERURBAN RAILWAY SYSTEM OF THE WASHINGTON WATER POWER COMPANY

THE Washington Water Power Company owns and operates 75 per cent of the street railway system in Spokane, Wash., and also interurban lines extending southwest to Medical Lake and Cheney. Within the City of Spokane the company operates 75 miles of well-built track, and the interurban lines comprise 29 miles of track. The principal investment of the company is in several large water-power developments and a steam relay station, all of which are connected by a high-tension transmission system with 450 miles of pole line, tying the stations together and distributing power to many of the important cities in Eastern Washington and to the mining districts between Spokane, Wash., and Coeur d'Alene and Wallace, Idaho.

TRACK CONSTRUCTION

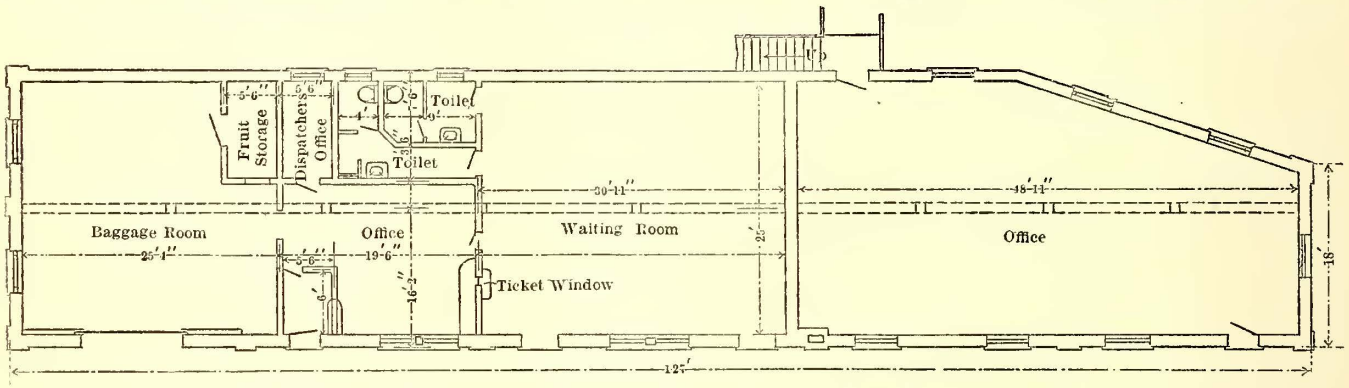
The company's tracks within the city limits of Spokane are laid with 7-in. 70-lb. T-rail connected by continuous rail joints and bonded with American Steel & Wire twin terminal bonds. Before installing these bonds the terminals are tinned and after the bonds have been placed in the rail the terminals are soldered to the steel, thus protecting them from corrosion. This method of soldering the bonds after installation was developed by the company's engineers.

The interurban lines are built on a private right-of-way and are modern in every respect. The tracks are laid with 60-lb. standard section rail and are well ballasted. The roadways are fenced and shelters are provided at important crossings. Attractive passenger stations have been built at the towns served. The overhead construction is standard flexible-suspension-supported d.c. single trolley.

It is the practice when building track to keep the cars operating on the street all the time and give up only one of the tracks to the construction forces during the time it is necessary to make the excavation and lay the rails. It is thought that by this means the continual passage of the cars over the track tends to set the ties into their foundation more securely than otherwise, and it is certain, also, that all the settlement takes place before the pavement is laid.

The track substructure includes a rock-ballast foundation on the top of which is a floor of concrete brought up above the rail base. Many of the streets in Spokane are paved with asphalt, and trouble has been experienced by the top coat of the asphalt being wedged up against the outside of the rail and above the running surface. In the track lately laid this troublesome feature has been obviated by a change in the method of placing the asphalt binder near the rail. Instead of bringing the binder level across the street and against the web of the rail, it is sloped down so that it does not come within more than 3 in. or 4 in. of the rail. The top coat thus fills the space along the rail from the concrete foundation to within 1/4 in. of the head of the rail. This top coat is pliable and so adjusts itself in expansion and contraction that it does not pile up, as it did when the binder was laid against the rail web.

The company makes its own trolley ears at its large repair shops in Spokane. These ears are cast in the brass foundry and finished on a shaper in the machine shop. Formerly when finishing one of these ears it was necessary to use three settings of tools and take three cuts to smooth the interior groove and the outside of the two lips. To effect an economy in this process an improved tool with a removable center was made, and with this tool the groove and lips of a trolley ear can be finished both inside and out on a shaping machine with one setting. The cutting tool has a V-shaped edge, in the center of which a removable piece of tool steel, ground with a round nose, is set. This removable piece serves to finish the inside of the ear and it may be lifted out for sharpening.



Washington Water Power Company—Floor Plan of New Station Building

BUILDINGS

The Washington Water Power Company's headquarters are in an especially fine office building owned by the company. The first floor of this building is used by the lighting department for a display room and as a public business office. The upper three floors are occupied entirely by the company's engineers and officials.

A terminal passenger station is now being built on Wall Street in Spokane. This station will be two stories and a basement in height, 127 ft. long and 27 ft. 2 in. wide. Along the street side of the station a projecting roof will form a passenger shelter and protect the loading space between the track and the building. The interior of the first floor of this building will be subdivided into a baggage room 25 ft. by 25 ft., an office 13 ft. 6 in. by 16 ft. 2 in. for the dispatcher, toilet accommodations, a waiting room 30 ft. x 25 ft., and a general office for the transportation department 50 ft. x 25 ft. in size. In one corner of the baggage room will be a compartment 10 ft. x 5 ft. for fruit storage. The structure is being built of brick.

The interurban station at Cheney, the southern terminus of one of the interurban lines, is an attractive looking brick building, rectangular in shape and 26 ft. x 89 ft. in ground dimensions. The building has a wide overhanging roof covered with tiling. Suitable accommodations are provided for passengers, freight and baggage. The freight platform is 28 ft. in length.

The Washington Water Power Company has the only amusement park within the city of Spokane. This resort, known as Natatorium Park, has attractive natural surroundings which have been fully developed. During the present summer the company has completed an elaborate bathhouse with a concrete swimming pool 75 ft. x 152 ft. in size and ranging in depth from 3 ft. to 12 ft. The enclosing building is 107 ft. x 184 ft. in ground dimensions. A continuous stream of water is warmed and fed into the bathing pool by steam ejectors which lift the water from the well. The use of steam ejectors in this connection is thought to be unique. Steam for the operation of the ejectors is generated in three 80-hp boilers.

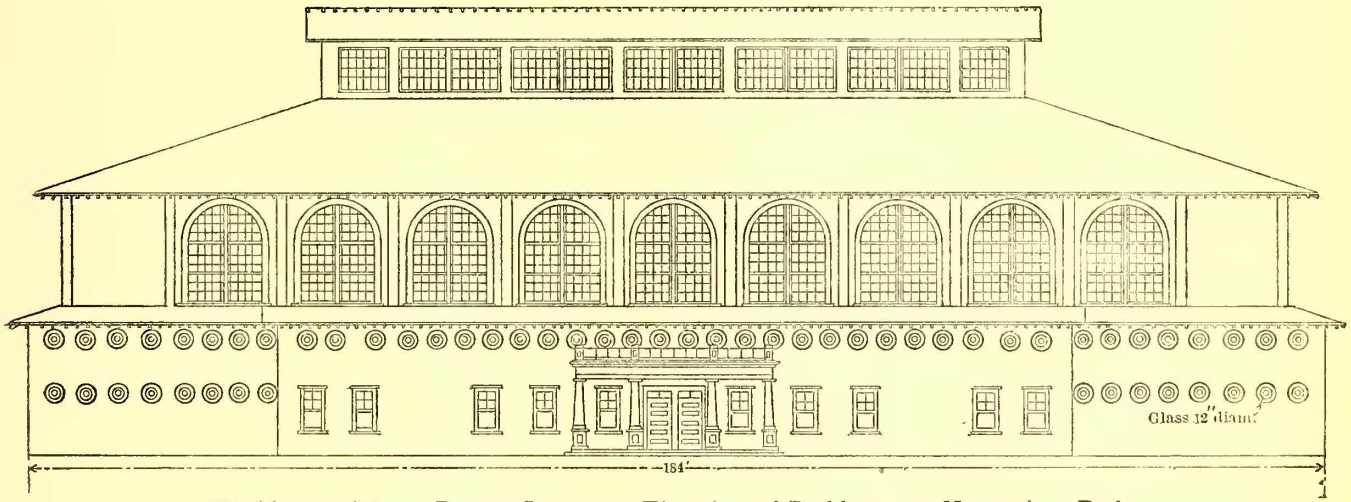
POWER STATIONS

The total generating capacity of the several power plants feeding the extensive transmission system is 40,500 kw. A power plant now in course of construction at Little Falls, on the Spokane River, will have an immediate additional capacity of 20,000 kw developed by four G.E. generators driven by I. P. Morris central-discharge horizontal turbines. The oldest water power station of the company is located within the commercial district of the city of Spokane, in the gorge of the Spokane River. This plant is now developing 13,000 hp and later, by the development of the total fall of 144 ft. within a distance of 1200 ft., the total capacity will be increased to 40,000 hp at low water. This plant is equipped with both a.c. and d.c. machines. The alternating-current machines operate in parallel with the transmission system and the direct-current machines feed the local street railway system.

At Post Falls, 24 miles east of Spokane, on the Spokane River, near its source at the foot of Lake Coeur d'Alene, the company has a power plant with an equipment of six 2,250-kw G.E. alternators driven by horizontal waterwheels. The plant is located at natural falls in the river. Just above the falls a bear-trap dam with Tainter gates diverts the water into the power-house canal. There is a head of 57 ft. The natural storage reservoir of the Post Falls plant is Coeur d'Alene Lake, which has an area of 45 square miles. Thus the company is not bothered with a shortage of water during the dry seasons. The power-station structure is a fireproof brick building supported on concrete foundations. Adjacent to the generator room is a transformer and switching station. In the transformer and switching station the current from the generators is stepped up to 60,000 volts potential, and fed to Spokane over either of two transmission lines and to Wallace, Idaho, on another line which is built in duplicate.

The steam relay station in the City of Spokane is an example of the latest type of plant and equipment. It is a brick structure supported on piling and concrete foundations. The boiler plant is made up of twelve 514-hp Aultman & Taylor hand-fired boilers. Steel stacks provided with four induced-draft fans built by the Buffalo Forge Company supply draft. Coal is unloaded automatically and transferred to the firing aisle by a bucket conveyor. The boilers are equipped with Mason steam pressure regulators and Spencer damper-operating mechanisms.

The main generating units are one 5,000-kw and one 9,000-kw 13,200-volt 60-cycle Curtis turbines. This plant is provided wtih a very complete switching gear for handling the 60,000-volt current delivered to the company's transmission system at its central substation in Spokane. The 60,000-volt transmission lines extending in three directions from Spokane center at a transfer substation located just south of the city. This station is provided with transfer buses and high-tension switching gear, as well as transformer equipment to lower the voltage for local distribution. An interesting feature of the 450-mile 60,000-volt transmission system of this company is the installation of open-air switches at the principal junction and branching-off points. These switches, which are of the horn type, are mounted on the tops of poles and are operated by long wooden rods which can be manipulated from a platform about 10 ft. below them.



Washington Water Power Company—Elevation of Bathhouse at Natatorium Park

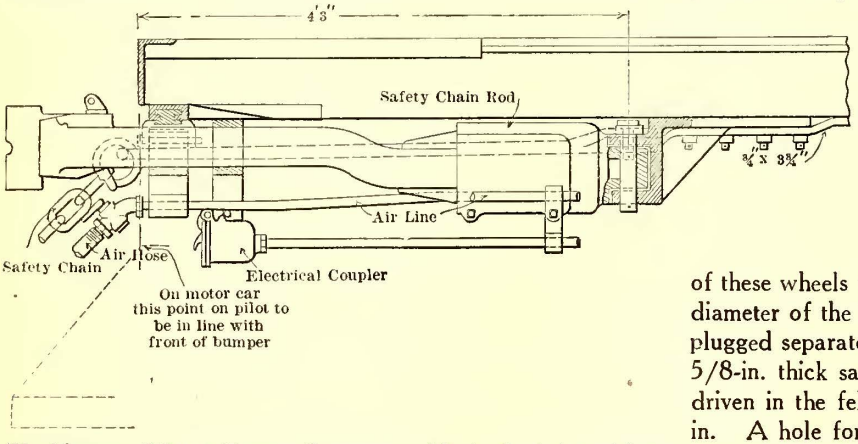
A large central receiving substation is now being built in the heart of the commercial district of Spokane. This building is to be 200 ft. x 107 ft. in ground dimensions and its equipment will include 30,000-kw capacity in transformers. The output of these motor generators will be used to supply the local railway system and the company's lighting feeders.

ROLLING STOCK

The shops of the Washington Water Power Company recently have completed a very useful combination wrecker and line car. This car has a substantially built box body mounted on Brill trucks carrying four GE-52 motors. The car complete weighs 21 tons and is equipped with National Brake & Electric Company's air brakes, two arc headlights, an elevating tower with swinging platforms which serves two tracks, and a reel stand for trolley wire. A swinging bracket and

chain block are provided at the entrance door of the car so that heavy supplies or tools can be lifted easily and swung onto the car floor. The roof of the car is floored over so that the linemen are free to use the entire space in their work. Several of the operations of the car and its equipment are controlled by compressed air. At the motorman's position there is the usual type of engineer's valve, also one which admits air to a large piston for raising and lowering the trolley tower, and a valve which operates an air brake on the trolley-wire pay-out wheel. An electric bell circuit is provided with a push button on top of the tower and a bell within the body of the car so that the linemen may conveniently signal the motorman. The telephone equipment is a wall set mounted with a hinge and so weighted that when it is not in use it will be held against the roof of the car and out of the way. A work bench, vise and a complement of small tools are carried on the car.

The rolling stock equipment of the Washington Water Power Company includes 108 city and interurban passenger, freight and miscellaneous cars. The passenger equipment bodies are mounted on a special type of Brill trucks with reinforced corners and milled pedestal guides. The trucks under the interurban cars have a 6-ft. wheel base with inside-hung motors and brakes. Both city and interurban cars have 34-in.



Washington Water Power Company—Method of Attaching Coupler for Train Operation

Midvale steel wheels weighing 790 lb. Solid gears are used throughout. The standard city passenger car is a double-truck equipment with longitudinal seats at either end and cross seats in the center. The interurban freight cars are operated in trains and are mounted on M.C.B. type Brill and Baldwin trucks and, as in the case of the interurban passenger cars, have Washburn M.C.B. type couplers.

SHOPS AND CAR HOUSES

The main repair shops and car houses of the Washington Water Power Company are located in the western part of the city of Spokane. The group of buildings comprises a shop structure 255 ft. square, subdivided into a main repair bay and car storage with 10 tracks, a paint shop, stock room, blacksmith shop, machine shop, armature room, foundry and office.

The central operating headquarters for the city and interurban service are located in the two-story office portion of the main car house and repair shop building. The receivers' office on the second floor of this building has been designed to provide against burglary. The room has brick walls and a door and front covered with heavy boiler plate. There is no view through this side of the room into the general trainmen's quarters. Cash is received in a swinging metal drawer arranged similarly to the deposit trap of a receiver's safe. The adjoining car house has concrete side walls with an average length of 450 ft. The building is 130 ft. wide at the rear wall. There are 10 storage tracks ranging in length from 300 ft. to 575 ft. The car house and a portion of the shops are protected against fire by a dry-pipe automatic sprinkler system with 18 main distribution pipes. The sprinkler heads in the car houses are spaced one for every 8-ft. square at the ceiling and are located 8 ft. apart along the aisles at the level of the car transoms. The water supply for this system ordinarily is obtained from the city pipes, but there is a 50,000-gal. reserve tank mounted on a steel tower 75 ft. high, located in the car-house yard. This car house has concrete walls and timber roof and pit construction.

A new car house is being erected at Cedar Street. This building is 256 ft. long by 225 ft. wide and will have pit tracks to hold 180 50-ft. cars. The car house tracks are laid on 12-ft. 6-in. centers and at the connecting ladder the shortest curves are 45-ft. radius. Four concrete fire walls divide the building longitudinally. The steel doors over the track entrances are operated by electric motors.

SHOP PRACTICE

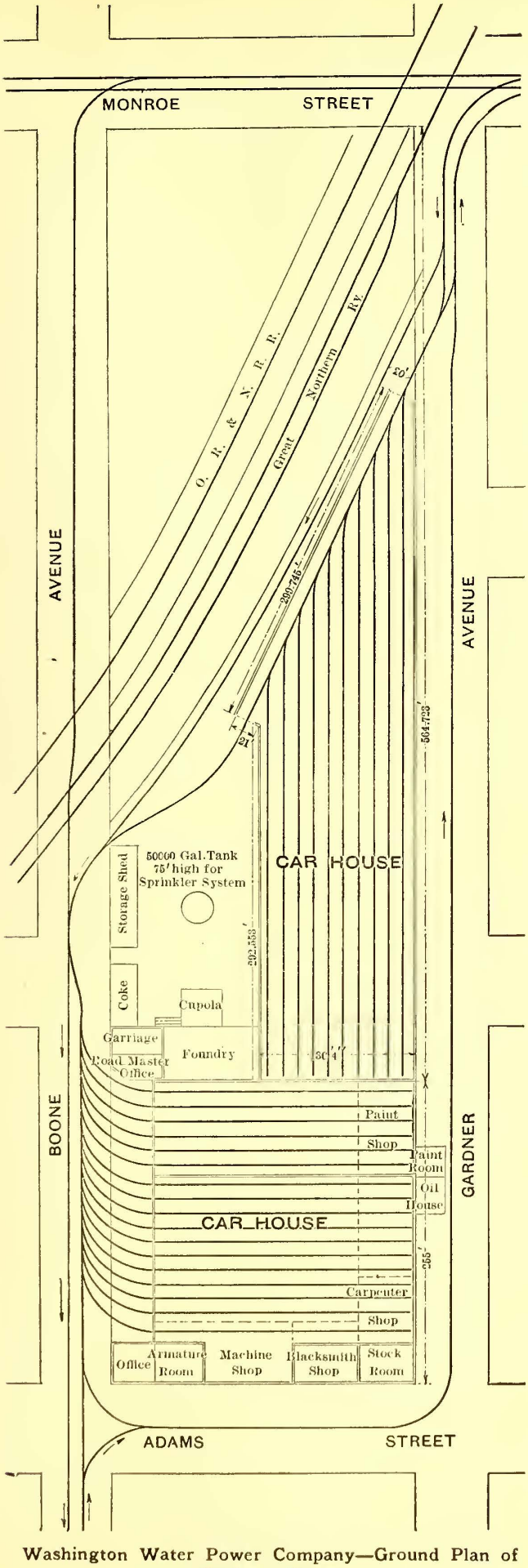
A view of the interior of the machine shop is presented on Plate XXI. The repair plant has a very complete equipment of machine and woodworking tools, and in this plant the company manufactures a considerable portion of its rolling stock parts and general supplies for the track and roadway department.

A type of trolley wheel is manufactured in the shops with which remarkably good results have been obtained. This wheel has the usual shape of web and rim. The hub, however, is fitted with a scheme for lubricating which has been developed by the company's employees. In the manufacture of these wheels the hub is first bored somewhat larger than the diameter of the bearing pin. Both ends of the hole are then plugged separately, and between the two plugs a layer of felt 5/8-in. thick saturated in oil is placed. When the plugs are driven in the felt is compressed to a thickness of about 3/64 in. A hole for the axle is then drilled in the ordinary manner. This felt washer retained at the center of the axle continually wipes it with the lubricating oil, which feeds outward, thus excluding the dust and affording a longer life to the bearing than can be had from the rim of the wheel.

In the truck shops a considerable number of welds of important parts are made with thermit and good results have been obtained. Controller repairing is not done on the cars, but when it is necessary to remedy some defect in a controller it is removed from the car and a new controller put in its place. In this way a car otherwise in operative condition is not held in for a minor repair.

In the maintenance work good results are being had from the use of a babbitt mixture comprising 100 parts of tin, 10 parts of antimony and 10 parts of copper. It is necessary to pour this mixture quickly and to have the molds hot. There results from this process a very tough metal which can be remelted often if not overheated. Special care is taken not to get any zinc into the babbitt mixture. As a precaution against this the babbitt is chipped and not melted out of the brass linings. To provide against overheating the babbitt mixture a large body of metal is used, heated by a wood fire which is easily controlled.

All of the wire from burned fields is cleaned and reinsulated with a machine purchased from the American Insulating Machinery Company. This wire-insulating machine will handle any size of wire from No. 10 to 1/2-in. square, but is used principally in reinsulating field wire. When a coil



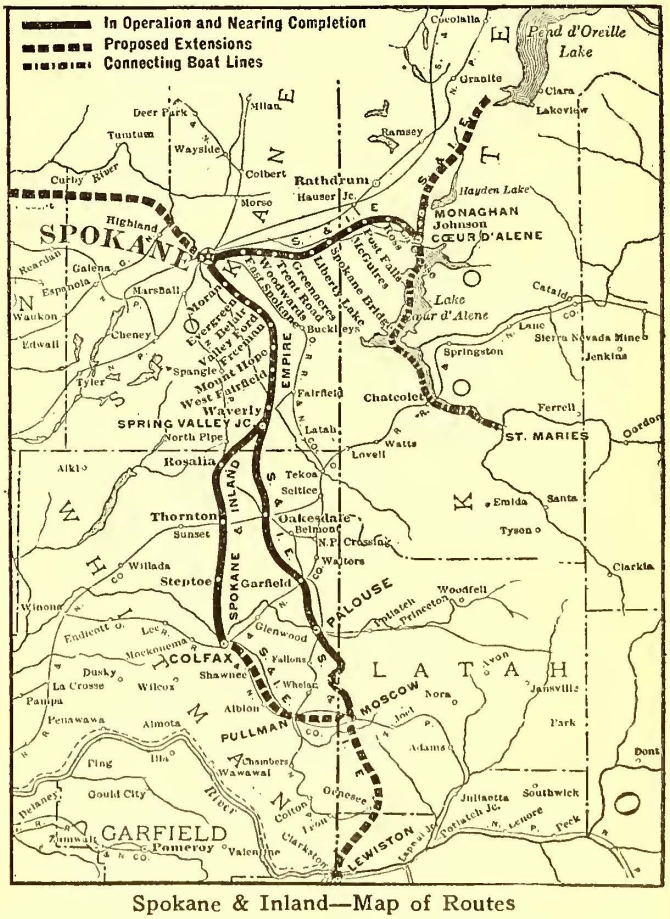
Washington Water Power Company—Ground Plan of Spokane Shops

of field wire is to be reinsulated the field spool is heated until the insulation is carbonized. Next the wire is fed through a scraper and then into the winding machine, where it is straightened thoroughly, cleaned and a cotton covering of single, double or triple braid applied. No. 80 S. I. 18-end cotton is used. The cost for reinsulating wire with this machine is stated to be less than 2 cents per pound for labor and material.

The oil house and paint storage rooms for the repair shop are concrete structures built underground and outside of the main shop wall. The rooms connect with the shops by concrete stairways, the openings to which can be closed by fire doors. The oil pumps are located below the floor level and the storage tanks are filled from out of doors. Oil is drawn from these tanks by six Bowser measuring oil pumps. The sprinkler system is extended into the underground oil house and into the paint storage room.

SPOKANE & INLAND EMPIRE SYSTEM

ONE of the two street railway systems in Spokane is owned and operated by the Spokane & Inland Empire Railroad Company. The other, as described, is owned by the Washington Water Power Company. The principal investment of the Spokane & Inland Empire Company, however, is its well-built interurban electric railway system, serving the large cities of eastern Wash-



Spokane & Inland—Map of Routes

ington and extending into Idaho at two points about 90 miles apart. From the passenger terminal at Spokane the lines of this railway radiate in two directions. To the east along the Spokane River a direct-current operated line serves a highly developed irrigated valley between Spokane and Coeur d'Alene, and an extension from Coeur d'Alene reaches Hayden Lake, an attractive resort. From Spokane south the single-phase division is a single-track line to Spring Valley junction, 40 miles, from which point two branches extend: one

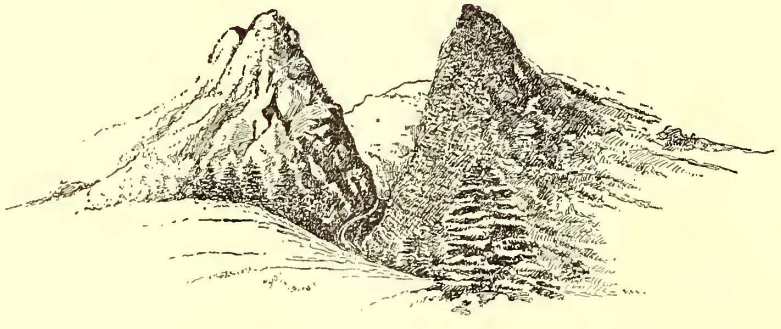
directly south to Colfax, 77 miles from Spokane, the other in a southeasterly direction to Palouse, 76 miles, and to Moscow, Ida., 90.4 miles from Spokane. The territory through which this southern division passes is a rolling wheat belt and a fruit and truck-gardening district.

In constructing the roadbed of the entire Spokane & Inland Empire system actual steam railroad standards have been so closely followed that no difficulty is experienced nor are special precautions needed when handling any train that a competitive steam railroad may handle.

The principal constructional and operating features of the Inland Empire Railway system have been described in earlier issues under the following references: STREET RAILWAY JOURNAL for April 27, 1907, page 725, general description; Feb. 8, 1908, page 207, special train service. ELECTRIC RAILWAY JOURNAL for Oct. 10, 1908, page 898, hydro-electric power plant; Oct. 15, 1908, page 1085, an article on publicity methods by Charles E. Flagg, advertising agent; Feb. 27, 1909, page 364, description of park and lake resorts. ELECTRIC RAILWAY REVIEW, Feb. 20, 1907, page 148, description of terminal station and office building at Spokane; Sept. 7, 1907, page 279, description of mail trains; Oct. 19, 1907, page 678, facilities for handling foreign shipments of grain; Oct. 26, 1907, page 697, power system, including description of phase-changing and storage battery plant; Dec. 7, 1907, page 891, repair shop; Dec. 28, 1907, page 997, an article on the parlor-car service.

The Spokane terminal of the Inland Empire system is located in the heart of the city in the block adjoining the new Federal Building and close to the Spokane River. The freight terminal is about one-half mile distant up the river. Work is now in progress on the driving of a tunnel which will permit all the interurban trains to pass under the business center of the town, between the end of the right-of-way at the freight terminal and the passenger terminal without operating over street tracks, as now is done. The view of the terminal station and office building presented on Plate XXII shows a large crowd of people about to take trains on the Coeur d'Alene division to participate in the drawing for the Indian reservation lands which were opened during July of this year.

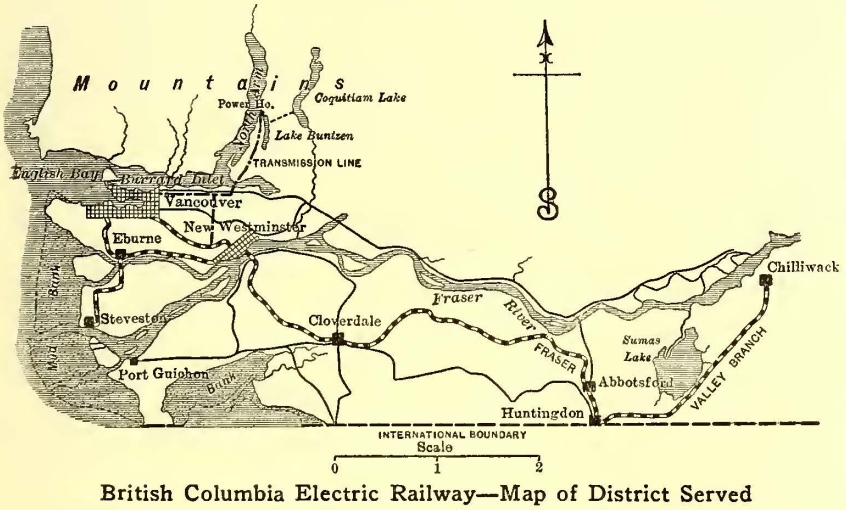
One of the many resorts on the Inland Empire system is Liberty Lake, Wash., which, in the past two years has been promoted by the railway interests. This resort is 17 miles east of Spokane on the Coeur d'Alene division. Liberty Lake is a beautiful body of water nestled among the foothills of the Mica Mountains at an elevation of 2,000 ft. The railway company owns property on the east shore of the lake and has built an attractive passenger station here with a loop track for turning its lake service trains. The Liberty Lake resort has been developed by the construction of dance and dining pavilions, bathing and boat piers and many smaller structures, all built according to the Swiss chalet style of architecture.



THE BRITISH COLUMBIA ELECTRIC RAILWAY

BRITISH COLUMBIA has shown a remarkable growth in the last 10 years. Vancouver, the largest city in the Canadian Northwest, is the commercial center of British Columbia. Since the first train over the Canadian Pacific Railway arrived in Vancouver in May, 1887, the population of that city has increased from 3,000 to 100,000, and its neighbor, New Westminster, has grown to be a city of 12,000 population. Vancouver has excellent water, rail and street transportation facilities. The British Columbia Electric Railway operates 24 miles of track within the city and has a total of 97 miles of track, centering in Vancouver. At the present time this road is being largely extended and many substantial improvements are under way.

The British Columbia Electric Railway now operates high-speed interurban lines to New Westminster on the Fraser River, 12 miles, to Steveston at the mouth of the Fraser River, about 20 miles, and a connecting service over the electrified Canadian Pacific Railway tracks between Eburne, the midpoint on the latter line, and New Westminster. By



British Columbia Electric Railway—Map of District Served

means of these lines it is possible to give direct service from Vancouver to Steveston and New Westminster and from New Westminster to Eburne, Steveston and Vancouver. The British Columbia Electric Railway has the railway, light and power franchises in all of these and other suburban cities. It is also giving similar service in North Vancouver, a city of 3,000 population, and owns and operates the 20-mile street and suburban system in the city of Victoria with 20,000 population on Vancouver Island. The company has under way a number of extensive projects which will include the construction of 12 miles of suburban trolley and the installation of lighting and power service wires through the district, which will be reached by the new lines. The old interurban line between Vancouver and New Westminster has been reconstructed within the past year and double tracking for half of its length completed. The proposed plans for expansion include the construction of an interurban line on Vancouver Island, leading out of the city of Victoria, but the most important project now in hand is the construction of a 63-mile line up the Fraser River valley. It is anticipated that the first 20 miles of this line will be in full operation before the close of the present year and work well in hand on the remainder of the line. The constructional details of this long interurban line are presented later.

OPERATION

The operating headquarters of the British Columbia Electric Railway are in Vancouver. During the year ending June 30, 1909, the lines in Vancouver and its suburbs carried 25,250,000 passengers. This was an increase of 3,160,000 passengers over the number carried the year before, and these were carried with but a small additional increase of trackage. The headquarters of the transportation department are in the group of buildings which includes car houses, central repair shops and a substation near the commercial center of Vancouver.

Sixty-two regular city cars, 15 trippers and an observation car are regularly operated in Vancouver. The local service in New Westminster includes six regular cars. In Victoria the company has 40 cars. Six regular freight trains are operated daily between New Westminster and Vancouver.

The observation car, an illustration of which is presented on Plate XXIII, is built with cross seats rising in steps from the front to the rear. This car has a seating capacity for 50 persons. The heavy underframe is mounted on two pairs of Brill trucks, each carrying two inside-hung GE-67 motors. Westinghouse air-brake equipment and platform control are provided. This car, which presents an attractive appearance, was built in the shops of the British Columbia Electric Railway, and makes two trips a day throughout the city and suburbs, visiting the bathing beaches, the ocean shore and Stanley Park.

On its city lines in Vancouver the company collects three classes of fares other than the straight 5-cent fares. Commutation tickets, good at any time, are sold six for 25 cents; workmen's tickets, good between the hours of 6 and 9 a. m. and 5 and 7 p m., and are sold eight for 25 cents; children's school tickets are sold eight for 20 cents. Transfers given on any line are acceptable on any other line. Formerly a separate transfer was printed for each line, but a new transfer has been put into use, which covers all of the lines and thus a considerable saving in cost of printing is made by the use of the universal transfer. A sample transfer is reproduced on page 530. The original size of these transfers is 4 1-4 in. x 2 1-2 in. Fares and transfers are collected on the cars with Coleman portable fare boxes similar to those used in Montreal.

In training new men the course of instruction includes service on the cars with five different instructors, one of whom is an air-brake expert. After these five men have certified to the ability of a student he serves two weeks in the car house to familiarize himself with the details of the equipment and then is examined by the superintendent of transportation. The student is not required to write his answers, but dictates them to a stenographer in the presence of the superintendent. When the notes are transcribed one copy is retained by the superintendent and the other is sent to the general manager. The company maintains a course of lectures delivered daily by electricians and traffic experts. The men are invited to at-

tend these lectures and to broaden and refresh their knowledge on operating and maintenance subjects.

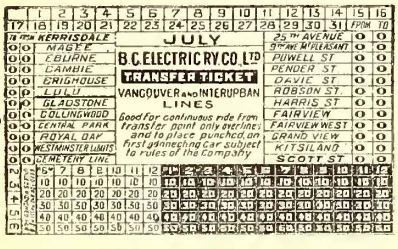
Trained ambulance corps fully equipped for the handling of emergency cases until the hospital surgeon arrives with more complete equipment, are maintained at the traffic headquarters and at one of the substations. The equipment for these ambulance corps includes two hand ambulances with very complete "first aid" outfits.

The shop forces of the British Columbia Electric Railway are divided into maintenance and car construction organizations. The maintenance shops are in Vancouver, while the construction shops are located on a large property just north of New Westminster. These shops have in hand the construction of 26 city passenger cars, built with platforms on which the pay-as-you-enter method of fare collection may be used if desired, work locomotives and two portable substations for the new Fraser valley interurban extension.

Seventy men are regularly employed in the car construction shops, which are fully equipped for building car bodies and trucks. Views of the interior of the shops and of a passenger car and freight locomotive built here are presented on Plate XXIII.

POWER GENERATION

Power for the operation of the cars and for feeding the lighting and commercial circuits is generated in a large hydraulic station owned and operated by the company and located at tidewater on the north arm of Burrard Inlet, 16 miles from Vancouver. The generating equipment consists of four pairs of 3,000-hp Pelton wheels, each pair driving a Westinghouse 1,500-kw 3-phase 2,200-volt generator and one pair of 5,000-hp Pelton wheels driving a GE 5,000-kw 2,200-volt generator. Construction work is well advanced on an extension of the plant, which will permit the installation of a 5,000-kw Dick-Kerr generator to be driven by a 10,000-hp Doble waterwheel.



Universal Transfer

The water supply for operating this plant with its present capacity of 22,000 hydraulic horse-power now developed and 50,000 hp total capacity, is taken from Coquitlam Lake, a body of water about 6 miles long, located 3 miles over a mountain ridge from the power house. The original outlet of this lake led to the Fraser River, about 18 miles south of the south end of the lake. Flowage through this outlet was stopped by the construction of a 12-ft. dam, and thus the lake made into a large reservoir. From this lake a tunnel 12,774 ft. long was driven under a mountain nearly a mile high, and a new outlet for the waters of Coquitlam Lake was thus made. The tunnel discharges into Trout Lake, a body of water about 3 miles long, the north end of which is about 1.5 miles from the power house. From Trout Lake the waters are led through flumes and steel pipes to the power house located at the foot of a steep mountainside at sea level. The hydraulic head on the waterwheels is 400 ft., and water is fed to the Pelton wheels through riveted steel pipes varying from 54 in. to 60 in. in diameter. The 10,000-hp Doble wheels will be fed by similar pipes varying from 7 ft. to 6 ft. in diameter.

Provision for the large increase in the generating capacity of this plant is being made, not only by the extension of the power station building, in which work 7,000 cu. yd. of rock were blasted out of the side of the mountain and a very complete reinforced concrete wharf built on which to unload new machinery, but also by the enlargement of the tunnel between the two lakes and the construction of a new diversion dam at the foot of Coquitlam Lake. The original tunnel, 2.5 miles long, between Trout and Coquitlam lakes, was 8 1-2 ft. square in section. Its size is being enlarged to 13 1-2 ft. square, which will more than double the capacity. The diversion dam is being raised in height from 12 ft. to 60 ft., thus greatly increasing the storage capacity.

The output of the generators of this plant at 2,200 volts is controlled by a new switchboard with Westinghouse instruments and is conducted to a large reinforced concrete transformer house located on the mountainside, just above the power plant. In this transformer house is an equipment of air-blast step-up transformers with Sturtevant blast fans belted to Westinghouse induction motors. Here the pressure is stepped up to 40,000 volts and the current fed 18 miles by a transmission line to a receiving substation in the center of the city of Vancouver. A branch line feeds two substations, one located in New Westminster and one about 3 miles west of New Westminster on the interurban line to Vancouver. A new substation has been built on the Vancouver-Steveston line, and plans have been made for the construction of several stations on the Fraser River valley line to Chilliwack.

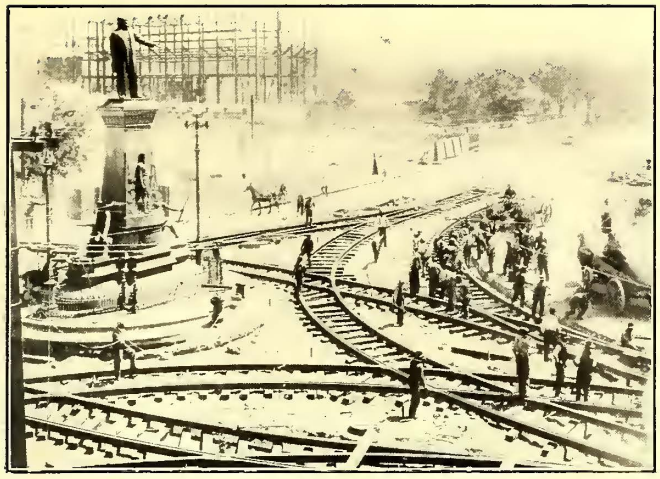
FRASER VALLEY BRANCH

An interesting description of the Fraser valley interurban extension now under construction, was read by Robert Howes, electrical engineer, before the last annual meeting of the Canadian Street Railway Association, and acknowledgment is made for the following information regarding the most interesting features of this line.

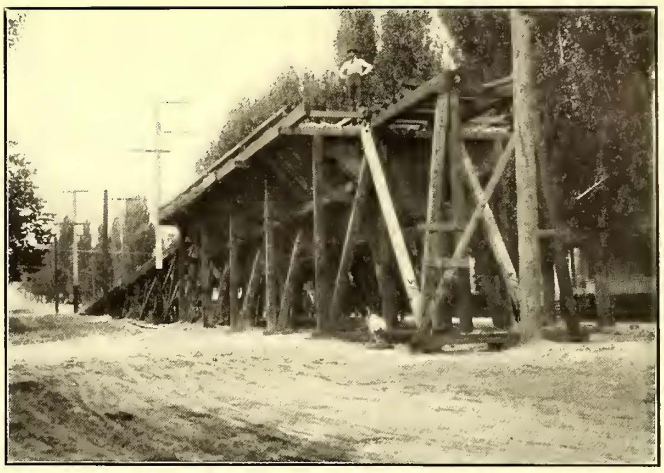
Immediately to the east and south of Vancouver and between the Fraser River and the international boundary line lies a strip of land measuring practically 60 miles in length and averaging 10 miles in width, through which the British Columbia Electric Railway Company is now building a modern interurban electric railway. This line, when completed, will be 63 miles long and will serve the territory referred to between the city of New Westminster and the town of Chilliwack. The line will pass lengthwise near the center of this tract of land and will serve the towns of Cloverdale, Abbotsford and Huntington. The road has been designed for high-speed operation, and the franchises secured by the company provide for the carrying of passengers, express, baggage and freight. The overhead trolley system with a line pressure of 600 volts d. c., will be used. At New Westminster the line will connect with the existing line, also owned by the company, between New Westminster and Vancouver.

PORTABLE SUBSTATIONS

The power used by this company for the operation of cars on all of its lines is obtained from a hydro-electric plant located on the north arm of Burrard Inlet, as earlier described. Along the new line substations will be located at New Westminster and Chilliwack and at four other intermediate points. The substations will be an average distance of 12 miles apart. They will be equipped with motor generators and air-blast transformers, which have a factory insulation test guarantee of 88,000 volts from primary to secondary and to the core. The incoming high-tension current will be controlled by 45,000-volt hand-operated oil switches. The motor generators will receive current at 2,300 volts. Two portable substations are now being built for use in case of emergency. These portable substations will be equipped with apparatus



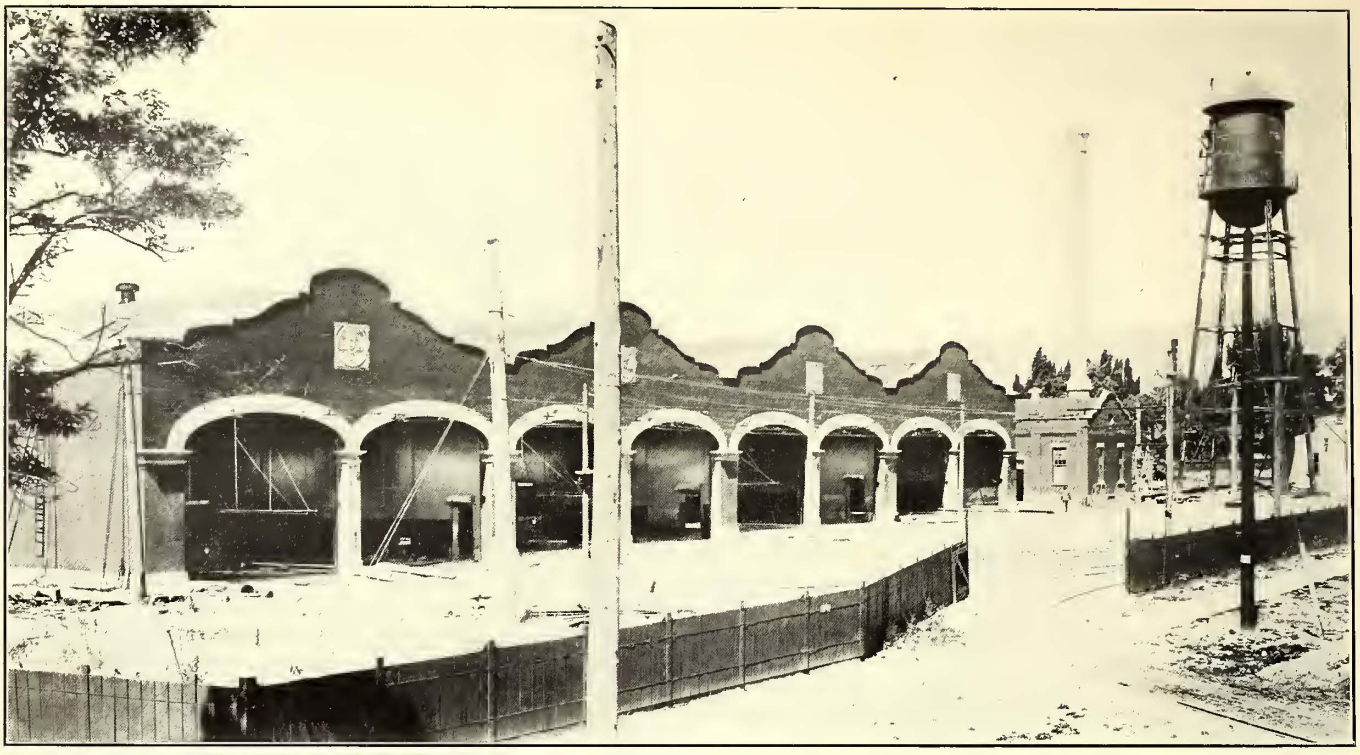
Utah Light & Railway—Large Special Work Layout



Utah Light & Railway—Portable Bunker for Crushed Stone

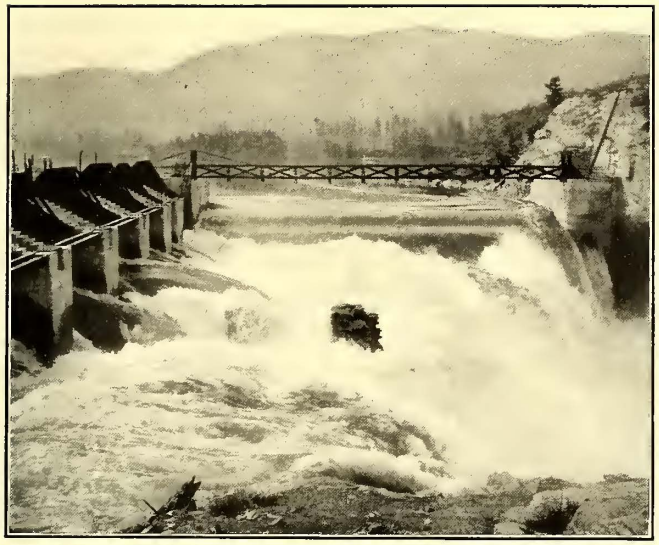
Utah Light & Railway—Welding Track Joints by Thermit Process

Utah Light & Railway—Main Street, Salt Lake City, with and without Center Poles



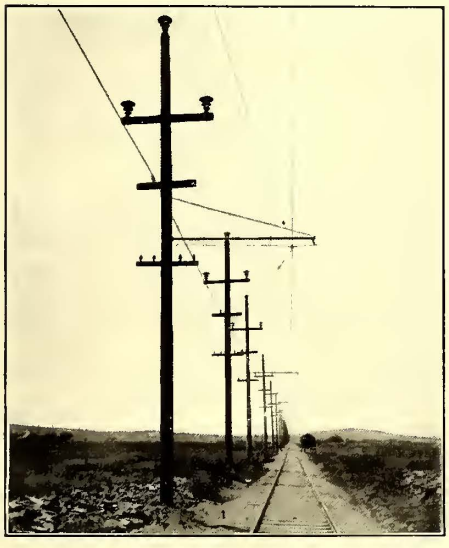
Utah Light & Railway—General View at Front of New Car House, Showing Heating Plant and Elevated Water Tank for Supplying Sprinkler System

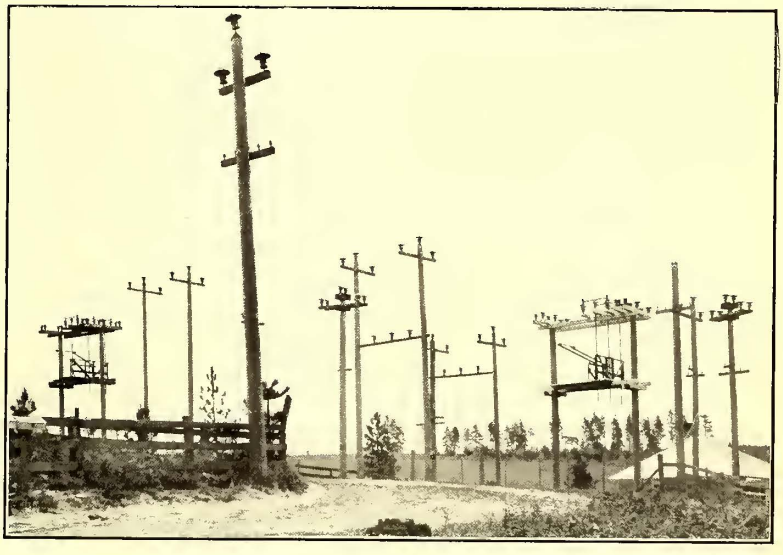
Utah Light & Railway—Interior of New Car House in Salt Lake City, Showing Skylight Arrangement and Lines of Aisle Sprinklers



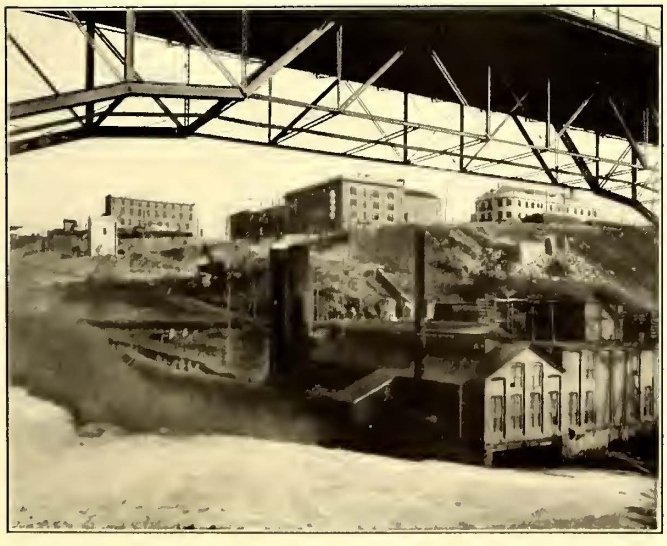
Washington Water Power Company—Dam and Tainter Gates at Post Falls

Washington Water Power Company—Interior of Post Falls Power Station



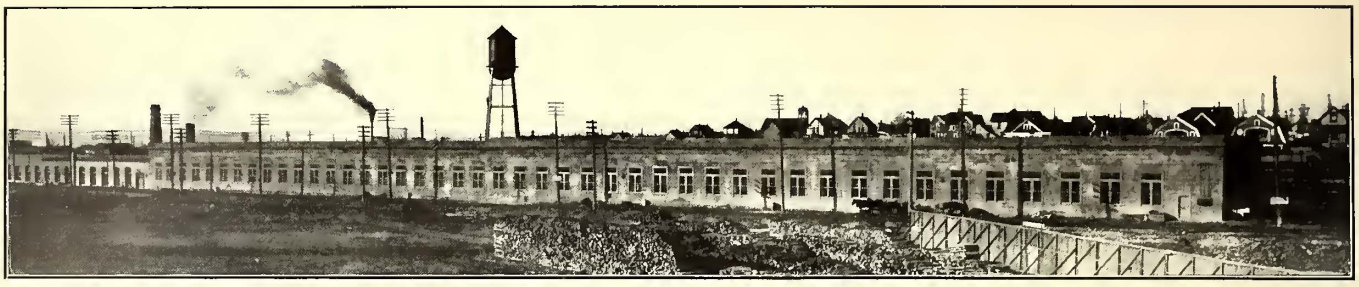


Washington Water Power Company—Cheney Interurban Line and Typical Open-Air Switching Station

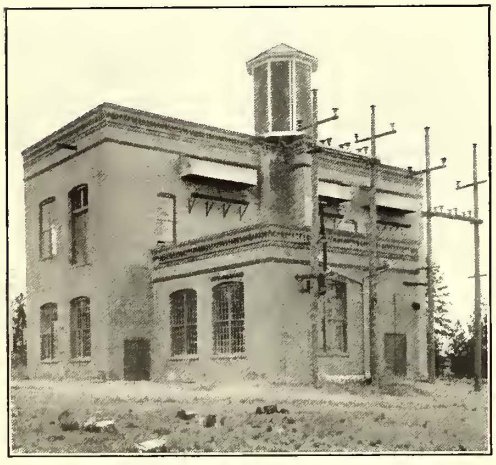


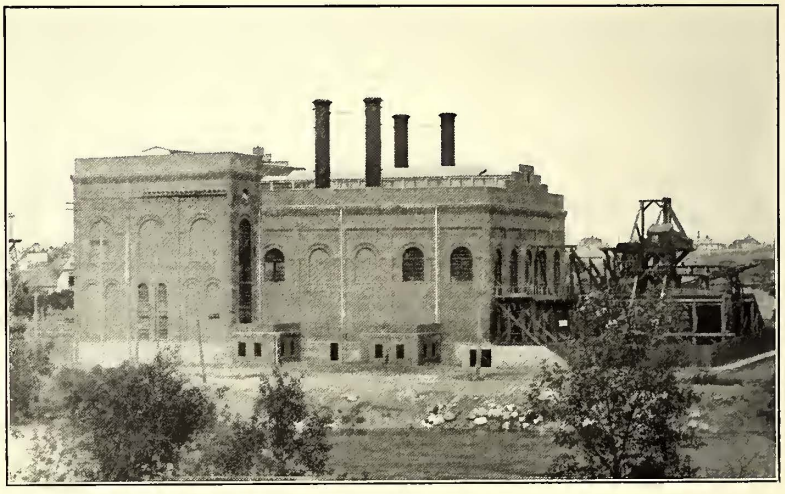
Washington Water Power Company—Old Water Power Plant in Spokane

Washington Water Power Company—Boiler House of Steam Relay Station

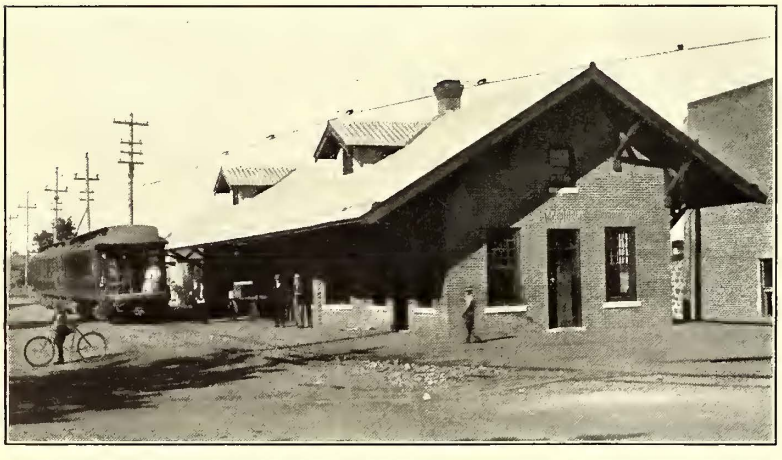


Washington Water Power Company—New Spokane Car House

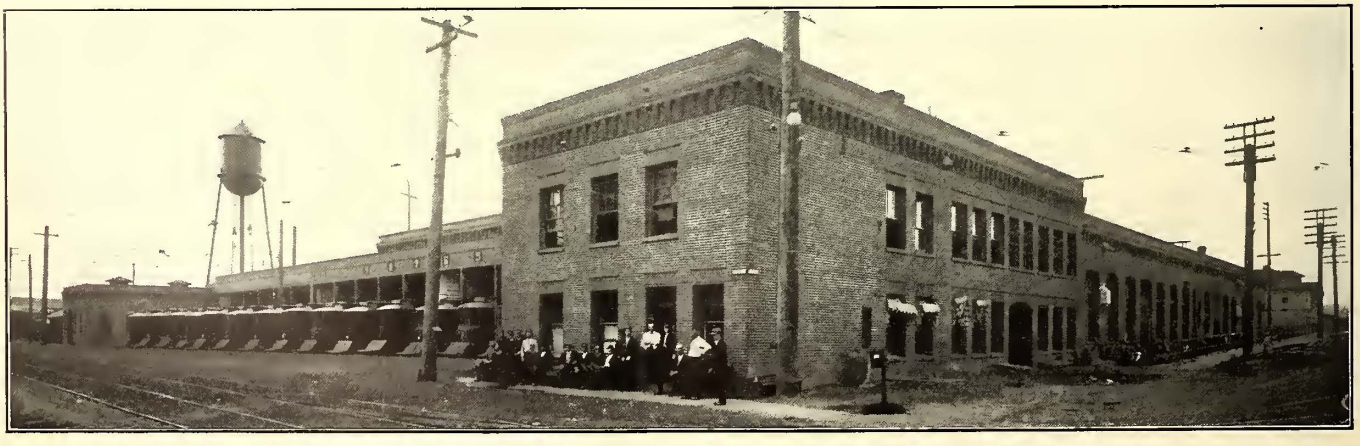




Washington Water Power Company—Receiving Substation and Steam Relay Station at Spokane

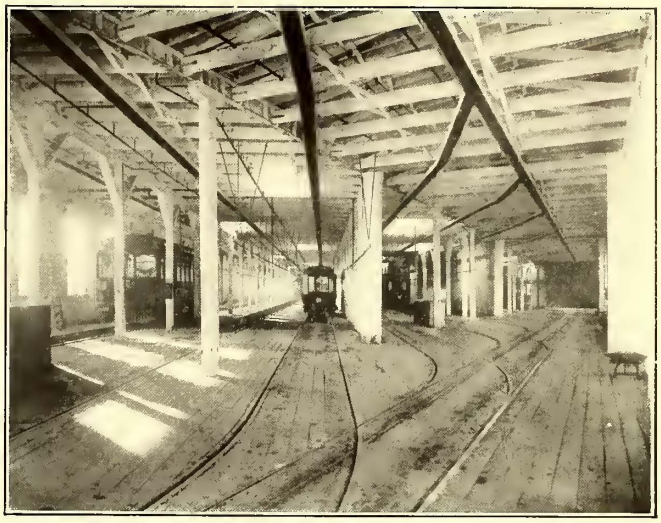


Washington Water Power Company—Interurban Station at Cheney and Spokane Office Building



Washington Water Power Company—Main Repair Shop and Car House

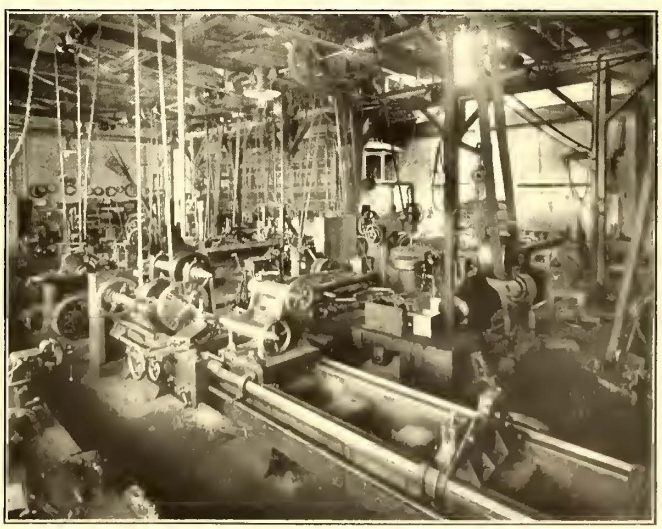
Washington Water Power Company—Line Car



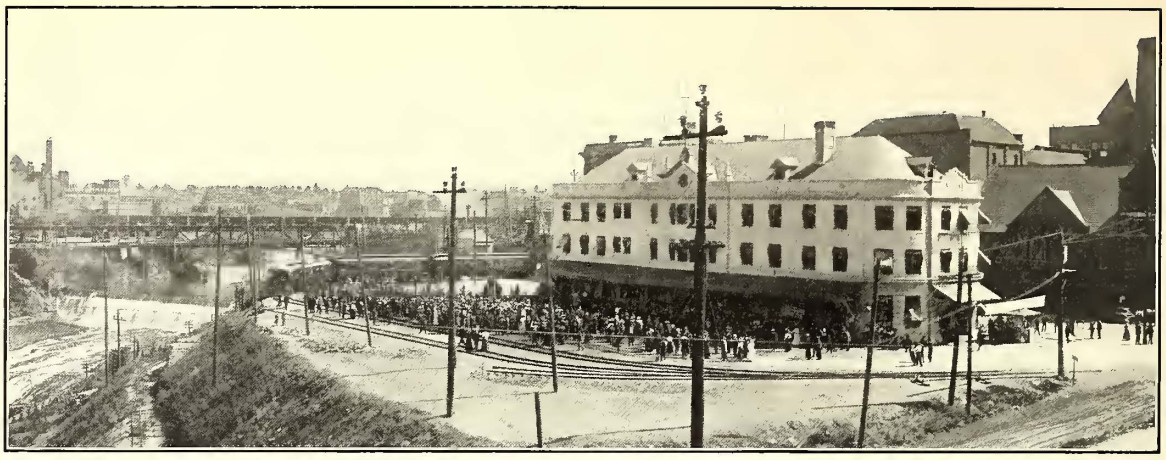
Washington Water Power Company—Car House

Washington Water Power Company—Standard Home-Built Freight Train

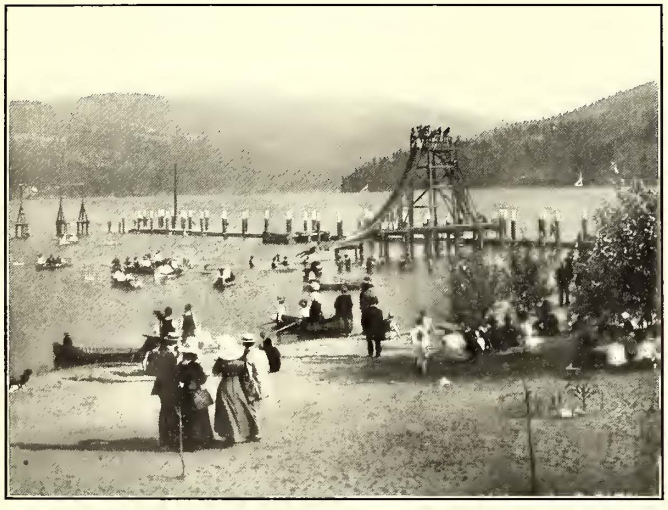
Washington Water Power Company—Standard Double-Truck Car Used in Spokane



Washington Water Power Company—View of Machine Shop Looking Toward Repair Bay



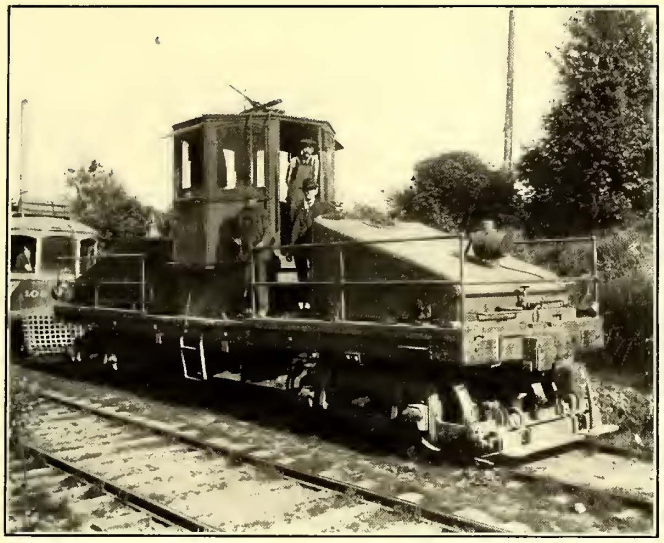
Spokane & Inland Empire—Terminal Station and Loading Tracks at Spokane



Spokane & Inland Empire—Beach at Liberty Lake

Spokane & Inland Empire—Liberty Lake Station

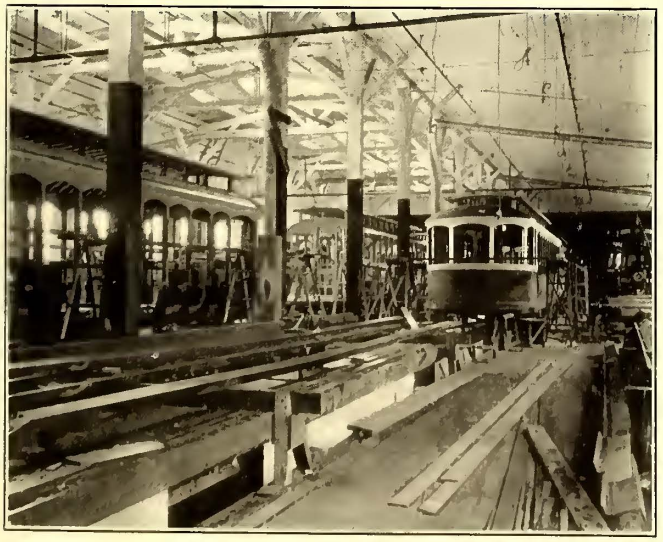
Spokane & Inland Empire—Heavy Freight Train on Single-Phase Division



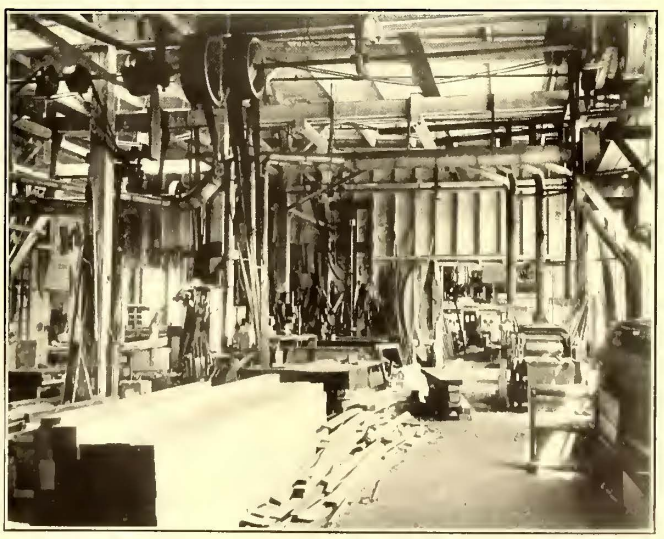
Vancouver, B. C.—Electric Locomotive

Vancouver, B. C.—Standard Passenger Car

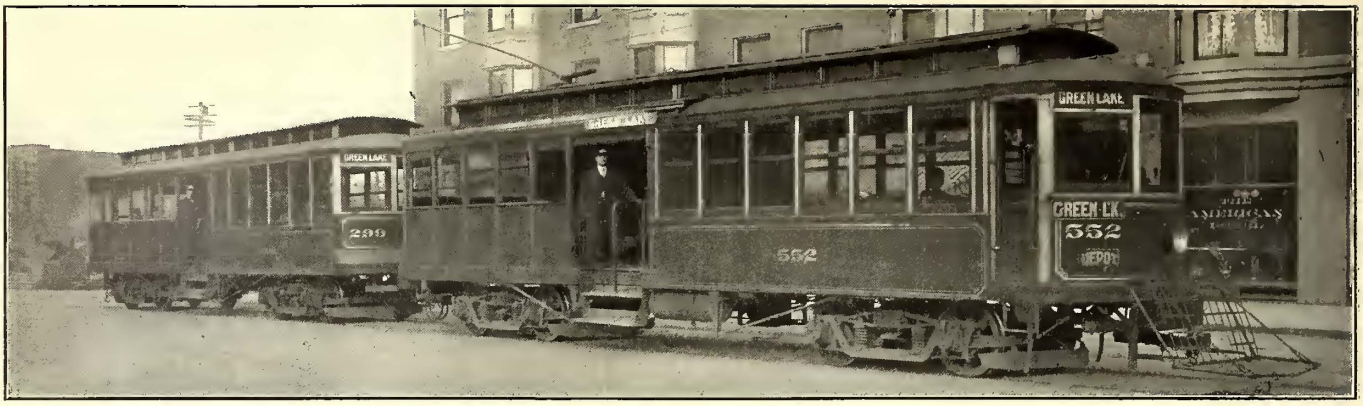
Vancouver, B. C.—Observation Car Built in the Company Shops



Vancouver, B. C.—Interior of Erection Shop



Vancouver, B. C.—Interior of Mill at Car Shops

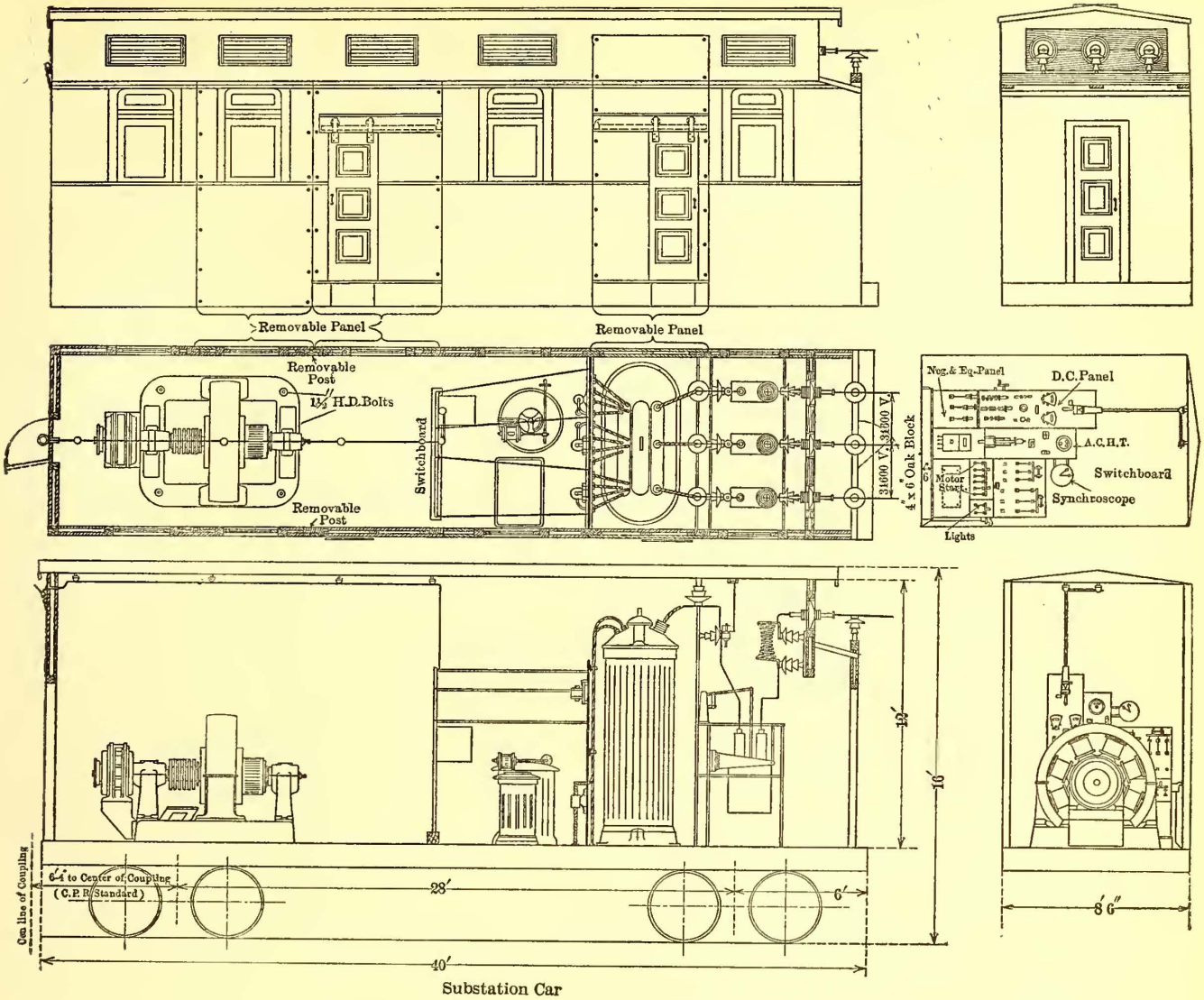


Seattle Electric Company—Standard Motor Equipment and Trailer

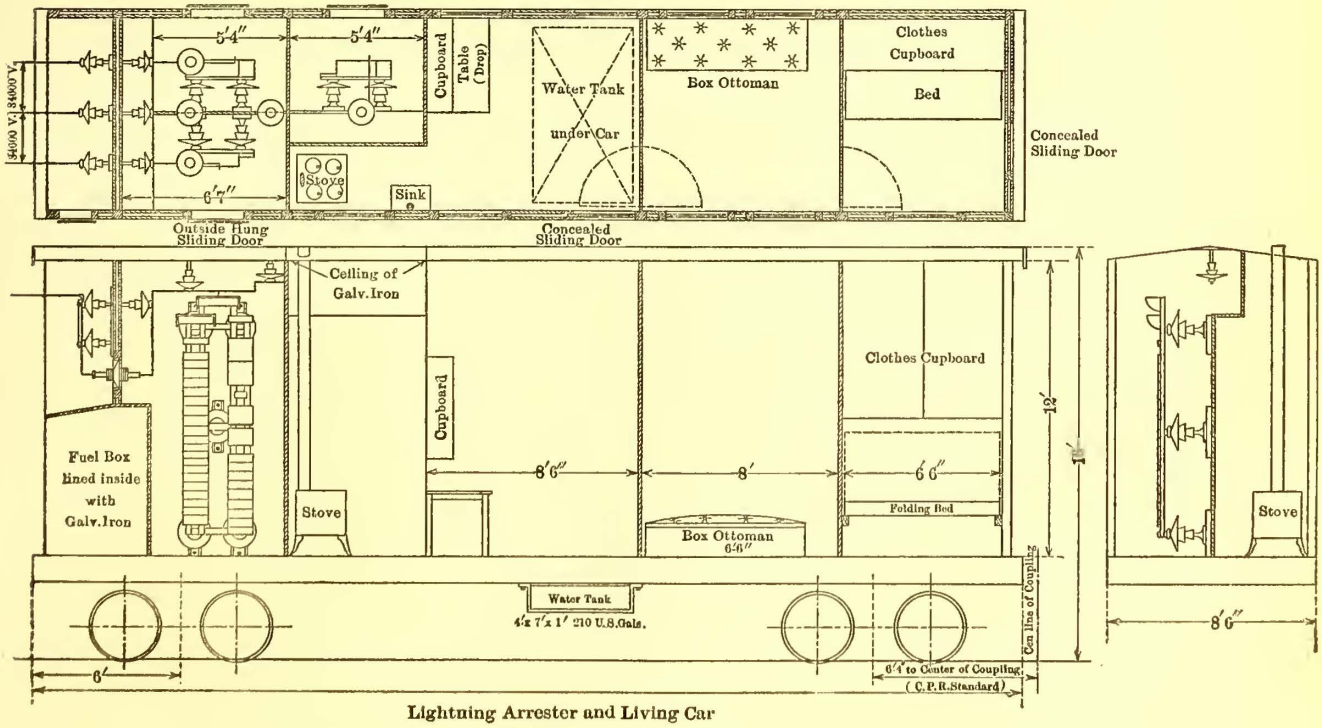
Seattle Electric Company—Division Superintendents, Station Masters and Traffic Aides

Seattle Electric Company—One Corner of Instruction Room

Seattle Electric Company—Division Headquarters, North Seattle



Substation Car



Lightning Arrester and Living Car

British Columbia Electric Railway—Plans and Sections of Two-Car Portable Substation

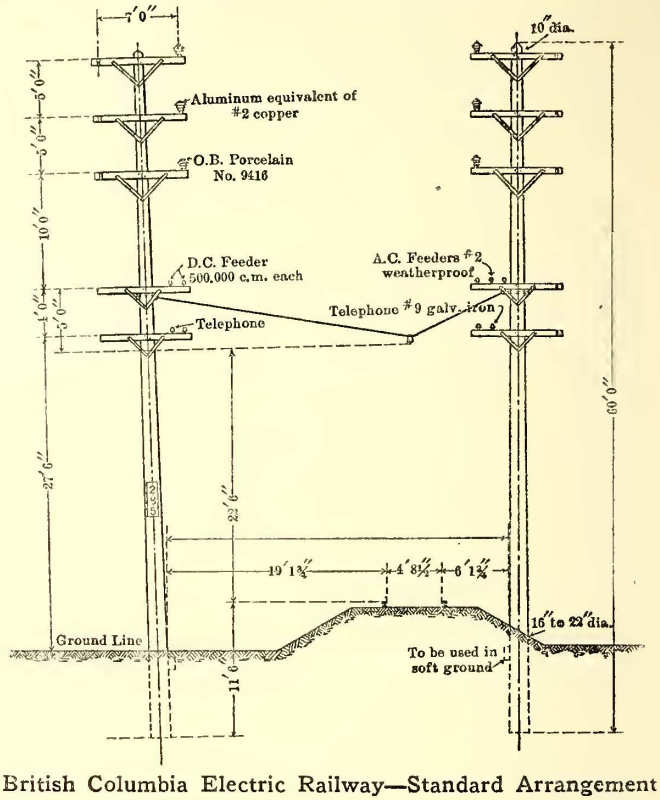
similar to that installed in the stationary substations, with the exception of one three-phase transformer instead of three single-phase transformers will be used to save space and weight.

The British Columbia Electric Railway and its subsidiary corporations operate in conjunction with their electric railway properties an electric light and power business. As there is a possibility of securing a great deal of power business through the territory served by this new railway, and to minimize the chances of a shutdown, the company is building duplicate pole lines, on each of which there will be strung wires for a three-phase transmission line. The poles are set on each side of the roadbed and are spaced 100 ft. apart. They will be used to support the span wires for the trolley-wire suspension.

The poles used in the construction of the pole lines are 60 ft. in length and have minimum 16-in. butts and 10-in tops. The cross-arms used on these poles are 8 ft. x 4 in. x 4 1-2 in. and are bolted to the pole by 1-4-in. x 4-in. lag screws. The arms are sway-braced by 1-4-in. x 1 1-4-in. x 3-ft. iron braces. To allow for future extensions three cross-arms for the transmission lines are provided on each pole. These are spaced 5 ft. apart. As the poles are exceptionally heavy and the transmission wires are light, it was decided to string the three-phase lines one above another and only on the track side of the poles. This arrangement precludes the use of equilateral triangular spacing of wires, but permits a wide spacing of the transmission wires on the short cross-arms. The arrangement also provides for the future possibility of running two sets of three-phase wires with short cross-arms on one set of poles. By this arrangement, an illustration of which is presented, either of the circuits can be repaired without shutting off the current from the other one. An easy means is provided also for making taps for branch lines. No. 0 stranded aluminum cables are to be used as transmission wires. These will be supported on triple-petticoat porcelain insulators tested to withstand 100,000 volts.

When necessary, current for light and power will be supplied from the railway transmission line, although in normal operation one of the three-phase lines will be used exclusively for railroad purposes and the other for light and power purposes. One of the objects of building duplicate tranmission lines was to have available at all times a supply of current which would enable the operators to keep the railway running in emergencies.

The track is being built with long-radius curves and a maximum of 2.7 per cent grades, which, when completed, will allow the operation of passenger trains at high speeds and the hauling of freight trains of large tonnage. The territory served by this line has not yet been fully developed, so it is not anticipated that the passenger traffic for the next few years will be exceedingly heavy, but it is expected that the freight traffic in lumber and farm products will tax the capacity of the line. About 20 miles of this new railway will be completed and ready for operation in December of the present year, and it is anticipated that construction work on the balance of the line will be well under way by Jan. 1, 1910. Already it has been announced by the officers of the company that if traffic warrants the arrangement, three-car trains will be operated over the first division of the line on a two-hour schedule. By this arrangement it is thought that ample



British Columbia Electric Railway—Standard Arrangement of Poles

provision can be made for handling the freight, which is awaiting the completion of the first division of the line.

Included in the rolling stock equipment ordered for this branch are three 50-ton electric locomotives, each of which will be equipped with four 160-hp 600-volt motors. These locomotives are to be provided with two trolley poles, which were thought necessary to give ample contact surface for gathering the requisite amount of current to supply the motor equipments when operating under load. The locomotives are to be built by Dick, Kerr & Company, Ltd., of England, and are to be of sufficient tractive power to haul freight trains made up of standard M. C. B. freight cars.

RAILWAYS OF THE PUGET SOUND DISTRICT

RAILWAY SYSTEM OF THE SEATTLE ELECTRIC COMPANY

SEATTLE, the metropolis of the State of Washington, is built on several long ridges which rise sharply to an elevation of from 250 ft. to 350 ft. above the water level of Puget Sound, which forms the western boundary of the city. Between these ridges are two lakes, the shores of which are occupied by fully developed residence properties. The uneven topography of the city brings about an unusual amount of riding and calls for especially careful operation. Because of the natural features of the city's location and of the marvelous increase in population served, the railway system of the Seattle Electric Company presents an interesting subject for study.

TRACK AND ROADWAY

The Seattle Electric Company has 191 miles of track in the city and its nearby suburbs. It is interesting to note that on account of the topography, 70 miles of this track originally were built on trestles. These trestles were necessary to adjust the grades and in some instances were required for tracks which serve a tide-flat area of about 5 square miles. Other lines are built along the water front, and in many instances, are located outside of the shore line at high tide.

The latest type of track construction installed by the Seattle Electric Company was illustrated in the ELECTRIC RAILWAY JOURNAL for April 3, 1909, page 590. The substructure supporting the rails comprises two stringers of concrete 16 in. x 10 in. in horizontal and vertical dimensions, tied together with a 6-in. floor of concrete. A mixture of 1:4:7 of cement, sand and broken stone is used. Rail chairs similar to those used in Philadelphia, spaced on 5-ft. centers and entirely buried in this concrete foundation, support the T-rails, which are tied with rods spaced on 5-ft. centers. The rails are fastened to the cast-iron chairs with lugs held on by bolts on either side of the foot of each rail. In placing brick or granite pavement a 3:1 mixture of sand and cement is used as a cushion for the paving blocks, which are grouted with a 1:1 mixture.

A large amount of track reconstruction has been made necessary in Seattle by the regrading work which the city has carried on in the business district during the past year. There are four regraded districts in which the original surface of the ground beneath thickly settled residence and business property has been lowered in some instances 105 ft. The larger part of the earth was removed by sluicing with water pumped from Puget Sound. Large nozzles served to turn the force of this water against the face of the hills. As the dirt was broken away it mixed with the water and was carried through sluices either to depressions to be filled in between hills or to the tide flats south of the commercial center which are being filled in and will form valuable railroad terminal properties.

The expense of this work to the railway company can be realized when it is stated that the company must stand the cost, not only for lowering its tracks and diverting its traffic (except on cable lines where the tracks were cribbed and the schedules maintained), but in some instances for removing a prism of earth 18 ft. wide and 105 ft. deep.

This regrading work now under way or completed was subdivided into three districts: Jackson Street regrade, 2500 ft. long, had a maximum cut of 95 ft., and the dirt was sluiced down the hill to make new land on the tide flats; Pine Street regrade was 3000 ft. long, and had an average fill of 20 ft.; Denny Hill regrade included 5000 ft. of track, which had to be lowered a maximum of 105 ft. Dirt from this regrade project was sluiced into Puget Sound. During the regrade work continuous service was maintained on the cable lines by supporting the track yokes on cribbing. The Madison Street cable line was operated on cribbing 30 ft. high at some points. As the work progressed the track was lowered or raised on cribbing at night.

The main business streets of Seattle paralleling the water front formerly had grades as high as 30 per cent, but these have been cut down to a maximum of 12 per cent. The regraded districts included several car-house sites, where it has been necessary to build new structures and place them on concrete posts, awaiting the completion of the filling-in work. At the location of the company's car house, office buildings and freight terminal, near the center of the commercial district, the grade was changed so that the sidewalks are now at the height of the tops of the car-house doors.

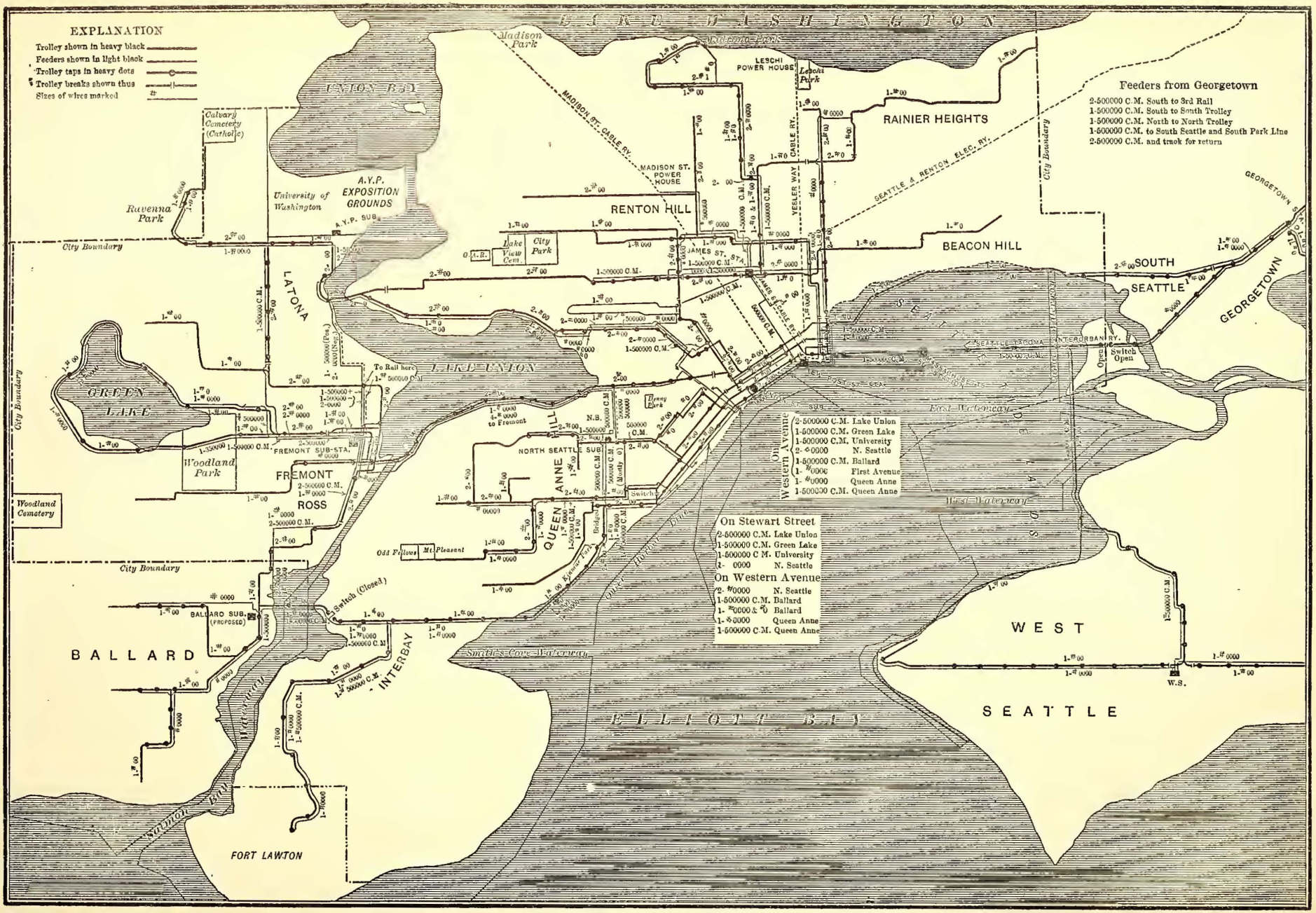
The great increase in the value of the car-house property brought about by the regrade work made it advantageous for the company to sell this car house and office property, and plans have been completed for a new modern office building to be located not far from the old site. The new building will be wholly occupied by the Seattle Electric Company, and its allied interests controlled by Stone & Webster, of Boston. It will be seven stories high, located on the corner of Olive Street and Seventh Avenue, and will be fireproof, having two floors below ground and dimensions of 60 ft. x 120 ft. A new freight house also will be built close by this building, with ground dimensions of 120 ft. x 240 ft. This structure will serve as a freight collection or distribution center for the extensive city package freight service carried on by the Seattle Electric Company.

TRANSPORTATION FEATURES

The Seattle Electric property is operated with four transportation divisions having headquarters at the more important car houses. The company has four car barns for electric cars, one for the electric and cable cars and two for cable cars only. Four hundred and twenty-five scheduled cars are now operated, 55 of which are cable cars. A year ago 318 cars were sufficient for handling the traffic. This increase of more than 100 regular cars has been brought about partly by the Alaska-Yukon-Pacific exposition, and more largely by the phenomenal growth of the city.

The shopping and office district of Seattle is about five blocks wide and a mile long, the main thoroughfares of which run parallel to Puget Sound. This district is shut in on its eastern side by a hill, also parallel with the Sound. The company has trunk lines on the four principal business streets through this district, and has three cable cross-town lines, which climb the steep hill separating the business district from the principal residence portion of the city in the rear. On account of these topographical conditions the traffic on the street car lines within the business district is especially heavy. Headways of 27 and 30 seconds are necessary on the more important lines.

The cross-town cable lines, which serve to carry the people up the steep grades to transfer points with electric lines, also



Seattle Electric Company—Map of Seattle, Showing Location of Trolley Wires and Feeders

serving a residence district, are known as the Yesler Way, James Street and Madison Street lines. On the Madison Street cable line there is a headway of 65 seconds and grades up to 15 per cent are negotiated. This line is about 2.25 miles long and 32 cars are operated. The cars are 29 ft. long, seat 44 passengers and are equipped with slipper track brakes. On an average heavy day these cars handle 28,000 passengers. The cables used in this service cost about $8,000 and last, ordinarily, about six months. During the rush hours the regular conductor on these cable cars is assisted by a "hill conductor," who rides with the car and helps to collect fares until the top of the hill leading out of the business district is reached. The hill conductor uses a portable register and the regular conductor the permanently installed car register.

The Seattle Electric Company operates a sight-seeing car, which makes two 26-mile trips daily. The features of most interest to visitors, which are reached by the sight-seeing trips, are: Leshi, Madrona and Madison Parks, attractive resorts originally promoted by the company. These parks are all located on the shores of Lake Washington and afford scenes of much natural beauty. The sight-seeing trip also takes the visitor to Woodland Park, Queen Anne Hill observatory, Ft. Lawton, Ravenna Park, with its big trees, several amusement parks and to the Alaska-Yukon-Pacific exposition grounds.

Effective March 14 1909 190..,to.....190 Approved; .....Div Inspr.
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.....190..,to.....190

THE SEATTLE ELECTRIC COMPANY

CEDAR-NORTH Q.ANNE

Sunday Schedule No. 5

Fig. in ROMAN Ind. time leaving ..... South End
Fig. in ITALIC Ind. time leaving ..... North End
Indicate ..... Reliefs

Conductor	Run	Leave Barn														Arrive Barn	Nr's	Motorman
Griffin, Jno.	1	5.30 A.M	5.50	6.50	7.49	8.49	9.55	10.55				12.55	1.55	2.55	3.55		9.38	Ramage, W. C.
				6.19	7.19	8.18	9.18	10.24			12.24	1.24	2.24	3.24				
Hansen, C. H.	2	7.14 A.M				8.04	9.04	10.05	11.05	12.05	1.05	2.05	3.05	4.05	5.05		10.04	Burtt, C.
					7.34	8.33	9.33	10.34	11.34	12.34	1.34	2.34	3.34	4.34				
Caldwell, Geo.	3	5.50 A.M	6.10	7.10	8.19	9.18	10.16	11.15				1.15	2.15	3.15	4.15		9.38	Buford, J. O.
				6.39	7.49	8.49	9.47	10.44			12.44	1.44	2.44	3.44				

TIME POINTS

OUTBOUND			INBOUND		
South End to	Virginia St.	10	North End to	Boston & Q. Anne	03
	Republican St.	17		Republican St.	13
	Boston & Q. Anne	27		Virginia St.	20
	North End	30		South End	29

Seattle Electric Company—Typical Sunday Run Schedule

SCHEDULES

The transportation department of the Seattle Electric Company includes a traffic subdivision in charge of the assistant superintendent. This division studies traffic conditions and adjusts the schedules on all lines to suit the traffic, thereby reducing the car mileage to the lowest consistent figure. The basis for this schedule-making work is a chart on which the number of passengers carried on the regular cars and trippers each hour is shown by separate curves. On each chart a line is drawn to indicate the seating capacity of the cars, and thus there is available a graphical record indicating at what time during the day the loads were above or below the seating capacity, at what time the cars passed the reporting points and the headway.

These charts are supplemented by a system of reports from the traffic aides stationed at the more important traffic centers. If any curve shows an overcrowded or an unfilled condition of the cars, the assistant superintendent notes the fact and sends the chart to the schedule clerk, who superintends the formulating of the operating schedules. The schedule clerk has two assistants, and he not only carries on the work of making up the schedules, but also makes up the working lists. He is assisted in the latter duty by the division station masters.

Whenever the traffic charts show that a schedule needs readjustment the schedule clerks make up the first draft of a new schedule and the assistant superintendent then confers with the line inspectors or "traffic aides," as they are called in Seattle, regarding changing the number of cars. It is a part of the work of the traffic aides to observe closely how well the existing schedules are handling the loads, and to report frequently to the office with any suggestions that may assist in the improvement of the service. Whenever a new schedule is put into effect, the assistant superintendent gets frequent reports from the aides as to how the new schedule is handling the loads.

Three classes of schedules are now used by the Seattle Electric Company: Saturday, Sunday and week-day. One of these schedules, showing the use of rubber stamps for indicating the relief of crews, is reproduced. With the rubber stamp indicating the time of relief or the time of taking a run, and the number of the crew interested, there is little opportunity for a misunderstanding. Two forms of stamps are used. The stamp indicating the relief time for a crew is circular in shape, and that indicating to a crew that it is time to take a run from some other crew, is square. Black ink is used with the round stamp and red ink with the square stamp. Thus there is a prominent distinction between the two. The schedule sheets are posted in glass in frames mounted along the walls of the trainmen's quarters.

A training school for platform men is maintained at the general headquarters of the company. On account of the rapid increase in the number of cars used by the Seattle Electric Company, its school of instruction has been rather busy during the past year. During the month of May, 1909, 300 men took the course in this school. The apparatus of the school consists of three skeleton cars complete in every detail with working apparatus. Student classes are taken over the various routes in the city in a school car and given an opportunity for practice work and observation under the eye of instructors. The company furnishes the transportation employees with commodious quarters in each of the division car houses, supplies reading material and encourages club activities.

ROLLING STOCK

The rolling stock equipment of the Seattle Electric Company includes the 100 combination open and closed side-entrance cars, which were described in the ELECTRIC RAILWAY JOURNAL for April 10, 1909, page 693, and a complement

of special cars for handling sight-seeing traffic and special parties. Some of the new cars received during the present year are operated as trailers in connection with the other new cars used as motors. The company has received 130 cars of its standard stype from the St. Louis Car Company during the year 1909. These cars are equipped with Standard motor trucks, GE-80 motors and K 28-J control. Thirty of them have Standard steel wheels, and all have Tomlinson couplers and National air-brakes. The trailer service is found to be very satisfactory, but is adapted only for lines with moderate grades.

FREIGHT HANDLING

The Seattle Electric Company has industrial connections with many plants located about the city, and acts as local distributor for the freight brought into Seattle by the Puget Sound Electric Railway from its interurban districts and from Tacoma and Renton. The street railway company also makes local deliveries for steam roads and boats operated on Puget Sound and on Lake Washington. The principal freight station of the company is located close to the general office building in the heart of the city. Other stations are located at Ballard and at Massachusetts Avenue. The Ballard station will be shared jointly by the Seattle Electric Company and the Seattle-Everett Interurban Railway, which is now completing a line north from Seattle along the Sound to Everett. This station is near the docks of the Chicago, Milwaukee & Puget Sound Railway, on which docks the Seattle Electric Company has tracks so that it can receive and deliver lumber, wood and heavy materials. The Massachusetts Avenue station is located in the steam railroad terminal district and is used jointly with the Puget Sound Electric Railway.

The freight traffic in Seattle includes the collection of lumber, shingles and wood from the mills and their delivery to steam railways. About 50 carloads of this freight are handled daily, for which a switching charge of $5 per car is received. The company has 19 freight motor cars and 44 miscellaneous freight cars. Part of the motor cars are equipped with four 50-hp motors and those of later design have four 75-hp motors with multiple-unit control. The work of the freight department is under two heads: a freight agent who reports to the auditor and who handles rates, bills, solicitation work, etc., and a "freight inspector," who reports to the trainmaster and is in charge of all freight-car movements.

SHOPS

All important car maintenance and construction work is carried on in a very complete group of concrete shop buildings, which was built for the Seattle Electric Company in 1907 by the Stone & Webster Engineering Corporation. Constructional details of these buildings were presented in the Electric Railway Review for June 22, 1907, page 806. The shops are located at Georgetown, just outside of the Seattle city limits, and on a large property which is occupied partly by the Georgetown turbo-generating relay station of the company. The repair shop buildings, all of which are of solid concrete, include a machine shop, erection shop, paint shop, blacksmith shop and a combination store house, office and car house. Views of some of these structures showing their substantial appearance are presented. In addition to the group of concrete buildings there is a special track-work shop building of mill construction. With the exception of the store house, which has two stories, all of the buildings are one story high. All have concrete roofs with ribbed glass skylights.

The erection shop, 98 ft. x 180 ft., has four tracks leading from the transfer table and a complete equipment of woodworking tools. A mezzanine floor over a portion of the machine tool floor is used for wood storage. The paint shop, 100 ft. x 192 ft., which is across the transfer table from the erection shop, has 10 tracks. The building is subdivided across one end, forming a room in which the paint and varnish supplies are kept. Adjustable scaffolds are provided between the pairs of tracks in the paint shop and the floors are sloped to provide rapid drainage of wash water.

The machine shop is 160 ft. x 180 ft. in floor dimensions, and one corner of this building is set off as an armature room, 80 ft. x 64 ft. Seven tracks lead from the transfer table into the machine shop, one of which passes on through the building and into the blacksmith shop, 80 ft. x 32 ft., located at the rear. As cars are received in the machine shop from the transfer table, the bodies are lifted clear of the trucks by screw hoists, so that if desirable the separate parts of the car may be moved to the different shops. Within the machine shop, which has a complement of modern tools, is located the office for the shop foreman, a tool room under lock and key and a drafting-room for the machine shop draftsman.

The armature shop does all the winding for the lighting and power department as well as for the railway department of the Seattle Electric Company. This shop is provided with I-beam hoist tracks extending over the larger tools. The heavy parts are lifted by a Sprague electric hoist supported from this overhead track which extends outside of the building and above the siding close to the door, so that the electric hoist may be used in unloading supplies from freight cars. The equipment of the armature shop includes a home-made commutator grooving machine, a home-made pinion puller and an armature oven, which has been built of sheet steel and asbestos. This oven is large enough so that a man can walk inside. It is heated by steam in winter and electricity in summer.

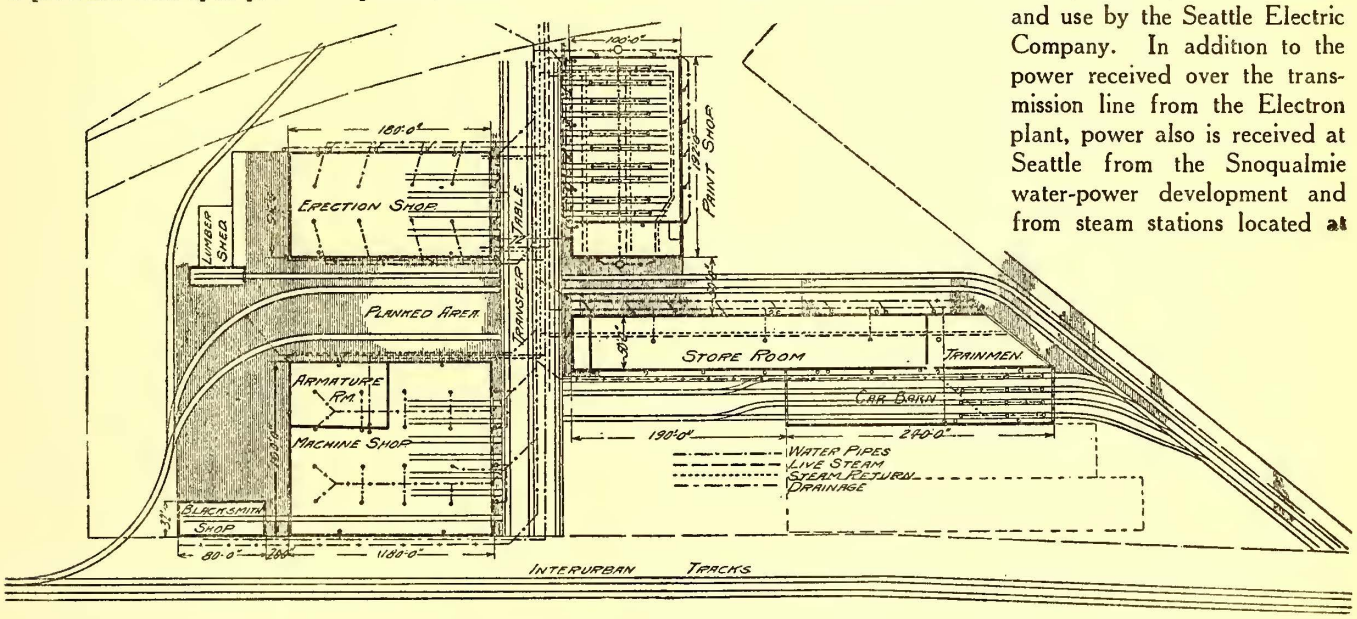
In winding railway motor field coils it is the practice to use Deltabeston wire and apply an insulation mixture of black Stirling insulating varnish and powdered mica. The coils are then baked for about 18 hours at 170 deg. F. The outside of the coil is protected from abrasion by asbestos tape and the completed coil is dipped in Mica Insulator Company's paint. The results from this winding practice are said to have been very satisfactory.

It is necessary to do a comparatively large amount of foundry and blacksmith work in these shops on account of the long distance from the more important sources of supply for such material. For this reason the blacksmith shop has a rather complete equipment of tools for car repair work and special track-work construction. The air-supply plant for the shops is located in a room in one corner of the blacksmith shop. This includes two Chicago Pneumatic Tool Company motor-driven compressors and a National Brake & Electric Company three-cylinder 225-ft. compressor direct-driven by a 40-hp Westinghouse induction motor. Oil-burning furnaces are used for melting babbitt.

The special track-work shop is a three-story frame building with no side walls for the first floor. This type of construction affords a large open space protected from rain in which long rails can be turned. The second floor of the shop is reserved for laying out curves and intersections. The third floor is a loft for the storage of templets. The templets which are used are built up of two flat wrought-iron pipes bent sidewise to the desired curves and bolted together by cross pieces, thus affording a rigid templet, which may be handled rather roughly without damage. The company builds its own hard-center special work as well as lighter special track work. All

machine and assembly work is done at these shops. Manganese steel centers are inserted in cast-iron frog blocks and held in place by bolts and babbitt. The special work yard is served by a large gin-pole crane and under the track shop building are a heavy bulldozer and portable forges.

The car house, office and store house sections of the shop group form a single structure 432 ft. long and 100 ft. wide, divided in the center by a concrete partition. The store-house section, 320 ft. x 50 ft., has two floors. The second floor is used for storing original packages and surplus stock. The estimated load capacity for this floor is 250 lb. per square foot. A switch track connecting with the Northern Pacific Railway facilitates the unloading of supplies directly at the door of the store house. Then they are trucked over scales onto an elevator, which carries them to the second floor. The car-house portion is 240 ft. x 50 ft. in ground dimensions and has four storage tracks. One end of the building is provided with open pits for inspection, another section with a plank floor and another with a concrete floor for car washing. Just through the wall from the car house is a part of the building used as the division headquarters. This section has a width of 50 ft. and an average length of 75 ft. It is fitted with tables, benches, lockers and toilet facilities. Rooms are provided for the storage of stationery and an office also is set off for the starter.



Seattle Electric Company—Plan of Shops

CONCRETE CAR-HOUSE CONSTRUCTION

The North Seattle car house is typical of the reinforced concrete structures which the Seattle Electric Company is erecting at its several division headquarters. A floor plan of this car house was presented in the ELECTRIC RAILWAY JOURNAL for Oct. 31, 1908, page 1275. The building is 190 ft. 2 in. wide by 191 ft. 8 in. long, and is supported on a series of concrete piers 20 ft. high. The elevated position of the floor was made necessary because of the proposed re-grade at this location. The building encloses 12 tracks built with open pits. This inspection and storage trackage is subdivided into two bays by a longitudinal wall of reinforced concrete. Along one side of the car storage portion is a very complete suite of offices and rooms for trainmen. The car house has a capacity for 60 cars and storage tracks are laid within the yard for 140 cars.

The front of this car house is made up of a continuous concrete beam supported in the center, each half spanning six tracks. The halves of the beam in turn are supported by the ends of the concrete cantilevers resting on columns 16 ft. back of the face line of the building. This construction feature provided car clearance so that the building could be set comparatively close to the street. The designs of the reinforced concrete columns, roof slabs, girders and the cantilevers which support the front of the building are presented on page 539.

POWER GENERATION AND DISTRIBUTION

The chief source of power for the Seattle Electric Company is the Electron plant of the Puget Sound Power Company, the stock of which is controlled by the Seattle Electric Company. The Puget Sound Electric Railway and the Tacoma city lines also are supplied from this plant. The power is transmitted 45 miles to Seattle at 60,000 volts. During the maximum load period the Electron plant supplies power to Seattle at the rate of about 12,000 kw, for distribution and use by the Seattle Electric Company. In addition to the power received over the transmission line from the Electron plant, power also is received at Seattle from the Snoqualmie water-power development and from steam stations located at Post Street in Seattle and in Georgetown, a suburb of Seattle. The respective amounts of power supplied from these various sources are indicated by the daily load diagram on page 539, which also shows the proportionate amounts of railway, lighting and power load.

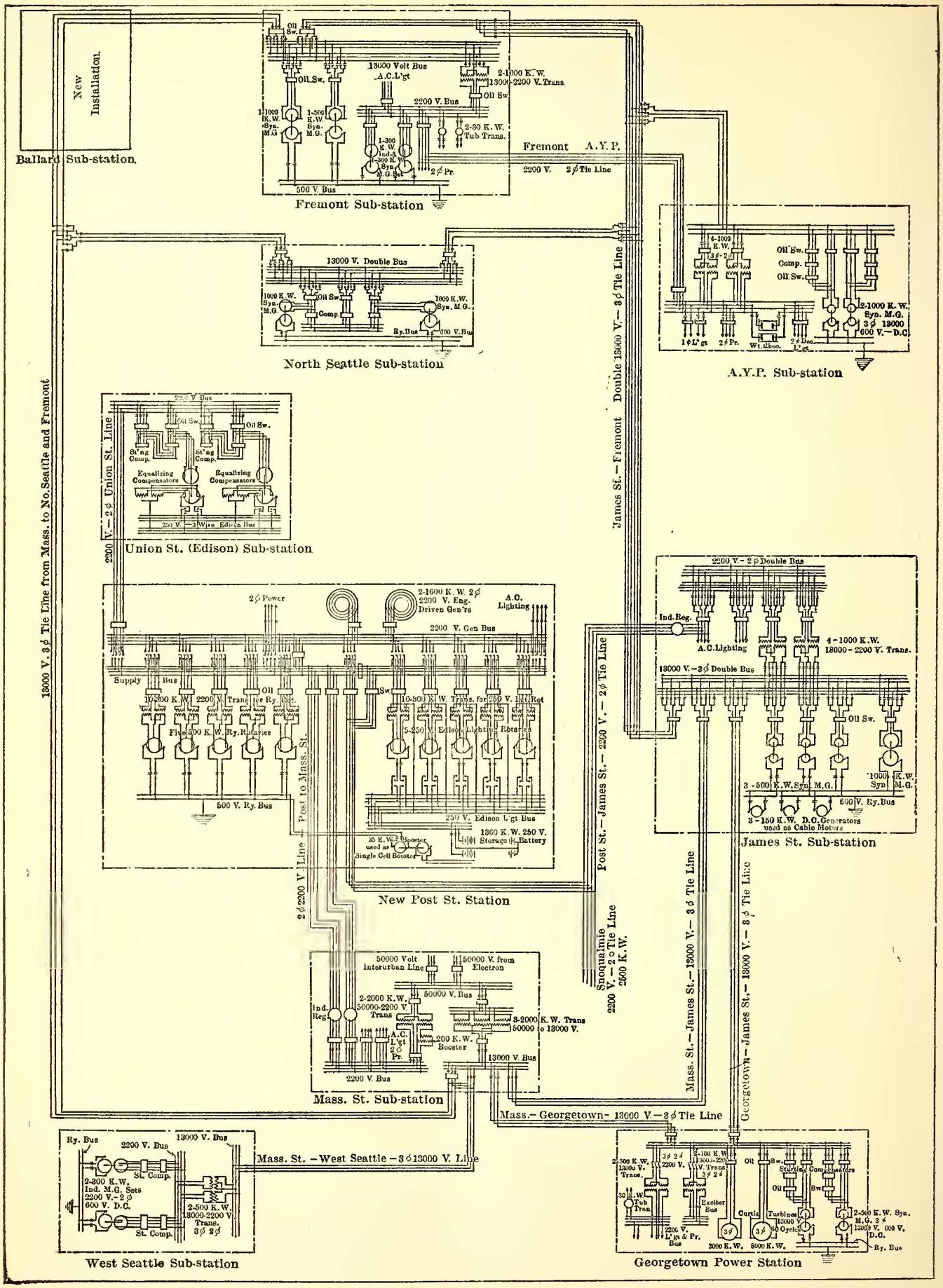
Power brought into the city over the high-tension transmission lines is received at the Massachusetts Avenue substation. Here it is transformed by 6000-kw capacity of transformers into 13,200-volt 3-phase current for railway motor-generators and by 4000 kw of transformer capacity into 2300-volt 2-phase current for lighting and power use. The 13,200-volt distribution to the company's seven substations is made on bare wire lines carried throughout the city on the tops of the lighting distribution poles. A map on page 534 shows the location of the trolley wires and feeders, the locations of the substations and the Post Street and Georgetown generating stations. The transmission circuits and their switching arrangements and types of converting units also are shown by an engraving on page 538.

The following table presents the types and capacities of units in the several substations now operated:

MASSACHUSETTS AVENUE SUBSTATION

Two 2000-kw G.E. step-down transformers, 50,000 volts to 2200 volts for tie-line system, local lighting and two-phase power.

Three 2000-kw G.E. step-down transformers 50,000 volts to 13,800 volts for tie-line system.



Seattle Electric Company—Plan of A.C. Power Distribution System, Showing Location and Capacities of Substation Apparatus and Steam Generating Stations

JAMES STREET SUBSTATION

Three 500-kw and one 1000-kw G.E. synchronous motor-generator sets, 13,200 volts three-phase to 600 volts d.c.

Four 1000-kw G.E. transformers Scott connected in two banks, 13,200 volts three-phase to 2200 volts two-phase, used for local a.c. lighting and transmission to Post Street over 2200-volt tie-line.

Three 150-kw 600-volt Edison bipolar generators used as motors to drive James Street cable.

FREMONT SUBSTATION

One 1000-kw and one 500-kw G.E. synchronous motor-generator set, 13,200 volts three-phase to 600 volts d.c.

One 300-kw G.E. synchronous motor-generator set, 2300 volts two-phase to 600 volts d.c.

One 300-kw G.E. induction motor-generator set, 2200 volts two-phase to 600 volts d.c.

Two 1000-kw G.E. transformers Scott connected, 13,800 volts three-phase to 2200 volts two-phase; for railway motor-generator sets, two-phase power and a.c. lighting.

Two 30-kw 6.6 amp tub transformers.

NORTH SEATTLE SUBSTATION

Two 1000-kw G.E. synchronous motor-generator sets, 13,200 volts three-phase to 600 volts d.c.

WEST SEATTLE SUBSTATION

Two 300-kw G.E. induction motor-generator sets, 2200 volts two-phase to 600 volts d.c.

Two 500-kw G.E. transformers Scott connected, 13,800 volts three-phase to 2200 volts two-phase.

ALASKA-YUKON-PACIFIC SUBSTATION

Two 1000-kw G.E. synchronous motor-generator sets, 13,200 volts three-phase to 600 volts d.c.

Four 1000-kw G.E. transformers in two Scott connected banks, 13,800 volts three-phase to 2200 volts two-phase; used for fair lighting.

BALLARD SUBSTATION

Two 1000-kw G.E. synchronous motor-generator sets, 13,200 volts three-phase to 600 volts d.c.

Three 1000-kw G.E. transformers, 13,200 volts to 2200 volts.

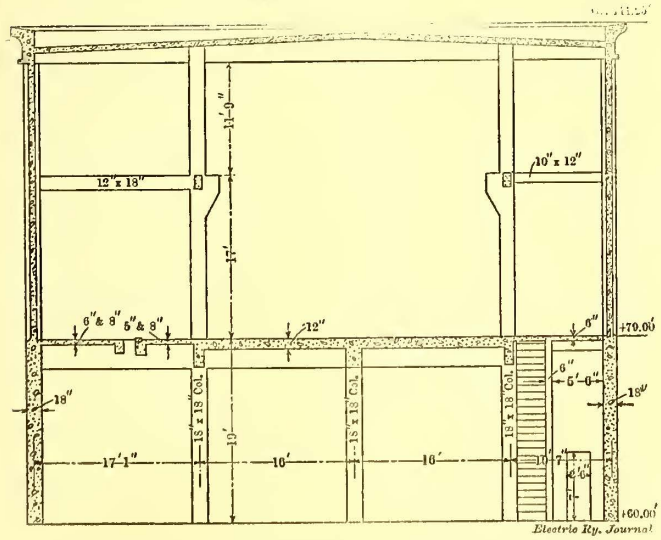
Below is listed the power apparatus in each of the steam power generating stations:

NEW POST STREET GENERATING STATION

Two 1600-kw Westinghouse 2200-volt two-phase engine-driven alternators.

Five 500-kw Westinghouse 500-volt–2200-volt rotary converters for railway service.

Five 500-kw Westinghouse 250-volt three-wire 2200-volt two-phase rotary converters for Edison Lighting service.



Seattle Electric Company—Dimensions of Reinforced Concrete Substation Structure

One 1360-kw 250-volt storage battery on Edison lighting service.

One 35-kw battery booster.

GEORGETOWN GENERATING STATION

One 8000-kw and one 3000-kw 13,800-volt three-phase Curtis vertical steam turbo-generators.

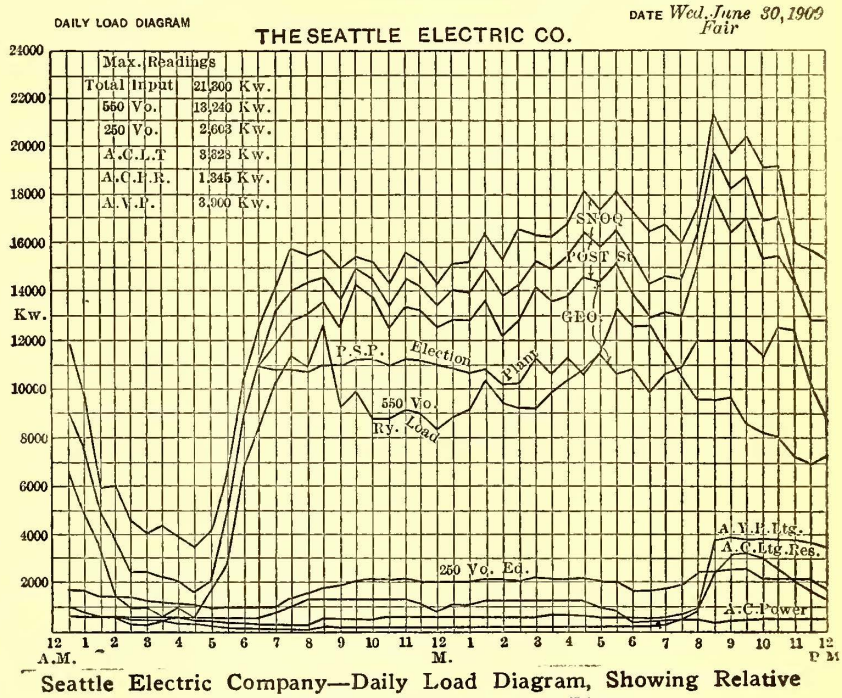
Two 500-kw G.E. synchronous motor-generator sets 13,300 volts, three-phase to 600 volts d.c.

Two 500-kw G.E. transformers 13,200 volts three-phase to 2200 vo two-phase for lighting and two-phase power.

One 30-kw G.E. 6.6-amp tub transformers for street lighting.

Two 100-kw G.E. transformers 13,200 volts three-phase, 2200 volts two-phase; used for station lighting and power.

The large power station at Georgetown is housed in a concrete structure which, together with the installation, was designed and erected by the Stone & Webster Engineering Corporation. The structure rests on a concrete monolith supported on piles set on 24-in. centers under the engine room and in rows of six under the boiler-house walls. The general dimentions of the building are: Engine room, 64 ft. 3 in. x 79 ft.; boiler house, 73 ft. x 151 ft. A floor plan of this station showing the arrangement of the turbine room and the boiler house with the firing aisle at right angles to the dividing wall was presented in the ELECTRIC RAILWAY JOURNAL for March 27, 1909, page 538. The areas per kilowatt of station capacity are, 0.43 sq. ft. for the engine room and 1.01 sq. ft. for the boiler room.



Seattle Electric Company—Daily Load Diagram, Showing Relative Amount of Power from Each Plant

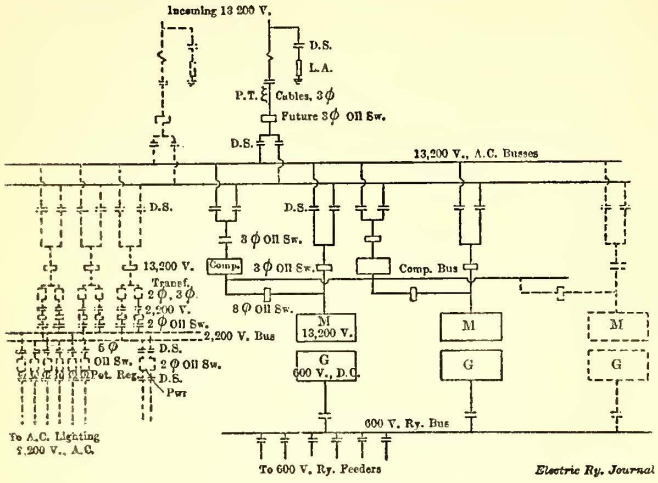
NORTH SEATTLE SUBSTATION

The North Seattle substation, a brief description of which was presented in the ELECTRIC RAILWAY JOURNAL for Oct. 31, 1908, represents the latest type of the Seattle Electric Company's installations. The main parts of the equipment of this station have been given in a preceding table. The building is a reinforced concrete structure, 61 ft. 2 in. x 72 ft. 1 1-2 in. in over-all dimensions, with a machinery room 32 ft. wide by 70 ft. long and 18 ft. 9 in. high to the lower side of the concrete roof beams. Crane girders are placed 17 ft. above the machinery room floor.

The machinery room floor, which is made up of 12-in. reinforced concrete floor slabs, was designed for 800-lb. live load plus 50,000 lb. concentrated load on the main 18-in. x 36-in. girders, which are spaced 14 ft. 1 1-2 in. between centers. The roof slab is 5 in. thick and is supported by concrete girders with 32-ft. span. The side walls are 6 in. thick.

As the construction of the Seattle-Everett Interurban line progresses the new substation at Ballard will be completed and another station will be built at Everett in which a 400-kw railway unit will be installed. These stations at Ballard and

Everett will supply the ends of the interurban line and a motor-generator substation at Hall's Lake, about halfway be-

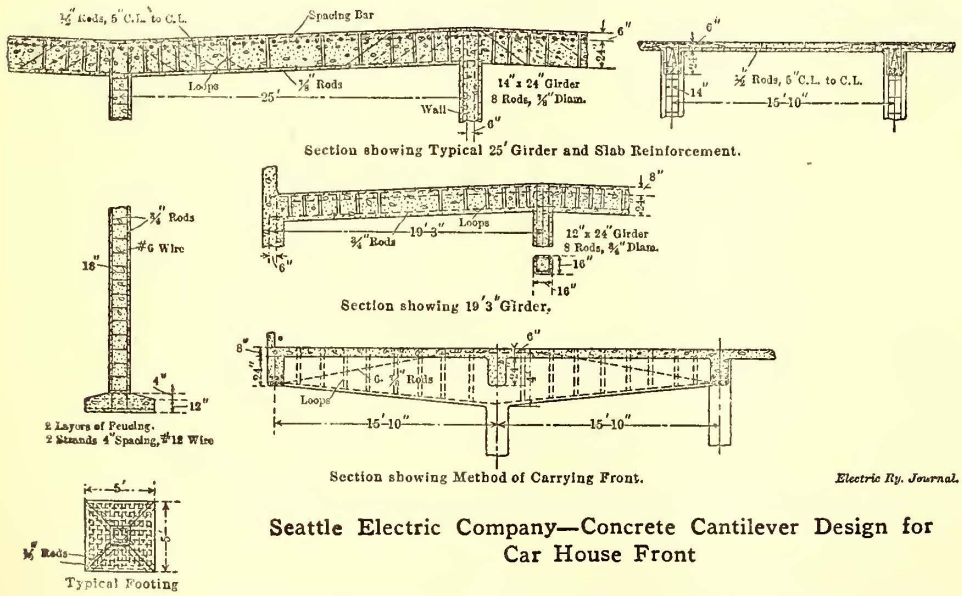


Seattle Electric Company—Wiring Diagram of North Seattle Substation

tween the two cities, will feed the middle section of the catenary supported trolley now being erected.

TRAFFIC AND TRANSPORTATION FEATURES OF THE PUGET SOUND ELECTRIC RAILWAY

THE Puget Sound Electric Railway connects Tacoma and Seattle, the two largest and most important cities of the fast-growing and attractive Puget Sound district. Both termini are seaports which are favored with exceptional harbor facilities. The route of the interurban line between Tacoma and Seattle follows a very productive river valley, except near the Tacoma end, where distance is saved by cutting through a range of hills. The length of the line from terminal to terminal is 36.5 miles and measured as single track, the total length is 52 miles.



Seattle Electric Company—Concrete Cantilever Design for Car House Front

The equipment of this road, which is operated by third rail, is of the heavy interurban type for passenger service with M.C.B. standard steam cars for freight service, the freight trains being handled by electric locomotives. Eighty-four per cent of the track between Tacoma and Seattle is tangent, and 75 per cent of the curvature has a radius of 574 ft. or more, so that fast running time can be made. The track is of standard construction, with 70-lb. running rails and a 100-lb. third-rail. The road was first opened for service on Oct. 5, 1902.

The Puget Sound Electric Railway controls the Tacoma Railway & Power Company, and both properties are managed by one organization, which is a part of the Stone & Webster Management Association. W. S. Dimmock, manager of the Tacoma Railway & Power Company and the Puget Sound Electric Railway, has had charge of the operation of these properties since the interurban line was built, and under his guidance the amount of traffic handled has shown a great increase. During the summer season this year the passenger traffic of the Puget Sound Electric Railway has been considerably augmented by tourists visiting the Alaska-Yukon-Pacific Exposition at Seattle. On account of the excellent transportation facilities between Seattle and Tacoma, Tacoma has shared largely in entertaining Seattle's visitors.

SERVICE

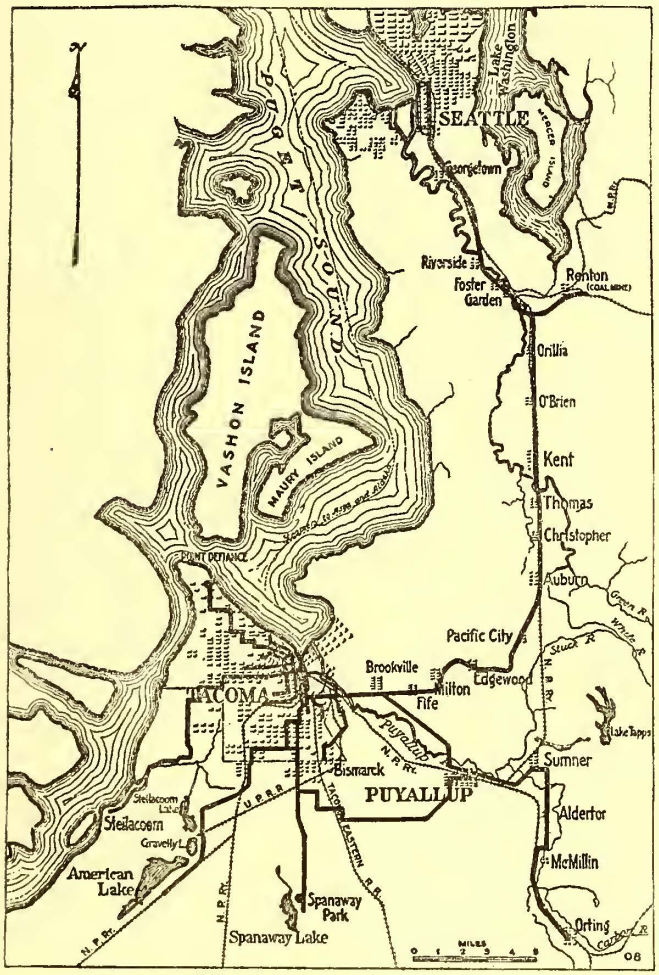
The operation of the passenger and freight trains is conducted with about the same methods as those used by single-track steam railways. The standard code of rules of the American Railway Association is used and is followed very closely. The passenger service over the main line between Seattle and Tacoma includes a three-car train each way every hour from 6 a. m. till 11 p. m. The running time of these trains is 1 hour and 30 minutes, which includes the time required to traverse 1.64 miles of slow-speed track in Seattle and 2.36 miles of track in Tacoma. Two limiteds are operated each way each day, one in the morning and one at night. The running time of the limiteds is 1 hour and 15 minutes. Between Seattle and Renton two-car trains are run hourly in each direction. These trains operate for 11.5 miles south of Seattle over the main line and for 2.2 miles over the Renton branch. On account of the heavy traffic between Seattle and Tacoma during the morning and at night it is necessary to dispatch extra passenger trains until the service is equivalent to three-car trains running on 20-minute headway for two hours in the morning and three hours in the evening.

The rolling stock equipment used in this service is luxurious and was designed especially for train operation. An illustration on Plate XXX shows the handsome appearance of a three-car train standing at the Tacoma station. These trains are made up of a combination baggage and smoker motor car, a passenger motor car and a parlor observation car on which an extra fare of 25 cents per passenger is charged. The observation end of this car in summer is guarded by an ornamental brass grille, which is replaced in winter by a curved glass end. Thus the observation end space may be fully occupied during both seasons. Ohmer fare registers are used on all passenger cars.

POWER SUPPLY

Power for the operation of the interurban lines and the city lines in Tacoma is obtained over a transmission system

from Electron, Wash., where it is hydraulically generated in the water-power plant of the Puget Sound Power Company, also controlled by Stone & Webster. From the power house two parallel transmission lines extend for a distance of 22 miles to Bluffs, a station on the interurban line 9 miles from Tacoma and 25 miles from Seattle, where the transmission lines divide and follow the interurban right-of-way to the terminal cities. A duplicate transmission line parallels the railway throughout its length. Current at 60,000 volts is transformed and converted for railway use in three substations, located respectively at Milton, Kent and Georgetown. An additional substation is now nearly completed at Puyallup on the Orting suburban line, which extends southeast from Tacoma for a distance of about 20 miles. Motor-generator sets are used in the substations for converting current, and at each substation a storage battery of 288 type-G chloride accumulator cells has been installed.



Puget Sound Electric Railway—Map of Lines

SELECTION OF TRAINMEN

It is not the general practice to use street railway trainmen in the service of the Puget Sound Electric Railway, either from this company's or other city lines. An ample number of applicants to fill all vacancies is available, so that a high-grade personnel is maintained, notwithstanding the rigid requirement that applicants for interurban train service must have had previous experience on either steam or electric roads operating under the standard code of rules of the American Railway Association.

After a new man has been examined by the superintendent as to his references, antecedents, previous service, etc., he is put into the railway company's shops for five days if he has not had previous experience in operating an electric car. In the shops he becomes generally familiar with the important parts of a car and its equipment. When this preliminary schooling in the shops is finished the new man rides for 100 hours' time on the platform with an instructing motorman, and then returns to the shop, where the master mechanic examines him on the principal features of operation and emergency work. During the course of his preliminary instruction the new trainman must pass a physical examination at the hands of the company's surgeons, and his watch also must pass inspection. The examination period concludes with an oral examination by the superintendent on train operation, train rules and the duties of employees. Separate examinations are given for motormen, conductors and flagmen.

The photographic system of identification was instituted by the operating department about two years ago, and it is said that no friction occurred at the time because portraits were not requested from the men then in service. When an applicant is being investigated the company requires that he furnish six portraits 2 1/2 in. by 1 5/8 in. in size, which are made by the company photographer at a charge of 25 cents. One of these portraits is attached to the application and filed with the permanent records of the office. Other portraits are sent out attached to the reference blanks. During two years' use of photographs for identification not less than 50 men have been detected using assumed names who would have been undesirable employees. A copy of the reference blank used in investigating the past history of applicants for employment is reproduced on page 542.

DISPATCHING

For train movements not provided by time-table, train orders are issued by the authority and over the signature of the superintendent. Train orders are written on the standard No. 19 and No. 31X forms and are transmitted by telegraph from the office of the chief dispatcher in the terminal station at Tacoma. All freight trains are run as extras. Passing sidings have been put in at an average distance apart of 1 1/2 miles, and telegraph operators are on duty at eight stations, which are also passing points between Seattle and Tacoma. In regular operation on a normal day the dispatcher's office issues about 100 train orders besides keeping the regular train sheet which exhibits the time progress of each train, regular and extra, the train number, motor and other car numbers and the names of the crew. The number of passengers carried and the causes of all delays longer than five minutes are reported by the conductors and are recorded by the dispatcher under the head of "remarks" below the record of running time on the train sheet.

Formerly the dispatcher's train record was kept on a single sheet, which covered the entire record for the day. On account of the large number of trains operated (122 regularly scheduled and many extras) these sheets were about 9 ft. long, and therefore were inconvenient to handle on the dispatcher's desk. To serve their purpose with less inconvenience to the dispatcher and with greater reliability a scheme has been adopted for using a single progress card for each train. One of these cards is reproduced on page 543, and an engraving on Plate XXXI shows the method of mounting the cards on the dispatcher's desk. With this arrangement the general scheme of entering the records of the trains as they are reported along the route is identical with that ordinarily followed by steam roads, but there is the additional feature that as soon as a train has completed its run the section of the train sheet for that train may be removed from its pocket

on the dispatcher's desk and a new card inserted for the next train leaving. The dispatcher has before him the time-progress record of only those trains which are operating, and therefore he is neither confused nor, as formerly, hindered in his work by being obliged to enter train time reports at various scattered points on a large record sheet.

One feature of train operation which is very thoroughly carried out by the Puget Sound Electric Railway is train protection and flagging. When the leading train is delayed a fusee is dropped to protect against a following train. These fusees burn red for five minutes and green for five minutes, thus giving a five-minute stop signal followed by a caution signal of the same length. Frequent use of torpedoes is made in the operation of heavy freight trains, which are sometimes difficult to handle over heavy grades, especially if these trains are made up of many cars of logs.

The traffic department of the Puget Sound Electric Railway is headed by a general traffic agent. The station agents report to the traffic department insofar as the handling of traffic is concerned. The traffic department is responsible for the handling of all passenger and freight traffic and claims. It has charge of advertising and compiles all freight and passenger tariffs for both the Puget Sound Electric Railway and the Tacoma Railway & Power Company. The general superintendent of the interurban and the city system, of course, is in complete charge of the operation of all trains.

The station agents who report to the traffic agent are, with a few exceptions, telegraph operators who handle the train orders for the transportation department. As these operators have been recruited largely from steam railroad service they are well trained in handling the very complete steam railroad system of freight accounting forms used.

The local agent at Tacoma is also joint agent for the Tacoma Railway & Power Company. He has an office assistant and four warehouse men. The agent at Seattle has two clerks and four warehouse men. At other stations the agents have no assistants. The Seattle and Tacoma ticket offices, both located in the business districts of their respective cities, are open from 6 a. m. to 1 a. m., and the ticket selling is in charge of two agents at each station.

The accompanying table shows the large amount of equipment required for handling the extensive freight traffic over the interurban and the Tacoma city and suburban lines.

Freight equipment of Puget Sound Electric Railway:

2 express motor cars with four GE-66 motors.
3 open-cab motor cars with four GE-66 motors.
35 M.C.B. 50-000-lb. capacity 34-ft. box cars.
25 80,000-lb. capacity hopper cars.
14 60,000-lb. capacity gondola cars.
100 50,000-lb. capacity 36-ft. and 41-ft. flat cars.

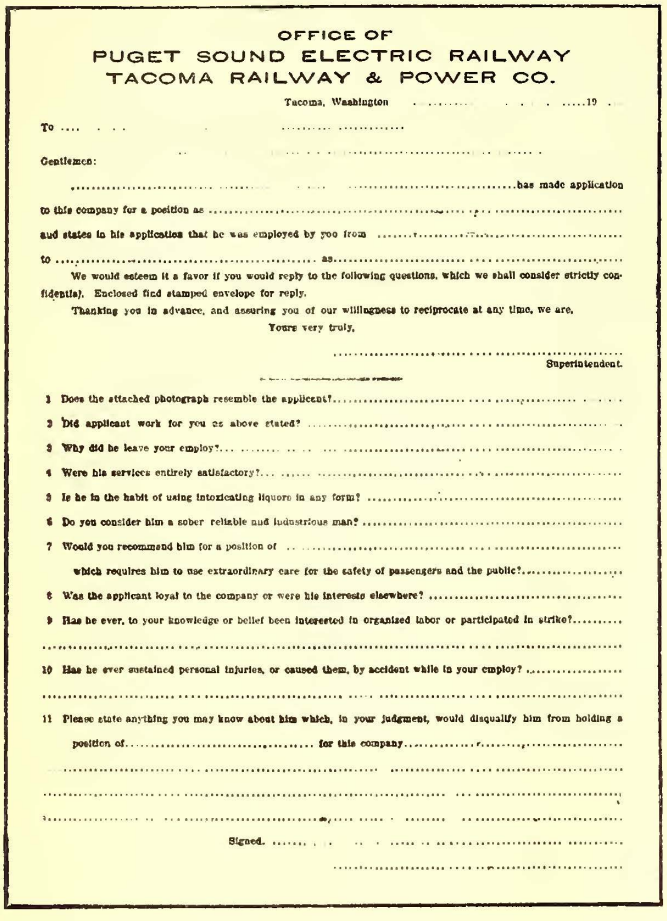
Freight equipment of Tacoma Railway & Power Company:

2 express motors each with four GE-67 motors.
1 express motor with four GE-90 motors.
2 open-cab motors equipped with GE-67 and GE-57 motors.
2 open-cab motors equipped with four GE-90 motors.
5 box cars.
100 flat cars.

It is customary to operate freight equipment in trains, and therefore all cars and locomotives are built to M. C. B. specifications and equipped with M. C. B. type couplers.

The remarkable growth of the freight business on the Puget Sound Electric Railway and the Tacoma Railway & Power Company's lines is shown by a comparison of the total gross earnings from freight traffic, which increased from about $8,000 per month in 1904 to $18,000 per month in 1908. These figures do not include any revenue for handling company construction or maintenance materials. The careful handling of freight is evidenced by the amount of freight claims paid, which do not average more than 0.25 per cent of the freight earnings.

The freight accounting methods used closely resemble those of steam roads, except that on the Tacoma city and suburban lines there are no agents, and the billing is done by conductors. The accompanying statement showing the cost of freight operations for the first four months of the year 1909 was made with a view to ascertaining whether or not



OFFICE OF
PUGET SOUND ELECTRIC RAILWAY
TACOMA RAILWAY & POWER CO.

Tacoma, Washington ..... 19 ..

To .....

Gentlemen:

.....has made application

to this company for a position as .....

and states in his application that he was employed by you from .....

to ..... as.....

We would esteem it a favor if you would reply to the following questions, which we shall consider strictly confidential. Enclosed find stamped envelope for reply.

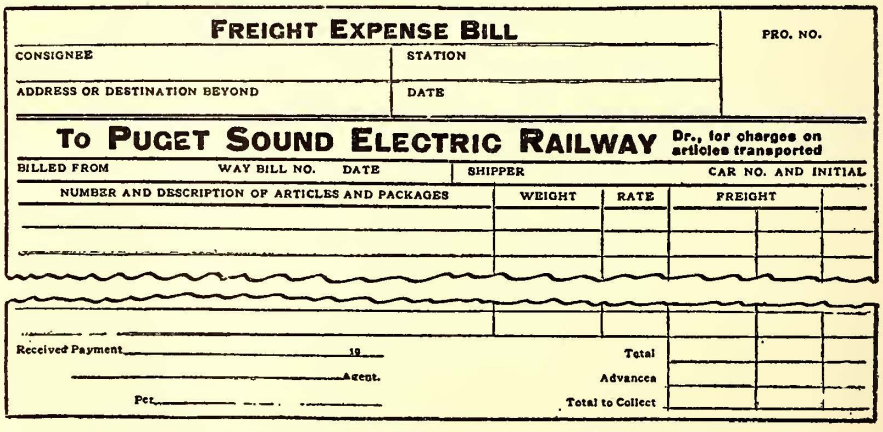
Thanking you in advance, and assuring you of our willingness to reciprocate at any time, we are,

Yours very truly,

.....
Superintendent.

1 Does the attached photograph resemble the applicant?.....
2 Did applicant work for you as above stated? .....
3 Why did he leave your employ?.....
4 Were his services entirely satisfactory?.....
5 Is he in the habit of using intoxicating liquors in any form? .....
6 Do you consider him a sober reliable and industrious man? .....
7 Would you recommend him for a position of .....
which requires him to use extraordinary care for the safety of passengers and the public?.....
8 Was the applicant loyal to the company or were his interests elsewhere? .....
9 Has he ever, to your knowledge or belief been interested in organized labor or participated in strike?.....
.....
10 Has he ever sustained personal injuries, or caused them, by accident while in your employ? .....
.....
11 Please state anything you may know about him which, in your judgment, would disqualify him from holding a position of..... for this company.....
.....
.....
.....
Signed. .....
.....

Puget Sound Electric Railway—Reference Blank for Employees (Original 8 in. x 11 in.)



FREIGHT EXPENSE BILL — PRO. NO.

CONSIGNEE | STATION

ADDRESS OR DESTINATION BEYOND | DATE

TO PUGET SOUND ELECTRIC RAILWAY Dr., for charges on articles transported

BILLED FROM | WAY BILL NO. | DATE | SHIPPER | CAR NO. AND INITIAL

NUMBER AND DESCRIPTION OF ARTICLES AND PACKAGES	WEIGHT	RATE	FREIGHT	

Received Payment _____ 19__
_____ Agent.
Per _____

Total
Advances
Total to Collect

Puget Sound Electric Railway—Form of Freight Expense Bill

PUGET SOUND ELECTRIC RAILWAY

REPORT OF OVER-SHORT AND DAMAGED FREIGHT

Agent's No. ..... DUPLICATE ..... Station ..... 190 ....

Car No. ..... Initials ..... Rec'd ..... 190 ..... Train No. ..... Conductor .....

Way-Bill No. ..... Dated ..... 190 ..... From ..... To .....

CONSIGNEE AND DESTINATION	ARTICLES AS BILLED	AS RECEIVED	*OVER—*SHORT—*DAMAGED
Seals-East Side			
" -West Side			
" -North End			
" -South End			

Was Car set out, or Freight unloaded from passing train? .....

By whom checked? ..... Did conductor verify check? .....

What is your estimate of amount of damage? .....

What is the Consignee's estimate of the amount of damages? .....

What in your opinion was the cause of the damage, over, or shortage? .....

What disposition was made of the freight? .....

FORWARDING AGENT'S STATEMENT. ..... Receiving Agent

Was shipment loaded in full as per your Way-bill? .....

What car loaded into? ..... Seals-East Side ..... West Side ..... North End ..... South End .....

For what other station did you load freight in this Car? .....

By whom checked and loaded? .....

Remarks .....

*Cross out if not covered by this report. ..... Forwarding Agent

Puget Sound Electric Railway—Over, Short and Damaged Freight Report
(Original 11 in. x 8 3/8 in.)

CONDUCTOR'S WHEEL REPORT

..... Division

Train No. ..... Conductor .....

Left ..... at ..... M. ..... 19....

Arrived at ..... at ..... M. ..... 19....

Motor No. ..... From ..... To ..... Motorman .....

Numbers must be taken from Cars and not from Way Bills

	Initials	Kind of Car	Car Numbers Loaded	Car Numbers Empty	Taken at	Left at	Contents	Billed From	Billed To	Weight Car	Weight Cont.	Mileage Loaded	Mileage Empty	Seal Record Side N or E	Seal Record Side S or W	Seal Record Ends N or E	Seal Record Ends S or W	
1																		1
2																		2
3																		3
29																		29
30																		30
	Total																	

Cooductors will leave spaces below vacaot

	Car Mileage			Loaded	Empty
Motor Miles	P. S. E. Co. Tracks		P. S. E. Co. Cars		
Train Miles	T. R. & P. Co. Tracks		T. R. & P. Co. Cars		
Car Miles	S. E. Co. Tracks		S. E. Co. Cars		
			Foreign Cars		
Ton Miles	Total		Total		

INSTRUCTIONS

1. This report must be made oot in duplicate, promptly at end of each single trip, original forwarded to Auditor and duplicate to Superintendent, immediately.
2. Conductors of work traios will make bot one report for each day, showing nature of service, number of trips, and other information necessary.
3. Exact time of leaving aod arriviog at terminals must be shown.
4. Cars must be taken to give correct oombers and initials of all equipment reported.
5. Cars should be reported io order as much as possible. Cars of this compaoy first, then foreigo cars.
6. Column for Seal Record will apply only to through cars aod not to Way-freight cars.
7. Mileage figures must be written in opposite each car oomber in the columo so provided; Ditto marks must not be used.

Puget Sound Electric Railway—Conductor's Wheel Report
(Original 8 1/2 in. x 14 in.)

88—25M-6-09

Puget Sound Electric Ry.

TIME TABLE DATE 7/21-9 NO. 12a

DIRECTION North

TRAIN NO. 14

CONDUCTOR Colpitts

MOTORNEER Merrel

BRAKEMAN Alexander

MOTOR 510-517-523

TIME ORDERED

	Corridorial and Trailer Way	
Am 1030	SEATTLE	1.00
	MASS. ST.	1.21
	SPOKANE AVE.	1.01
	ARGO	0.76
	GEORGETOWN	2.28
	MEADOWS	1.44
	DUWAMISH	1.69
	FOSTER	1.11
	BLACK RIVER	0.52
1006	RENTON JCT	2.44
	RENTON	1.70
	ORILLIA	2.04
	O'BRIEN	2.12
1001	KENT	1.89
	THOMAS	0.93
	MEREDITH	2.27
1522	AUBURN	1.60
	FARROW	0.48
	VALLEY	1.40
	BLUFFS	1.37
	JOVITA	0.85
	EDGEWOOD	2.27
1934	MILTON	1.95
	WILLOW JCT.	0.58
	McALEER	1.13
	ARDENA	1.15
	FIRWOOD	1.64
	BERRYTON	0.76
	PUYALLUP	1.23
	MEEKER	
	BROOKVILLE	1.16
	BOSWORTH	0.80
	BAY ST.	2.26
2115 Am	TACOMA Eighth and A Streets	

DISPATCHERS

GVP

DELAYS

119 Through passengers

22 Parlor Car.

Puget Sound Electric Railway—Train Card
(Original 1 3/4 in. x 17 in.)

the freight traffic was profitable as compared with the passenger business. This statement is for the Puget Sound Electric Railway only, and it is said that the operating costs on the Tacoma Railway & Power Company lines are even less for freight, because the latter company has fewer agents and does not maintain extensive terminal facilities.

CHARACTER OF TRAFFIC

Inasmuch as the freight traffic of the Puget Sound Electric Railway is very closely indicative of the lines of business and trade which are serving to build up the Puget Sound district so rapidly, it may be of interest to summarize the character of the freight, the amounts handled and the rates paid between each of the important shipping points on the line.

At Renton, the terminus of a 2-mile branch which leaves the main line 11.5 miles south of Seattle, the company owns

and operates a coal mine having an output of from 400 to 500 tons per day. A large glass bottle factory and a brick-making plant with a capacity of 600 tons of pressed vitrified brick and tile per day are also located in Renton. In addition to its well-filled two-car passenger trains operating hourly in and out of Renton the company handles part of the products of the coal mine and the manufacturing plants located there. An average of about 400 tons of coal is distributed each day to various stations on the line. The rate on coal for the 28-mile haul between Renton and Tacoma is 55 cents per long ton, in addition to which a local switching charge of 30 to 50 cents per ton is made in Tacoma. The company. The bodies of these cars are large enough to hang the beef in halves instead of in quarters, as is usually done. Meat is loaded and unloaded from the warehouses directly into the cars by means of overhead trolley systems, which are extended into the car body.

The interurban line operates a milk train, which leaves Tacoma at 5 a. m., and, after stopping at country loading platforms, takes an average of about 4000 gal. of milk into Seattle each morning. A charge averaging about 1 1/2 cents per gallon is made for delivering the milk and returning the cans. In the fall of the year the interurban line handles from three to five cars of market garden stuff each

STATISTICS OF FREIGHT TRAFFIC, 1909

	January	February	March	April	4 Months
Gross earnings	$10,627.03	$10,613.55	$12,355.35	$12,092.85	$45,688.78
Operating expenses:					
Maintenance of cars	426.68	770.73	428.35	772.74	2,458.50
Maintenance electric equipment of cars	38.32	30.77	17.65	39.79	126.53
Hired power	1,175.74	1,052.87	1,034.10	1,172.75	4,435.46
Wages of conductors	369.68	319.07	349.24	328.87	1,366.85
Wages of motormen	414.04	353.74	386.84	363.92	1,518.54
Wages of other car service employees	1,471.70	1,154.60	1,484.91	1,490.42	5,601.63
Miscellaneous car service expenses	56.16	25.95	17.50	13.60	113.21
Salaries of general officers	65.00	65.00	65.00	65.00	260.00
Salaries of clerks	115.00	115.00	115.00	115.00	460.00
Printing and stationery	50.00	50.00	50.00	50.00	200.00
Damages	15.00	15.00	15.00	15.00	60.00
Rent of tracks and terminals	390.80	269.45	269.45	259.85	1,189.75
Insurance	40.00	40.00	40.00	40.00	160.00
Total	$4,628.12	$4,262.38	$4,333.04	$4,726.94	$17,950.48
Net earnings	$5,998.01	$6,351.17	$8,022.31	$7,365.91	$27,738.30
Per cent expenses to earnings	43.5	40.1	35.1	39.1	39.03
Tonnage	16,573	15,614	18,817	17,412	68,416
Gross earnings per ton, cents	64.12	67.97	65.66	69.45	66.78
Expense per ton, cents	27.93	27.30	23.03	27.15	26.24
Net earnings per ton, cents	36.19	40.67	42.63	42.30	40.54
Mileage	35,396	33,927	40,281	39,183	148,787
Gross earnings per mile, cents	30.02	31.28	30.67	30.86	30.71
Expense per mile, cents	13.08	12.56	10.76	12.06	12.07
Net earnings per mile, cents	16.94	18.72	19.91	18.80	18.64

coal is weighed on the scales at the mine before shipment. The rate on coal from Renton to Seattle, 13.5 miles, is 30 cents per ton of 2000 lb., and a local switching charge is made by the Seattle Electric Company for delivery over its tracks.

The traffic in brick from January 1 to July 15, 1909, amounted to 3,000,000 brick, having an average weight of 7 lb. each, carried from Renton to Tacoma. The regular rate on brick for this distance is 50 cents per ton over the interurban line, in addition to which the Tacoma Railway & Power Company makes a switching charge of from 20 cents to 25 cents per ton for delivery on its tracks in Tacoma. The rate on brick from Renton to Seattle is 30 cents per ton, and deliveries are made by the Seattle Electric Company over its city lines at regular switching charges. The minimum carload weight of 20 tons is charged for in brick hauled over the interurban and the Tacoma city lines. The average carload weight, however, is about 56,000 lb.

The through freight business between Tacoma and Seattle includes three cars of merchandise and two cars of fresh meat daily from Seattle to Tacoma and three carloads of manufactured products and three carloads of fresh meat daily from Tacoma to Seattle. About four cars of local merchandise are delivered daily from Seattle to way stations and about two cars from Tacoma. The meat traffic is handled in specially built refrigerator cars owned by the packing night. Because the interurban line has direct competition with several boats operating between Tacoma and Seattle a large commodity tariff is published and the traffic department maintains an aggressive campaign for new business.

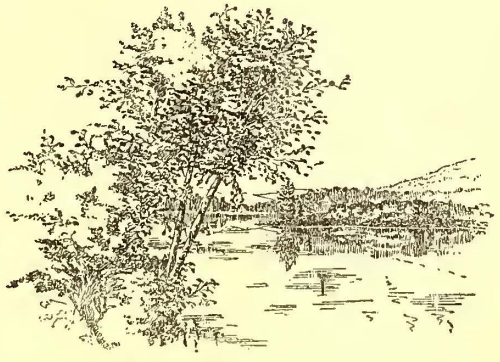
Lumber and timber handling is an important part of the freight traffic. Sawmills are located along the line at Milton, Valley City and Ardena. There are two mills at Milton, one of which is owned by the electric railway interests. In Tacoma, which is famous for its lumber trade, the railway company has track connections with all of the important mills. The Tacoma Railway & Power Company handles logs, piling and poles from points on its suburban lines to the sawmills and shingle mills in South Tacoma. This local traffic includes about six cars of logs, which are brought into Tacoma each night. A large part of the lumber-mill traffic along the interurban lines is made up of building lumber and slabs, of which from 5 to 10 cars are transferred each night. There are 19 spurs into wood, coal and industrial plants on the Tacoma Railway & Power Company lines and 23 on the Puget Sound Electric Railway. The rate on logs for a 10-mile haul is $1 per 1000 ft. b.m. with a minimum of 5000 ft. per car. The rates on lumber, lath, posts, piling and poles range from 2 cents per 100 lb. for 10 miles and under to 3 1/2 cents per 100 lb. for 40 miles and under, with a minimum carload weight of 40,000 lb. The rate on wood and slabs, with a minimum carload of 12 cords, varies

from 60 cents per cord for 10 miles and under to 80 cents per cord for 35 miles and under.

The Tacoma Railway & Power Company operates express and freight cars over its 85 miles of city and suburban tracks, and charges for general merchandise freight 10 cents per 100 lb. with a minimum of 15 cents within the city and 25 cents outside of the city. A freight house 30 ft. wide by 300 ft. long accommodates the freight of both city and interurban lines in the city of Tacoma. The following switching charges are made for terminal delivery in Tacoma:

Lumber, 50 to 75 cents per 1000 ft. b.m.; minimum, 12,000 ft.
Gravel, 40 to 50 cents per yd.; minimum of 20 yd. capacity of car.
Brick, 30 to 35 cents per ton; minimum, 20 tons.
Furniture and household goods, $7 per car.
Merchandise and commodities, 50 to 60 cents per ton; minimum of 24,000 lb.

No freight collections or deliveries are made and the charges here given include only transportation over the companies' lines.



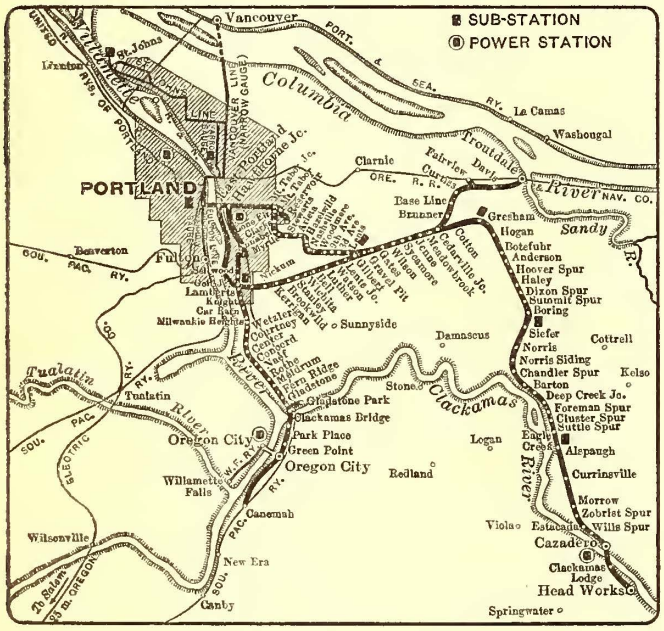
THE ELECTRIC RAILWAYS OF OREGON

OPERATING FEATURES OF THE PORTLAND RAILWAY, LIGHT & POWER COMPANY

THE Portland Railway, Light & Power Company controls and operates the properties of the Portland Railways Company, Oregon Water Power & Railway Company, Portland General Electric Company and the Vancouver (Ore.) Light & Power Company. A map is presented showing the general location of the district which the interurban lines operated by this company serve. The total mileage of the railway system, which is made up of city and interurban tracks of 3-ft. 6-in. gage and standard gage, is 226 miles. The rolling stock equipment includes 497 passenger cars and 160 freight cars. Fares are collected on some lines according to the pay-as-you-enter plan.

SHOP RECORDS AND METHODS

The rolling stock equipment is maintained in three shops—one shop with standard gage tracks for freight equipment, one for passenger equipment and one narrow-gage shop also



Portland Railway System—Map of Portland Interurban Lines

for passenger equipment. A peculiar organization of the shop forces of this company is brought about by reason of the two gages of track and the consolidation with the parent company of several properties, each with its own shops. Besides the three shops there are five car houses with day and night forces, all under the jurisdiction of a superintendent of equipment. Reporting to him are a shop superintendent and a car-house superintendent. The car houses are located at an average distance of about 3 miles apart and two of the shops are located 1.5 and 6 miles distant, respectively, from the third. The foundry is located about 10 blocks distant from the largest shop, which is at Twenty-third Street.

A uniform system of shop and maintenance reports is followed at all car houses and shops. This systematic scheme for obtaining permanent records of the work done is of interest and will be described as used in the Twenty-third Street shop. The first information in this system of records is presented on a large blackboard mounted on one wall of the repair shop. All men engaged in maintenance work make a record under the proper heading on this board of what they do and these records are transferred by an office clerk to a daily shop report blank 25 in. x 18 in. in size, with headings as reproduced in Fig. 1, page 547. This blank has exactly the same arrangement of rulings and headings as painted on the blackboard.

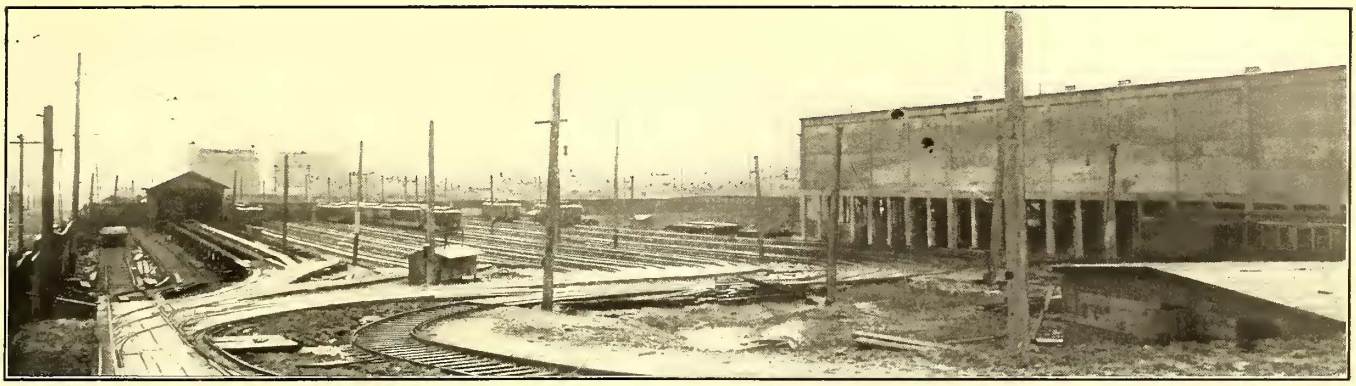
When an armature or field is taken out of a motor a tag is attached, as illustrated in Figs. 2 and 3. These tags show the armature or field number, its location in the motor and the name of the man who takes it out or puts it in. One tag is securely attached to the armature or field and remains with the part during its course through the shop until it is returned to a motor. The use of these tags assists the electrical repair man in learning what repairs, other than those found by easy inspection, are necessary.

Referring again to Fig. 1: After the information contained on the blackboard has been copied on this blank by the shop foreman or his assistant, it is sent to the office of the superintendent of shops and the blank so filled out forms the shop foreman's report of what his force has done during the day.

A card index for each armature and field is kept in the office. The headings presented on one side of an armature card are shown in Fig. 4. One of these cards, 8 in. x 5 in. in size and ruled on both sides, exhibits the complete record of one armature or field from the time it was first put in service. A similar record for smaller parts of the equipment, such as pinions, gears, etc., is kept in a book with pages ruled similarly to the armature and field record card.

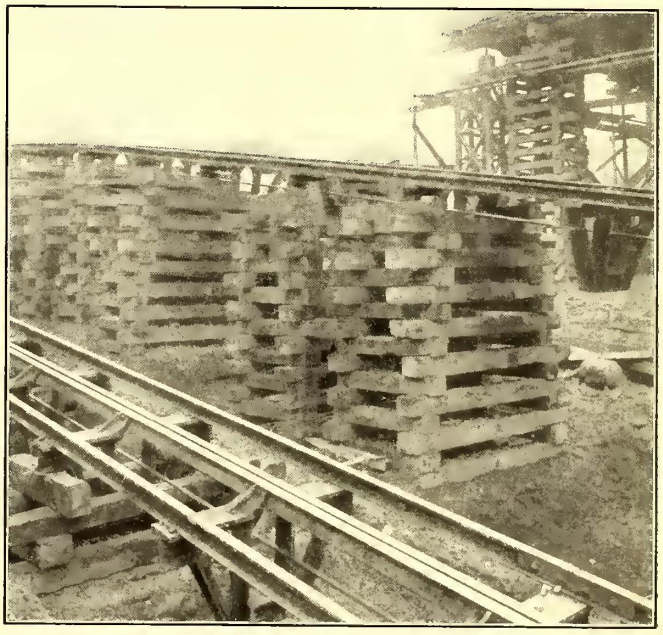
A car record card of heavy manila paper, 8 1-2 in. x 11 in. in size and ruled on both sides, is kept for each car. This card is shown in Fig. 5. The data showing the repairs or changes made on the car are taken off from the daily shop report each day. One of these car record cards lasts about 12 months and affords a very useful means for the head of the shop to locate weaknesses in any part of the car equipment. After all the data exhibited on the daily shop report have been transferred to the car record card the clerk in charge of the records then fills out a truck record, Fig. 6. This record blank, 8 1-2 in. x 11 in. in size, is printed on yellow paper. The reverse of the blank form presents truck data and also statistics regarding controllers, car wiring, brakeshoes and trolley. The truck records, when filled out, are sent to the general office, where their details are entered on a permanent record kept by the statistical section of the auditing department. These statistics present the record of each part of the equipment under its individual number. The statistical department makes a monthly report to the president showing the performance of the equipment according to mileage. Such reports are of considerable value for comparative purposes, and it is stated that the slight additional expense necessary for obtaining the data is warranted, because when purchases are made the records show actual results and the personal element is entirely eliminated from the decision. The statistical work is carried on by one clerk.

Only light repairs and replacements are made at the car houses, and so the daily car house report is not so complete as the daily shop report, although it presents the same general features of maintenance work. The daily car house reports

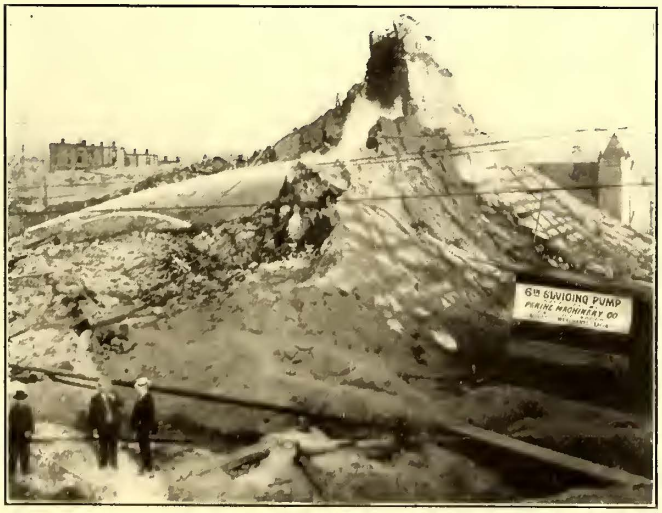


Seattle Electric Company—Storage Yards and Rear of North Seattle Car House

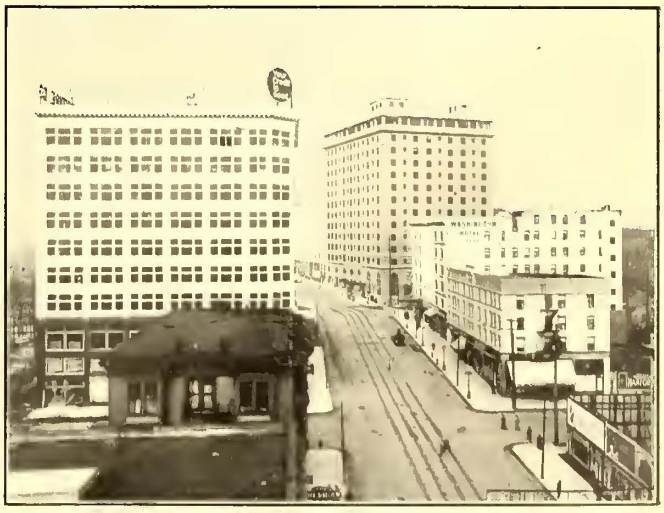
Seattle Electric Company—Denny Hill in 1906, Before Commencing Regrade



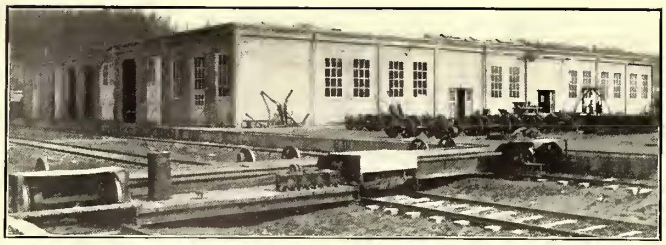
Seattle Electric Company—Difficult Operation of Cable During the Regrade Work



Seattle Electric Company—Cutting Away Denny Hill in 1907

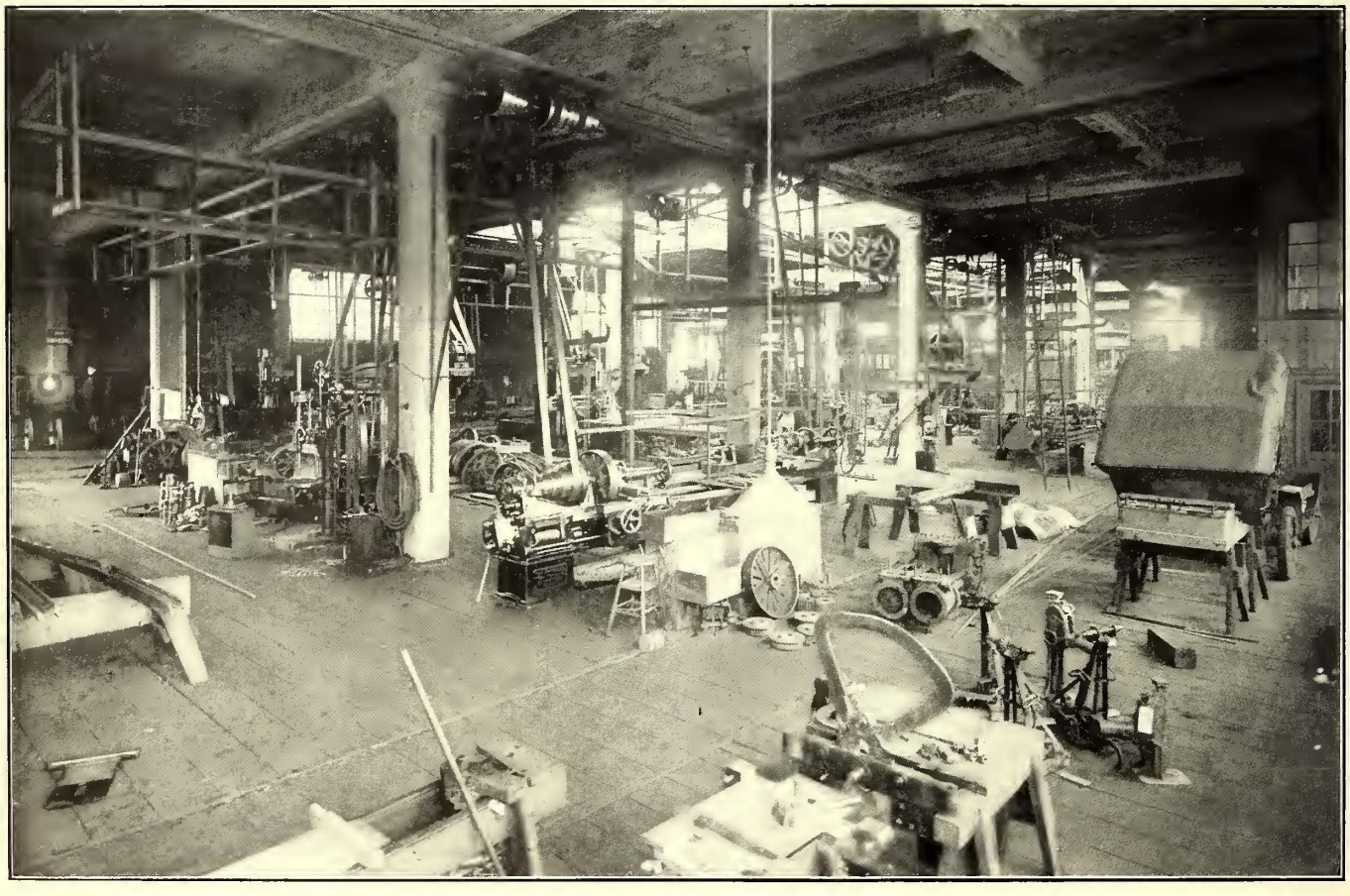


Seattle Electric Company—Denny Hill Regraded and Rebuilt, 1908



Seattle Electric Company—Machine Shop

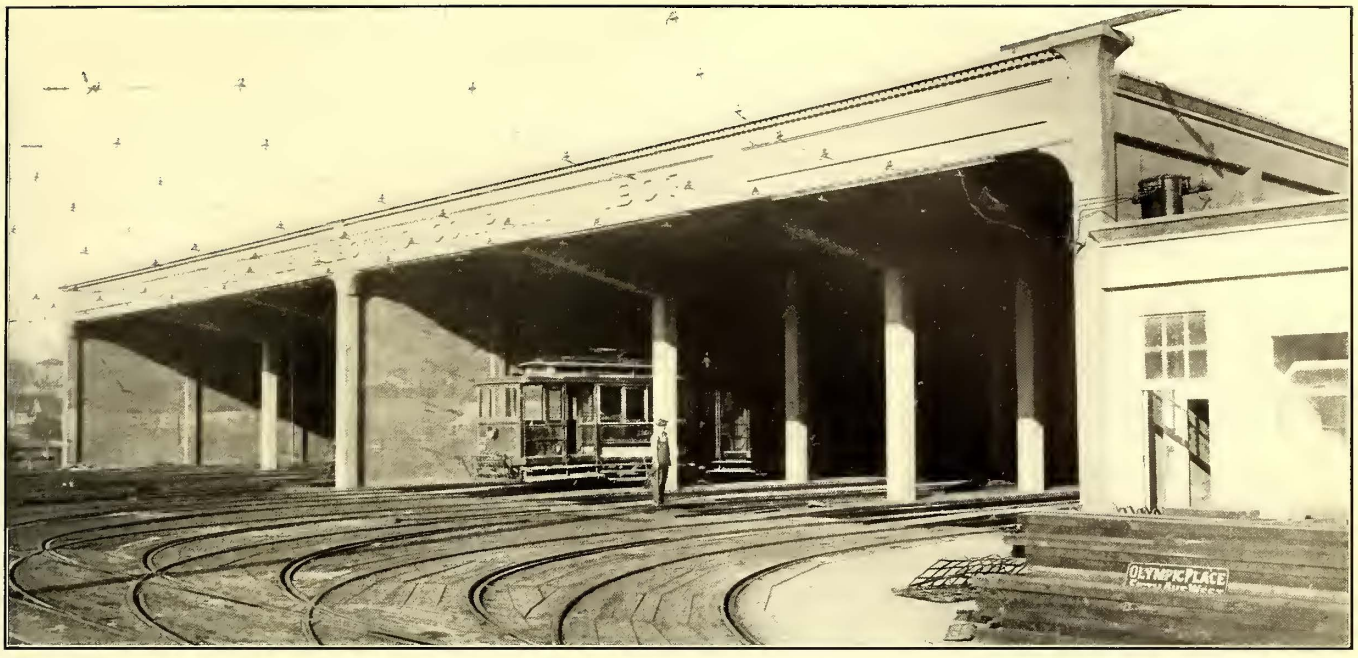
Seattle Electric Company—Paint Shop



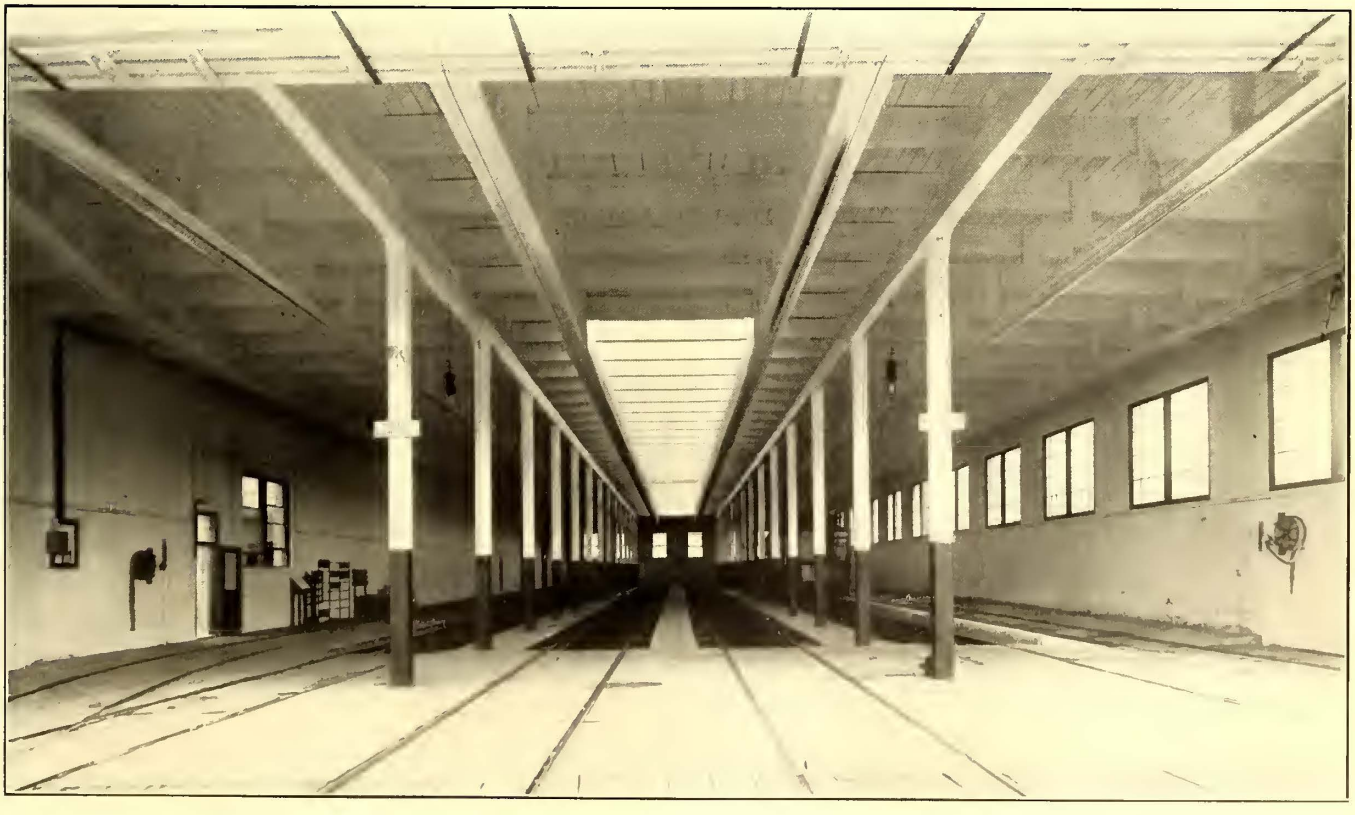
Seattle Electric Company—Interior of Machine Tool Section of Georgetown Shops

Seattle Electric Company—Erection Shop

Seattle Electric Company—Storehouse and Offices

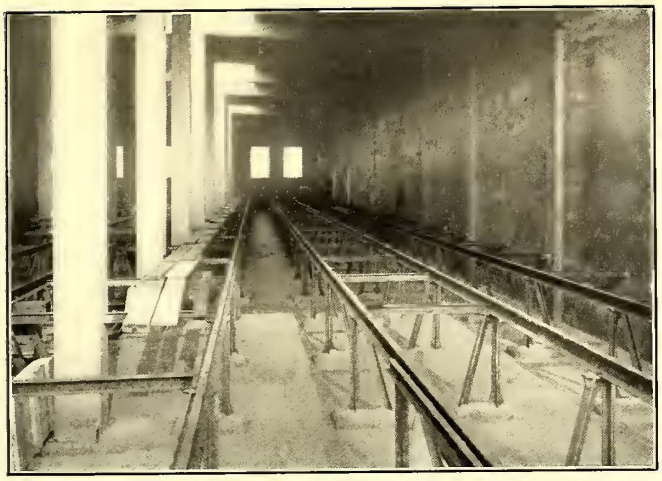


Seattle Electric Company—North Seattle Car House, with Wide Entrances and End Wall Supported by Concrete-Steel Cantilevers Carried on Columns Set Back of Building Line

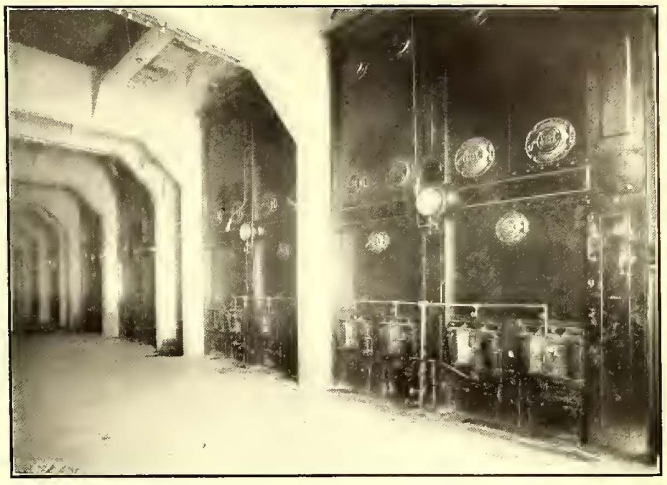


Seattle Electric Company—Interior of Fremont Car House, Showing Type of Structure, with Brick Side Walls, Frame Roof Supports, Plank Floor and Open Pits

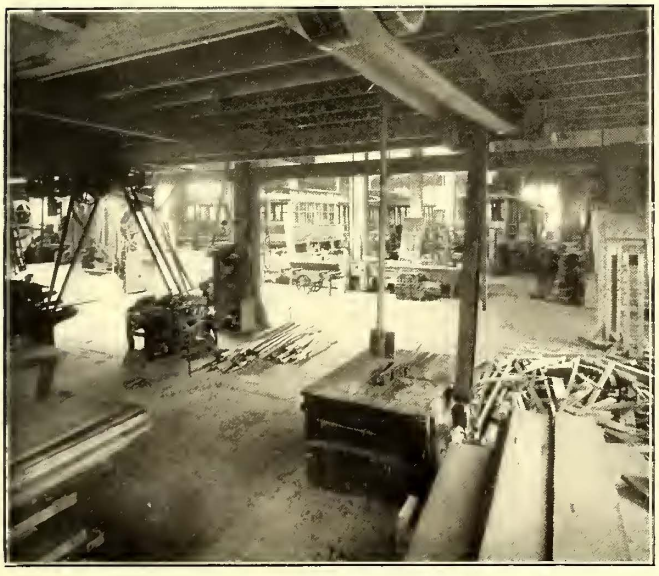
Seattle Electric Company—View of Electrical Galleries in Georgetown Steam Relay Station



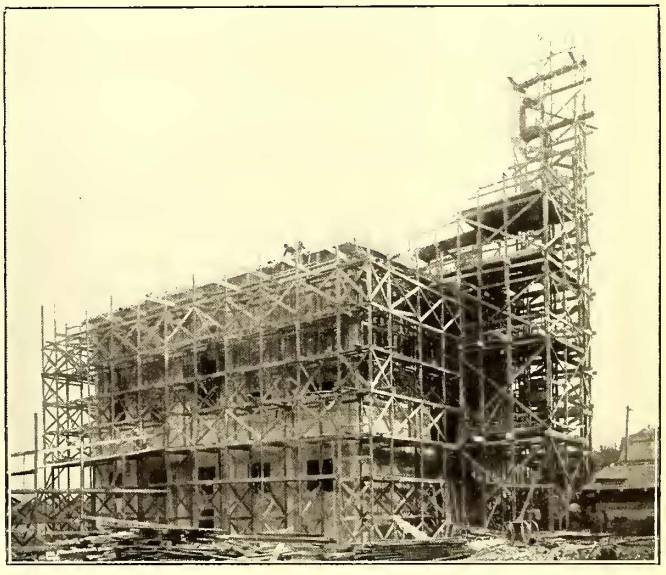
Seattle Electric Company—Track Pit Construction in North Seattle Car House



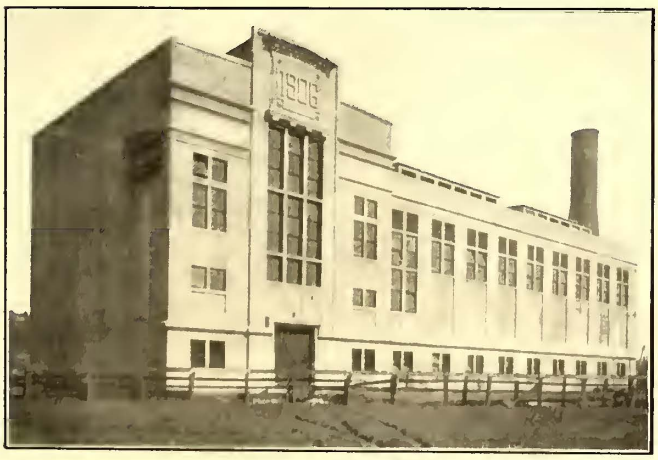
Seattle Electric Company—Oil Burners at Georgetown Power Station



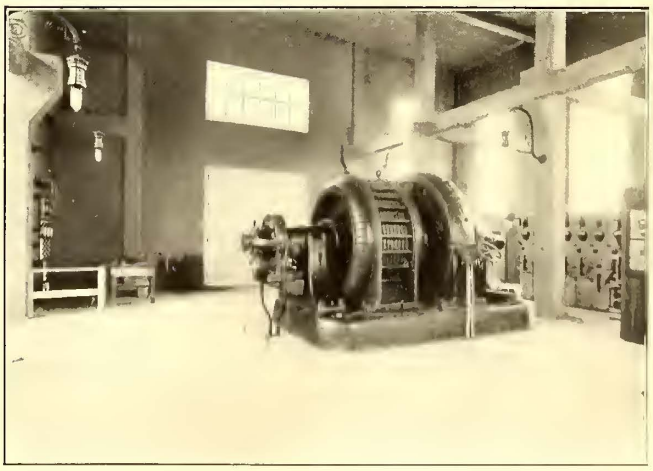
Seattle Electric Company—Interior of Carpenter Shop at Georgetown



Seattle Electric Company—Falsework Used in Erecting Concrete Substation



Seattle Electric Company—Exterior of Georgetown Power Station

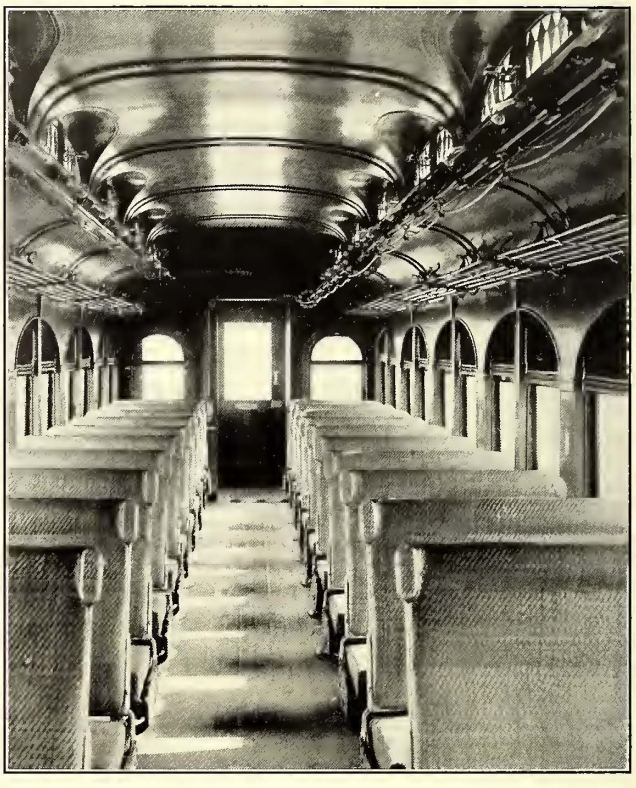


Seattle Electric Company—Interior of North Seattle Substation

Puget Sound Electric Railway—Observation Car Train

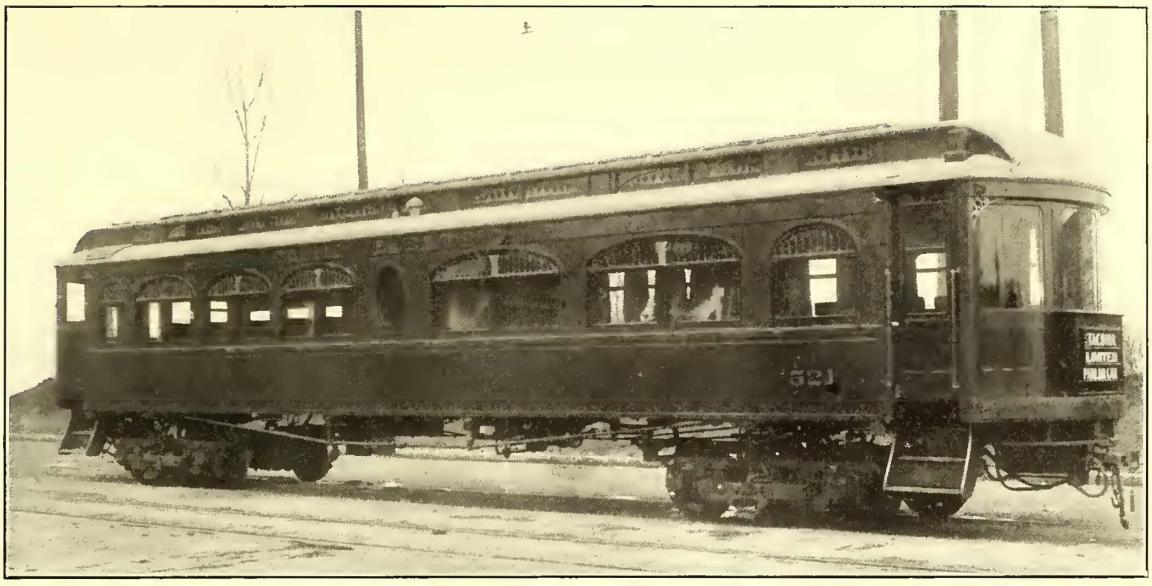
Tacoma Railway & Power Company—Suburban Train

Puget Sound Electric Railway—Interior of Parlor Observation Car

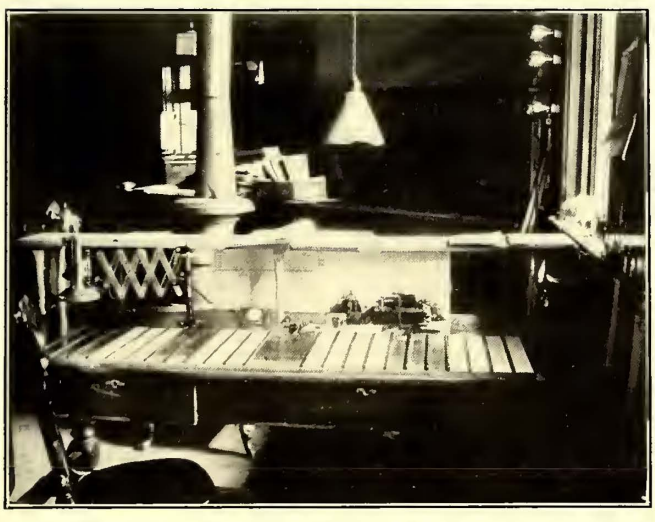


Puget Sound Electric Railway—Interior of Standard Passenger Car

Puget Sound Electric Railway—View Along the Interurban Line Near Tacoma



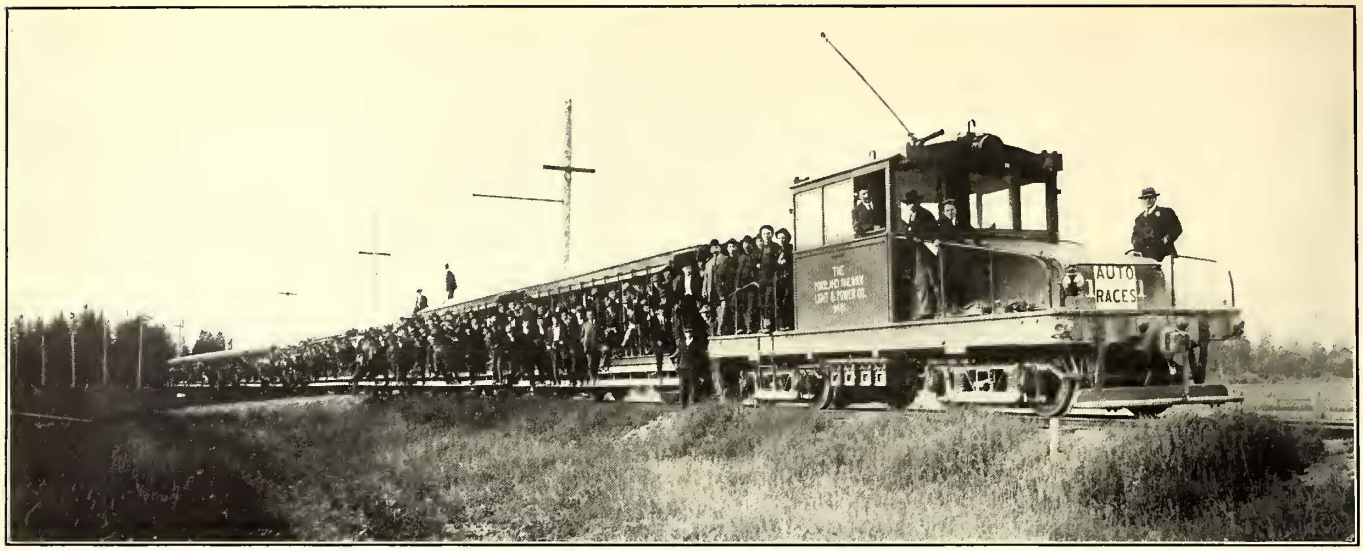
Puget Sound Electric Railway—Observation Trailer with Platform Enclosed for Winter



Puget Sound Electric Railway—Dispatcher's Desk and Train Cards

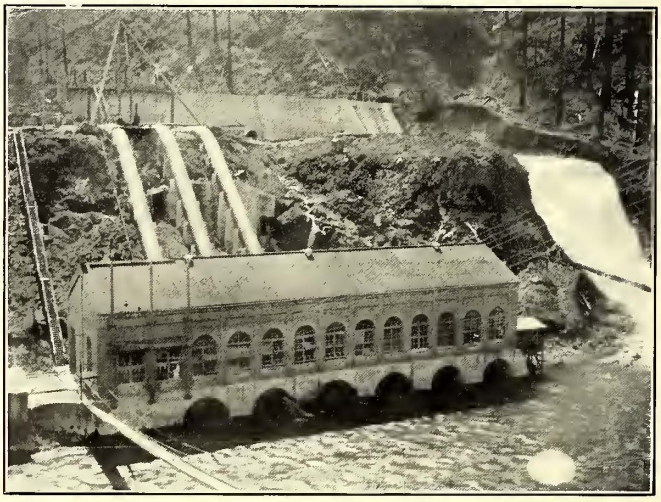
Oregon Electric Railway—Standard Passenger and Express Train

Puget Sound Electric Railway—Combination Baggage and Smoker Motor Car



Portland Railway System—Ten-Car Train Handling Race Track Crowd

Portland Railway System—South Portland Substation



Portland Railway System—Cazadero Power Station

Portland Railway System—New Freight Station and Office for Oregon Water Power Division

DAILY SHOP REPORT

_________ CAR SHOP

_________ 19__

Car No.		TRUCKS								MOTORS														CONTROLLERS				MISCELLANEOUS	EMPLOYEES
		Type	No.	Axles	Journal Brasses	Wheels	Brake Shoes	Cause of Removal	Work Performed	Type	No.	Arma-ture	Fields 1	2	3	4	Bearings Pin.	Com.	Axle	Pinion	Gear	Cause of Removal	Work Performed	Type	No.	Cause of Removal	Work Performed		
	In																												
	Out																												
	In																												
	Out																												

Portland Railway System—Fig. 1—Daily Report of Work Done by Shop Employees

TYPE	G. E. 58	G. E. 800	W. P. 30	W. P. 50
ARMATURE NO				
	IN	OUT	MONTH	DATE
CAR NO.				
END	1	2	3	4
OUT				
IN				
TAKEN OUT BY				
PUT IN BY				

DICKINSON'S K QUALITY K

TYPE			G. E. 58	G. E. 800	W. P. 60	W. P. 50
FIELD No.		OLD				
		NEW				
CAR NO						
MOTOR No						
POSITION NO IN MOTOR	1 2	3 4	MONTH	DATE	YEAR	
TAKEN OUT BY						
PUT IN BY						

Portland Railway System—Figs. 2 and 3—Armature and Field Tags

ARMATURE RECORD

No.______ TYPE______

IN				OUT				
DATE	CAR	MOTOR	EMPLOYEE	DATE	CAR	MOTOR	CAUSE	EMPLOYEE

Portland Railway System—Fig. 4—Armature Record

CAR RECORD

CAR NO.______ TRUCKS______ TYPE______

Date	Truck	Motor		Armature	Cause of Removal	Work Performed	Miscellaneous	Employee
			Out					
			In					
			Out					
			In					
			Out					
			In					
			Out					
			In					
			Out					

Portland Railway System—Fig. 5—Car Record

TRUCK RECORD

TRUCK NO ______ CAR NO.______ TYPE______ ______ 190__

OUT

MOTOR	NUMBER 1	CAUSE OF REMOVAL	NUMBER 2	CAUSE OF REMOVAL	NUMBER 3	CAUSE OF REMOVAL	NUMBER 4	CAUSE OF REMOVAL
Armature								
P. Brasses								
C. "								

IN

MOTOR		NUMBER 1	WORK PERFORMED	NUMBER 2	WORK PERFORMED	NUMBER 3	WORK PERFORMED	NUMBER 4	WORK PERFORMED
Armature									
P. Brasses									
C. "									
Axle "									
Journal "									
Pinions									
Gears									
Wheels									
Axle									
Fields	1								
	2								
	3								
	4								

Remarks:

TRUCK IN SERVICE CAR NO.______

Portland Railway System—Fig. 6—Truck Record

are printed on two tints of paper to distinguish between reports made by day and night men, and are 13 in. x 11 in. in size. The information exhibited on the daily car house report is handled in the office of the superintendent of shops along with that shown on the daily shop report.

The records kept for the foundry include a continuous inventory of the stock on hand and a record of the castings made. These reports are summarized at the end of each month to show the amount of material used and the castings delivered. This foundry pours each month an average of about 35 tons of cast iron used in special work, brakeshoes, etc., and about four tons of brass used in car fittings, journals, trolley wheels, etc. A continuous record is kept at the shop in the form of a card index covering the supplies most frequently used and thus any shortage of material to work with is avoided. There are 108 men employed in the Twenty-third Street shop and 10 men in the foundry.

SHOP KINKS

The company manufactures a large part of its own special track work and is prepared to do this work in a thorough manner. The standard crossings made are built up with manganese steel centers purchased from Edgar Allen & Company and from local dealers. The rail shop casts compromise joints with about 3 ft. of each weight of rail. These are kept in stock for quick use in connecting old and new track.

In the electrical shop an improvement has been made which has largely prevented the necessity for frequent rewinding of fields. The method of winding now followed is to use Deltabeston wire and paint the layers of the field coils with a thick mixture of Ajax varnish and whiting. In winding the field coil a terminal plate with a rigid terminal stud and two check nuts to hold the connection, is built into the coil. By the use of this stud and the check nuts the connection can be broken easily, even though it is badly burned, and thus the work of drilling out the connection stud, as when a screw-set terminal is used, is saved. The foreman of the armature room is made responsible for the repair work on cut-outs, controllers and electrical winding, and thus no friction can arise on account of lax work in one part of the electrical department being charged against another part.

FREIGHT SERVICE

The Oregon water power division of the Portland Railway, Light & Power Company is made up of 85 miles of interurban line extending south to Oregon City and Canemah on the Willamette River, east to Troutdale on the Columbia River, and southeast to Cazadero on the Clackamas River. This division handles a heavy freight and passenger traffic. The freight equipment includes 185 flat, box and coal cars and seven electric locomotives, one of which was described in the Electric Railway Review, Dec. 21, 1907, page 959. These seven locomotives include two of all-steel construction, two with steel underframes and sloping type cabs, and three heavy express motor cars. Two double-truck cabooses are used with long freight trains. The freight service is handled according to steam railroad practice, and in the accounting work and the filing of tariffs all the requirements of the Interstate Commerce Commission are followed.

The headquarters of the Oregon water power division are located in a large new freight house, which is situated on the Columbia River. The freight house loading tracks have a capacity for 20 cars. A large number of yard tracks nearby provide for the economical storage of cars and for the switching of trains.

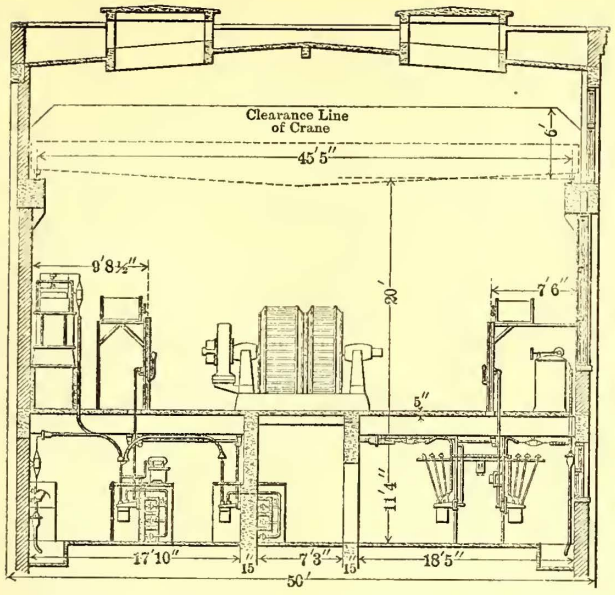
The freight house is 50 ft. x 200 ft. in size, with an office extension 50 ft. x 48 ft. in size. It is built of heavy timbers covered with corrugated iron. On each side of the entire length of the freight house is a row of Wilson rolling steel doors which afford an entrance opposite any car that may be standing on the track. A socket for portable extension lamps which can be used in any car is provided at each door post. The floor of the freight house is made up of 2 in. x 5 in. planks set on edge so that the heaviest loads do not cause sagging. The interior is illuminated with Nernst lamps. Along the river front, at the end of the freight house, the railway company owns a dock 1,000 ft. long, where lumber and other heavy materials can be loaded directly for river or ocean shipment. River boats which carry building stone, paving blocks and other heavy materials are unloaded at this dock and the freight transferred directly to cars for delivery on the interurban divisions.

Practically all of the Portland freight business is handled through this freight house, an illustration of which is presented on Plate XXXII. The daily merchandise traffic from this point includes about eight cars of local merchandise destined for points along the Oregon water power division, two cars of inbound local merchandise, and from 25 to 30 tons of express. The total tonnage in an average month through the Portland freight house in less than carload lots amounts to 3,000,000 lb. On account of the care taken in the design of the loading platforms and the door arrangements of the freight house, freight can be handled from trucks on one side into cars on the other side, or vice versa, at an average cost of 20 cents per ton. The drop-truck system of freight handling, in which the merchandise is not lowered to the floor of the house but is stored temporarily on trucks until the outgoing cars are ready for loading, is used to bring about this low cost for freight handling through the terminal station.

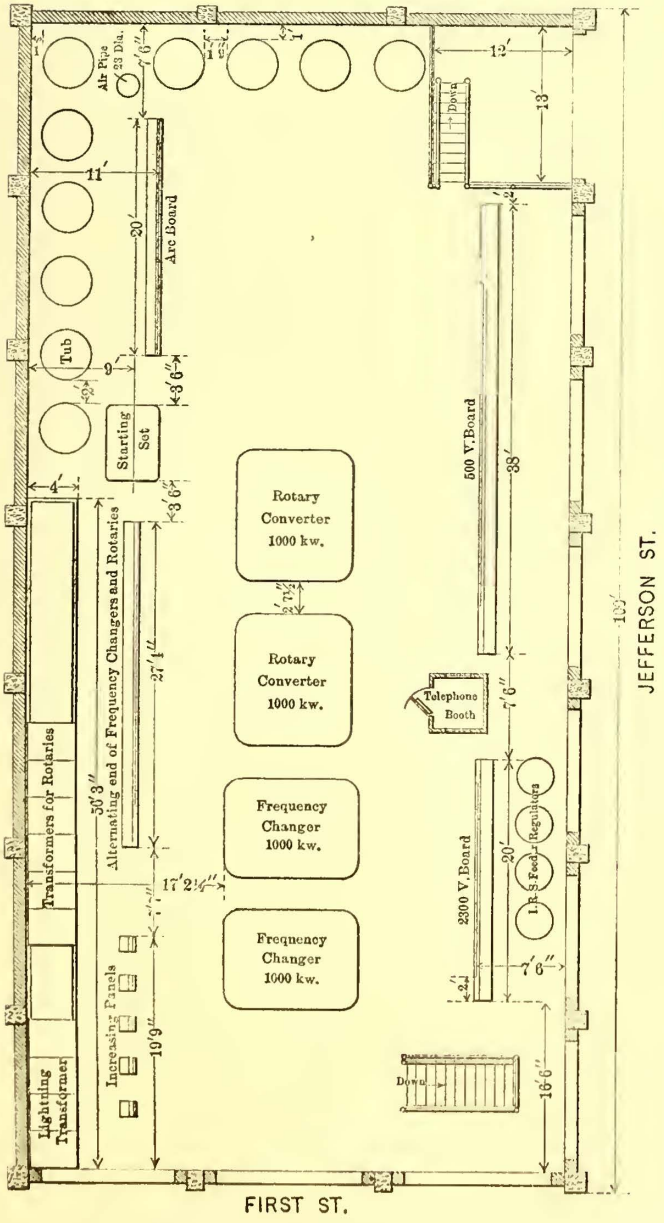
In addition to the merchandise and express freight handled daily, a local freight train is operated daily except Sunday. This train is loaded at night at Portland and deliveries are made at the farthest point, 36 miles away, about 11 o'clock in the morning. The package freight, milk express and miscellaneous traffic is handled by two trains each way daily, and this traffic brings a higher return than that carried on the local freight train. The rates for package freight are the same as those charged by competitive express companies. The milk business amounts to 15,000 gal. per day, for which a charge of from 10 to 15 cents a can is made according to the distance hauled.

The yearly business in and out of Portland which passes through the Portland freight house amounts to 18,000 carloads, and even this large amount does not include l. c. l., or so-called express freight. The local and through freight trains, which are hauled by locomotives, seldom make up with less than 25 cars. The locomotives handling such trains each weigh 40 tons, and are of the slanting cab type with steel bodies. They are equipped with four GE-55 motors and type M control. At one point on the line there is a summit with a 2 per cent grade on either side. An extra locomotive is kept at this point without a crew, so that when a train approaches the heavy grade the extra locomotive may be coupled to the train locomotive and the heavy load drawn over the summit with the two locomotives operating through the medium of the multiple-unit control.

On one division, 26 miles long, there are 31 sidings averaging from 400 ft. to 1400 ft. in length, and as there is so much switching to be done five men are required for a freight-train crew. This crew is made up of a motorman, a trolleyman, a conductor and two flagmen. The trains are operated under the standard code of rules of the American Railway Association, and to conform strictly to these rules the two flagmen are required for protection during the switching.



Portland Railway System—Vertical Section of South Portland Substation



Portland Railway System—Plan of Machine Floor of South Portland Railway and Lighting Substation

The Oregon Water Power line interchanges freight with the Southern Pacific at East Portland and with the Oregon Railroad & Navigation Company at Fairview. This interchange is required by the State and Interstate Commerce commissions, and the electric lines get a local rate on all through business.

INTERURBAN PASSENGER SERVICE

The passenger service on the Oregon Water Power line includes a train every hour to Gresham, located about midway between Portland and the terminus at Cazadero. Every other one of these trains operates through to Cazadero so that there is an hourly service on the more heavily traveled portion of the line, and a train every two hours on the extreme end. As regularly made up these trains comprise a motor car and a trailer car. Frequently trains of four cars are operated on the regular schedule. On Sundays an hourly service is given to Cazadero because of the special travel to the resorts on the Clackamas River.

The Oregon City division of the Oregon Water Power lines operates for 4 miles over the same tracks as the Springwater-Cazadero division. This line is 15 miles long, and a half-hourly service with motor cars and single trailers is given between Oregon City and Portland. On one division between East Portland and Lents Junction, which traverses a thickly populated suburban territory, a 10-minute service is given with two-car multiple-unit trains. These cars are equipped with four GE-81 motors and type M control, and the operation of trains is protected with United States automatic block signals.

CAZADERO POWER STATION

The rapid growth of passenger and freight traffic on the city and interurban lines of the Portland Railway, Light & Power Company has necessitated an increase in the company's power supply. The principal generating station of this company, located at Cazadero on the Clackamas River, 37 miles from Portland, was described in the STREET RAILWAY JOURNAL for May 18, 1907, page 868. This plant is equipped with three 42-in. Victor turbine wheels of the Francis type, direct-connected to three 2500-kw, 11,000-volt, Allis-Chalmers water-wheel type generators. The ultimate capacity of the plant is 25,000 hp. About a mile above the power plant is a dam across the Clackamas River, 130 ft. wide at the base, which diverts a portion of the water into a flume 2622 ft. long leading to a reservoir on the hillside above the plant. This reservoir covers 50 acres when filled to an average depth of 20 ft., and has a storage capacity of 326,480,000 gal., affording a sufficient supply of water to run the wheels of the power plant for six hours after the gates at the dam have been closed.

POWER IMPROVEMENTS

In addition to this plant the company's operating engineers, and Sellers & Rippey, of Philadelphia, consulting engineers, are making investigations and planning the construction of a 25,000 kw or 30,000 kw capacity water-power development to be built 3 miles above the present Cazadero dam. The interurban line will be extended to facilitate the handling of materials at the new water-power development. It is planned to dam the Clackamas River to a height of 135 ft., which will fill the gorge for a distance of 6 miles. The dam will have a crest 650 ft. long. At the present time test drills are at work to determine the geological formation below the bottom of the gorge, and it is thought that work on the bed of the dam can be started in the fall of 1910. Power from this development will be delivered to Portland over high-tension transmission lines.

The water-power plant at Oregon City is now equipped with a 450-kw, 33-cycle, 10,000-volt generator, direct-connected to a 42-in. Victor vertical turbine, and there is an additional 60-in. Victor wheel which may be belted to this generating set. It is planned to install an additional 500-kw railway generator to be driven direct by the 60-in. wheel so that the two machines can be operated independently by the wheels or can be coupled together and disconnected from the wheels for operation as a motor-generator set.

The transmission lines, of which there are three between Cazadero and Portland, are operated at 30,000 volts potential. Between Portland and Oregon City there are also three lines operating at 10,000 volts, two of which are on the west side of the Willamette River, and the third on the east side parallel with the railway. From Oregon City current is transmitted at 33,000 volts to feed the substations of the Oregon Electric Railway which operates high-speed interurban lines extending 50 miles south and 22 miles west from Portland. These transmission systems are interconnected through transformers and are fed by steam power plants at Portland and the water-power plants mentioned.

SOUTH PORTLAND SUBSTATION

A large fireproof substation has just been completed at the intersection of First and Jefferson streets in the business district of Portland. The structure has a reinforced concrete frame designed and built according to the Kahn system. The concrete is filled in with brick panels enclosing the large window frames. The roof is supported by concrete trusses of 50-ft. span, and concrete girders carry a 20-ton capacity single-motor Niles-Bement-Pond crane serving the entire machinery and transformer floor. At one corner of the machine floor there is an opening 13 ft. x 12 ft. in size, through to the street level so that the crane can be used to unload machinery from wagons.

The South Portland substation serves as a distributing center for both railway and lighting current. Its main equipment comprises two 1000-kw, 33-cycle, 60-cycle frequency-changing sets, each made up of one 10,000-volt, 33-cycle motor and one 2300-volt, 60-cycle generator, and two 1000-kw General Electric rotary converters. The lighting equipment includes 10 tub transformers which furnish constant current for circuits of 4-amp magnetite arc lamps operating through a large installation of mercury arc rectifiers. All high and low-tension lines in and out of the building are carried in underground conduit. There are duplicate 10,000-volt buses for the incoming feeding current, and duplicate 2300-volt buses for lighting distribution.

NEW OFFICE BUILDING AND SUBSTATION

A new substation and office building for the accommodation of the operating organization of the Portland Railway, Light & Power Company is now nearing completion. This building is located at the corner of Seventh and Alder streets, and is nine stories high with a basement. The overall dimensions of the building are 100 ft. x 100 ft. A portion of the basement and first floor, 60 ft. x 100 ft. in size, is used as a railway and lighting substation. The load of the seven stories and the roof above the substation operating room is carried on steel trusses 11 ft. deep with a 60-ft. span. A part of the basement will be used as a storage battery room. That portion of the street floor not occupied by the substation will be subdivided into a general office for the lighting department, and the various other floors will be subdivided according to the needs of the executive and operating departments.

TRANSPORTATION FEATURES OF THE OREGON ELECTRIC RAILWAY

A LITTLE more than a year ago the Oregon Electric Railway was opened for traffic between Portland and Salem, Ore., 50 miles. Since that time an additional branch from Portland, 22 miles west to Forest Grove, has been put into service. This new 72-mile d. c. railway has a substantially built roadbed and a catenary-supported trolley. Multiple-unit trains are operated on frequent headway at high speeds, and the first year of operation has been remarkably successful, not only from a traffic standpoint but because of the clear record of the transportation department. Since the first public train was run in February, 1908, until August of the present year not a single passenger had been injured.

Strict adherence to the standard code of rules of the American Railway Association is the reason given for this clear record. Special care also is taken in the selection of men, and for these reasons it may be of interest to review some of the features of the transportation department of this road.

The operating organization of the Oregon Electric Railway is headed by Guy W. Talbot, general manager, to whom report George F. Nevins, the traffic manager and auditor, and C. A. Coolidge, superintendent. The master mechanic, road master and electrical engineer report to the superintendent, with the exception that the electrical engineer reports to the general manager on questions of policy. It will be noted that this organization scheme closely approximates that used by steam railways.

SELECTION OF TRAINMEN

In selecting conductors and motormen for either passenger or freight service the strict rule is followed that all acceptable applicants must have had previous experience with a steam railway operated under the American Railway Association rules, and also must show that their record in this service was satisfactory. In the electric railway organization a freight brakeman is next in line for promotion to a position as passenger car conductor. At the present time all of the motormen are experienced steam railroad locomotive engineers. Portland is an important steam railroad center and there is no scarcity of good men who are willing to leave the steam railroad service for work on the electric trains at the same or even less wages than they formerly received. The Oregon Electric Railway Company is a member of the American Railway Association.

When a man applies for employment in any part of the train, station, yard, signal or crossing service, he is given a thorough test of sight and hearing. Applicants for engineer or train and switching service are also given physical examinations by the chief surgeon of the company. The general questions on the application blank filled out by each applicant are similar to those used in good steam railroad practice. A schedule of the very thorough physical examination record made by the medical examiners is reproduced.

The rule book of the company includes all the American Railway Association rules for train operation that apply to electric railway service, and the rule numbers as used in the steam railroad standard rule book are retained in the rule book of the Oregon Electric Railway so that there may be no confusion, and so that the experienced steam railroad trainmen employed will be familiar with the location of each rule by number. Before accepting a conductor or a motorman he must satisfactorily pass an examination on rules, which includes 173 questions printed on a blank and arranged with

spaces for written answers. These questions refer to train signals, classification and movement of trains, movement of trains by train orders, and require the interpretation of various sample train orders.

After having passed the physical tests and the examinations on rules, the new motorman is put on a train with an instructor, who teaches him the important features regarding the operation of the electrical equipment and the control system, and gives him an opportunity to familiarize himself with the roadway. New conductors also are put on with old men and serve as assistants while learning the road, the tariffs and the methods of handling tickets and making the reports required by the auditing department.

New motormen are required to work a few days in the repair shop, and particularly to study the multiple-unit control system. After their knowledge of this part of the equipment meets with the approval of the master mechanic, and after the instructing motorman certifies to their ability to operate a train, the new men are given runs, but are kept under close observation a sufficient length of time to make the officials sure that each knows his duties.

TRAIN OPERATION

The telegraph system is used exclusively for transmitting train orders, unless this service is interrupted by some accident, when telephones placed in shelter sheds at the sidings may be

Short Trips—SALEM DIVISION—Oregon Electric Railway

Going leave PORTLAND	Returning arrive PORTLAND	DESTINATION And Miles from Portland	Time Required for Round Trip	ROUND TRIP FARE Saturdays Sundays	ROUND TRIP FARE Other Days	TIME At Destination Before Returning
8.50 AM	9.35 AM	GARDEN HOME....7 Miles	45 min.	$ .25	$ .35	Meet return train.
8.50 "	11 00 "	TUALATIN.....14 "	2 hours 10 "	.55	.75	52 minutes.
8 50 "	1.15 PM	SALEM.....50 "	4 " 25 "	2 00	2.75	55 "
9.55 "	11.00 AM	METZGER.....9 "	1 " 05 "	.35	.45	05 "
9 55 "	12 05 Noon	WILSONVILLE.....21 "	2 " 10 "	.80	1.15	10 "
9.55 "	3.05 PM	SALEM.....50 "	5 " 10 "	2.00	2.75	1 hour 10 "
2.00 PM	2.55 "	GARDEN HOME.....7 "	" 55 "	.25	.35	05 "
2.00 "	3.05 "	METZGER.....9 "	1 " 05 "	.35	.45	05 "
2.00 "	6 15 "	SALEM.....50 "	4 " 15 "	2 00	2.75	15 "
3.45 "	5.05 "	TUALATIN.....14 "	1 " 20 "	.55	.75	Meet return train.
3.45 "	6.15 "	WILSONVILLE.....21 "	2 " 30 "	.80	1 15	38 minutes.
3.45 "	8.20 "	SALEM.....50 "	4 " 35 "	2.00	2.75	35 "
6.20 "	8.20 "	WILSONVILLE.....21 "	2 "	.80	1 15	Meet return train
6 20 "	10.40 "	SALEM.....50 "	4 " 20 "	2 00	2 75	20 minutes

Short Trips—FOREST GROVE DIVISION—Oregon Electric Railway

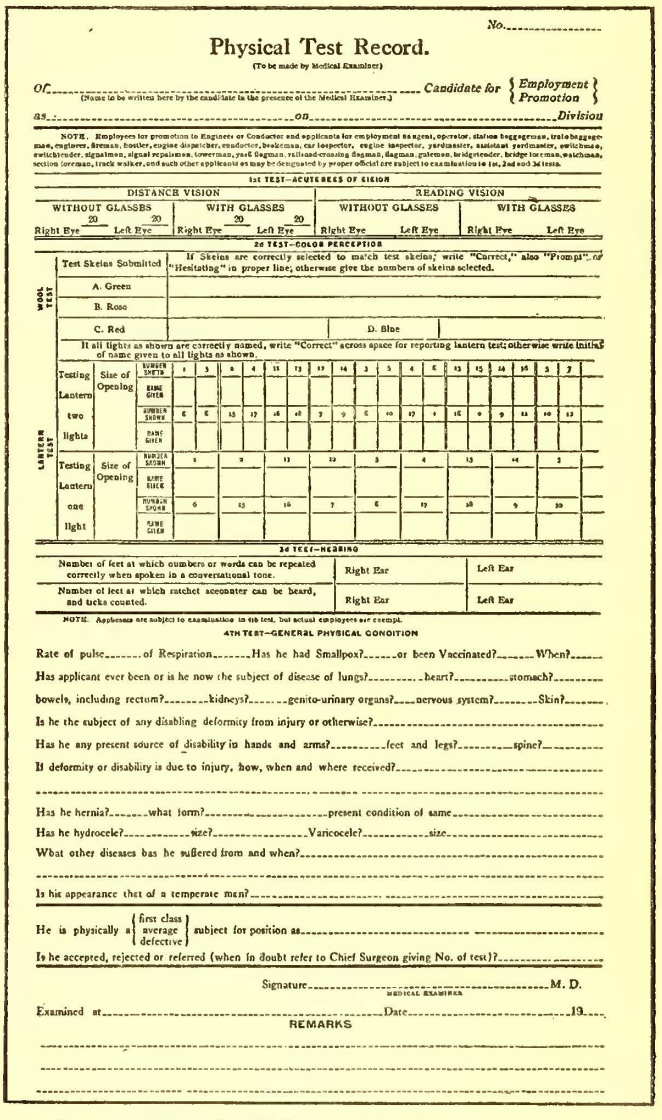
8.30 AM	9.35 AM	BEAVERTON.....10 Miles	1 hour 05 min.	$ .40	$ .55	Meet return train
8.30 "	11.25 "	FOREST GROVE...26 "	2 " 55 "	1.00	1.45	35 minutes.
10.10 "	1.30 PM	HILLSBORO.....20 "	3 " 20 "	.80	1.15	1 hour 30 "
10.10 "	1.30 "	FOREST GROVE...26 "	3 " 20 "	1.00	1.45	1 "
2 15 PM	4.35 "	HILLSBORO.....20 "	2 " 20 "	.80	1.15	30 "
2.15 "	4.35 "	FOREST GROVE...26 "	2 " 20 "	1.00	1.45	Meet return train.
2.15 "	4.35 "	ORENCO.....16 "	2 " 20 "	.65	95	47 minutes.
3.30 "	4.35 "	BEAVERTON.....10 "	1 " 05 "	.40	.55	Meet return train.
3.30 "	5.23 "	ORENCO.....16 "	1 " 55 "	.65	.95	18 minutes.
3.30 "	5.25 "	HILLSBORO.....20 "	1 " 55 "	.80	1 15	Meet return train.

Oregon Electric Railway—Advertisement Showing Possible Excursion Trips

used. Each freight caboose is equipped with a telephone set and a hook pole so that the dispatcher may be called quickly if the train becomes stalled between stations. Operators are on duty at 10 telegraph stations on the Salem division and at four stations on the Forest Grove division. A number of these telegraph stations are at power substations. Operators for power substation service are recruited from the steam railroad telegraph service, and their duties on the Oregon Electric Railway lines include the operation of both the substation and the handling of train orders. The Postal Telegraph Company uses the railway company's telegraph line, but by agreement the dispatcher always has first right to the wire.

The movement of trains past stations where operators are on duty is controlled by two semaphore blades—one for each direction—which are mounted on a high post in front of the telegraph offices. The semaphore blades are always set in the stop position except when right to proceed is called for by an approaching train. In approaching a station the motorman sounds four blasts of his whistle, and if there are no orders for his train the agent pulls the proper semaphore blade down to the "proceed" position. The motorman acknowledges this movement of the blade by two blasts of his whistle. Should a train come within sight of a station and find the semaphore blade in the proceed position, the motorman must stop and get clearance from the dispatcher, provided that the incident takes place while an operator is, or should be, on duty at that station. This rule, therefore, makes it necessary for the station agent to lower the semaphore blade only after a motorman has called for a proceed signal. The finding of a station semaphore in the proceed position (unless the motorman has seen it lowered) is considered an improper signal.

This method of blocking trains at each station where there is an operator on duty is thought to be as complete a manual block system as could be devised. If the operator does not handle his semaphore properly he is disciplined; for the first offence he is admonished, and for the second he is given demerits, according to the judgment of the superintendent. If a motorman runs his train by one of these station semaphores placed in the stop position or by an improperly displayed sig-



No._____

Physical Test Record.

(To be made by Medical Examiner)

Of_____ Candidate for { Employment / Promotion }

(Name to be written here by the candidate in the presence of the Medical Examiner.)

as_____ on_____ Division

NOTE. Employees for promotion to Engineer or Conductor and applicants for employment as agent, operator, station baggageman, train baggageman, engineer, fireman, hostler, engine dispatcher, conductor, brakeman, car inspector, engine inspector, yardmaster, assistant yardmaster, switchtender, signalman, signal repairman, towerman, yard flagman, railroad-crossing flagman, flagman, gatemen, bridgetender, bridge foreman, watchman, section foreman, track walker, and such other applicants as may be designated by proper official are subject to examination as to 1st, 2nd and 3d tests.

1st TEST—ACUTENESS OF VISION

DISTANCE VISION				READING VISION			
WITHOUT GLASSES		WITH GLASSES		WITHOUT GLASSES		WITH GLASSES	
20 / 20		20 / 20					
Right Eye	Left Eye	Right Eye	Left Eye	Right Eye	Left Eye	Right Eye	Left Eye

2d TEST—COLOR PERCEPTION

WOOL TEST

Test Skeins Submitted	If Skeins are correctly selected to match test skeins, write "Correct," also "Prompt" or "Hesitating" in proper line; otherwise give the numbers of skeins selected.
A. Green	
B. Rose	
C. Red	D. Blue

LANTERN TEST

If all lights as shown are correctly named, write "Correct" across space for reporting lantern test; otherwise write initials of name given to all lights as shown.

	Size of Opening																			
Testing Lantern two lights		RUBBER SMITH	1	3	8	4	11	13	19	14	2	5	6	8	13	15	16	18	3	7
		BAKE GIVEN																		
		RUBBER SHOW	6	6	13	17	16	18	3	9	6	10	17	1	12	6	9	11	10	12
		BAKE GIVEN																		
Testing Lantern one light	Size of Opening	RUBBER SMITH	1		9		11		20		3		4		13		14		2	
		BAKE GIVEN																		
		RUBBER SHOW	6		15		16		7		6		17		18		9		20	
		BAKE GIVEN																		

3d TEST—HEARING

Number of feet at which numbers or words can be repeated correctly when spoken in a conversational tone.	Right Ear	Left Ear
Number of feet at which ratchet accounter can be heard, and ticks counted.	Right Ear	Left Ear

NOTE. Applicants are subject to examination in this test, but actual employees are exempt.

4TH TEST—GENERAL PHYSICAL CONDITION

Rate of pulse_____ of Respiration_____ Has he had Smallpox?_____ or been Vaccinated?_____ When?_____

Has applicant ever been or is he now the subject of disease of lungs?_____ heart?_____ stomach?_____

bowels, including rectum?_____ kidneys?_____ genito-urinary organs?_____ nervous system?_____ Skin?_____

Is he the subject of any disabling deformity from injury or otherwise?_____

Has he any present source of disability in hands and arms?_____ feet and legs?_____ spine?_____

If deformity or disability is due to injury, how, when and where received?_____

Has he hernia?_____ what form?_____ present condition of same_____

Has he hydrocele?_____ size?_____ Varicocele?_____ size_____

What other diseases has he suffered from and when?_____

Is his appearance that of a temperate man?_____

He is physically a { first class / average / defective } subject for position as_____

Is he accepted, rejected or referred (when in doubt refer to Chief Surgeon giving No. of test)?_____

Signature_____ M. D.

MEDICAL EXAMINER

Examined at_____ Date_____ 19____

REMARKS

Oregon Electric Railway—Physical Test Record (Original 7 in. x 13 1-2 in.)

nal, the train crew is discharged. Thus the object of requiring the motorman to acknowledge the dropping of a station semaphore by two whistles serves the double purpose of advising the station agent that the signal is seen, and also notifies the conductor that the train has obtained the right to enter the next block. Rules 221 and 221-A regarding this method of blocking trains, as used by the Oregon Electric Railway, follow:

221. A fixed signal must be used at each train order office, which shall indicate "stop" when there is an operator on duty, except when changed to "proceed" to allow a train to pass for which there are no orders. A train must not pass the signal while "stop" is indicated. The signal must be returned to

"stop" as soon as a train has passed. It must be fastened at "proceed" only when no operator is on duty.

Operators must have the proper appliances for hand signaling ready for immediate use if the fixed signal should fail to work properly. If a signal is not displayed at a night office, trains which have not been notified must stop and ascertain the cause, and report the facts to the superintendent from the next open telegraph office.

Where the semaphore is used, the arm indicates "stop" when horizontal and "proceed" when in an inclined position.

221 (A). Clearance card (Form 0.1) will be issued to all trains stopped by train order signal, and will show numbers of orders, if any, for that train.

Enginemen in approaching a telegraph station, after whistling for station, if signal can be seen, will sound four short blasts of the whistle for "proceed" signal, and will acknowledge receipt of same by two short blasts of the whistle, and proceed, unless required to stop for other purposes. If "proceed" is not received, train must come to a stop and not proceed without a clearance card. If signal is at "proceed" when engineman comes in sight of it, he will not whistle for "proceed" but must stop and get a clearance.

Operators in changing position of the train order signal from "stop" to "proceed," should do so only when the movement can be seen by the engineman. If engineman fails to see the movement of arm or light, he must stop and not proceed until after receiving a clearance card. He must always instantly acknowledge the change in signal to "proceed" by two short blasts of the whistle.

Unless some form of block signals is used operators must space trains 10 minutes apart, using the train order signal for that purpose. They must show on clearance card time train will be allowed to depart.

Conductors and enginemen must respect time marked in clearance and follow preceding train as per rule 91.

DEMERIT SYSTEM

The discipline methods of the transportation department of the Oregon Electric Railway are based on an adaptation of the Brown demerit system with dischargeable offences, one of which is "violation of any rule that might cause accident, such as leaving a switch open or an operator overlooking an order." The bulletin regarding the conduct of this discipline system as distributed at the time of its introduction follows in part:

TO ALL EMPLOYES

1. On April 1, 1908, the system of "Discipline by Record" for permanent employes will be put in effect, and upon that date all employes will be considered as starting in with a clear record. As occasion demands an individual account will be opened with each employee, in a book kept especially for that purpose in the superintendent's office.

2. The objects to be attained under this system are
   (a) To avoid loss of wages by person employed;
   (b) To stimulate and encourage employees in the faithful and intelligent discharge of their duties.

3. Under this system a certain number of marks will be entered against the record of each employee for violation of the rules, etc., instead of suspension.

4. Each employee will be notified in writing of any favorable or unfavorable entry against his record; the reason therefor, and the number of marks given.

5. Whenever demerit marks are given a notice will be posted stating how many marks have been given and on what charge, but omitting name, date, train, or location.

6. When an employee's demerit marks have reached the number of 75, he shall be called in by the superintendent, duly cautioned, and advised that when his demerits amount to 100 he will be subject to dismissal from the service.

7. Such acts as disloyalty, dishonesty, desertion, intemperance, insubordination, willful neglect, gross carelessness, immorality, violation of the rules whereby the company's porperty is endangered or destroyed, making false reports or statements, or concealing facts concerning matters under investition, etc., will subject the offender to summary dismissal.

8. Credits will be given on the record, and may also be bulletined, for notably excellent conduct, deeds of heroism and loyalty, good judgment in emergencies, etc.; these special credits will be given full consideration in connection with any charge entered.

9. Employees will be allowed to examine their record at any time upon application.

10. The company reserves the right to discharge any employee under this system.

Merit and demerit marks are given according to the following schedule:

DEMERITS

Incompetent or unsatisfactory service	10–100
Disobedience of rules governing railroad crossings	10–100
Failure to report accidents	10–100
Smoking on duty (passenger crews)	10
Incomplete and poor accident reports	1– 20
Inattention to passengers	1– 10
Failure to show up or report for duty	10–100
Untidy condition of dress	5
Frequenting saloons	10– 50
Accidents when avoidable	10–100
Ungentlemanly conduct	5–100
Disobedience of orders	10–100
Gambling	50
Criticism of management of road	50
Talking about accidents to others than proper officers of road	20
Failure to report negligence or delay	2– 10
Failure to protect trains	10– 50
Failure to transfer orders	10– 50
Signals improperly displayed or failure to notice and answer signals	2– 50
Running ahead of schedule	10–100
Careless or indifferent operation of trains	5– 25
Backing train without proper signals and protection	10– 25
Injury to equipment caused by improper handling	10– 50
Failure to report trouble or any defects with car, roadway or overhead	5– 50
Acts detrimental to good service	3– 20

MOTORMEN'S SPECIAL DEMERITS

Running over circuit breakers with current on	1– 5
Allowing unauthorized persons to ride in cab	25
Headlight not burning according to rules	1–10
Failing to whistle or ring gong at proper places	10
Starting train without proper signals, except to avoid collision	10– 25
Exceeding speed limit within yard or city limits	5– 25
Flattening wheels except to avoid collision or accident	5– 20
Reversing car except to avoid accident	25
Failure to observe slow, stop, or caution signs	5– 50
Improper use of air	5– 10
Splitting switch	5–100
Using current with brakes set	5– 25
Running too close to wagons	5– 25
Leaving car without taking controller handle, throwing breaker and cutting out control	5– 25
Not obeying conductor's signals	25
Running ahead of time	10–100

CONDUCTORS' SPECIAL DEMERITS

Repeated mistakes in reports to auditor	5– 25
Inattention to passengers	1– 10
Bad judgment and carelessness in regulating heat or ventilators	1– 10
Carelessness in using hat checks	5– 25
Failure to cancel tickets	1– 10
Failure to make daily reports to auditor	1– 10
Failure to make daily remittance to bank	1– 10
Failure to hold trolley when necessary	5– 25
Failure to be supplied with tickets, reports and other necessary supplies	5– 25
Failure to give proper signals	5– 25
Failure to call stations or announce train stops at terminals	5– 25

MERITS

Warning persons in act of jumping from moving trains; thus preventing accidents	1– 25
Assistance rendered in case of accident such as to bring commendation from passengers	1– 25
Securing names and addresses of witnesses to accidents other than those on report	5– 25
Politeness and attention to passengers	1– 5
Reporting defects in equipment, track or overhead	1– 5
Complete and perfect accident reports	5– 10
Good judgment and work in case of wrecks, washouts, etc	5– 25
Neatness in personal appearance	1– 10
One month without demerits	5
For any meritorious act which in the opinion of the superintendent deserves recognition	1–100

MOTORMEN'S SPECIAL MERITS

Careful handling of car during previous month	5– 25
Good stop to avoid accident	5– 25
For bringing in defective car without delay to other trains	5– 25
Good judgment in using sander	1– 25

CONDUCTORS' SPECIAL MERITS

Handling boisterous, unreasonable or drunken passengers with tact and judgment	1– 25
Special attention to aged and infirm persons or children	1– 25
Perfect reports to auditor for one month	5– 25

SERVICE

Thirty-eight trains a day are operated in and out of Portland, including one limited train, which makes the run between Portland and Salem, 50 miles, in 1 hour and 30 minutes, or at an average schedule speed of about 33 miles an hour. The local trains make an average schedule speed of 25 miles an hour.

The maximum rate of fare charged for passage between Portland and Salem, and between Forest Grove and Gaden Home and intermediate points, is 3 cents per mile. However, a reduction of 5 per cent from this rate is allowed on daily return tickets which, in the form issued, permit the tickets to be used for two fares going in one direction. The company also sells 60-ride commutation books at 1 1/2 cents per mile. These books are valid for a period of six months

after date of issue, and may be used by any member of a family between points located within a radius of 16 miles from Portland. This latter plan has induced many families to build homes in the suburbs of Portland, and in several of the small settlements along this electric line. A rate of 1 cent per mile is made to school children. This transportation is issued in books of 46 rides, which must be used up in one month from date of issue. Mileage books good for 1000 miles are sold for $25. These books are valid only for the passage of their original purchasers. Week-end return-trip tickets good going on Saturday and Sunday and returning up to Monday night are sold at a rate of 2 cents per mile. When a fare is paid on the car an excess charge of 10 cents is made. A receipt for this excess charge is redeemable on demand at any of the company's offices.

In connection with the promotion of business for the Oregon Electric Railway, the traffic department has issued cards 3 in. x 5 1-2 in. in size, calling attention to the fast round-trip time that can be made between Portland and each of the more important towns on the two divisions. The reverse of one of these cards, which presents a number of possible trips and the time required to make them, and other information, is reproduced on page 551.

UNITED RAILWAYS OF PORTLAND

THE United Railways Company of Portland, Ore., is completing an interurban road 27.5 miles long, from Portland to Forest Grove. This line, of which 17 miles are in operation, traverses suburban territory of Portland along the bluffs on the west banks of the Willamette and Columbia Rivers for 14 miles, serving the towns of Whitwood Court, Linnton, Harborton, Miller's Station and Burlington. At Burlington the line turns west and passes through Helvetia, Glencoe and Centerville to Forest Grove, in Washington County. The territory tributary to this line is either timber land or is under a high state of cultivation for market gardening and farming. Freight terminals have been purchased in the steam railroad terminal district, at the north end of Portland, and plans are being made to handle heavy freight.

In building the roadbed the rugged nature of the country necessitated a comparatively large amount of excavation and filling. Along the river bluffs there are cuts from 50 ft. to 60 ft. deep and trestles from 90 ft. to 100 ft. high. The track is laid with 60-lb. rails and has maximum grades of 1 1/2 per cent and maximum curves of 4 deg. The rails are bonded with Ohio Brass Company's soldered bonds, which were put on with special care and mechanically tested after installation.

In addition to its interurban line the company has 10 miles of standard-gage track within the city of Portland. This track is laid with 114-lb. girder rails in streets paved with Belgian blocks and serves as a city entrance for the interurban line and also as a track connection for the steam and electric freight lines. At the present time the company is handling between 10 and 40 cars of freight each night. A new line, about 3 miles long, is being built to the suburb of Riverdale, south of the city.

The overhead construction of the new road includes No. 0000 grooved trolley, with side suspension, and Ohio Brass Company's overhead fittings carried on 40-ft. poles. The trolley is supplemented with a 800,000-circ. mil aluminum feeder cable. The 10,000-volt three-phase high-tension current is transmitted by No. 0 aluminum strand cables mounted on the tops of the trolley poles and carried on Locke porcelain insulators tested to 14,000 volts. This line feeds a substation 8 miles from Portland with one 250-kw motor-generator set of Westinghouse manufacture.

The rolling stock equipment for the operation of that portion of the line now completed includes four 60-ft. interurban coaches, built by the American Car Company, at St. Louis, two open trailers and one Westinghouse-Baldwin electric locomotive. The interurban coaches have four Westinghouse 75-hp motors carried on Baldwin trucks and Westinghouse electro-pneumatic control. The locomotives have motors rated at a total of 440 hp. Another Westinghouse-Baldwin freight locomotive of 600-hp motor capacity is now under construction and soon will be added to the rolling stock equipment of this road.

ELECTRIC RAILWAYS OF SAN FRANCISCO AND ITS ENVIRONS

OPERATING FEATURES OF THE UNITED RAILROADS OF SAN FRANCISCO

SO much has been written of the severe trials through which San Francisco and its electric railway system have passed during the last three years that the history of the rapid reconstruction following the earthquake and fire and the quick resumption of normal service following the strike of 1907 need not here be repeated. The present article will treat of extensive power-plant improvements now under way, the most recent and interesting features in track construction and the methods used in the employment of platform men.

POWER SUPPLY

At the present time the company is operating two generating stations and purchases power from power supply companies with transmission systems fed from water-power and gas-engine driven generators. The railway steam plants are known as the North Beach and the Bryant Street stations. During the past summer the United Railroads of San Francisco purchased control of the water-power property of the Stanislaus Electric Power Company, and a contract between that company and the United Railroads has been made whereby the Stanislaus Company will soon furnish all the power required for the operation of the railway systems in San Francisco.

The present plant of the Stanislaus Company includes four 6700-kw generators, driven by Pelton wheels operating under a 1500-ft. head. The output of this station, which is located in the Sierra Mountains, 140 miles east of San Francisco, is to be carried at 110,000 volts over a steel tower transmission line extending to the city limits of San Francisco, where the voltage will be stepped down to 11,000 volts, three-phase, 60 cycles, for distribution to the substations of the United Railroads and to other users. The ultimate capacity that can be developed by the Stanislaus property is 60,000 hp. The operating contract between the railroad and the power company provides for a purchase rate of about $30 per hp-year, and the railroad company expects to use an average of 20,000 hp. Sanderson & Porter, New York, are the consulting engineers for this extensive hydraulic development. In the operating contract between the two companies it is provided that the power company shall operate the steam stations now owned by the railway company. These stations are to be used for relay and emergency service.

The new power supply, with its 60-cycle current, will make advisable changes in the substation equipment heretofore operated by the railway company. The four substations, known as Turk and Fillmore, Bryant Street, Geneva Avenue and Millbrae, are now equipped with 25-cycle rotary converters. Motor-generator sets will be substituted for these units. The motor end of the new sets will operate on 11,000-volt, 60-cycle current without the use of substation transformers. Most of these motors will be of the synchronous type, although a few of the units will be driven by induction motors to provide against hunting. The generating ends of the motor-generator sets will each have a capacity of 1500 kw.

NORTH BEACH POWER STATION

The North Beach power station was completed during the summer of 1903, and carried the entire alternating-current load generated by the railway company until the time of the earthquake in 1906, when service was interrupted. Directly after the earthquake, which severely damaged the building and stack, but not the boilers or generating machinery, emergency repairs were made so that power could be obtained quickly. Since that time the permanent reconstruction has proceeded until now the station is in better condition than ever before. The reconstruction work included the addition of a 6-ft. top on the original side walls and the erection of a new roof. The height of the building was increased to permit the installation of a 50-ton Morgan crane, which now serves the entire engine-room floor. Originally the boiler-house stack, which was built of brick, was 150 ft. high. This stack is 10 ft. in diameter. The top half of the stack fell at the time of the earthquake and a new cap has been put on at a height of 78 ft. It is said that the short stack is of ample height to afford good draft for the boiler plant now that oil is burned for fuel.

The equipment of the boiler plant includes 14 B. & W. boilers, the waste gases from which are passed through Green fuel economizers into a single large concrete breeching. There are eight 500-hp boilers with 4-in. tubes, 21 wide and 12 high, and six 600-hp boilers with 4-in. tubes, 21 wide and 14 high. California crude petroleum is used as fuel. This is held in a 30,000-bbl. storage tank and two 20,000-gal. auxiliary tanks, which are fed from either of two oil supply companies' underground piping systems.

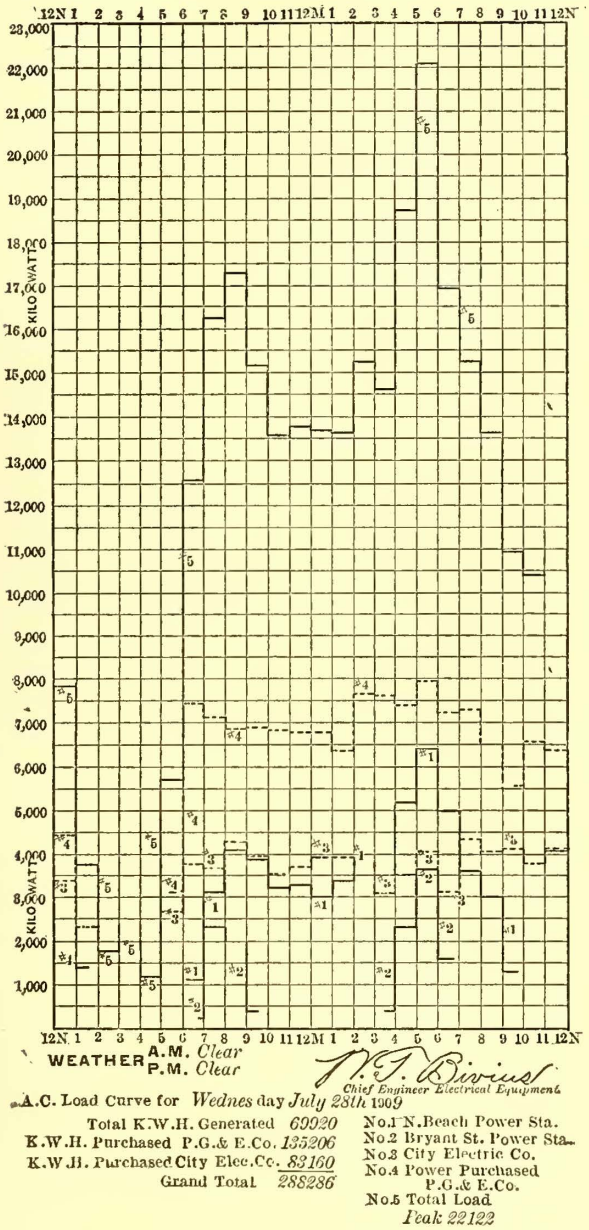
The engine-room equipment includes two three-cylinder Union Iron Works marine type engines, each driving two General Electric 1200-kw, 13,200-volt, three-phase alternators at 136 r.p.m. and a five-stage Curtis turbine of 5,000-kw capacity, which operates at 750 r.p.m., generating 13,200-volt, 25-cycle current.

Vacuum for the turbine is maintained by a Wheeler condenser with motor-driven, wet-vacuum pumps and circulating pumps handling sea water. The motor which drives the circulating pump is a three-phase General Electric induction unit of 200-hp capacity. The condensers for the reciprocating units are supplied with circulating water by engine-driven pumps, which are piped, however, so that they can be used as auxiliaries for the turbine equipment. The supply of circulating water is drawn from San Francisco Bay through two large cast-iron suction lines. An emergency supply tank provides sufficient water to prime these pipes three times in case the vacuum is lost, and a small air pump also serves to pick up the water if needed. Make-up water for the boilers is drawn from the city system, and the exhaust from the turbine condenser is passed through a Warren-Webster heater for boiler feeding. The boiler feed pumps are located in the basement and include three steam-driven and two motor-driven units. The fire-pump supply lines are fed with salt water.

An interesting part of the electrical equipment of this plant

is a 4000-kw phase-changing machine, which handles current from a long-distance transmission system operated at 60 cycles and delivers it to the railway company's substation transmission system. This phase-changing unit also operates in parallel with the 5000-kw Curtis turbine generator. The unit, which was built by the General Electric Company, is a four-bearing machine receiving 11,000-volt, 60-cycle current and delivering 13,200-volt, 25-cycle current to the railway company's a.c. substation feeders.

A daily load chart is presented showing the normal load



United Railroads of San Francisco—Typical Daily A.C. Load Curves

curve and the sources of the proportionate amounts of power which go to make up the total curve.

Views are presented on Plate XXXIV, showing the interesting method of handling the heavy machinery recently installed in this plant. Use was made of a steam railroad wrecking crane for handling a heavy armature, and the heavy parts of the largs Curtis turbine were delivered on a lighter at the beach directly in front of the plant and moved into the building on rollers.

The United Railroads of San Francisco now operate about 270 miles of standard-gage track, including 14.7 miles of cable track. An interesting part of the track reconstruction work in San Francisco, which has been steadily progressing since the spring of 1906, was the relaying of the double-track line on Market Street, the main business artery of the city which leads from the ferries through the retail district. A description of a portion of this work was published in the ELECTRIC RAILWAY JOURNAL for Jan. 18, 1908, page 68. The article described the general methods of track construction in San Francisco following the earthquake, and illustrated, among other things, some of the features of the reconstruction and track elevation work at the lower end of Market Street, near the ferry.

In March and April of this year the track in that part of Market Street which carries the heaviest traffic was entirely rebuilt for a single-track distance of 9420 ft. with 141-lb. rails in the short period of six weeks. This work was done by contract at a cost of $6 per running foot, exclusive of the asphalt paving. On account of the heavy traffic the asphalt surface which was put in by the city was laid 2 in. thick on 1 in. of binder. The accompanying views, taken during the process of this track construction, presented on Plate XXXIII, illustrate the several stages of this work. One view shows an electric crane raising the old cable yokes imbedded in the concrete of the existing track. When these yokes had been pulled out the concrete was broken with hammers or put through a crusher. Then it was replaced and releveled to form a foundation bed 2 ft. deep. The wooden ties were ballasted with 8 in. or 9 in. of broken stone covered with a 1:3:6 mixture of concrete to support the gage blocks and asphalt surface.

A unique piece of track work is presented in one of the illustrations on Plate XXXIII, showing a cable track with its built-up yokes and deep foundation of concrete being moved to a new location in the same street and having its elevation raised about 3 ft. without disturbing or interrupting the operation of the cars. This work was made necessary on account of a change in the street grade extending for about four blocks along Clay Street. In carrying out the work, which was done with company forces, the cable track and its massive concrete foundation, tied together with structural iron conduit yokes, was lifted in lengths sufficient to give the 3-ft. rise in about 100 ft. of length and temporarily supported on blocking. Short screw jacks were used for lifting, and as soon as the body of concrete and steel had been blocked to its final surface the space beneath was refilled, thoroughly tamped and flushed. This work was completed more than a year ago, and there has been no perceptible settlement.

EMPLOYMENT METHODS

Immediately after the strike of 1907 it was necessary to hire as many as 100 new men each day, including Sunday, but as soon as the schedules had all been filled the requirements for admission to service were raised and the regulations for hiring, training and disciplining employees were placed on a high basis. A bureau has been established for obtaining and keeping complete employees' records for the use of the transportation department. A part of the work of this bureau is the investigation of all local references given by new men. The bureau is under the direct charge of the superintendent of employment who has sufficient clerical assistance to carry on the work of investigating the characteristics of applicants and keeping up the photographic and record files of all men in the service.

Applicants for work are received by the superintendent of employment only on Tuesday of each week. The superintendent talks with each man and takes the references offered by

the most acceptable looking candidates. New men must be between 5 ft. 6 in. and 6 ft. 2 in. tall and be more that 21 and less than 40 years of age.

As the men stand in line awaiting their turn to meet the superintendent of employment each one is asked to fill out a skeleton reference card, which is handed to the superintendent as the man is admitted to the office. These cards are printed on heavy manila paper cut 7 in. long by 4 in. wide and punched at one end for insertion in a loose-leaf binder. The following information is required to make the card complete:

Name	Former employer
Address	Former rate of pay
Position wanted	Why did you leave
Past occupation	Age

If the superintendent should employ a man with whose qualifications he is acquainted and thus forego the customary

M 574—11-16-08-1M

Application No. Rule Book No.

United Railroads of San Francisco

Signature of Applicant

Superintendent will please verify this signature before placing applicant on car

190

Mr. Supt.

Place bearer Badge

whose signature is above on your lines to learn the duties of Motorman.

General Superintendent.

Instructed by

(Motormen instructing students will sign below)

DAYS	
	Badge
	Badge
	Badge
	Badge
	Badge

This is to certify that I have received the necessary instructions from the above named employees and thoroughly understand the duties of the position of Motorman as required by the rules of the Company.

Name,

Date,

I believe the above named applicant to be competent to perform the duties of Motorman, have examined and found him familiar with instructions and book of rules.

Division Superintendent.

Date,

To be returned to office of General Superintendent, in envelope, with order for Buttons.

United Railroads of San Francisco—Instruction Record Card (Original 3 3/4 in. x 8 3/4 in.)

inspection of references, he advises the chief clerk of the employment bureau of his action by sending him a small announcement slip, 3 in. x 4 in. in size, bearing the date, name of the new man, time appointed, car house to which he should be assigned, by whom recommended and any pertinent remarks necessary. This information is followed by the signature of the superintendent of employment before filing.

REFERENCES

After an applicant has been approved by the superintendent he is handed a four-page application blank which must be filled out in ink in his own handwriting in the presence of the clerk of the employment bureau. The completeness of this blank is an index of the thoroughness of the methods used in examining new employees. The general wording of the blank is reproduced in the opposite column.

After the application blank is filled the applicant is given an order requiring him to present himself at the hospital department for physical examination by the company's surgeon. If his physical condition is satisfactory the applicant is sent to the company's photographer with a blank requesting that four photographs be taken and sent to the employment de-

APPLICATION FOR EMPLOYMENT

To be answered in applicant's own handwriting
Use Ink

1. Applicant's name in full (no initials) .....
2. For what position.....
3. Where born, City (or Town) of.....
   State (or Kingdom) of .....
4. Date of Birth.....Month.....Day.....Year
5. Trade or occupation.....
6. Married, Single or widower.....
7. No. in family.....
8. General Appearance.....
9. Color of eyes.....
10. Color of hair.....
11. Weight .....lb.
12. Height .....feet.....inches
13. Complexion .....
14. Special Remarks: .....
15. Present address, No.....City of.....
16. Are any persons depending on you for support? If so, who? .....
17. With whom are you living?.....
18. How long have you resided at your present address?.....
19. Where did you move from to that place?.....
    No. .....City of .....
20. How long did you reside there?.....
21. How long have you resided in San Francisco?.....
22. By whom were you last employed?.....
23. Employer's address, No.....City of.....
24. Employer's business .....
25. How long in their employ? From.....to.....
    At what wages? .....
26. By whom were you previously employed?.....
27. Employer's address, No.....City of.....
28. Employer's business .....
29. How long in their employ, From.....to.....
    At what wages? .....
30. How long have you been out of employment? .....
31. Where does your parent or nearest relative now reside?
    Name .....
    No. .....Street or Avenue, City of.....
32. How is this person related to you?.....
33. To what extent do you use liquors (either wines, spirits or malt) as a beverage? .....
34. Were you ever injured? If so, state, when, where and nature of injury? .....
35. Have you ever been employed on any steam railroad or any electric, cable or horse railroad in any capacity? If so, state where, on what roads and in what position, length of service, and cause of leaving service, in each case.....

The persons whose names and addresses are given below are offered as references as to character, etc., by the applicant. Applicants will please bear in mind that the willing endorsements of persons well known in the community are the best possible references, but the endorsement of persons acquainted with applicant are more valuable in this connection than the unwilling endorsement of some one more prominent, who is acquainted with him.

(The original blank contains space for four references with lines for the Name, Business, Street No., City and State of each.)

N. B.—The applicant is cautioned that inasmuch as the references on this paper will be called upon for such detailed (written) information as to ability, industry, character, habits, etc., as they can give, he should be careful to secure those who know him well, especially in his occupation, and who will be willing to furnish such information in greater detail when asked. A failure to so furnish it promptly will be deemed a refusal, and will be necessarily a disadvantage to the applicant, and no statement in lieu of it will be accepted under any circumstances.

In consideration of my receiving employment from the United Railroads of San Francisco, I hereby agree that I will faithfully perform all of the duties and fully comply with all of the Rules and Regulations now existing, or which may hereafter from time to time be prescribed by the United Railroads of San Francisco for the government of its employees.

I further agree that my employment with the said Company may be terminated by it on any day or at any hour, by either written or verbal notice from the Company, its General Manager, General Superintendent, or other officer of said Company under whom I may be working.

I decline to accept the benefit of the provisions of the Act of February 27, 1893, California Statutes, of 1893, page 54, providing for a day of rest from labor, and I request permission to work my full time each month; being satisfied with such relief from work as said Company may allow. And I expressly understand and agree that the amount paid me for each month's or week's service shall be in full for all my services during such month or week, as the case may be.

IMPORTANT—I hereby guarantee the truth of the above answers made by me to the foregoing questions, which constitute the basis of my employment. And it is expressly understood that the United Railroads of San Francisco may summarily dismiss me from its service if at any time it be ascertained that I have concealed the truth or made false statements in any of the above answers.

I hereby declare that I have carefully read all of the foregoing application.

Witness my hand this.....day of 190

Signature of Applicant.....

Letters of recommendation must be handed in with this application, to remain on file with the Company. Applicants with such recommendation are given preference.

partment. A note at the bottom of the order for photographs says: "This company is in no wise to be responsible for or charged with the cost of the above-mentioned photographs." The applicant pays the photographer 50 cents for this work and he pays the doctor $1 for the physical examination. The photographs include two copies each of full face and profile portraits of the head.

If the bureau of employment finds that the references of the applicant are satisfactory and if the man is approved by the surgeon, he is next given an instruction record card and sent to the general superintendent's office for approval and assignment to instruction service on a particular division. These instruction cards are 3 3-4 in. x 8 3-4 in. in size, printed on heavy manila stock and bearing the information as reproduced herewith. When the new man is assigned to a division for instructions, if a motorman he deposits $2.50 for a badge and buttons and if a conductor $5 for his badge, buttons and punch.

INSTRUCTION SERVICE

When a conductor has successfully proceeded thus far he is taken in hand by an instructor who delivers to him a course of lectures and oversees his breaking-in service of seven days on the car platform. Next the student is carefully examined by an inspector or the car dispatcher as to his ability and knowledge, not only of operating his car, but of making out reports, punching transfers and other necessary duties. Then he is questioned by the superintendent and after approval he is instructed to report to the car dispatcher for work.

When a motorman receives his assignment for preliminary instruction he is given a card filled out by the instructor of motormen, authorizing him to report at a certain car house for preliminary instruction and to return later for a final examination. The preliminary instruction period covers seven days in a school equipped for training men in the handling of their cars and in emergency work. The schoolroom equipment includes a skeleton car with complete running gear so that the wheels may be operated and the brakes used. After instruction in this school the student motorman must pass a written examination before he is assigned to an instructing motorman with whom he gets his first experience on the road. When he has successfully passed his written examination the student is assigned to a car house and there the division superintendent puts him on a car to break in with an experienced motorman for seven days. As soon as the motorman declares the student to be competent he returns to the school instructor for his final examination, which includes the answering of 82 questions on car operation. If this examination is satisfactory and if he can also satisfy the division superintendent who questions him that he is competent to operate his car, he is then assigned to the extra list. Particular care is taken to keep the extra list within such limits that all men get on a car once each day. The rate of pay for new men is 25 cents an hour, increasing by one cent a year to 33 cents per hour.

Several of the blank forms used by the employment bureau are of interest on account of their completeness. One of these blanks, an identification card, is the brief statement of the employee's distinguishing characteristics. On each of these cards a photograph is pasted and before a new man is approved for work each division superintendent must have noted on the card whether or not he recognizes the portrait of the new man. After this card has been filled out it is filed with the discipline record.

REFERENCE BLANKS

The reference blank sent out to previous employers is an imitation typewritten letter asking for the usual information. A more extensive reference blank is sent to those given as character references. This blank contains a list of 16 questions regarding the applicant's characteristics.

The discipline records of all employees are kept in a card index at the office of the general superintendent. These record cards are 9 in. x 6 in. in size and ruled on white cardboard as shown. Each new employee is required to sign a copy of the following agreement:

THIS AGREEMNET, WITNESSETH:

That ....., party of the first part, has made application to the UNITED RAILROADS OF SAN FRANCISCO, party of the second part, to be employed as .....upon its cars, and in consideration of his employment agrees, as follows:

1. To honestly and faithfully perform the duties of said position so long as he shall be continued in that employment, and to obey and fully comply with all the rules and regulations now existing, as well as those which may from time to time be prescribed by the company for said position on its cars.

2. If for any reason he shall be suspended from the employment of said company, he shall not be entitled to any compensation during such suspension.

3. When his employment with said company ceases, he will at once return to said company any badge, buttons or other property of said company, in his possession; and that any wages due him from said company, when his employment under this agreement shall terminate, shall be retained by said company until all of said property is returned by him to said company.

4. That the term of his employment shall be during the pleasure of the company and no longer.

As a part of the consideration of this agreement, it is further agreed that the party of the first part is not now a member of any division of the Amalgamated Association of Street and Electric Railway Employees of America, or any other similar organization, society or association, and will not during his employment with said company join any of said divisions, or any other similar organization, society or association, wthout first notifying said company of his intention so to do.

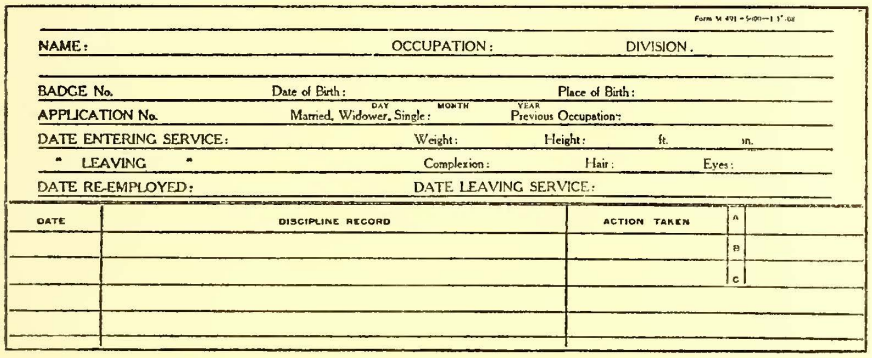
First party further declines to accept the benefits of the provisions of the ACT of 1893 of the Legislature of the State of California providing for a day of rest from labor, and requests permission to work his full time each month, being satisfied with such relief from work as the company may allow.

This agreement is freely and voluntarily entered into by first party, and he is not acting under coercion or compulsion of said company, or any of its agents, officers or other persons on behalf of said company.

IN WITNESS WHEREOF, first party has hereunto subscribed his name and the said UNITED RAILROADS OF SAN FRANCISCO have caused these presents to be subscribed by their General Manager this.....day of ....., One Thousand, Nine Hundred and .....

.....

UNITED RAILROADS OF SAN FRANCISCO,
By CHAS. N. BLACK,
General Manager.


NAME: OCCUPATION: DIVISION.

BADGE No. Date of Birth: Place of Birth:

APPLICATION No. Married, Widower, Single: (DAY MONTH YEAR) Previous Occupation:

DATE ENTERING SERVICE: Weight: Height: ft. in.

" LEAVING " Complexion: Hair: Eyes:

DATE RE-EMPLOYED: DATE LEAVING SERVICE:

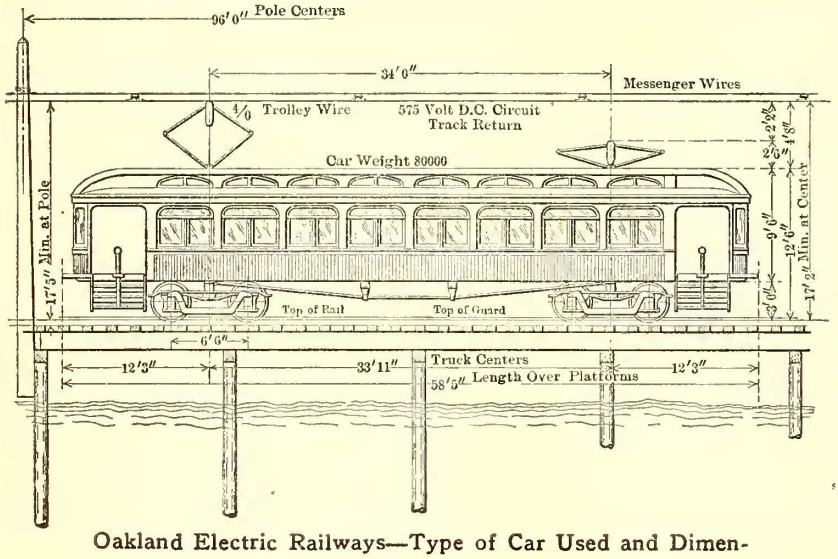
DATE	DISCIPLINE RECORD	ACTION TAKEN	
			A
			B
			C

United Railroads of San Francisco—Service Record Card
(Original 9 in. x 6 in.)

Employment of men for car service, according to the methods here outlined, has materially assisted in improving the electric railway service in San Francisco. The thorough training given the new men serves greatly to lessen the probability of accidents. Also, discipline is maintained much more satisfactorily with the assistance of a complete set of records which shows all the essential information required in selecting men, together with their records while in service.

OPERATING AND CAR-BUILDING METHODS AT OAKLAND, CAL.

THE Oakland Traction Company and the San Francisco, Oakland & San Jose Consolidated Railway are two entirely independent organizations, but the two railways serve the same population—one with a fast interurban and frequent ferry service leading to San Francisco, and the other with local and suburban street railway service. While these two properties are separately owned, their railways are operated by the one staff. The San Francisco, Oakland & San Jose, commonly known as the "Key Route," has 32 miles of track extending from a pier terminus 3 miles from shore in San Francisco Bay to five population centers in Oakland and Berkeley. The important parts of the road are double tracked and laid with 70-lb. rails on a private right-of-way. The Oakland Traction Company has 199.49 miles of track and also serves the cities of Oakland, Berkeley and Alameda, all of which are located on the east shore of San Francisco Bay. The total population served by the two roads is about 350,000. An extension of the "Key Route" to comprise about 4 miles of track in the fast developing suburban territory north of Berkeley, is now under way.



Oakland Electric Railways—Type of Car Used and Dimensions of Pier Structure

The Oakland Traction Company operates 230 cars in its street railway service and the "Key Route" has 62 large interurban-type cars and is now constructing 16 70-ft. coaches for operation in connection with its train service to and from the San Francisco ferries. The tracks of the Oakland Traction Company have lately been reconstructed from narrow-gage to standard gage, so that the roadbed throughout is in excellent condition. Power for the operation of the Oakland Traction Company's cars is purchased from the Pacific Gas & Electric Company, which took over the old power plants of the traction company and supplies current through substations fed by a high-tension transmission system.

The pier terminal of the "Key Route," 3 miles from shore, includes a four-track passenger station, terminals for two ferry boats and a four-track storage and switching yard, all supported on piling. An interlocking tower near the end of the pier controls the switches for the terminal yards. The company owns five large ferry steamers which run on 20-minute headway between the Key Route ferry terminal and the Market Street terminal in San Francisco. These steamers were built in Oakland. As the boats arrive at the ferry terminal each is met by four trains of from four to eight cars. The passengers step from the ferryboat directly into the train shed and quickly load into their respective trains, which pull out one after the other and traverse the 3-mile pier to shore, where their routes divide, one each going to Berkeley, Claremont, Piedmont and Broadway. The service to the boats is operated in the same manner, and every 20 minutes a train from each of the four main divisions passes onto the pier and out to the terminal to meet a ferryboat leaving for San Francisco. The pier terminal is 2.7 miles from San Francisco and the fare between any station on the "Key Route" and San Francisco is 10 cents. The fare between stations on any branch of the "Key Route" is 5 cents. The company has a number of attractive terminals and way stations where tickets are sold. Ohmer fare registers are used in the collection of all fares.

ROLLING STOCK

The present standard type of motor car operated in the "Key Route" train service has either two or four motors. The four-motor cars weigh 80,200 lb. and the two-motor cars weigh 72,000 lb. Both car bodies are the same and seat 68 passengers. The motors are GE-66, with type M control, and trains are so made up of motor cars and trailers that there is a capacity of at least one motor per car. The four-car trains operate at speeds up to 35 m.p.h.

The motor equipment used in this service has had a clear record for five years. It is stated that although all of the "Key

CAR EQUIPMENT		
Car No. 334	Type Motors GE 70-A-4	Trolley #6
Motor Truck M.C.B-20	No. " 4	Size 6"
Builder O.T. Co.	Control K-6	
Wheel Base 6'-0"	Cir. Breeker M.R.5	
Wheels 34" MID TIRE + C.I. C.S.	Fuse	
Axles 5" × 9'-0"	Resistance C.G.	
Trail Truck "	Main Switch "	
Builder "	Brakes AIR + HAND WHEEL	
Wheel Base "	Compressor NATIONAL - A4	
Wheels "	Governor " TYPE N	
Axles "	Engineer's Valve " SLIDE	
Brake Shoes (S) S.B	Brake Cyl. 8"	
Ref. Drawings No. 4522	Air Signa.	
	Whistle	In Service 4-3-09.

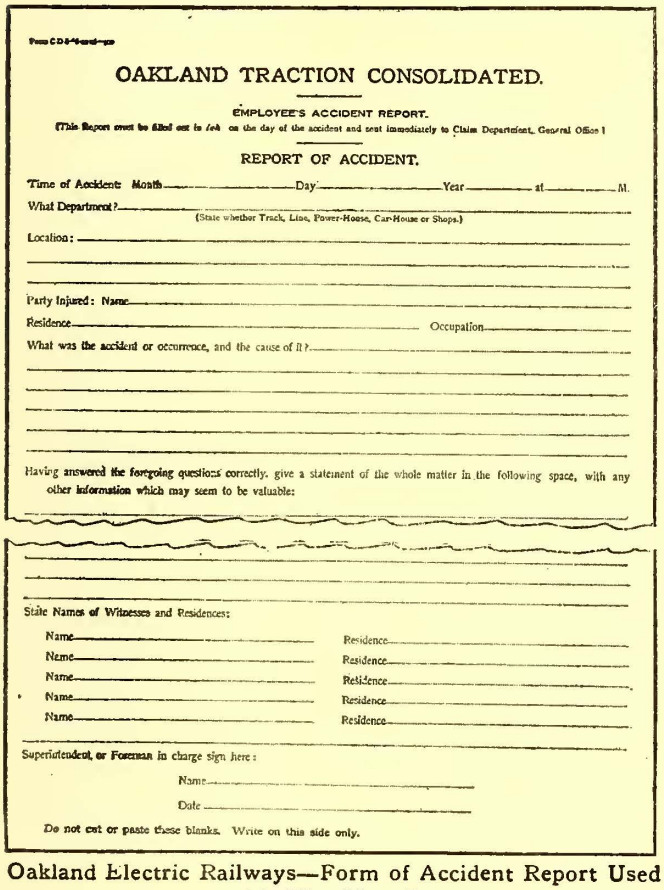
Oakland Electric Railways—Blank Presenting Record of Car Equipment

CAR BODY RECORD		
Car No. 334	Wt. Car Body 22560	Width over Steps 9'-0"
Original No. "	" with Trucks 27440	" " Roof 9'-0"
Type CLOSED - 2 SEC.	" Complete Eqd., 50,000	" " Deck 5'-10"
Class L1	Length Body 34'-6"	" " Sesh Rail 9'-0"
Builder O.T. Co.	" Open Sec.	" at Sills 8'-10"
Year Built 1909	" Platforms 5'-2"	Number Steps 1
How Acquired	" over Couplers 48'-2"	Length " 4'-4"
Date "	Height of Body 9'-8"	Brake NATIONAL AIR & HAND
Rebuilt	" Roof from Rail 12'	Couplings
Date	" Floor " "	Fenders STANDARD
Drawing No. 4922	" Coupler from Rail 2'-7½"	Headlight MOSHER ARC
Disposition	Truck Centers 22'	Signs STANDARD
	Wheel Base 28'	Trolley #6

Oakland Electric Railways—Blank Presenting Record of Car Body Details

Route" motor cars are equipped with GE-66 motors, neither a field nor an armature has burned out since operation started. Some of the brushes have been in service for more than two years. The commutators of these motors are slotted and the type of brush used is a high-grade quality manufactured either by the Speer Carbon Company or the General Electric Company.

Current for the operation of trains is collected from an overhead wire by means of the Brown pantograph roller trol-



OAKLAND TRACTION CONSOLIDATED.

EMPLOYEE'S ACCIDENT REPORT.

(This Report must be filled out in full on the day of the accident and sent immediately to Claim Department, General Office.)

REPORT OF ACCIDENT.

Time of Accident: Month ..... Day ..... Year ..... at ..... M.

What Department? .....
(State whether Track, Line, Power-House, Car-House or Shops.)

Location: .....

Party Injured: Name .....

Residence ..... Occupation .....

What was the accident or occurrence, and the cause of it? .....

Having answered the foregoing questions correctly, give a statement of the whole matter in the following space, with any other information which may seem to be valuable:

State Names of Witnesses and Residences:

Name ..... Residence .....
Name ..... Residence .....
Name ..... Residence .....
Name ..... Residence .....
Name ..... Residence .....

Superintendent, or Foreman in charge sign here:

Name .....

Date .....

Do not cut or paste these blanks. Write on this side only.

Oakland Electric Railways—Form of Accident Report Used with Wrecking Car

ley. The roller for this trolley, which is held against the wire by a spring-actuated pantograph, is a brass cylinder 5 in. in outside diameter and 1-8 in. thick. The pantograph has a vertical movement suitable to accommodate the rise and fall of the trolley wire between the limits of 14 ft. and 22 ft. above the rails. This type of trolley requires little attention, and the brass cylinders show an average life of about nine months on cars making 250 miles a day.

POWER STATION

The power station which furnishes current for the operation of all of the "Key Route" trains is located close to the right-of-way near the shore of San Francisco Bay. This station lately has been enlarged. It is an attractive brick structure, and its interior presents a unique arrangement in that there is no dividing wall between the boiler and the engine room. The generators are all General Electric d.c. railway-type machines direct driven by Corliss engines. These units include one 850-kw generator and Pennsylvania Iron Works engine; one 600-kw generator and St. Louis Corliss engine, and two 1600-kw generators with Hamilton Corliss engines. The battery of Babcock & Wilcox boilers which furnishes steam for the engines is fired with fuel oil drawn from either of two 35,000-gal. steel tanks located in the power station yard. An important part of the power station equipment is a 1500-amp hour Electric Storage Battery Company's chloride accumulator, which serves a very useful purpose in furnishing "peak" current when several long trains are operating close together on their way to the ferry terminal.

A system of identification colors for all pipe lines in the power station, shops, steamers and plants of the "Key Route" and Oakland Traction Company is consistently followed out, and when familiar with this scheme it is easily possible to tell the part of the piping system to which any section of pipe is connected by means of its identifying color. The accompanying table shows the colors for piping and pipe fitting used for the various pipe-line services.

CAR-BUILDING AND REPAIR SHOPS

All of the car-building and repair work for both the Oakland Traction Company and the "Key Route" is done at the Emeryville shops of the Oakland Traction Company. These shops are located on the main line of the "Key Route," close to one of the principal city lines of the Oakland Traction Company. The shop buildings are constructed of structural steel frames covered with corrugated iron. The group of buildings includes a machine shop, carpenter shop, erecting shop, foundry, blacksmith shop, storehouse, paint shop, and car house. Cars may be handled in and out of the buildings either on a transfer table or by switch tracks.

In connection with the extensive foundry work necessary in making all car parts, a Schwartz 60-in. melting furnace recently has been installed in the iron foundry. This furnace is charged by means of a special carriage designed and built in the company's shops. The carriage is supported on two pairs of wheels, so that it may be moved along a track extending from the pig-iron storage space outside of the foundry to the mouth of the furnace within the building. The charging car is built of structural steel and has a charging hopper which ordinarily rests in a horizontal position while being loaded, or

PIPE LINE IDENTIFICATION COLORS

Pipe Lines	Colors of Pipe	Colors of Bands, Couplings, Flanges, Valves or Fittings
Steam, 100 lb. and over	White	White.
Steam, 100 lb. and less	White	Black.
Steam, atmosphere for heating, etc	White	Aurora red.
Exhaust to condensers	Buff	Buff.
Exhaust to atmosphere	Buff	Aurora red.
Vacuum	Buff	Blue.
Drips and drains, steam line	Black	White.
Drips and drains, air pipes and tanks	Black	Light blue.
Blow-off from heaters, boilers, etc	Black	Orange.
Overflows from heater, hotwell, etc	Black	Aurora red.
Drains from crank pits	Black	Black.
House and roof drains	Black	Black.
Water, Cold, city supply or other external source	Dark green	Dark green.
Well, cistern or tank	Light green	Light green.
Hydraulic supply under pressure for lifts, etc	Light green	Yellow.
Discharge from lifts, etc	Light green	Aurora red.
Cooling to engine bearings and jackets	Light green	Light green.
Drinking	Dark green	Dark green.
Lavatories, basin, sinks, etc	Light green	Aurora red.
Fire lines and tanks	Vermilion	Vermilion.
Salt supply and intake	Slate	Slate.
Salt discharge	Slate	Aurora red.
Water, Hot, from hot wells, heaters to pumps, economizers, etc	Orange	White.
Returns from bearings and jackets	Orange	Black
From condenser to air pump	Orange	Orange.
Air pump to hotwell	Orange	Aurora red.
Hot to lavatories, basins, etc	Orange	Light green.
Cylinder oil to high pressure cylinder	Aurora red	Aurora red.
Cylinder oil to low pressure cylinder	Aurora red	Aurora red.
Cylinder oil to auxiliary pressure cylinder	Aurora red	Aurora red.
Engine oil to bearings	Aurora red	Aurora red.
Engine oil from bearings	Aurora red	Black.
Fuel oil	Dark brown	Dark brown.
Air, Compressed for tools, etc	Light blue	Light blue.
Low pressure	Dark blue	Dark blue.
Ventilator, fresh cold	Azure blue	Azure blue.
Ventilator, vitiated	Azure blue	Black.
Gas	Light brown	Black.
Gasoline	Light brown	Light brown
Electric ducts	Light yellow	Vermilion.
Kerosene	Light brown	Vermilion.

Note.—Stencil an arrow on pipe at suitable places showing direction of flow in the pipe. Arrow to be black or white.

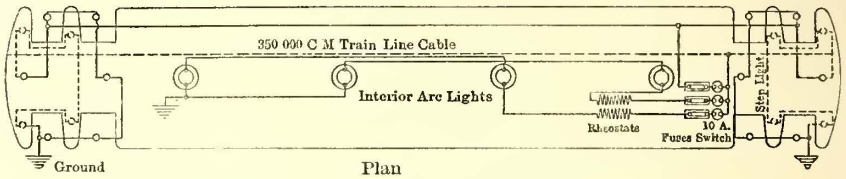
while transporting the charge of iron. When the car is placed in front of the furnace the charging hopper is dumped by power through the medium of a 12-in. air cylinder. The use of this car saves a considerable amount of labor in charging the furnace.

CAR CONSTRUCTION

All of the regular car equipments of the Oakland Traction Company and the "Key Route" are designed and built in the company's shops. During the past year these shops have constructed 20 34-ft. 6-in. closed-body city passenger cars for the Oakland Traction Company, and 16 96-ft. 3 1-2-in. steam-coach type trailers for the "Key Route."

Each of the 20 Oakland street cars built during the past year is 48 ft. 2 in. long with 5-ft. 7-in. platforms. The body is 9 ft. 8 in. high, 12 ft. high from the rail to trolley board and 9 ft. wide. A view of one of these cars on the shop transfer table is presented in Plate XXXVII. These cars are mounted on M. C. B. type trucks built in the company's shops. This truck carries two GE-70 A-4 motors on 5-in. axles with 34-in. wheels. The seating arrangement of the cars includes a smoking section 11 ft. 3 1-16 in. long with longitudinal seats and a general section 22 ft. 5 9-16 in. long with 18 Hale & Kilburn seats. The main stresses in the underframe of the car are carried by steel sections, and the platforms are supported by structural steel knees tied to the ends of the steel side sills, which are supported by truss rods. The extreme plaform overhang from bumper to truck center is 13 ft. 1 1-4 in. and the distance between truck centers is 22 ft. The detail features of this type of car and its equipment are presented by accompanying reproductions from car equipment record cards, which are types of similar records kept for all cars owned by the company.

The 69-ft. 3 1-2-in. trail cars for the "Key Route" service, of which an order of 16 is just being completed in the shops, follow in general design the former type of trail and motor cars operated in the company's train service and have bodies of similar design to those of steam railroad coaches, with the exception of the vestibuled platforms, which are 6 ft. 8 3-4 in. long and subdivided by a stanchion. The new cars complete weigh 60,000 lb. each, and have a seating capacity for 88 passengers. The cars, including all castings and trucks, were designed and built in the Oakland shops. Each car body is mounted on two M. C. B. type trucks with 36-in. 912-lb. Midvale rolled-steel wheels. It is stated that a saving in weight of 536 lb. per car is made by the use of this wheel over the weight for steel-tired wheels with cast-iron centers used on some of the other equipments.



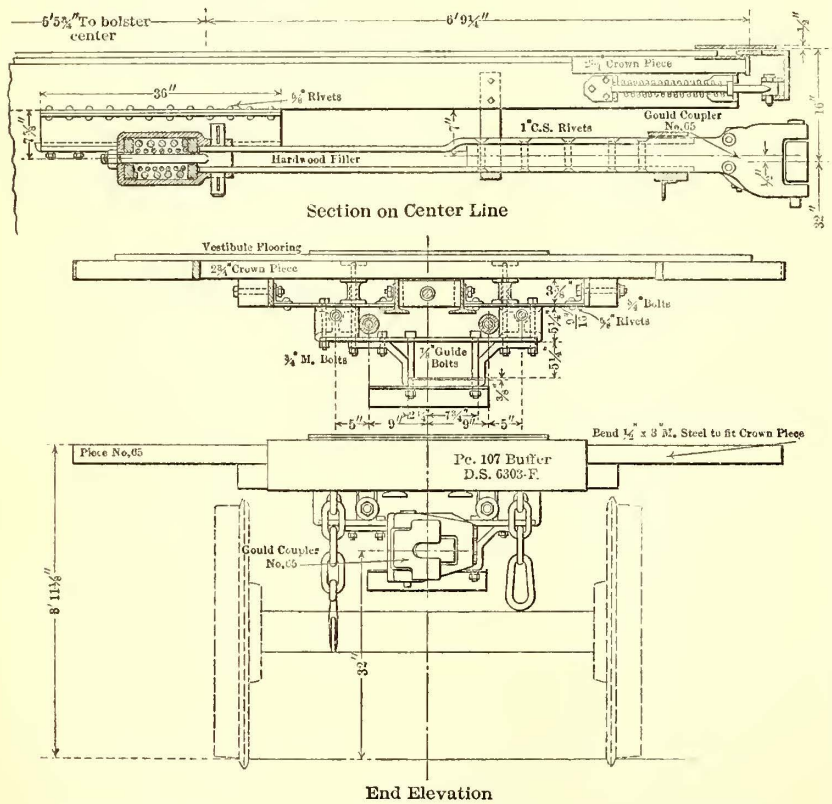
Plan

Oakland Electric Railways—Plan of Car Light Wiring

As the new cars are to be operated in trains of four or more units, they are provided with end doors and Gould standard steam railroad spring buffer platforms and couplers. The coupler anchorage is carried back to the end body sill and there riveted to the two 7-in. I-beams which form the center sills.

A view on Plate XXXVI shows the interior of the erecting shop during the construction of these cars. The bodies of the cars are 8 ft. 9 1-2 in. wide, and are subdivided into 10 window panels with fixed double sash. On account of the short run in this service it is not necessary to build the side framing construction so that the windows will raise, and this practice is desirable, not only on account of economy in construction, but also on account of the narrow clearance in some of the city streets. The interiors of the car bodies have green tinted ceilings and are finished in natural mahogany. Deck sash also are fixed, and each car is fitted with four 10-in. Globe ventilators to remove the vitiated air from the upper portion of the car. The air-brake equipment on all "Key Route" cars is the Westinghouse standard railway passenger type, with a line of piping and hose for whistle signals.

The long platforms have no side doors, and to provide against accidents gates are hung over the steps on each side. These gates are made up of heavy mesh in channel-iron frames and are supported on roller trolley carriers so that at stations the trainmen may slide them back along the sides of the cars. The interiors of the cars are illuminated by four incandescent arc lamps, operated two in series, and the platforms are illuminated by a group of six incandescent lamps in series, two placed in the hood and two under the stanchions just above the steps. A 350,000-circ. mil power cable is carried throughout the length of each car and provided with couplers.



Oakland Electric Railways—Details of Motor Car Draft Rigging

The wrecking equipment of the "Key Route" and Oakland Traction lines includes a 40-ton capacity of self-propelling steam wrecking crane weighing 140,000 lb., manufactured by the Bay City Industrial Works, and a wrecking tool car with a 30-ft. body 8 ft. wide mounted on a floor structure 46 ft. long. The electrical equipment of the tool car includes two GE-66 motors with multiple-unit control.

The emergency equipment of the tool car is very extensive,

and was listed in the ELECTRIC RAILWAY REVIEW for June 29, 1907, page 866. In general this equipment includes rope and tackle, lashings, steel hoisting cables, slings, blocks, chains, chain fittings, jacks, replacers, carpenters' tools, track tools and supplies, machinists' tools, overhead tools and supplies, miscellaneous roadway and car appliances, parts and supplies and first-air emergency packages, medicines and surgical supplies. An extra truck with an adjustable bolster is carried on the extension of the car platform and skids are provided so that this truck can quickly be lowered to the track. The two trucks on which this car is carried are of the M. C. B. type with steel-tired wheels. One motor is mounted on each truck and a pair of connecting rods distributes the torque to all four wheels of the truck. The car wheels are counterbalanced with approximately 65 lb. of lead placed between retaining plates riveted together between the spokes opposite the crank pins.

The steam wrecking crane and the electrically operated wrecking tool car are kept at the Emeryville shops in such a condition that they are always ready for service. The shop foreman has charge of the service performed by this equipment, and after the use of the equipment enters the details of the accident in a log book kept in the small office in the wrecking tool car. He also turns in a complete accident report. A steam locomotive used in freight switching is always available at night in the shop yards for hauling the wrecking equipment to the scene of a wreck, and thus this entire equipment can be used, even though the trolley may be down.

THE 1200-VOLT INTERURBAN DIVISION OF THE CENTRAL CALIFORNIA TRACTION COMPANY

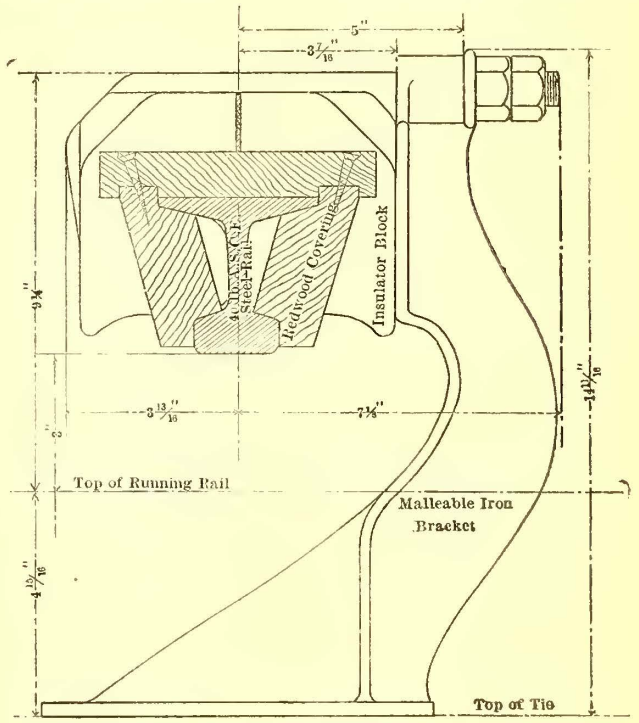
THE interurban division of the Central California Traction Company is unique in that it was the first road in this country to be operated with 1200-volt d. c. motors and generators. Current at this high voltage is generated in substations with induction motor-generator sets and is distributed to the cars by an under-running protected third-rail. The 1200-volt equipment was first operated in June, 1908, and has shown remarkably good results since that time.

In March, 1906, the Central California Traction Company began operation with a 10-mile city line in Stockton, Cal. The present interurban line between Stockton and Lodi, 15.4 miles, was built by the company and put into service in September, 1907. Between the limits of these two cities the track is practically level and is laid on a private right-of-way 100 ft. wide. There are few curves and only one bridge. The road traverses a level valley noted for its highly productive farms. The route passes through orchards and vineyards for its entire length. All of the neighboring country is under intensive cultivation and is irrigated with water supplied either from windmills, gasoline engines or electrically driven pumping plants. Stockton, the southern terminus, has a population of 25,000 and Lodi has a population of 2500. The company is now building some track in Sacramento, 50 miles north of Stockton, and the interurban line will be extended from Lodi to Sacramento during the coming year.

The present interurban division from Stockton to Lodi has a substantially built track, laid with 75-lb. rails, tie-plated, and bonded with the Ohio Brass Company No. 0000 soldered bonds. Native redwood ties, ballasted with gravel, are used. All passing sidings are stub-end and are so laid that southbound trains always head in. The turnouts are located on the side of the track opposite the third-rail, thus avoiding unnecessary breaks in the continuity of the rail and third-rail jumper complications. A line of square redwood poles, 26 ft. high, carries a pair of No. 10 copper telephone wires, connected with instruments mounted in booths, at each siding.

THIRD-RAIL CONSTRUCTION

The third-rail construction, which is illustrated on Plate XXXIX, is of special interest on account of the high voltage carried. The conductor rail is the standard 40-lb. section of ordinary track rail steel, held in an inverted position by semi-porcelain insulating blocks clamped to the tops of the malleable iron brackets with steel T-bolts. Ties 10 ft. long are spaced 12 ft. apart to carry these brackets. The third-rail joints are made with ordinary four-bolt fishplates and are bonded with Ohio Brass Company No. 0000 ribbon bonds soldered to the base of the inverted rail. The conductor rail is enclosed in a cover made of two pieces of 2-in. x 4-in. and one piece of 1-in. x 6-in. redwood, milled to fit the web and base of the rail. This protecting guard completely covers the top of the rail between the porcelain insulating blocks at the



Central California Traction Company—Third Rail Support and Protection

brackets. A chart is presented showing the voltage drop along the 1200-volt third-rail and the 1200-volt trolley in Lodi.

The continuity of the third-rail is broken at highway crossings and the electrical circuit made complete with 400,000-circ. mil rubber and lead-covered copper cable jumpers laid in 3-in. fiber conduit and anchored in concrete at the terminals.

The cost of the third-rail per mile of single track, complete and including cables, is given as follows:

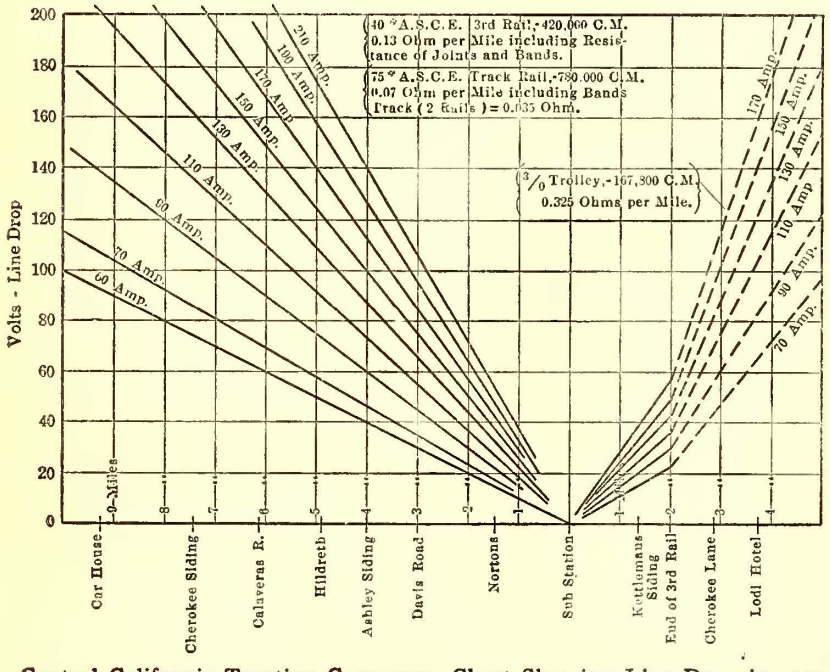
Material (total), including brackets, bonds and cables delivered	$2,748.70
Labor—	
Erection	240.00
Bonding	24.00
Cable crossings	92.60
Wooden covering	181.00
Shop work on rail ends, etc	12.40
Total cost per mile	$3,298.70

OVERHEAD TROLLEY

Within the city of Stockton and for a short distance in Lodi, where the track runs in city streets, 600-volt current is conveyed to the cars through a catenary-supported No. 000 grooved trolley. Views showing the general characteristics of this overhead work are presented on Plate XI. The messenger cable is 3/8-in. galvanized steel-supported in 120-ft. spans, either by angle-iron brackets or cross suspensions of 5/16-in. stranded cable. On straight track five trolley hangers are used in each span.

POWER SUPPLY

Power is purchased from the transmission system of the American River Electric Company, which operates a water-power plant at Placerville, about 80 miles from Stockton, and transmits current at 44,000 volts. This company also has a steam relay station located on the river front in Stockton. The equipment of this station includes three oil-burning B. & W. boilers, one 1500-kw 2200-volt Curtis turbine generator, one 600-volt 400-kw motor-generator set, and one 1200-volt 500-kw motor-generator set. Switching and transforming apparatus also is provided so that the turbo-generator may be operated in parallel with the water-power plant and assist it in handling the load on the 44,000-volt transmission system.



Central California Traction Company—Chart Showing Line Drop in 1200-Volt Third-Rail and Trolley Between Stockton and Lodi

In connection with the entire electrical equipment of this road it should be remembered that all the generating machinery and motors are satisfactorily operated with 1200 volts across the commutator and not with two 600-volt machines connected in series. The 1200-volt generator in the power house is an interpole machine driven by a 2200-volt induction motor. It is so arranged that it can be operated with half excitation to deliver 600 volts to the local railway or at full excitation to feed the interurban line over an independent feeder, which is regularly used as a part of the local 600-volt trolley network. The 600-volt motor-generator set is used to supply current to the local street cars of the company.

SUBSTATION EQUIPMENT

The entire third-rail section ordinarily is fed with 1200-volt current from one motor-generator substation, located 11.5 miles north of Stockton. This station, pending the completion of the extension from Lodi to Sacramento, feeds 9 miles in one direction and 4 miles in the other. The substation equipment is housed in two galvanized iron buildings, one containing the 2200-volt-1200-volt induction-motor-generator set with its switching apparatus, and the other enclosing three 275-kw water-cooled, oil-insulated General Electric transformers, which step down the current from the transmission pressure of 44,000 volts to 2200 volts for use by the induction motor. The switching equipment of this station is characteristic of many California plants.

An illustration on Plate XXXVIII shows the horn type air-break line switch mounted on poles in the open air. This switch serves to disconnect the entire substation equipment from the high-tension transmission system. In series with the open-air switch is a Kelman oil switch connected on the high-tension side of the transformer. The machine switches are the ordinary three-pole single-throw oil-break type used in connection with a compensator for starting the 500-kw three-phase induction motor, which drives the 1200-volt General Electric interpole generator. The output of the generator is fed to the third-rail through a line switch, a choke coil comprising 10 turns of iron rod wound around a wooden core and an I. T. E. circuit-breaker. It is found that this simple choke coil is effective in preventing the generator from arcing over on third-rail short-circuits. The generator also is fitted with fiber barriers to prevent damage to the brush-holders in event of line "shots."

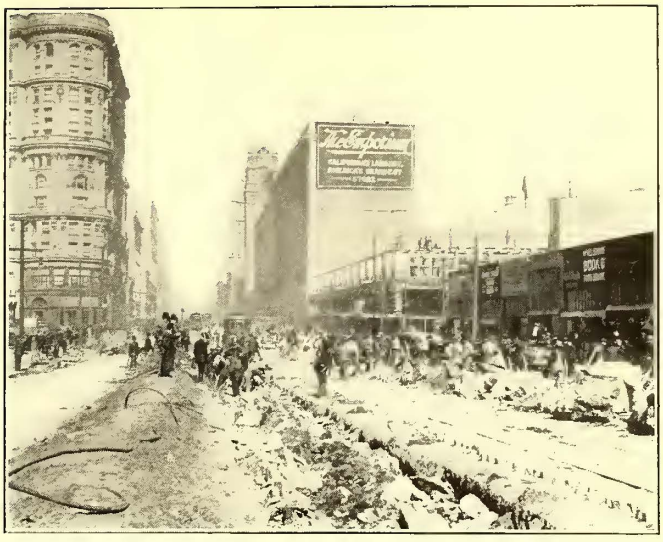
The railway company operates this substation with three men, each working nine hours a day. The total operating cost, exclusive of fixed charges, is about $300 per month. Power is purchased on the 2200-volt side of the step-down transformers at a basic rate of 1 cent per kw-hour. The cars consume an average of 4.69 kw-hours per car mile on the 1200-volt division; this amount includes the losses of the motor-generator set, third-rail distribution and track return.

ROLLING STOCK

The rolling stock equipment of the interurban division includes one 32-ft. freight locomotive, two 45-ft. motor express cars and four 50-ft. passenger cars. The motor express cars have the same equipment as the passenger cars with the addition of automatic air-brake equipment. The cars were built by the American Car Company. The passenger cars seat 56, are double-ended and weigh 38.56 tons without load. The motor equipment consists of four General Electric No. 205, 1200-volt, 75-hp interpole motors with type M control. Westinghouse schedule S M E air-brakes are used on the passenger equipments. The car bodies are mounted on the American Car Company's M. C. B. type truck. The gear ratio for passenger-car motors is 23 to 51 and for express motors 16 to 58. The efficiency curves of these motors are shown in an accompanying engraving.

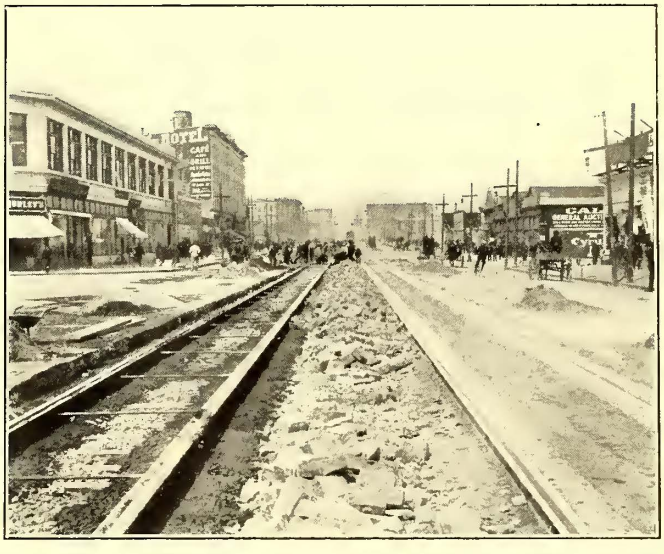
On account of the very high voltage at which these cars are operated all of the wiring has been laid out and installed with particular care. The auxiliary apparatus is supported from an angle-iron subframe insulated from the main car frame and all the cables and wires are carried in loricated conduit. This plan of subframe support has two advantages—it does away with the cutting and weakening of the car under-frame and it makes thorough insulation

United Railroads of San Francisco—Removing Cable Yokes with Electric Crane

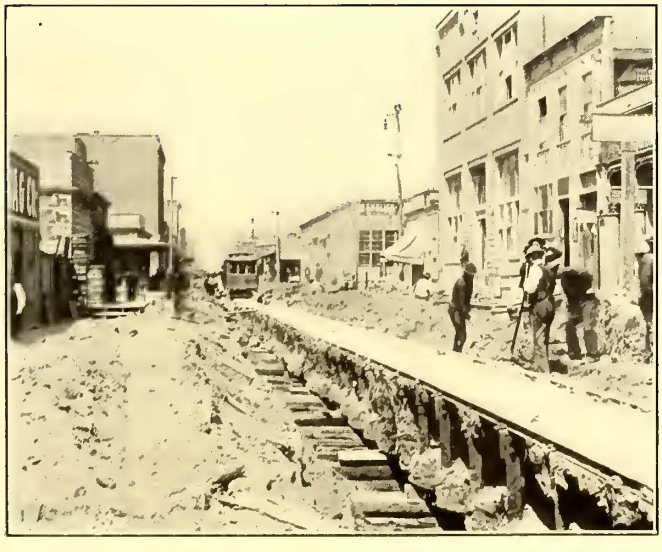


United Railroads of San Francisco—Excavating Market Street Track

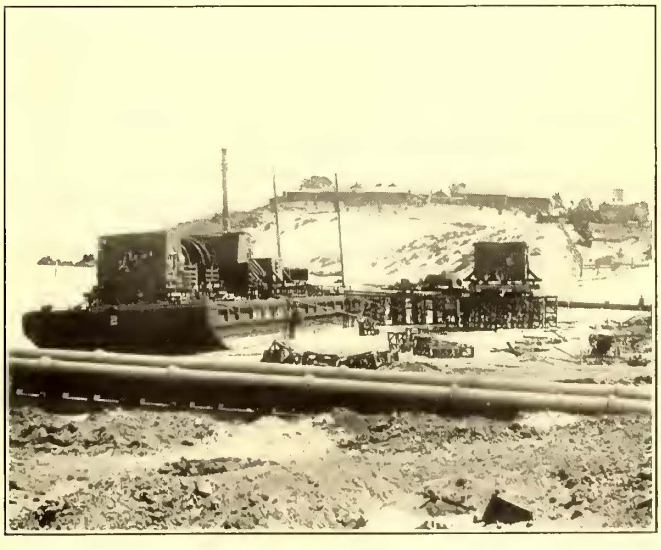
United Railroads of San Francisco—Laying Market Street Track



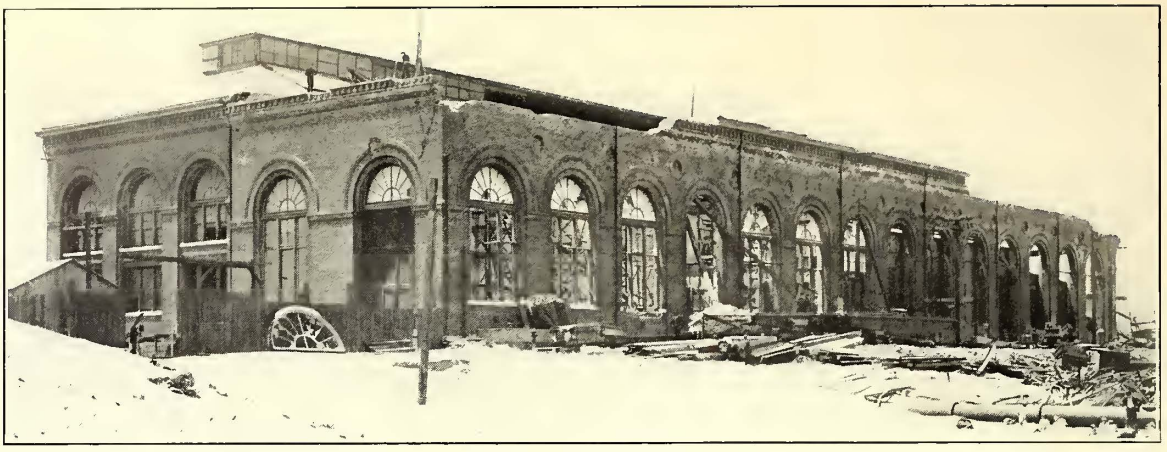
United Railroads of San Francisco—Paving Market Street Track



United Railroads of San Francisco—Moving and Raising Cable Track During Operation

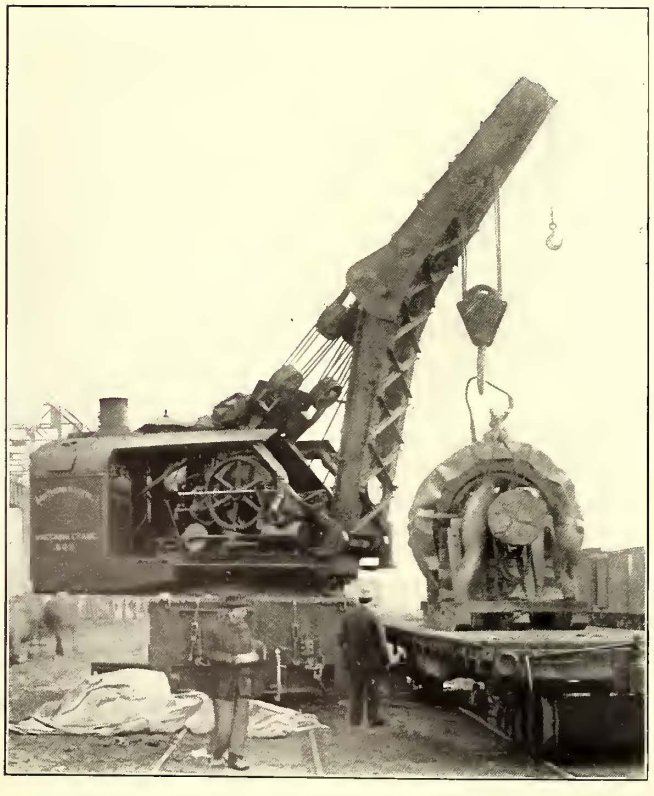


United Railroads of San Francisco—Unloading Electrical Equipment from Barge

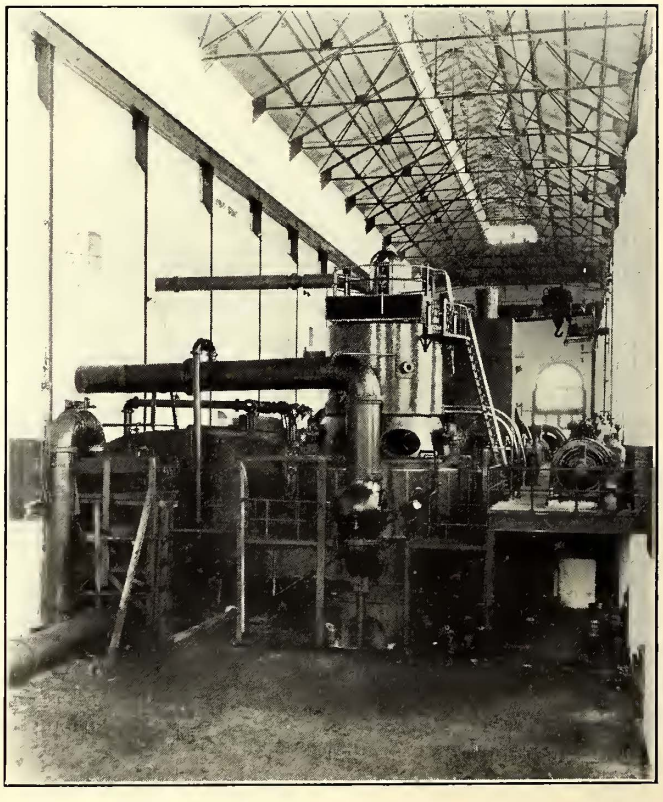


United Railroads of San Francisco—North Beach Station After Earthquake

United Railroads of San Francisco—North Beach Generating Station



United Railroads of San Francisco—Handling Electrical Machinery with Wrecking Crane

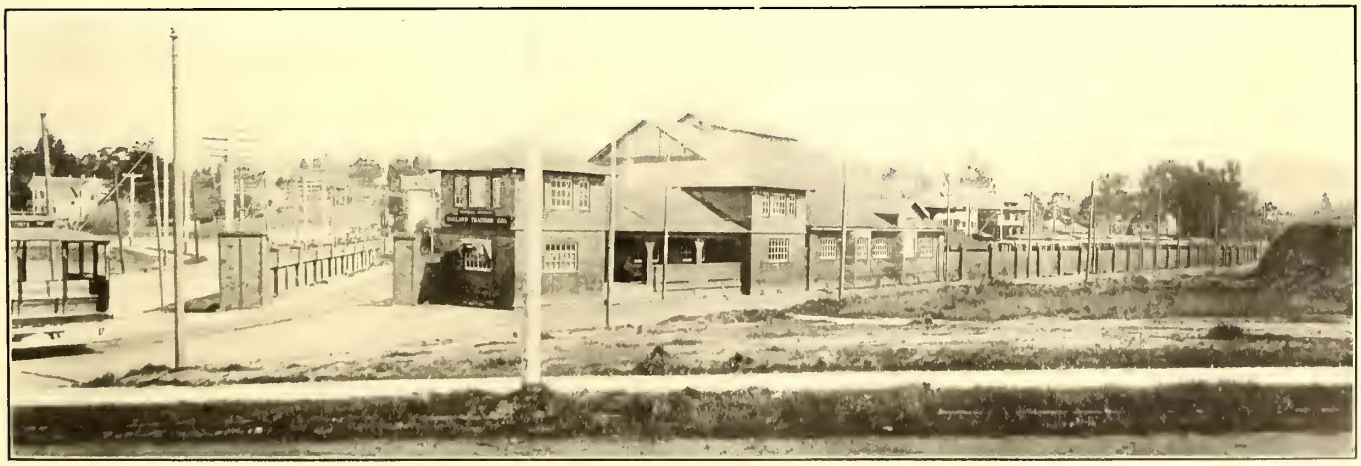


United Railroads of San Francisco—New Turbine Unit at North Beach Station

Oakland Electric Railways—Wrecking Tool Car and Crane

Oakland Electric Railways—Key Route Ferry Terminal Three Miles from Shore

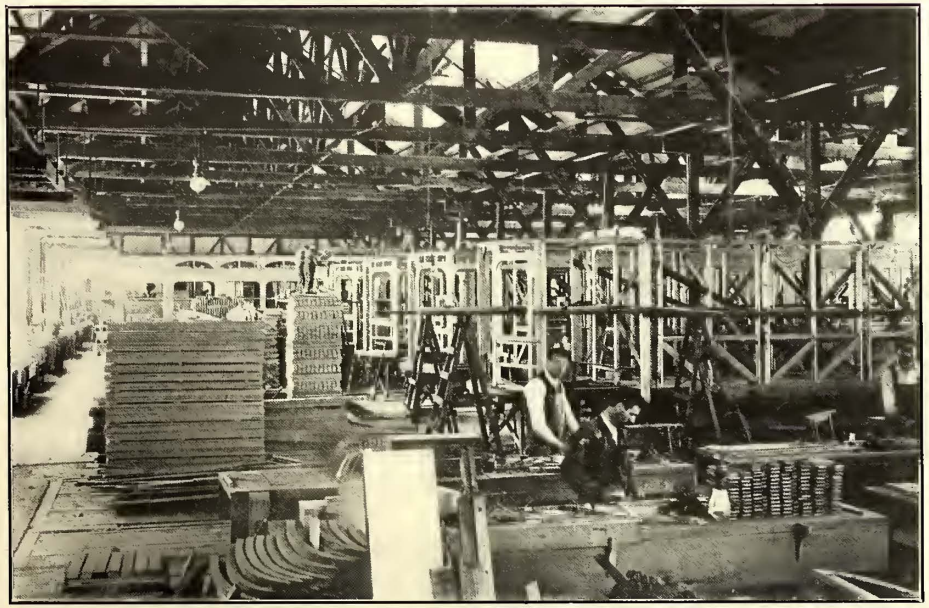
Oakland Electric Railways—Shops of the Oakland Traction Company Located on the Key Route Main Line in Emeryville



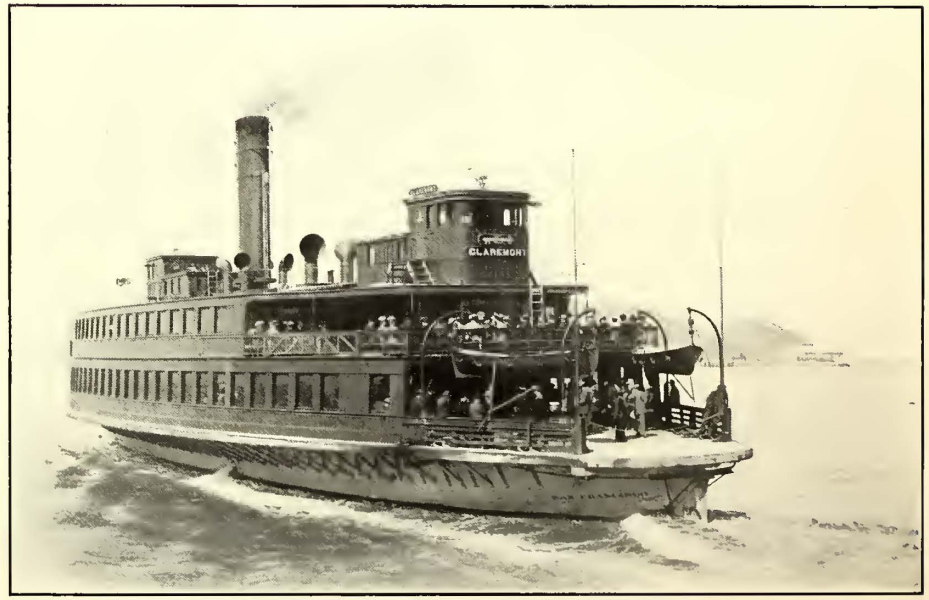
Oakland Electric Railways—Central Division Car House and Yards, Including Employees' Rooms, Waiting Room and Inspection Pits

Oakland Electric Railways—Terminal Station and Hotel

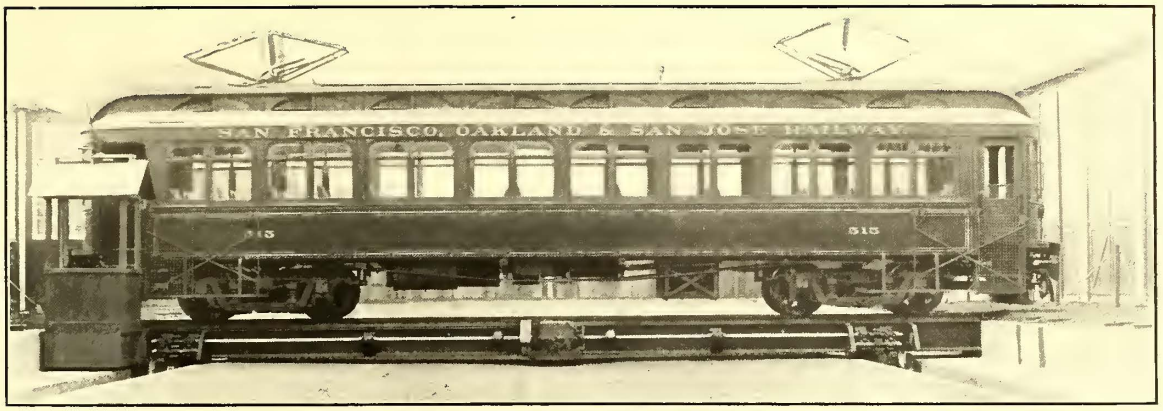
Oakland Electric Railways—Key Route Roadbed



Oakland Electric Railways—Interior of Erection Shop



Oakland Electric Railways—Key Route Ferry Steamer



Oakland Electric Railways—Key Route Motor Car

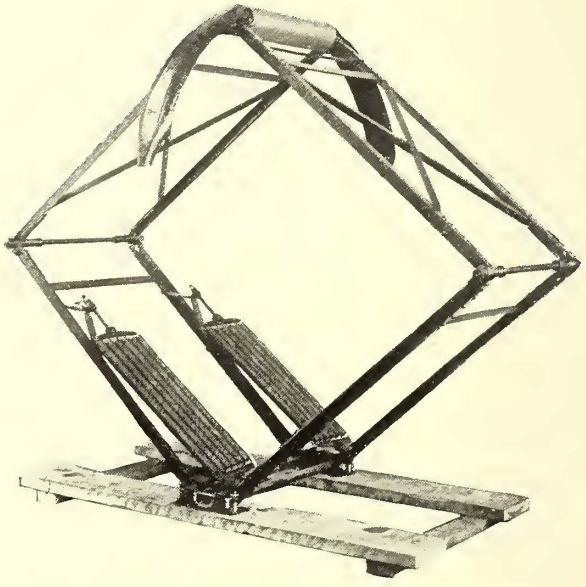
Oakland Electric Railways—Key Route Power Station

Oakland Electric Railways—Typical Suburban Station

Oakland Electric Railways—Subway Under Southern Pacific Railway

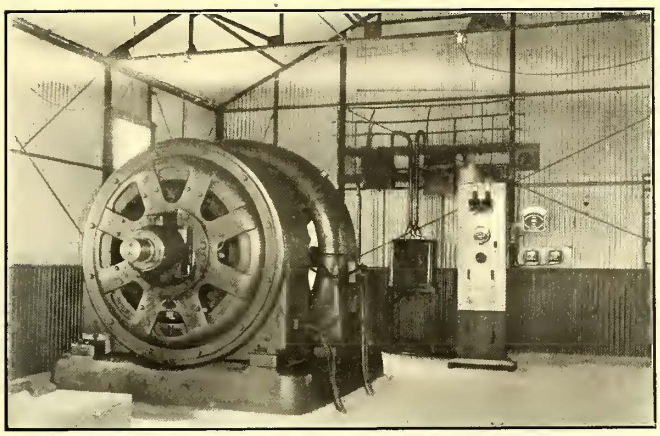
Oakland Electric Railways—Loading Station at Key Route Pier Terminal

Central California Traction—Open-Air Switching Station

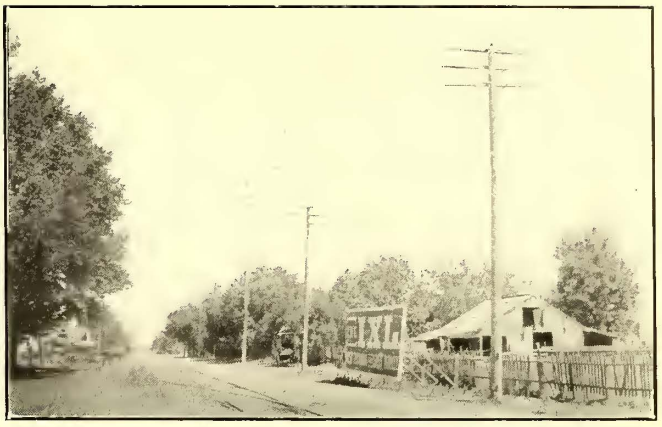


Oakland Electric Railways—Brown Roller Trolley

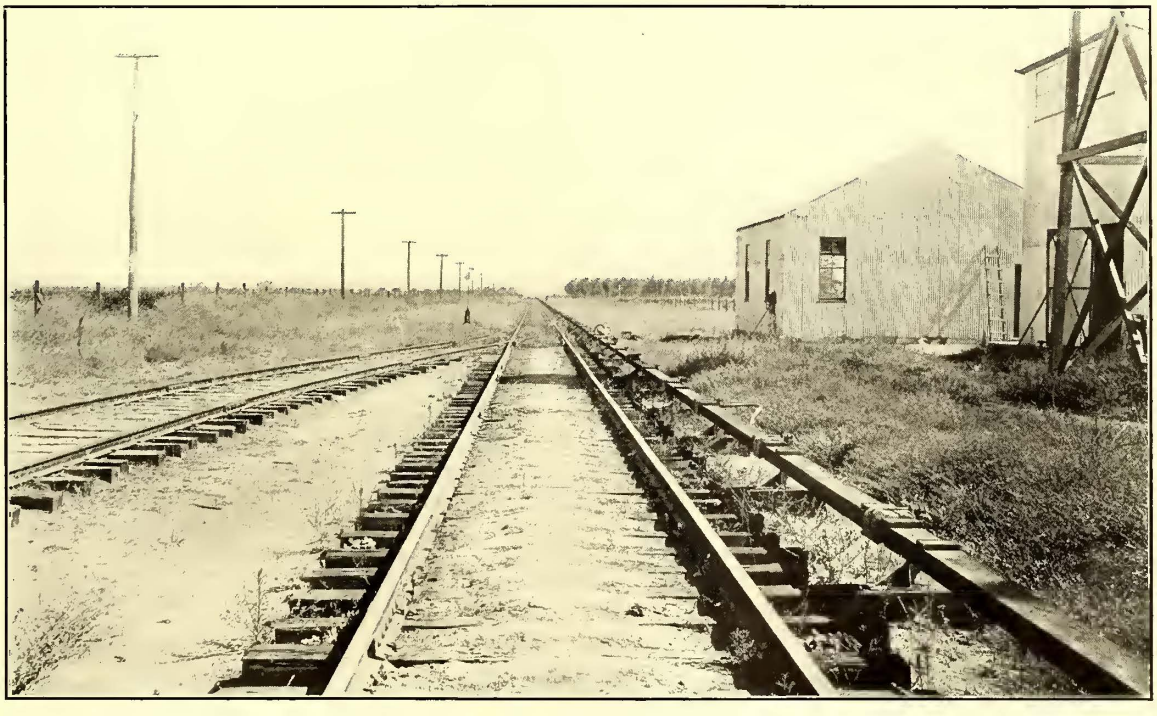
Central California Traction—Standard Interurban Car



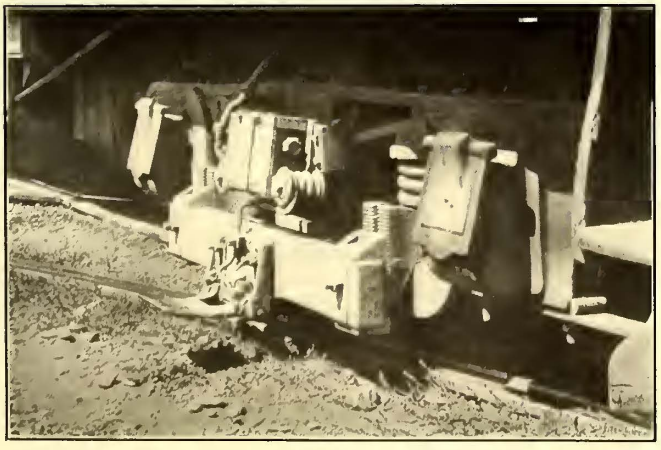
Central California Traction—1200-Volt Substation Equipment



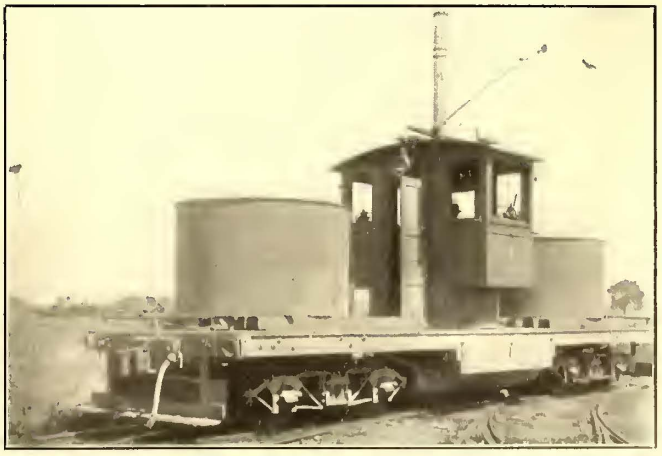
Central California Traction—Catenary Overhead at City Entrance



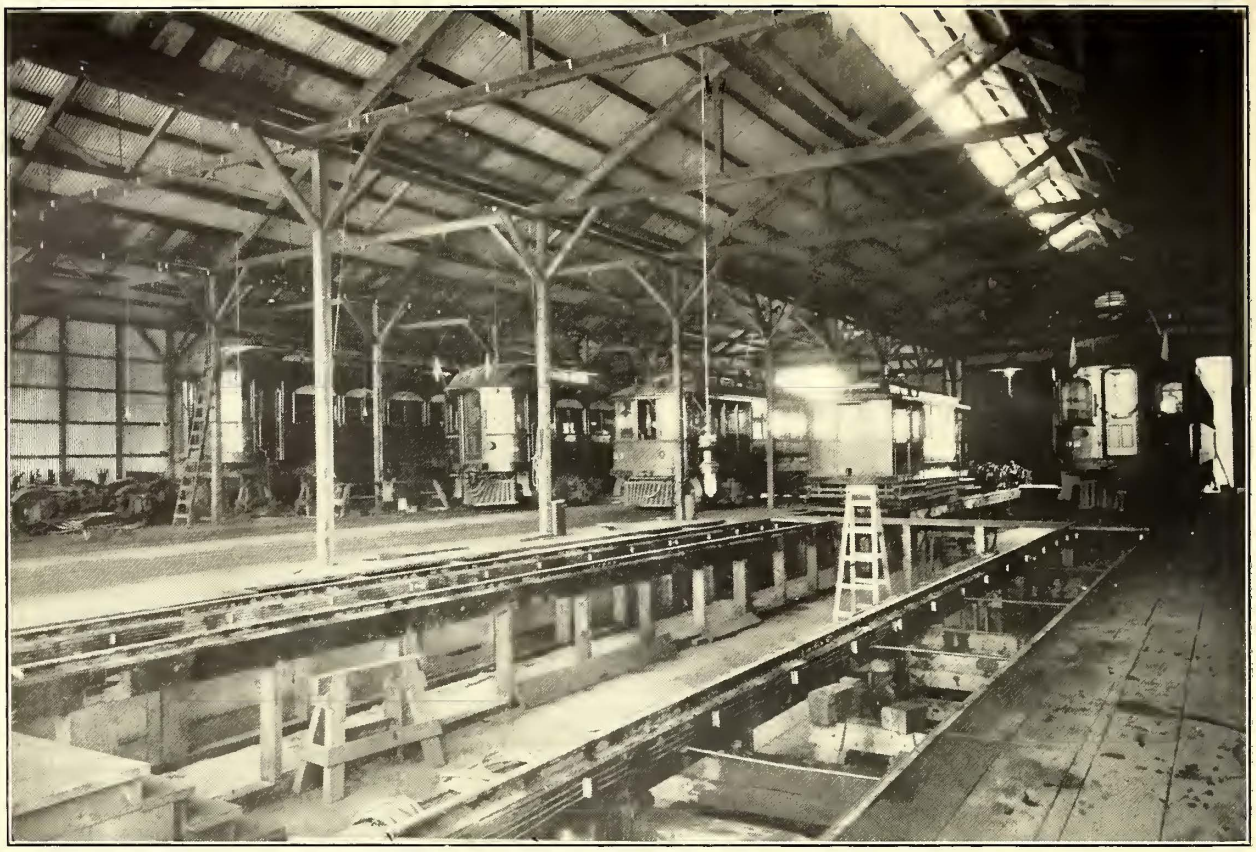
Central California Traction—Main Line Track, Showing 1200-Volt Third-Rail at Substation



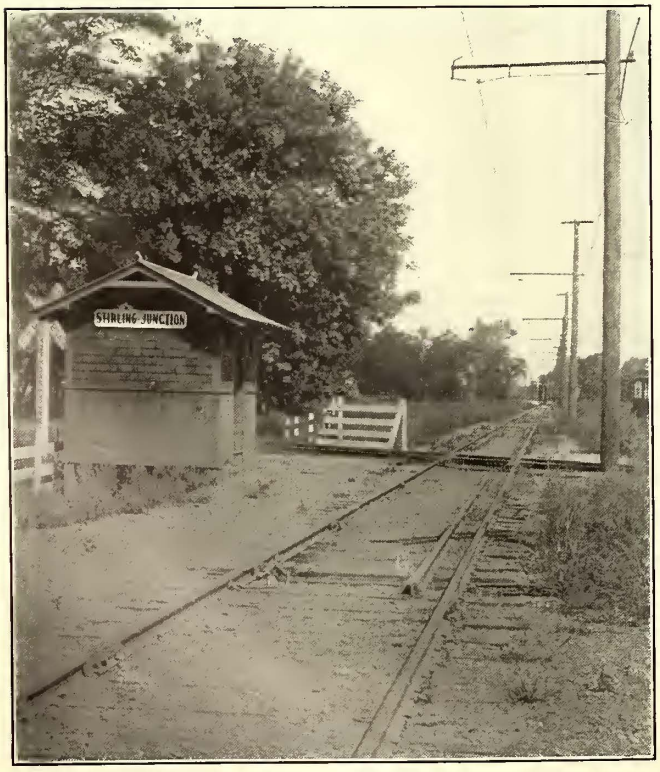
Central California Traction—Third-Rail Shoe Attachment and Fuse-Box



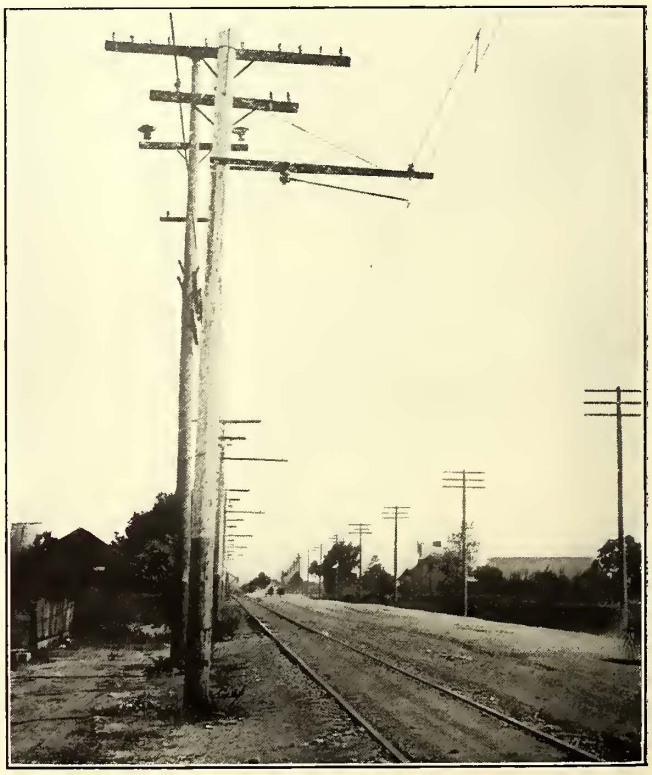
Central California Traction—Combination Work Car and Sprinkler



Northern Electric Railway—Interior of Repair and Inspection Shops at Chico



Northern Electric Railway—Type of Shelter at Way Stations

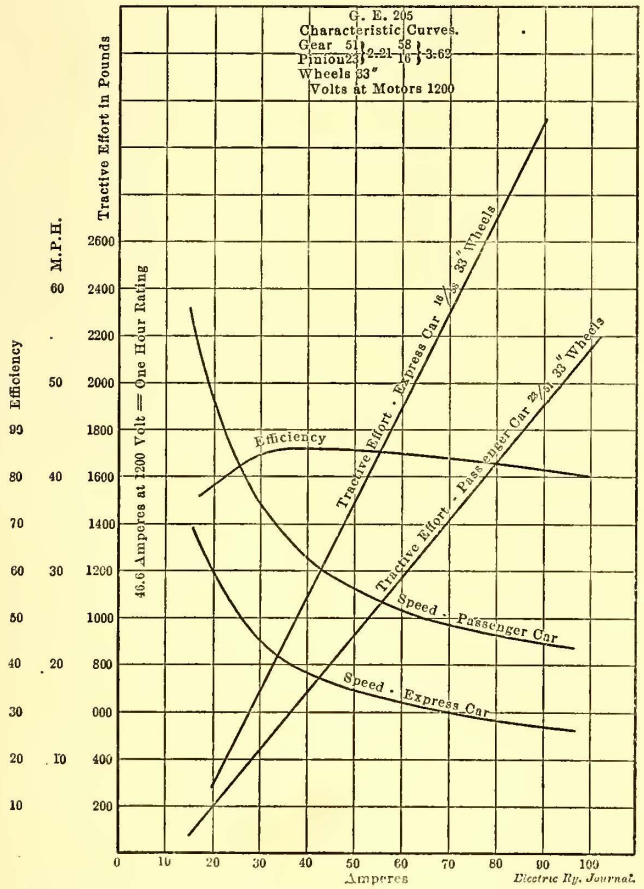


Central California Traction—1200-Volt Catenary Overhead in the City of Stockton

easily possible. The general arrangement of the third-rail current collecting shoe and its support is shown in the accompanying engraving. Steel shoes are used and those put on the cars when operation was begun are still in service. The shoes are supported and insulated by wooden beams, carried on the truck equalizer bars. Current is carried from the shoe through a nearby fuse box to the car circuits. The fuse box, which is made of horn fiber, contains a ribbon fuse and is fitted with blow-out coils to extinguish any arcs.

1200-VOLT MOTORS

The motors operate with 1200 volts across each commutator while the car is running on the 1200-volt third-rail section. In Stockton, where the motors are fed with only 600-volt current, they operate at half speed, or a maximum of 22 m.p.h. A dynamotor supplies 600-volt current for the operation of the control system while the car is running on the 1200-volt section. The dynamotor is a small motor with an armature having two commutators and two sets of



Central California Traction Company — Characteristic Curves for 1200-Volt Passenger and Express Car Motors

coils wound on the core. The coils which are connected to the 600-volt commutator are placed in the bottom of the slots, and those connected to the 1200-volt commutator are wound on top of them. The rated capacity of the dynamotor is 10 kw. It is hung from the subframe under the car body and is said to operate satisfactorily and to require very little attention. The electrical control equipment includes an electrically operated transfer switch to connect the power-supply cable with either the trolley base or third-rail shoe. Two contactors, mounted in a box next to the dynamotor under the car body, serve to change the control and dynamotor circuits for either 600-volt or 1200-volt operation as the car passes a 120-ft. dead section in the trolley line. One contactor is wound for 600 volts and the other for 1200 volts, and only one is closed at a time. The operation of changing over is entirely automatic, except that one switch must be thrown by the motorman when entering the live section beyond the dead section at either end. The change is made while the car is running at full speed.

This unique electrical equipment, including the 1200-volt motors and 1200-volt generators, has operated satisfactorily and with remarkably few pull-ins during the past 18 months. The commutators of the motors show less wear than that ordinarily found on 600-volt motors performing the same service, and some of the brushes installed at the beginning of operation are still in service.

SERVICE

The regular schedules of the interurban line of the Central California Traction Company include one car each way every hour from 6 a.m. to 11 p.m., except the hours of 8 and 10 p.m. On Saturday and Sunday the headway is shortened to 40 minutes between the hours of 1 p.m. and 7 p.m. The round-trip rate between Stockton and Lodi is 50 cents and the one-way rate 35 cents. Special commutation and other tickets are sold at reduced rates. All fares collected on the cars are registered on Ohmer fare registers.

During the year 1908 the road handled about 25,000 passengers per month, and had freight earnings averaging $1,000 per month. About half of the freight business is in carload lots. The following table shows the costs of passenger operation from January to June of the present year:

STOCKTON-LODI PASSENGER SERVICE—JANUARY TO JUNE, 1909, INCLUSIVE

Gross earnings	$24,822.00
Car miles	93,161
Earnings per car mile	$0.267
Total passengers carried	137,510
Trainmen's wages	$3,325.00
Trainmen's wages per car mile	.0357
Cost of power	4,375.00
Cost of power per car mile	.047
Maintenance (car bodies and trucks) per car mile	.0125
Maintenance (electrical equipment) per car mile	.0083
Maintenance way per car mile	.025
Substation wages per car mile	.0131
Cleaning cars per car mile	.0018
General shop expense per car mile	.0026
Maintenance (substation line, third rail) per car mile	.0041
General expense per car mile	.0114
Operating expense per car mile (total)	.1605
Operating ratio	60%

FREIGHT AND EXPRESS

A local express service is given and through freight is handled in connection with the steamers of the California Navigation & Improvement Company, running from Stockton to points on San Francisco Bay and the San Joaquin River. A through tariff is published for this service. The following tables give the monthly average costs of handling freight, both carload and express, for the year 1908:

CARLOAD FREIGHT SERVICE

Gross earnings	$455.00
Ton miles	6,726
Freight car miles	1,000
Locomotive miles	443
Earnings per ton mile	$0.0676
Earnings per locomotive mile	1.02
Trainmen's wages	59.50
Trainmen's wages per ton mile	.0088
Trainmen's wages per locomotive mile	.134
Power cost	15.80
Power cost per ton mile	.0023
Power cost per locomotive mile	.035
Other charges (maintenance, etc.) per ton mile	.0078
Other charges (maintenance, etc.) per locomotive mile	.118
Total operating expense per ton mile	.0189
Total operating expense per locomotive mile	.287
Operating ratio	27.9%

Express Car Freight Service—L.C.L. Freight

Gross earnings	$419.00
Express car miles	851
Ton miles	4,642
Earnings per express car mile	$0.492
Earnings per ton mile	.0902
Trainmen's wages	125.00
Trainmen's wages per express car mile	.1469
Trainmen's wages per ton mile	.0269
Power cost	29.60
Power cost per express car mile	.0348
Power cost per ton mile	.0064
Other charges (maintenance, etc.) per express car mile	.1733
Other charges (maintenance, etc.) per ton mile	.0318
Total operating expense per express car mile	.3551
Total operating expense per ton mile	.0651
Operating ratio	71.8%

The freight service bears its proportion of all general expenses, of maintenance charges, substation charges, track maintenance, etc.; substation charges are proportioned to the power used; track maintenance to the ton-miles operated. Practically all the carload freight handled by this road is grapes and in the three months of September, October and November, 1908, 250 cars of grapes were handled for the Eastern market and 500 cars were delivered to local wineries.

NORTHERN ELECTRIC RAILWAY

THE Northern Electric Railway Company operates the longest third-rail line in the West. This road, since 1906, has increased its mileage from a division of less than 25 miles to a system embracing 130 miles of standard-gage third-rail track. The principal city on the line and the southern terminus is Sacramento, the capital of California. From Sacramento the line extends north 41 miles to Marysville, thence about 30 miles to Oroville Junction and from there 20 miles to Chico. From Oroville a branch 5.5 miles long connects with the main line. Local service is operated in these cities.

The district which this road serves derives its support from the exceedingly fertile valley of the Sacramento River, along which the route of the railway extends. A fast service, including trains, which make the 90 miles between Oroville and Sacramento in three hours, is operated with large interurban cars run in multiple-unit trains. The company has developed a large freight traffic, the trains for handling which are hauled by 41-ton electric locomotives.

The principal constructional features of the Northern Electric Railway were described in the Electric Railway Review for June 8, 1907, page 738, and a map of the route was then presented. Since that time the construction of the company's cars was described and illustrated in the Electric Railway Journal, for Oct. 31, 1908, page 735, and the design of a new concrete substation was presented in the issue of Oct. 24, 1908, page 1249. The latter two articles were written by J. P. Edwards, electrical and mechanical engineer of the company, to whom acknowledgement is made for a part of the following information descriptive of new features.

ROADWAY

The roadway of the Northern Electric Railway passes through a level valley and therefore the track was easily constructed, so that high speeds can be made. Outside of the towns the private right-of-way varies in width from 80 ft. to 100 ft., and in Sacramento the right-of-way extends close to the center of the city. There are few curves on the main line. In the 50-mile run between Chico and Marysville, there are only three curves outside of the city limits, and none of these is sharper than 3 deg. The maximum grade on the entire road is 0.5 per cent. Standard steam railroad construction with 60-lb. rail is followed. The track rail joints are bonded with two 500,000-circ. mil Chase-Shawmut soldered bonds and the third rail, which weighs 60 lb. to the yard, is bonded at each joint with two 250,000-circ. mil Chase-Shawmut soldered bonds. At highway crossings the ends of the third-rail are connected with 500,000-circ. mil copper cables enclosed in bituminized fiber conduit and buried underground.

Current for the operation of the cars is received from the Pacific Gas & Electric Corporation's transmission lines, which are fed by numerous hydro-electric plants. Alternating current at 60,000 volts is delivered to the Northern Electric substations located approximately 10 miles apart along the line. The selling company owns the step-down transformers at the substations and sells current to the railway company at 2,200 volts pressure. When the road was first put into operation and during the construction of extensions, two portable substations, each of 400-kw capacity, the product of the railway company shops at Chico, were used. These substations receive current at 60,000 volts and feed 600-volt direct current to the third rail. The total weight of one of the substations with equipment ready for operation is 90,500 lb. Screw jacks and anchors are attached to the sills of the cars so that the weight of the body and machinery may be lifted from the springs enough to make the floor level.

The design of the Nicolaus substation, a reinforced concrete structure 53 ft. 6 in. long and 28 ft. 6 in. wide, is typical of the thoroughness with which the entire construction of this road has been carried out. This substation, as stated, was described in the issue of the Electric Railway Journal for Oct. 24, 1908. In the building are the high-tension parallel switches of three transmission lines, step-down transformers, substation equipment consisting of two 400-kw motor-generator sets and the controlling switchboard. Separated from the substation proper by an iron railing are a passenger waiting-room and ticket office.

ROLLING STOCK

The main shops for the construction and repair of rolling stock equipment are located at Chico. A general view of these shops and the material yards in their rear is presented on Plate XLI. The buildings in this group include a general car house and repair shop with six tracks, a paint shop, carpenter shop and a blacksmith shop. The rolling stock equipment includes 42 passenger cars, 5 electric locomotives, 3 steam locomotives and 400 freight and miscellaneous cars.

The latest design of construction for passenger and baggage cars operated by this road was presented in one of the articles by Mr. Edwards. These cars, of which six recently have been completed in the Chico shops, are of the double-end combination smoker, baggage and express type, which is standard on this road. They are designed for operating in trains and are fitted with M.C.B. couplers, spring-buffer platforms and multiple-unit control. The bodies, which are 55 ft. 4 in. long over vestibules and 9 ft. 2 in. wide over sheathing, are mounted on Baldwin No. 200 trucks with 36-in. Standard rolled-steel wheels and 6-in. straight-turned axles. Each truck carries two Westinghouse 121 motors with a gear ratio of 24:51. The air brakes are the Westinghouse automatic schedule AMM with quick release and recharging features and a D-3 air compressor, which also furnishes air for the Westinghouse unit-switch multiple-unit control system. These cars have a seating capacity of 30 in the smoking compartment, which occupies practically half of the car body. The other half of the body serves for baggage and express and has a small mail room partitioned off in one corner. As the cars

are designed for operation in trains the non-smoking passengers are carried in trailers at the rear. The total weight of a car is 80,500 lb.

The miscellaneous rolling stock equipment includes five electric locomotives, three of which weigh 32 tons and two 41 tons each; one 15-ton wrecking car with two cranes; 220 40-ton M.C.B. flat cars; 30 side-dump ballast cars, and 110 box cars.

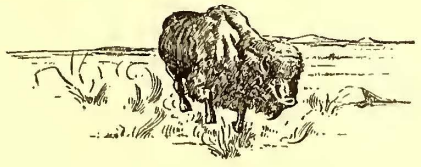
STATION BUILDINGS

The operating headquarters of the transportation department are in a large combination office and station building at Chico. A store building is used as a terminal at Sacramento and at each station along the route frame depots of attractive design have been erected. A number of shelter stations of the design illustrated on Plate XLI has been built at the principal highway crossings along the route.

Shelter stations of this type are 12 ft. 6 in. x 19 ft. outside of the walls, and have a roof projection of 2 ft. 4 in. on all sides. The walls are built of hard-burned brick to a height of 2 ft. 6 in. above the floor, and the roof is supported by 10-in. x 10-in. posts on the sides and 10-in. x 14-in. posts at the ends. The roof is shingled and is capped with a galvanized iron ridge carrying ornamental pieces at either end. Every second course of shingles is doubled with a 1-2 in. x 1-in. furring strip laid under the edge to give a rough effect to the roof. The end walls above the plate are finished with 2-in. x 8-in. panels. Within the brick enclosure a floor of concrete is made level with the outside platform, which is laid 12 in. above the tops of the running rails. The side walls extend down to the natural ground level and the inside is filled and tamped before the floor is placed. An 8-ft. 6-in. opening is left for the doorway on the side facing the track and seats extend around the full length of the interior. The woodwork is stained throughout with a brown shingle stain and station signs are hung in the angles of the gables.

At the corner of each station and in full view of the track is placed a semaphore signal which may be operated by depressing a lever, which in turn, raises the semaphore to a stop position, and also completes a circuit through a bank of green and white lamps. The semaphore blades are painted green and white and will fall to normal position when the lever is released. One of the shelter stations with a 100-ft. passenger platform, signal post, etc., complete, costs about $450.

All of the shelter stations are located on the right-of-way and are on the side of the track opposite the third rail. At road crossings cattle guards are placed in line with the wing fences and a gate is provided for the entrance of passengers.



ELECTRIC RAILWAYS AT LOS ANGELES

TRANSPORTATION FEATURES OF THE PACIFIC ELECTRIC RAILWAY

LOS ANGELES, Cal., has a population of 307,302 and is remarkable for its substantial growth. The rapid progress made may be attributed largely to the very excellent electric railway transportation service given by the street and interurban electric lines. Electric railway service is given Los Angeles and its environs by the following roads: The Los Angeles Railway Company with 218.6 miles of 3-ft. 6-in. gage track, largely within the city; the Pacific Electric Railway with nearly 600 miles of interurban track radiating to the north, south and east; the Los Angeles-Pacific Railway with 260 miles of track serving the district and ocean shore west and northwest of Los Angeles, and the Los Angeles & Redondo Railway with 84.3 miles of track between the city and the ocean shore to the southwest. All of the interurban trains operate into the heart of the city and many of them carry local passengers. The Pacific Electric Railway operates more than 1800 trains a day, practically all of which enter or pass the company's large terminal station in Los Angeles. This station occupies the entire first floor of the railway company's large office building at Sixth and Main Streets.

The general roadway construction standards of the Pacific Electric Railway were presented in the ELECTRIC RAILWAY REVIEW for Aug. 31, 1907, page 245.. The maintenance of the track, roadway and building department is in charge of the assistant general manager, whose organization includes three roadmasters and 38 track section foremen. On level ballasted road the sections have as high as 20 miles of track, but on the Alpine mountain road the section is only 5 miles long. A supervisor of bridges and buildings has charge of the maintenance of all such structures.

The general designs of the track and roadway structures closely follow steam railroad standards. Almost without exception the lines are built with double track and are laid with low grades and long-radius curves.

A most important part of the track of this large system is a 14-mile four-track entrance to the city of Los Angeles, built on a private right-of-way reaching to within a very short distance of the terminal station. This four-track route affords a high-speed terminal entrance for the four double-track divisions which extend south and southeast of Los Angeles to Whittier, Santa Ana, the ocean beaches and to the port of San Pedro.

The maintenance of way department closely supervises the amount of work performed by its section and track gangs. The roadway is divided into 30 sections and there are eight extra gangs with a total of about 250 men at work continuously on extensions and improvements. By means of a large chart ruled with spaces for making entries opposite the name of each section foreman for each day of the month, it is possible to see conveniently whether the total number of hours' work by any one gang or all of the gangs exceeds the fixed amount which it is decided shall be spent during the month. In addition to this method of checking the number of hours worked daily by each gang, the section gangs are checked frequently by a traveling timekeeper, who also checks the extra gangs twice each day.

The maintenance of way department is now rebonding all of the company's tracks with electrically brazed bonds. Two bonding cars supplied by the Electric Railway Improvement Company, Cleveland, Ohio, are being used in this work. An experimental tie-treating plant recently has been installed.

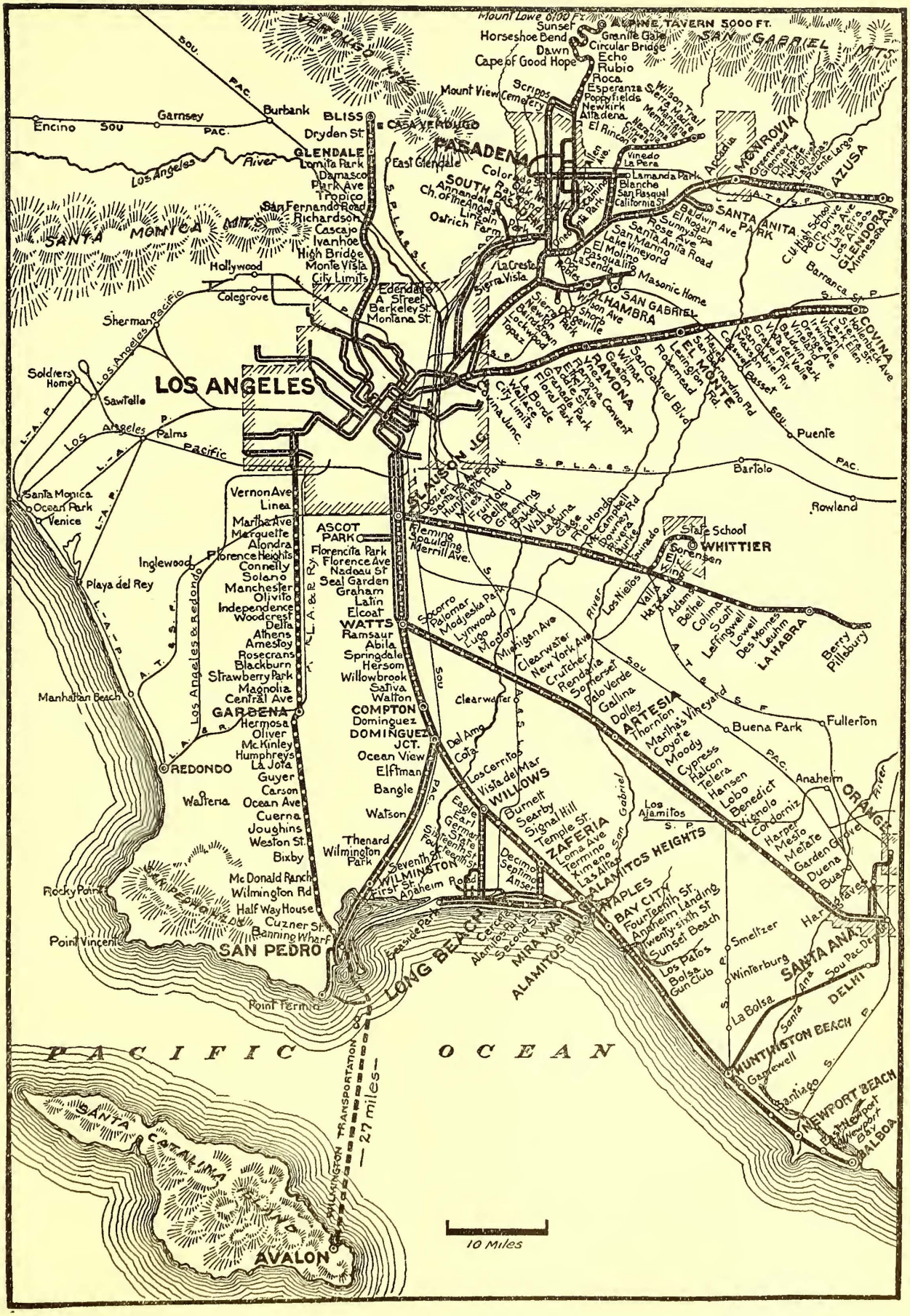
INTERLOCKING PLANTS

Wherever the tracks of the Pacific Electric cross intersecting steam lines interlocking plants have been installed. The plant at Oneonta, on the Pasadena branch of the Southern Pacific, has a 16-lever machine installed by the Union Switch & Signal Company. At Amoco, on the 4-track division, and within the city limits, where the Southern Pacific Railway's double-track line to Santa Monica crosses the four-track line of the electric railway, is an electrically operated interlocking installation built by the General Railway Signal Company. This installation has 40 levers, of which 30 are working levers. At Slauson Junction, where the Redondo line of the Santa Fe Railway crosses the four-track Pacific Electric line and also where the two-track division of the Pacific Electric to Whittier leaves the four-track line there is a 50-lever interlocking installation with 40 working levers. The design of this installation is the same as that at Amoco. In 18 hours, for regularly scheduled electric trains only, the Slauson interlocking plant averages between 1,800 and 2,000 signal movements. The plant is so well designed and maintained that it frequently operates for 90 days without a single failure. At Dominguez the operation of trains to and from Los Angeles, San Pedro and the ocean beaches is controlled by a manual interlocking 32-lever machine installed by the Union Switch & Signal Company. The crossing with the Southern Pacific system at this point is also protected by this interlocker.

The southern end of the four-track route is at Watts. From this point two tracks extend to Santa Ana and two to the ocean beaches. Until recently it was the practice for all through trains to stop at Watts for local passengers from Los Angeles. It was found, however, by reason of this practice that through cars were crowded with passengers who properly should ride on local trains. A four-blade signal was erected in front of the station and now the southbound limited trains do not stop unless signaled that there are passengers or orders waiting.

The design, erection and maintenance of interlocking towers and telephone and signal work are all under the direction of a department head known as superintendent of telephone, telegraph and signals. The dispatching of trains is done with telephones installed at depots and in booths along the lines. The Postal Telegraph Company has offices in all of the Pacific Electric Railway depots. The railway company recently purchased 300 Western Electric telephone sets for use on its dispatching wires. These instruments will replace an assortment of older types, which are not standard.

The famous Mt. Lowe railway forms a part of the Pacific Electric system. This scenic road includes a cable incline, which is 3,000 ft. long and has a difference of elevation of 1,325 ft. between its two ends. Its two cars are under the control of an operator in a driving station at the top of the incline. Motive power is supplied by a 100-hp 550-volt motor geared to a Holliday cable-grip wheel driven at 13 r.p.m. From the summit of the cable incline a narrow-gage trolley line operates for 5 miles to the Alpine Tavern, owned by the



Pacific Electric Railway—Map of Interurban Lines Near Los Angeles

railway. A roadbed for this narrow-gage line has been cut out of the side of the mountain and has an average grade of 7 per cent for its entire distance.

TRAFFIC AND TRANSPORTATION

The transportation department of the Pacific Electric Railway is in charge of a general superintendent and three division superintendents. The operation of trains is closely in accord with steam railroad methods. There are 370 passenger cars, 430 freight and express cars and 17 locomotives or construction motor cars available for service. The types of passenger and freight equipments were illustrated and described in the Electric Railway Review for July 24, 1907, page 64. All passenger cars are built with a half-open end, but the siding along the open section is brought up to the window level to stiffen the body framing. The underframing comprises four 7-in. 15-lb. I-beam sills, the center sills extending from bumper to bumper. Quadruple sets of General Electric 76 or Westinghouse 112 motors controlled by the Westinghouse electro-pneumatic multiple-unit control system are used. The air-brake equipment is the Westinghouse AMM schedule. St. Louis Car Company type 23-B trucks are used and this company also built the larger part of the car bodies. These large passenger cars have seats for 56 passengers and weigh complete about 68,800 lb. They are equipped with M. C. B. type couplers and a train control line for multiple-unit operation.

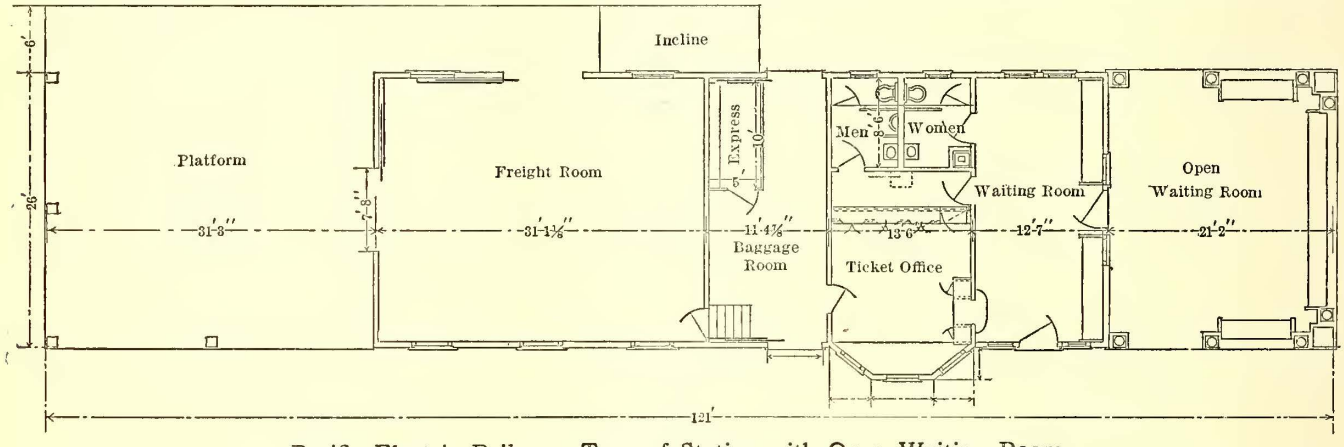
The freight equipment conforms closely to M. C. B. standards. One of the several types of freight locomtives weighs 102,800 lb. and has four Westinghouse 86-A motors of 200-hp capacity each, with General Electric multiple-unit control, Westinghouse automatic air brakes and a motor-driven compressor of sufficient capacity for handling the brakes on long freight trains. The motors have a gear ratio of 65:17. In actual service one of these locomotives has handled easily over the Pacific Electric lines from Los Angeles to Long Beach, trains of 14 standard Pullman sleeping cars. The present rolling stock equipment will soon be increased by the addition of 50 Hicks ballast cars, 50 steel flat cars and 50 passenger cars, some of which will be used for local service within the city.

PASSENGER TRAFFIC

The organization of the passenger department includes a general agent, a Los Angeles city passenger agent, three traveling passenger agents and the 38 station agents. With this department rests the responsibility for building up traffic, and therefore it maintains an aggressive campaign of general advertising and soliciting by letter and in person. The company has so many attractive rides to offer and has such excellent fast service that this department has been remarkably successful in building up an enormous special business. During the summer months there is hardly a day but some picnic is to be handled from Los Angeles to some one of the termini, favorite points being along the beaches on the Pacific ocean shore.

The passenger department has charge of the advertising and uses the daily newspapers extensively. This advertising is, of course, governed by the season and by the amount of tourist travel. There are 425 tourist apartments in Los Angeles and each is kept supplied with Pacific Electric literature. At the larger hotels the information clerks also are kept supplied with large stocks of publicity matter describing the interesting points to be reached by the Pacific Electric lines.

The passenger department keeps in touch with all special trains leaving the Eastern cities which are destined for points near Los Angeles. These trains are met at points as far east as Salt Lake City and Albuquerque by traveling passenger agents, who distribute Pacific Electric publicity matter and make definite arrangements for handling parties over the Pacific Electric lines. The agents have in hand the correspondence that has been carried on between the originating steam line and the Pacific Electric Railway and meet the persons in charge of the party or the tourist agent, and either sell tickets for the entire party to take the more important trips offered



Pacific Electric Railway—Type of Station with Open Waiting Room

by the Pacific Electric Railway, or make a personal canvass of the train. If so desired the passenger agent is prepared to make up combination trips, including Mt. Lowe, Catalina Island, San Gabriel Mission, Long Beach, etc. All such tickets are sold at the regular excursion rates. These special parties are taken over the various lines in special cars and every attention is shown by the passenger department, which sends a representative with the party to explain local features of interest.

In seeking business from such large conventions as that of the Order of Elks held in Los Angeles, this summer, the Pacific Electric Company keeps men in the important railroad centers about 24 hours east of Los Angeles. These men organize excursions and sell special party tickets to all excursion parties bound for Los Angeles. Before the Elks' convention the passenger department corresponded with the secretaries of the various lodges and endeavored to make arrangements for the special trips. Nearly 70,000 postcards illustrating attractive features to be reached on its lines were sent out by the Pacific Electric Railway Company. Thus, the work of the traveling passenger agents who greet the incoming excursionists and tourists is begun before meeting the parties. All Raymond & Whitcomb and other tourist agency parties are booked in the East for these tours, which include the Mt. Lowe trip and the combination electric and steamer trip to Catalina Island. The New York Central and the Pennsyl-

vania Railroad companies' agents in the East have coupons for these trips which can be used in building up a ticket to include these features.

One of the largest picnics organized by the traffic department during the past year was a barbecue at Arcadia, 18 miles from Los Angeles, on July 17. The capacity of the railway system for handling dense traffic was well shown at this time when the service given included 80 large interurban cars per hour with an average of 145 people per car.

The Catalina Island trip, which includes a ride of 27 miles straight south on the Pacific ocean from San Pedro to Avalon, is the source of considerable regular and tourist traffic. The electric trains which carry passengers from Los Angeles to meet the Catalina boats at San Pedro are operated separately from the regular hourly interurban service to San Pedro. Boat trains ordinarily are made up of three or four cars. On Sundays, when three boats are operated between San Pedro and Avalon, as many as 18 carloads of passengers for Catalina alone frequently are handled.

In addition to its enormous special traffic, the Pacific Electric Railway has a heavy regular riding suburban traffic made up of people who live in Pasadena and the nearby valley or at points along the 50 miles of ocean shore served by the electric line. The passenger department is now filing tariffs with the Interstate Commerce Commission for a through business from Los Angeles to San Francisco, Portland and North Coast points by way of the Pacific Electric from Los Angeles to San Pedro, and thence by steamship. Considerable joint business is done with the steamship lines operating from San Pedro to San Diego.

The large amount of special traffic initiated by the passenger department of the Pacific Electric Railway calls for the careful handling of special car business. The company, in making arrangement for special cars, reserves the right not to charter them for any Sunday, holiday and other day of heavy traffic, such as annual excursions, church picnics, etc. When arrangements are made for a special car or train the passenger department fills out a blank order specifying whether the regular type of car or a special type is desired, the number of people to be carried and the time of the run, sending this information to the general superintendent. In this connection the minimum number of passengers for a special car is 40 and the maximum is the seating capacity of the car. When he receives the advice the general superintendent issues instructions to the division superintendent regarding the handling of the special car and then the passenger department furnishes the party with special chartered-car tickets good only on the car for which arrangements have been made. The date is stamped on these tickets and the purchaser advised that his ticket is good only on the special car. Thus the regular trains are relieved from handling special parties.

The Pacific Electric Railway operates funeral cars over its entire system. Within the limits of the principal cities served —Los Angeles, Pasadena, Long Beach, San Pedro and Santa Ana—the rate for a special funeral car is $10 without casket, and the number of passengers is unlimited. If a casket is carried the rate is $15. Funeral parties traveling from one city to another on the interurban lines are handled as chartered car business and the casket is carried without charge.

The traveling passenger agents have been successful in booking several excursion parties for chartered cars for an 8 to 12-hour trip. Such parties frequently are made up at the hotels and a car will be chartered for their use during the entire day. Runs are made to the interesting points, usually including the 50-mile trip along the beaches. If desired the passenger department will send a representative with such parties to point out the features of interest and make arrangements with the operating department of the road for the routing of the car at the wish of the occupants. For such a special car service the regular one-way rates between stops are charged for each passenger, and to this are added a charge of $5 for special car service and 20 cents per mile for dead mileage.

FREIGHT HANDLING

The principal freight handling center of the Pacific Electric Railway is the large new freight station at Eighth and Hemlock Streets, Los Angeles. This station is illustrated on Plate XLIII. On account of the crowded condition of the streets in Los Angeles nearly all freight trains are handled between 12:30 and 5 a. m. As many as 120 loaded cars are taken across the city in one night. Some of the special sources of traffic are fruit, sugar beets, garden stuff and crushed rock. There are two large rock crushers on the lines which furnish material for the street paving in Los Angeles and also for use in construction work along the ocean shore. The company has several agreements with the purchasers of rock for night delivery at different points on the line. One of these agreements includes 30 cars per day. About 20 carloads of sugar beets are handled per day over the new 10-mile connecting line between Huntington Beach and Santa Ana. Huntington Beach is on the double-track line which parallels the ocean, and Santa Ana is inland about 10 miles at the terminus of a double-track branch extending to Los Angeles. The beet traffic lasts for five or six months each year. Each day 20 cars of beets, in addition to the local delivery of 20 cars, are hauled to Los Angeles for delivery to the Southern Pacific Railway for through shipment. The beet cars are loaded through traps from farmers' wagons. During four months of the year four carloads of berries per day are carried into Los Angeles. The new Huntington Beach line passes through a large celery-raising district, and thus is the source of considerable freight destined for the commission houses in Los Angeles. Twice each week the electric freight trains make connections with the steamers to and from San Diego; once each week a steamer from Seattle, and twice a day with the boats running to Catalina Island.

LOS ANGELES RAILWAY

An abundant train service has brought about a marvelous growth in the suburbs and the district tributary to Los Angeles. The track of the Los Angeles Railway Company is all built to 3-ft. 6-in. gage and is largely laid with 7 1-4-in. high T-rails weighing 87 lb. per yard. In the paved streets the rails are supported by wooden ties 6 in. x 8 in. x 6 ft., ballasted with 12 in. of crushed rock extending nearly to the tops of the ties. Above the rock is a 4-in. bed of concrete supporting the 2-in. asphalt surface. During the past summer some concrete ties have been laid on Spring Street, one of the most heavily traveled thoroughfares of the city. About three years ago the company began welding its rail joints by the Thermit process and since that time more than 16 miles of track have been welded. The base and the web of the rail, but not the head, are joined with the weld.

The Los Angeles Railway Company operates 365 cars in regular weekday schedule and 398 cars in Saturday schedule. Typical cars were described in detail and illustrated in the Electric Railway Review for July 17, 1907, page 4. Their design conforms to the so-called "California" type,

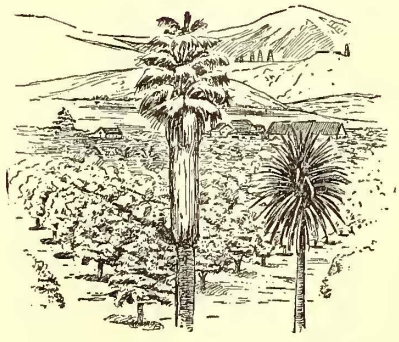
with two open ends and a closed center. Each car has two pairs of trucks with 5-ft. 7-in. wheel base, each carrying one Westinghouse 101-L motor. An illustration on Plate XLV presents the exterior appearance of one of these cars. The company owns 533 motor cars. All cars are equipped with Eclipse fenders, which are said to give excellent service.

Operation of the cars within the city and suburbs is controlled by a telephone system of dispatching, which in general is like that described in this issue for the Denver City Tramway Company. The repair and car-building shops of the Los Angeles Railway are located at the southern edge of the city and comprise a group of buildings occupying two large city blocks. These shops and some of the interesting shop practices were described in the article earlier referred to.

Power for the operation of all the cars is either purchased from the Kern River Power Company to the amount of about 10,000 hp, or is generated in a steam plant operated by the railway company, which has a capacity of 5000 kw. A transmission loop about 18 miles long connects seven substations within the city. The equipment of these substations is made up largely of 50-cycle motor-generator sets of 1000-kw capacity. Storage batteries are operated in connection with several of the substations. A combined substation and office building for the power department of the railway company recently has been erected at Sixteenth and San Pedro Streets. This building is 105 ft. 7 in. long and is subdivided into three bays: a generator room 36 ft. wide, a transformer room 13 ft. wide, and a store room, shop and office section two stories high and 25 ft. wide. The building is 27 ft. high to the roof trusses and is constructed with reinforced concrete foundations and floors and brick side walls. The two-story section is subdivided on the first floor into a machine shop 32 ft. long, a store room 47 ft. long and a vault and lavatory. Above these rooms on the second floor the subdivisions provide for the accommodation of the electrical engineer, who has a private office 19 ft. x 25 ft.; a main office 40 ft. x 25 ft., and drafting and meter rooms 22 ft. and 18 ft. long, respectively, by 25 ft. wide. The offices on the second floor are reached by an outside stairway. In the Electric Railway Review for Sept. 14, 1907, page 302, the detail construction of a typical substation of the Los Angeles Railway was presented. The interior arrangement of the substation section of the new building conforms to the design of the substation earlier described.

LOS ANGELES & MT. WASHINGTON CABLE RAILWAY

THE Los Angeles & Mt. Washington Railway Company in June, 1909, began operating a novel cable road which is 3,000 ft. long and has grades in some places of 42 per cent. The road was built by real estate dealers to make available choice property located on the top of a hill between Los Angeles and Pasadena. The company operating the road is constructing a $50,000 hotel, which will be completed next month. It also proposes to develop a 12-acre natural park. At the lower end of the incline railway passengers transfer to and from the cars of the Los Angeles Railway. A view of one of the cable cars is shown on Plate XLV.



HISTORICAL INTERURBAN ELECTRIC ROADS

ALTHOUGH the first interurban lines were built prior to the application of three-phase transmission with direct current distribution to railway service, it can fairly be said that to this invention the existence of interurban lines of to-day is principally due. Previous to this invention the only way of distributing power for railway work at higher potentials than that of the trolley wire, in general use in this country, was by the booster—a cumbersome and wasteful device when used for continuous periods, or by direct current busbars of two voltages, against which the same charge can be made.

History in the construction of interurban electric railways was made earlier and more extensively in the Central Western States than in any other section of the country. The cost of construction was somewhat less in those States than in the East and the possibilities for traffic by reason of the neglect by steam railroads of the short-haul business between towns and cities appeared to be better. Successful early experiments led to other projects and somewhat the same pioneers and capitalists were interested in a number of the important lines.

In the selection of various properties for this historical treatment an interurban road has been assumed to be a new property that connected adjoining communities. Strictly suburban lines and horse roads converted for electrical operation were rejected.

In the collection of the data relating to early lines in the Central electric territory it was the intention to present to the readers of the ELECTRIC RAILWAY JOURNAL as nearly complete information as could be secured concerning various properties. Lines which might be termed "interurban" by the historian who traces in this day the efforts and troubles of those who built roads connecting adjoining communities in the early nineties, do not rank in construction or equipment with the more modern properties that began to follow six or eight years later; but the projects appeared daring at the time and some of them afforded an experience which led ultimately to greater affairs.

It was natural that the equipment for electrical operation of urban lines operated by horse power about 1890 should lead to projects for the construction of lines connecting adjacent communities, either by the extension of existing properties or by the promotion of new companies; and the various movements of this character which began to develop would undoubtedly have gone much further had it not been for the panic of 1893. It was better for the future of the properties that postponement was necessary until further advance in the application of electricity to railways should take place before extensive construction was undertaken.

With the construction of the Akron, Bedford & Cleveland Railroad, which was placed in operation late in 1895, many practices were adopted that were fundamentally correct and from which it has not been necessary to depart widely in the great development that resulted shortly afterward from widespread appreciation of the possibilities and public necessity for interurban electric railways and of the business confidence which was made certain by the election of 1896.

With the construction of two of the earliest properties described in this issue Will Christy, of Akron, was identified. His subsequent construction of the Akron, Bedford & Cleveland road, in which Henry A. Everett and E. W. Moore were interested, was the initial development of the distinctive interurban line of a type that still remains standard in many respects. In Indiana Charles L. Henry did the work of the pioneer.

Progress of a similar character was also made in Michigan. The Rapid Railway Company was organized in 1895 to build a road between Detroit and Mt. Clemens, a distance of 17 miles, and cars were operated in 1896. Two years later another line was built between Detroit and Mt. Clemens, following the lake shore. After a short period of independent operation a consolidation was effected and an important extension was built to Port Huron, making the entire system one with 122 miles of track. This was probably the largest of any interurban system at that time. Both of the older lines had used the 500-volt direct-current system of power supply with boosters, but after the decision to extend to Port Huron the question of power distribution became a very serious one and led to the adoption, by Westinghouse, Church, Kerr & Company, the engineers of the line, of a three-phase installation with five substations and transmission at 15,000 volts. The installation was unique, inasmuch as it was not connected in any way with power distribution for lighting or for other than railway purposes and soon demonstrated the great superiority of the three-phase method of transmission over the booster. For many years Michigan maintained and still possesses a very high record for the excellence and extent of its interurban lines.

The adoption of a third-rail system, with the rail outside of the track, by the Albany & Hudson Railroad, which was completed in 1900, established another important date in interurban railway history. The practicability of this construction had been shown on the Metropolitan West Side Elevated Railway in Chicago in 1895 and on the Intramural Railway at the Chicago World's Fair in 1893.

Before beginning upon the detailed description of some of the early electric lines, a short statement in regard to the use of the word "interurban" may not be out of place. Although its literary standing is now unquestioned, it is of comparatively recent origin and has been included in the dictionaries only within the last few years. The first use of the word in a publication, of which the writers of this article can find record, is that on page 529 of the STREET RAILWAY JOURNAL for August, 1893, where it was used to describe a road, about 6 miles in length, between Buffalo and Tonawanda, then recently completed. It is interesting to know that in the same issue A. H. Chadbourne, in an article on the growth and possibilities of the "suburban" electric railways, commenced his article by saying, "The word 'suburban' in the heading of this article hardly covers the conditions that I wish to speak of, since I refer to the extending of electric railways through a series of towns and villages, the beginning of which may lie beyond what may be called the suburbs of the central point to which they are connected." Charles L. Henry of Indianapolis, to whom popular tradition assigns the credit of having coined the term "interurban," says that it was suggested to him by the name of the intramural railroad at the Chicago World's Fair in 1893. Its immediate widespread adoption showed that it was a most useful addition to the English language.

NEWARK & GRANVILLE STREET RAILWAY COMPANY

(Now a Part of the Ohio Electric Railway)

THE following particulars regarding the Newark & Granville Street Railway Company have been given to the ELECTRIC RAILWAY JOURNAL by J. A. Flory, of Newark, Ohio, who was the first secretary of the company:

The company was incorporated on May 10, 1888, under the laws of Ohio with an authorized capital stock of $100,000, to build and operate an electric railway from the stations of the Baltimore & Ohio Railroad and the Pittsburg, Cincinnati, Chicago & St. Louis Railroad through the city of Newark and the country outside to the depot of the Toledo & Ohio Central Railroad in Granville.

Originally it was the intention of the company to install the underground conduit system, but as this was found to be impracticable, it was decided to use the single trolley overhead system. For want of means the enterprise was dropped until the spring of 1889, when the citizens of Newark took hold of it and proceeded to construct the part of the road located within the city of Newark. As knowledge of electric railway engineering was very limited at that time the track was laid with flat rails on stringers, such as were used on horse railways.

The portion in the city of Newark was finished and commenced operation on Dec. 23, 1889, with one 16-ft. car mounted on a Manier truck and equipped with two 20-hp double reduction Sprague motors. The car was built by the Gilbert Car Company, of Troy, N. Y. The overhead construction consisted of a No. 6 silicon bronze trolley wire, with span wire construction. The power house contained one steam boiler and a high speed Taylor engine, belted to a small Edison power dynamo.

As some of the rails weighed only 30 lb. per yd. and were much too light for the cars used, the track had to be reconstructed soon. The Sprague motors cost $3,750 per equipment and were very expensive to maintain, as those who had charge of their operation knew nothing about them. The switch boxes on the cars also were the subject of continual care. No resistance coils were used and the cars started with a jerk. Another great source of trouble was lightning, which came into the power house and through the motors, continually burning out the electrical machinery. The so-called lightning arresters of those days were flimsy affairs and failed to protect the machinery. The result was that during severe lightning and thunder storms the car, with its passengers, stopped wherever it happened to be at the time.

The electric manufacturing companies were continually experimenting with their machinery at the cost of the railroad company, sending out first one device and then another; each was claimed to be an improvement over the previous one, but none amounted to much for the purposes for which it was sold.

The cars were continually breaking down, and it took a large part of the time, both day and night, to try to keep them in running order. Experts were sent out from the factory, but the only thing they seemed to know how to do was to experiment with the machinery at the cost of the railroad company.

Another enemy in the operation of the road was snow and ice on the track and trolley. No device seemed to be known by which the track and trolley could be kept clear of ice. The result was that the company had to keep a man on the front part of the car, with a long-handled shovel, to push light snow off the track. After a heavy snowstorm men were sent out to shovel off the snow. In the course of time other methods for cleaning the track became known, such as attaching steel brushes and shovels to the bottom of the car and letting them drag on the track. Men were also employed to ride on the front of the car with a long pole and knock the ice and sleet off the trolley wires so as to crack the ice and sleet thereon.

The construction of the railroad in the city of Newark was performed under contract with Will and James Christy, Jr., under the name of the Cleveland Construction Company.

In the spring of 1890 the road was completed from Newark to the depot in the village of Granville. The track on this section, like that of the earlier portion, was constructed of 35-lb. and 30-lb. rails, which, at the time, were thought amply sufficient for an electric railway roadbed when placed on oak ties. The trolley wire was of the same material and size as that already mentioned, with a small copper feed wire running the entire length of the road. The equipment consisted of four 16-ft. cars, two open trailers and one car equipped with two double-reduction 20-hp Sprague motors, somewhat better than the former motors. This entire road commenced operation on June 10, 1890.

On Nov. 13, 1890, the company entered into a contract with the United States Express Company for carrying all express matter for that company from Newark to Granville. On Dec. 6, 1890, it made a contract with the Post Office Department of the United States for the transportation of mail from Newark to Granville, and has ever since carried this mail, and either through an express company, or directly, has also always carried express and freight matter over its line. It was always supposed to be one of the first electric roads to carry mail and express.

The rails cost from $30 to $35 per ton, and the electrical equipment, as stated, was very expensive and needed constant replacement. The road was built by means of subscriptions to shares of stock and purchases of tickets by the people in the city of Newark and the country through which it operated, and by borrowed money secured by trust deeds upon the property. The 7 1-2 miles of road, four motor cars, three trailers and one open motor car cost about $120,000, of which $100,000 was borrowed and secured by a trust deed on the road and equipment, for which a bonus of $10,000 in money and about $40,000 in stock had to be paid, as people would not loan money upon the security offered except with a large inducement of this kind.

In 1893 the Newark & Granville Street Railway Company purchased the Newark City Street Railway property, which had been operated by horse-power, but was afterward electrified, paying therefor a little over $100,000. It continued to operate until 1895, when it went into the hands of a receiver, for the reason that the cost of construction, large expense for equipment, experiments and operation were so great that the income of the road would not enable the company to meet the obligations. The trust deed was foreclosed and the road sold. Since then it has changed hands three times until it is now a part of the Ohio Electric Railway system.

Mr. Flory adds that on looking back upon the limited equipment, the experimental steps through which this early road passed and the large expense of operation, it seems almost marvelous to consider the advanced state which such lines have reached. As to the difficulties of obtaining money at that time, Mr. Flory states that Mr. Christy "can tell you about the way he waited for his money while the company was using every possible means to raise it."

CLEVELAND & BEREA STREET RAILWAY

(Now a Part of the Cleveland, Southwestern & Columbus Railway)

THE present Cleveland, Southwestern & Columbus Railway system, operating 209 miles of track, was developed from a small beginning at Berea, Ohio. In 1884, A. H. Pomeroy purchased the horse-car line running from the settlement in the town of Berea, which had a population of about 2,000 at that time, to the station, a short distance away. Mr. Pomeroy, together with C. W. D. Miller and A. W. Bishop, had previously constructed a road in Sandusky, Ohio, and later one in Mt. Clemens, Mich. The line in Berea was retained by Mr. Pomeroy and members of his family for a number of years; and finally they decided to build an electric extension to the city limits of Cleveland, believing that sufficient traffic would be secured to justify this development. Before the extension was completed, the capital available became almost exhausted and other people were invited to inspect the property and to invest therein.

At a meeting at which these people considered the opportunities offered by the project, F. T. Pomeroy, son of A. H. Pomeroy; Dr. Harlan Pomeroy, a brother of A. H. Pomeroy, and A. E. Akins, the present vice-president of the Cleveland, Southwestern & Columbus Railway, agreed to acquire an interest if Will Christy would join them. Mr. Christy then held an option for purchase of the property so far as it had been constructed and the franchises; he agreed, however, to join the other people under the arrangement suggested.

When construction of the track was finished, a single storage battery car was operated in order to preserve the franchise rights of the company. The first car between Cleveland and Berea was operated, according to O. D. Pomeroy, president of the Bank of Berea Company, Berea, Ohio, on May 10, 1894. Operation of the property under these circumstances, although the arrangement was intended to be only temporary, was not entirely satisfactory either in service to the public or in gross revenue, and it was concluded after a short period to equip the line for overhead electrical operation. Mr. Christy had charge of the electrical construction. A power plant was built at Middleburg township near Berea and equipped with two Ball engines and other machinery that had been used by one of the Cleveland local systems. This machinery was used later for a line between New Philadelphia and Uhrichsville, Ohio, constructed by Mr. Christy and his brother, James Christy, Jr.

With the equipment of the line for operation electrically, three cars were purchased and were used constantly in the Cleveland and Berea service. One car was operated in Berea for the railroad station traffic. The company secured a great deal of business because of the novelty of the trip, and traffic developed steadily from the time the line was placed in operation with the new motive power.

In 1895 the interests which controlled the Cleveland & Berea Company organized the Cleveland & Elyria Street Railroad and built an extension from Elyria to a point on the Cleveland & Berea line called Kamm's Corners. Mr. Christy had direct charge of the construction of this line, which he supervised at the time the Akron, Bedford & Cleveland road was built. A subsequent merger of the Cleveland & Elyria and the Cleveland & Berea Companies was effected under the name of the Cleveland, Berea & Elyria Street Railroad. From that time, extensions by construction and consolidation have been made rapidly, effecting the present extensive Cleveland, Southwestern & Columbus Railway system.

F. T. Pomeroy, who was among those that acquired an interest in the road in 1894, was made general manager of the properties, a position which he held until the death of his father, A. H. Pomeroy, in April, 1906. At that time F. T. Pomeroy was elected president of the system to succeed his father. He continued to occupy this position until January, 1909, when ill-health compelled him to relinquish active work for the company.

SANDUSKY, MILAN & NORWALK ELECTRIC RAILWAY

(Now a Part of the Lake Shore Electric Railway)

THE Sandusky, Milan & Norwalk Electric Railway was organized as a successor of the Sandusky, Milan & Huron Electric Railway, which was formed to build a line from Sandusky to Norwalk with a branch to Huron, Ohio. In the issue of the STREET RAILWAY JOURNAL for September, 1892, it was stated that the Sandusky, Milan & Huron Electric Railway Company had filed articles of incorporation with capital stock of $100,000. In subsequent issues, it was reported that the necessary stock had been sold to provide funds for the extension from Milan to Norwalk and that the county commissioners at Norwalk, by a unanimous vote, had granted the company a franchise in Huron County. The plans formed by the first company were changed somewhat and the line, as constructed, extended from a point at the northeast corner of the Soldiers' Home, Sandusky, directly to Norwalk with a line and terminal in the main street of the latter city. There was no steam railway connection between Sandusky and Norwalk and none exists now.

The line as finally projected was 17 miles in length. The work of construction was begun in 1892, but operation was not started until the end of September, 1893.

The road was built with capital supplied by a number of residents of the district, including W. H. Gilcher, George H. DeWitt, T. B. Taylor, A. W. Prout, of Sandusky; Valentine Fries, of Milan; J. C. Gilchrist, of Vermilion, and W. H. Price and S. E. Crawford, of Norwalk. After the promotors of the line had raised all the money they could secure from local interests, additional funds were needed to continue the project on the scale which they had mapped out originally. Loans were outstanding with several banks, including the Erie County Banking Company at Vermilion, Ohio, of which Mr. Gilchrist was president, and F. W. Coen, now the vice-president and general manager of the Lake Shore Electric Railway, an employee. As this bank was the heaviest creditor of the company when financial conditions became acute, Mr. Gilchrist was appointed receiver and Mr. Coen was sent to Sandusky as representative of the receiver. The financial difficulties which had to be met arose from the need of about $15,000, which was finally raised and the receivership terminated after about three months. When the property became solvent, Mr. Coen was made cashier and kept the few books required.

The road was laid with 55-lb. rail, which is still in use on parts of the line. The first order for equipment was for five double truck cars, 36 ft. in length, equipped with two Westinghouse motors. The car bodies were supplied by the Jewett Car Company and the trucks by the McGuire Manufacturing Company. The car house at Milan was used as a power house and equipped with two 100-kw, Westinghouse 500-volt belted generators, McIntosh-Seymour engines and two 150-hp Babcock & Wilcox boilers. The engines and generators were sold a number of years ago and the plant has not been operated for eight or nine years. The build-

ing is now used as a paint shop by the Lake Shore Electric Railway. A substation was built at this point later.

Thomas Wood, who now lives in Cleveland, was the first operating manager of the company. Mr. Coen remained with the company until Nov. 25, 1895, when he went to Detroit for a few weeks, returning to Cleveland as assistant secretary of the Lorain & Cleveland Railway. This is also a constitutent property of the Lake Shore Electric Railway, so that with the gradual consolidation into the existing larger system Mr. Coen has been with the property during substantially all of his career with electric railways.

Subsequently, the Sandusky, Milan & Norwalk was consolidated with the property of the People's Electric Railway of Sandusky, which was controlled by the same interests. The consolidated property was known as the Sandusky, Norwalk & Southern Railway. Other changes took place and the railway was combined with other properties which formed a logical opportunity for consolidation, making the Lake Shore Electric Railway in September, 1901. The present system operates 215 miles of single track.

Mr. Coen states that no great trouble was experienced in starting operation of the early system. The city lines in Sandusky had been electrified previously and experience with that property gave the projectors of the new road an advantage which resulted in operation without much difficulty. Mr. Coen said that the obstacles in the way of interesting people sufficiently to secure the needed capital were so great that a large amount of transportation was given as a bonus.

THE CANTON-MASSILLON ELECTRIC RAILWAY

(Now a Division of the Northern Ohio Traction & Light Company.)

BEFORE the actual construction of an electrically operated railway between the cities of Canton and Massillon—distant between the main street centers about 8 miles—many attempts were made by different groups of non-resident capitalists and promoters to float the enterprise. These failing, local interests finally took hold and carried the project to a successful issue. W. A. Lynch, an attorney of Canton, Ohio, formerly associated with Judge William R. Day, now associate Justice of the United States Supreme Court, purchased control of the Canton Street Railway system. Mr. Lynch was also in control at the time of the Canton Electric Light Company. About the same time a franchise had been secured in Massillon for a local system in that city, and the same interests were projecting a line to connect Massillon and Canton independent of the Canton company. A consolidation was finally effected through which the interests in the two cities were united.

After a preliminary organization in April, 1892, one was formed subsequently with the following officers: W. A. Lynch, president, Canton; C. A. Gates, first vice-president, Massillon; R. A. Miller, second vice-president, Canton; A. J. Underhill, secretary, Canton, and the additional directors, J. W. Underhill, H. C. Fogle and W. L. Alexander, of Canton, and J. W. McClymonds and C. M. Russell, of Massillon.

In the Canton system there was already in operation on the street which, when continued, formed the main street of Massillon, about 1 3/4 miles of track. Grading and track laying along the line was begun and it was completed to the head of Main Street, near the corporation limits in Massillon, a distance of about 5.6 miles, on July 1, 1892.

Invitations were issued to the officials and leading citizens of both cities to partake of the hospitality of the new corporation. The cars containing the Canton guests left according to schedule and in due time reached the halfway station. The Canton guests sat for hours awaiting the delegation from the sister city and were finally compelled to return disappointed. In the meantime the Massillon guests sat patiently until cars lined up on the main street of the city, waiting and wondering, but the wheels would not turn. There was trouble at the power house at the Massillon lighting station, with which connection had been made to furnish current to a point half way between the two cities. The result was that the "opening" had to be called off, and not until early in the morning of the next day, July 2, 1892, was the trouble corrected. Then the officials boarded a car and made the first run from Massillon to Canton, and actual operation began.

In solving the problem of equipment Mr. Lynch secured the services of a railroad master car builder and proceeded to construct in the carhouse of the company at Canton two closed cars, without toilets, 38 ft. long with 11 seats on each side. The seats were wooden, covered with carpet. The cars had vestibules and controllers at each end and two trolley poles. This is said to have been the first time this arrangement was adopted in this country. A 16-cp incandescent light was used for a headlight. Two 30-hp Westinghouse motors were used. The trucks were J. G. Brill & Co. bicycle type No. 1. Later two more cars of the same type were built, but before they could be placed in service they were burned. Two open cars, each 42 ft. long, with 11 benches, were built in the company's shops and equipped like the closed cars. One single truck baggage car, 18 ft. long, with one 20-hp Westinghouse motor, was also built in the shops. These cars were supplemented by open and closed cars made by manufacturers, without electrical equipment, and used as trailers, constituting the "smoker" generally. It was not unusual to make up a train of one motor car and two or three trailers.

The power house consisted of three 150-hp Russell automatic engines, each driving two 60-hp direct-current bi-polar Edison machines of 550 volts. Three 72x18 boilers located in Canton were used to furnish current for the Canton system and the interurban line to a point halfway between the two cities. At Massillon two 120-kw Westinghouse d.c. generators were placed in the plant of the local lighting company and, driven by the latter company's engines, furnished current for Massillon and to the halfway point. The overhead consisted of No. 0000 insulated wire reinforced by side feeders extending from each city. As the Canton railway system at the time of constructing the interurban was of 4 ft. gage it was necessary to make the connecting line the same. T-rail weighing 52 lb. to the yard was used, laid on 6-in. x 6-in. sawed oak ties, with gravel bed. Though the same rails are in service to-day the gage was changed to 4 ft. 8 1/2 in. about seven years after the beginning of construction. The greatest grade was about 6 per cent, which, with the electrical provisions then made, required all the capacity of machines and transmission, and then left something to be desired. The first schedule provided for an hourly service.

In financing the interurban and Massillon line the local capitalists subscribed and paid for about one-third of the bond issue, receiving a small bonus of stock with each $1000 6 per cent bond. With this money paid in as a basis for credit the company issued its notes secured by the company's bonds for the necessities of the road and continued this arrangement for a number of years, until the bonds were finally sold.

The foregoing information was furnished by C. A. Gates, of Massillon, originally the first vice-president of the company.

THE AKRON, BEDFORD & CLEVELAND RAILROAD

(Now a Part of the Northern Ohio Traction & Light Company)

THE construction of the Akron, Bedford & Cleveland Railroad, begun in 1894, was the most important interurban electric railway project in the Central West up to that time. The history of the road as given to the ELECTRIC RAILWAY JOURNAL by Will Christy, now the vice-president of the Northern Ohio Traction & Light Company, and C. H. Howland, an attorney of Akron, Ohio, is as follows:

The owners of the Akron Street Railway built a line between Akron and Cuyahoga Falls, the construction of which was directed by Mr. Christy. As Mr. Howland was active as an attorney for the company in protecting its franchise in court proceedings, he made a careful study of the legal aspects of the case, and as a result concluded that he could draft a charter for an electric railroad that would carry the right of eminent domain. This conclusion was ridiculed, but Mr. Howland insisted that it was feasible. However, the suggestion was not adopted in connection with the line built by the Akron street railway to Cuyahoga Falls. It occurred to Mr. Howland that if this line could be a commercial success, it would be an excellent plan to construct an electric railway from Akron to Cleveland. When he suggested the plan to Mr. Christy and his brother, they took one day to consider the project, and decided to undertake it. The formal application for a charter was made on Oct. 13, 1894, and read:

These articles of incorporation of the Akron, Bedford & Cleveland Railroad Company, witnesseth, that we, the undersigned, all of whom are citizens of the State of Ohio, desiring to form a corporation, for profit, under the general corporation laws of said State, do hereby certify:

First. The name of said corporation shall be the Akron, Bedford & Cleveland Railroad Company.

Second. Said corporation is to be located at Akron in Summit County, Ohio, and its principal business there transacted.

Third. Said corporation is formed for the purpose of constructing, operating and maintaining an electric railroad with electricity for motive power, with single or double tracks, with such side-tracks, turnouts, offices, depots, shops, telegraph lines, telephone lines, switches, poles, wires, devices and all other necessary appliances for the operation of an electric railroad. It is also formed for the purpose of transporting passengers, packages, express matter, United States mail, baggage and freight over and upon said railroad. It is also formed for the purpose of generating electricity by steam or water power, and the selling of the same for light, heat and power purposes, and the owning of all necessary real estate to carry out said object.

Fourth. The kind of an improvement to be constructed under these articles of incorporation is an electric railroad with all the devices and appliances set forth in clause third of these articles.

Fifth. The termini of said railroad are as follows: first a point within the City of Akron, in Summit County, thence in a northerly direction through the counties of Summit and Cuyahoga to a point within the City of Cleveland, with branches extending from a point in Stow township in Summit County easterly through the counties of Summit and Portage to a point within the village of Ravenna in said Portage County.

Sixth. The capital stock of said corporation shall be $300,000, divided into 3000 shares of $100 each.

In witness whereof, we have hereunto set our hands, this 13th day of October, A.D. 1894.

(Signed) Jno. F. Seiberling, F. A. Seiberling, James Christy, Jr., Charles H. Howland, Will Christy.

The members of the Seiberling family were the owners of the local system in Akron.

Various contests concerning the charter were instituted. In Summit County the charter was contested on the ground that the company was not a railroad and could not have the power of eminent domain, but the probate court decided in favor of the railroad. In a series of suits started in Cuyahoga County, the contention of the company was upheld in every case. Mr. Howland said that the exact language of the charter was adopted later by many other Ohio interurban lines.

Rights-of-ways were secured on the highways for the entire line originally, but it was decided afterward to change the plan in order to reduce the distance and avoid some grades that it was found could be eliminated by the adoption of a new route. About 10 miles of the total length of the line was built on private right-of-way. The active work of grading was started on March 10, 1895, at Cuyahoga Falls, and also at the same time at Bedford, a point midway between Cleveland and Akron. As the contracts for equipment and material had been made in advance, different parts of the line were completed as the work progressed, and on Sept. 1, 1895, the company started operation from Cuyahoga Falls to Bedford. A little later the line was so far completed that cars were operated through to White House Crossing, one mile from the city limits of Cleveland. From that point passengers were carried at first by stage to Miles Avenue, Cleveland, connecting there with the city lines. Terminal privileges in the city of Cleveland were secured in 1896.

Mr. Howland has a clipping from a newspaper of Akron, published early in November, 1895, which reported that the last spike was driven. This article stated: "The Akron, Bedford & Cleveland Electric Railroad, the finest in the country, is completed. The last spike, a silver one made of eight Dueber watchcases by Jeweler Philips, of Cuyahoga Falls, was driven at 5:09 o'clock Saturday afternoon. * * * C. H. Howland, who originally proposed the road, was to drive it. This gentleman, however, was unable to be present, so the spike was driven by officials of the road and a number of invited guests. Exactly at nine minutes after 4 o'clock, James Christy, Jr., placed the spike in position and Mrs. Charles H. Howland struck the first blow. The lady missed the mark the first time."

Among others who struck the spike were William Ellsworth Davis, electrical engineer of the Detroit Street Railway, Superintendent Frank J. J. Sloat, Manager Will Christy, Director James Christy, Jr., J. H. Weeks, pay-master; J. F. Kronk, line foreman, and J. W. Colwell, track foreman.

In discussing the difficulties of construction, Mr. Christy referred to a fill in a piece of swamp land where a pit was found into which several thousand carloads of dirt had to be thrown. The No. 0000 trolley and feeder wires were thought to be very large at the time, and these features attracted a good deal of attention from railway officials and others interested.

The same power arrangements that were adopted at the time of construction of the line are in use now, although supplemented by additional machinery. A 300-hp engine with a 350-kw generator direct connected and four boilers have been added to the Cuyahoga Falls power house. A storage battery has been added to the Bedford plant, together with a condensing system. Stirling boilers were used. Two engines were installed in each power station with 200-hp Cooper-Corliss engines. Each engine was belted to a 250-kw generator of what was then known as the "double current" type. They were built by the Westinghouse Electric

& Manufacturing Company, and were really rotary converters, designed either to give a.c. and d.c. when used as generators, or to be employed as converters if a.c. transmission from another station should be installed later. Mr. Christy says that the engines and generators as operated to-day are still giving splendid service.

The specifications for the first cars were prepared by Mr. Christy. Some of those who were consulted about the plans thought it would be a great mistake to build double truck cars, but Mr. Christy adhered to his idea that this would be the only satisfactory type for the service that was planned. Two of the cars comprising the first equipment were built by the Barney & Smith Car Company and the balance by the Jackson & Sharp Company. Traffic developed so satisfactorily that in 1896, the year following that in which operation was started, 10 additional cars of substantially the same type were purchased from The J. G. Brill Company. As general manager, Mr. Christy selected the first trainmen, who were obtained principally among the employees of the Akron Street Railway. The first crew was composed of Henry Wing, as motorman, and Metlin Hard, as conductor. These men are still employed by the company and operate the first limited train each morning from Akron to Cleveland.

In speaking of the early discouragements, Mr. Christy said that the air brakes and control proved to be so unsatisfactory that they had to be abandoned before the first year was completed. During this year and the succeeding one, experiments were made with many different kinds of air brakes, trucks and controllers. The operation of cars with three motors was tried, and finally, in 1897, it was decided to use four motors, a practice which was adopted later by all similar interurban roads. Mr. Christy believes that the demands of the companies for improved apparatus forced manufacturers to take steps to meet the needs of the properties.

"When we demanded four-motor control," Mr. Christy added, "the first thing the manufacturing company did was to offer a double control system. We wanted motors that would permit us to operate cars weighing 30 or 40 tons at a speed of 35 to 40 m.p.h. The manufacturers seemed to be unable to appreciate how successful the results would be. It is astounding now to realize how much the early experiments meant in the subsequent development of electric railways."

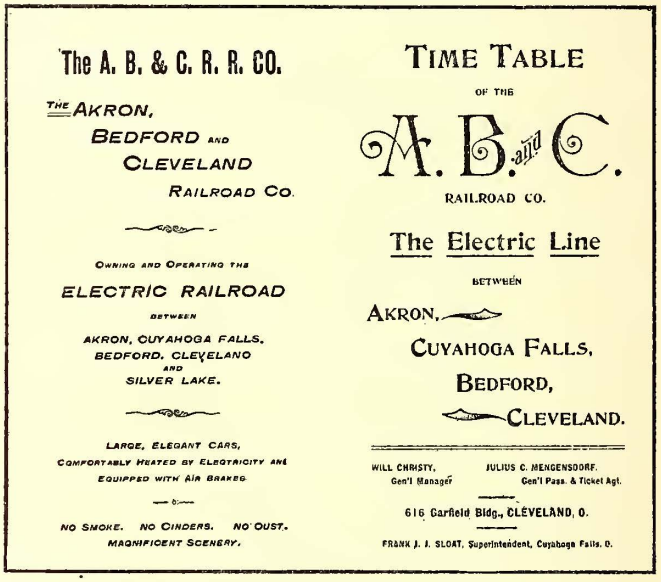
Within 60 days from the time the cars were run through from Akron to Cleveland, Mr. Howland said that the Cleveland, Akron & Columbus Railroad abandoned two local trains daily in each direction between Akron and Cleveland.

"The steam railroad officials," Mr. Howland recalls, "said we were crazy to expect much traffic. The Pennsylvania Railroad and the Wheeling & Lake Erie Railroad gave us readily the rights to cross their lines. They thought we could not amount to much of a competitor and that while we might carry a few passengers in summer, we certainly would not be able to operate in winter and that at any rate, if we could, people would not ride."

William Ellsworth Davis, now vice-president of the Cleveland Construction Company, who was afterwards a stockholder in the Akron, Bedford & Cleveland Railroad, and was employed as electrical engineer by the Edison Company when the Akron Street Railway was equipped for electrical operation, made the first circuit breaker ever used on an electric railway. This was made for use on the Akron Street Railway, for which many mechanical appliances had to be improvised. The simple contrivance was adopted also on the Newark & Granville Electric Railway and some of the other early lines. Mr. Davis recalls that after operation of the cars was started in Akron, they were sometimes followed on their trips up hill by junk dealers who collected the scrap that fell to the streets.

The financial problems connected with the construction of the Akron, Bedford & Cleveland Railroad became insistent during the early stages. Will Christy made many attempts to raise capital in other sources. Among those he saw was Charles W. Wason, who thought the project was so foolish that he rose from his chair to look for the hay-seeds on Mr. Christy. Afterward, Mr. Wason became interested in interurban lines and still retains a large interest in these properties. Finally, H. A. Everett and E. W. Moore were interested, and these men, with Mr. Christy, agreed to provide each one-third of the funds needed to complete construction.

"We estimated on a street railway line," said Mr. Christy, "and built a railroad. If I had known what the cost would be, I would never have agreed to furnish one-third of the necessary funds. It was just after the panic of 1893, prices were low and talk of prosperity was heard everywhere. We bought copper wire, delivered at Cuyahoga Falls at $10.65 per 100 lb. Ingot copper was selling at that time at $10.40, and it was made into wire and shipped from Waterbury, Conn., for the slight margin of 25 cents per 100 lb. Boil-



Akron, Bedford & Cleveland—Part of Cover of First Time Table

ers, including stacks, cost $5 per hp. Rails were purchased at $17 per ton. Motors were relatively higher. A ers, including stacks, cost $5.00 per hp. Rails were purchased at $17.00 per ton. Motors were relatively higher. A single equipment for a car cost $2,600 and the car body cost $1,400. It was only a very short while afterward that prices advanced to a much higher point. The manufacturers did not make any profit on the first cars. One salesman with whom I closed a contract said that there were 'tears in the prices.' His company wanted to keep its factory open and give work to its employees, and it could do so only by taking out contracts at prices which meant absolute loss. At the same time, we were in a position where we were straining in every way to raise the capital we needed.

The entire financing for the property was managed individually by Will Christy and Messrs. Everett and Moore until the completion of the first year of operation. The former estimated that the gross earnings during the first complete year of operation would be about $84,000. The actual figure was $86,000, although conditions of operation were necessarily unsatisfactory. The present earning capacity of this line is now nearly four times the record in the first year.

REMINISCENCES OF THE AKRON, BEDFORD & CLEVELAND ROAD

By F. J. J. SLOAT

THE Akron, Bedford & Cleveland Railroad as first operated about October, 1895, was considered the longest electric interurban road in the world; there were, however, several other interurban roads in operation at the time, among them the Cleveland & Berea Railway and the Sandusky, Milan & Norwalk Railway.

While the road connected the cities of Cleveland and Akron, the Akron, Bedford & Cleveland ownership was between Cuyahoga Falls, from which it was a distance of 4 miles to Akron over a road owned by the Akron Street Railway, and Newburg, 6 miles from Cleveland. From Newburg the line of the Cleveland Electric Railway was used. The intervening road of 26 miles, that is, between Cuyahoga Falls and Newburg, was owned by the Akron, Bedford & Cleveland Company. The through run from Akron to Cleveland was made on local cars in about 2 hours and 30 minutes. The road as constructed followed the county highway for the most part, with an occasional strip of private right-of-way. There were several severe grades; the principal one was in Akron, known as the North Hill grade, of 12.5 per cent, the distance being 1800 ft.

The road was supplied with 15 cars, seven of which were combination express and passenger and eight were straight passenger coaches, all, however, having smoking compartments, plush seats, toilet rooms, etc. The cars were about 40 ft. in length by 8 ft. 5 in. wide, with a seating capacity of about 38. The cars were constructed with motorman's vestibule on one end only, which necessitated the use of loops and Y's, which were located in Akron, Cuyahoga Falls, Newburg and Cleveland.

Late in 1896 a heavy motor car was constructed in the shops at Cuyahoga Falls which, with ballast to give it traction, weighed 24 tons. This car was to be used for hauling steam railroad excursion trains from Cuyahoga Falls to Silver Lake, a pleasure resort, and contracts for the movements were entered into with the Canton, Akron & Columbus Railroad, the Pennsylvania Railroad, the Northern Ohio Railroad and the Pittsburgh & Western Railroad, resulting in the movement of 21 trains during the season of 1897. These trains consisted of from 8 to 15 coaches loaded. The equipment on this car consisted of four 50-hp Westinghouse No. 38 motors, with slow speed gears, and operated from a rheostat controller. The car was designed and constructed in the shops at Cuyahoga Falls, with Dorner & Dutton trucks and Christensen's automatic air brake. It was of considerable interest to us after the first eight-car trains had been delivered by the Cleveland, Akron & Columbus Railroad, and handled with this motor, to find that the steam railroad people were not so skeptical as at first about this motor car.

On one occasion we received word that two sections of a certain train had 15 cars for us, but we were also asked not to attempt to pull the 15 cars as one train with our motor for fear of pulling out the draw bars on certain coaches.

CAR EQUIPMENT

The electrical equipment used comprised two Westinghouse B-38 motors and 30 hp each, or 100 hp for each car. The two motors were applied to the rear truck, the forward truck being used exclusively as a pilot truck. During the latter part of 1897 several quadruple equipments of General Electric No. 57 motors of 50 hp each, with electric brakes, were purchased.

During the year 1896 tests were made to learn the relative economy from the operation of 2-, 3- and 4-motor equipments, together with several newly designed controllers to handle the 4-motor equipments, our experience having proved that the controllers furnished with the equipment were too light and would not carry the heavy current necessary on the 12.5 per cent grade in Akron, or meet other requirements.

In the same year we tried the Lorain Steel Company's new quadruple 50-hp motor equipment and controllers. We also tried many trolley wheels and harps of various sizes and each of several kinds of metals, etc.

The air brakes supplied with the first equipments were furnished by the Hunt Air Brake Company, but owing to the severe conditions to be met, experiments were also made with the brakes of the Christensen Engineering Company and the Standard Air Brake Company. The first two companies furnished compressors having eccentrics fastened to the car axle, and the latter company furnished a compressor geared to the car axle. The great necessities of the situation and the desire on the part of the management to get the proper equipment were the incentives which inspired these experiments.

In connection with trying the axle-driven compressors the manufacturers did not install the proper relief valves at that time, with the result that we had considerable trouble on account of the air hose blowing off the compressor. This defect was remedied later by a newly patented device. We found, however, that the excessive speed of the cars, especially in coasting down grade, broke too many of the axle-driven compressors, so that this type of apparatus was abandoned, but not, however, until the various companies had placed on the market independent motor-driven compressors which were also tried on this property.

If my recollection serves me correctly, the Christensen Engineering Company was among the first in the field not only with the axle-driven compressors, but also with the independent motor-driven compressors. This improvement in the air brake equipment reached us about 1896.

The first trucks purchased for the Akron, Bedford & Cleveland cars were built by the Dorner & Dutton Company, of Cleveland, Ohio. They had 4-in. axles and 33-in. cast chilled wheels with 2 1-2-in. tread. The trucks were constructed with rigid bolsters, but after operating the trucks in this manner for about six months it became apparent that a swing bolster truck was necessary and the Dorner & Dutton Company, together with the Jackson & Sharp Company, furnished a number of sets of the M.C.B. type during the year 1896; during this same year about eight sets of No. 27 trucks were furnished by The J. G. Brill Company.

While all of the trucks having swing bolsters were satisfactory as to riding quality, the principal trouble was that they were not heavy enough for the work required of them and they were replaced later with other truck equipments.

From Cuyahoga Falls to Newburg the overhead line was constructed with 35-ft. poles set 100 ft. apart with one 2-pin cross-arm carrying two No. 0000 feeder wires, also two brackets carrying a telephone line. The trolley brackets were 7 1-2 ft. long and of the Christy type, carrying one No. 0000 trolley wire. The telephone line was installed to dispatch the cars from an office located at Cuyahoga Falls. The telephones used were furnished by the Garl Electric Company, of Akron, Ohio, which furnished also the switchboard, closed circuit type, with magneto generator operated by a belt from the engine shaft at the power house. As the telephone line paralleled the 550 trolley and feeder lines, the induction from these lines gave us the usual trouble, which took patience and work to overcome at that time.

All the cars were supplied with car telephones; telephone booths were installed at each siding also. At every 1000 ft. a connection box was installed on a pole for use with car telephones. This road was possibly the first road to be dispatched by telephones from a central office, and with the arrangements also of telephone booths at sidings and connecting boxes each 1000 ft. and telephones on the cars.

The track between Cuyahoga Falls and Newburg was laid with a 60-lb. T-rail with Heath joints. These joints Mr. Christy had specially rolled in Cleveland. The ties were 5 ft. x 7 ft. x 7 ft., but the renewals were made with standard ties. The track was ballasted with gravel.

A brick car house was located at Cuyahoga Falls, with a capacity for 16 cars, and later a machinery shop was added; all the repairs to the cars were made there. A small frame car house was also constructed at Bedford for the use of cars which were laid up at that point.

The track lay-out for the car house at Cuyahoga Falls was so arranged that cars could enter from the rear as well as from the front, facilities which seemed to me at the time to be very liberal and the benefits accruing were certainly worth the expenditure.

The bond was No. 0000 and of U-shape, riveted to the foot of the rail, the Heath joints having a receptable immediately under the joint of the rail to provide a sufficient space for the bond.

There were two power houses on the property, one at Cuyahoga Falls and another at Bedford. The machinery in each power house was alike, consisting of four Stirling boilers, two simple Allis engines and two 250-kw Westinghouse d.c.-a.c. generators.

The Cuyahoga Falls power house was of brick construction throughout, and large enough to admit of an increased capacity similar to the machinery installed at that time.

The Bedford station, while complete, was intended to be temporary for a few years, for the reason that the development of the d.c.-a.c. apparatus and the use of substations was yet in its infancy, and the intention was to move the Bedford machinery to Cuyahoga Falls and generate there all the power for the property, transmitting it by high tension lines wherever it was needed.

At this time it appears to the writer that great credit should be given to the engineers in designing this arrangement, as it seems to him to be the first installation of its kind, and the future development of the d.c.-a.c. arrangement was certainly well considered.

TRAFFIC ARRANGEMENTS

A passenger agent was in charge of the traffic on the Akron, Bedford & Cleveland road. The traffic between Akron and Cleveland was, as nearly as I can recollect, principally through travel or representing the longer hauls, about 40 per cent being local or intermediate travel. Hourly service was operated between Akron and Cleveland. Considerable special car and excursion business was handled during the summer season, and as many as 15 carloads were moved out of Akron for Cleveland, all leaving within one hour, to make connections with the boats for Detroit and Buffalo. A large excursion business was also handled daily from Cleveland to Silver Lake, located near Cuyahoga Falls, and from three to eight cars were necessary for these movements. As early as 1896 a contract was made with the American Express Company for the express privileges on the property, pro-rata with the Akron Street Railway and the Cleveland Electric Railway. Only compartment cars were used, however, by the express company, and only light express was hauled. Baggage was checked to all points on the road and in the same manner as was customary with steam roads at that time.

The property was greatly handicapped during the latter part of the year 1859; a bridge over the Gorge near Bedford gave way while a car drawing a load of coal was passing over it. This practically cut the road in two for a period of three months, and had a serious effect upon the earnings, especially during the early part of 1896. Through travel was accomplished by the transfer of passengers in wagons and buses for a distance of about a mile around the break.

As the road was conceded to be the longest interurban line at that time, necessitating two power houses, hardly a day passed without visits from persons in other parts of the country who had in mind the construction of interurban roads and were interested in investigating the property, its traffic, etc.

Considering present practices on interurban roads of to-day, the fact remains that as early as 14 years ago this property, one of the first interurban roads that was built, was completely equipped in all its departments, and, while its construction and equipment were somewhat modest, as compared with our present views regarding construction, the property notwithstanding is still in existence; although somewhat reconstructed and improved, the ear-marks of the original road are still very much in evidence.

I will enumerate as nearly as I can the principal details in connection with this road, to show how much difference there is between the practices of 14 years ago on this property and those of the present time.

The operation was in charge of a vice-president and general manager, a superintendent, two dispatchers and an inspector. The accounts were in charge of an auditor and assistants. The movement of all cars was recorded on a train sheet kept by the dispatcher.

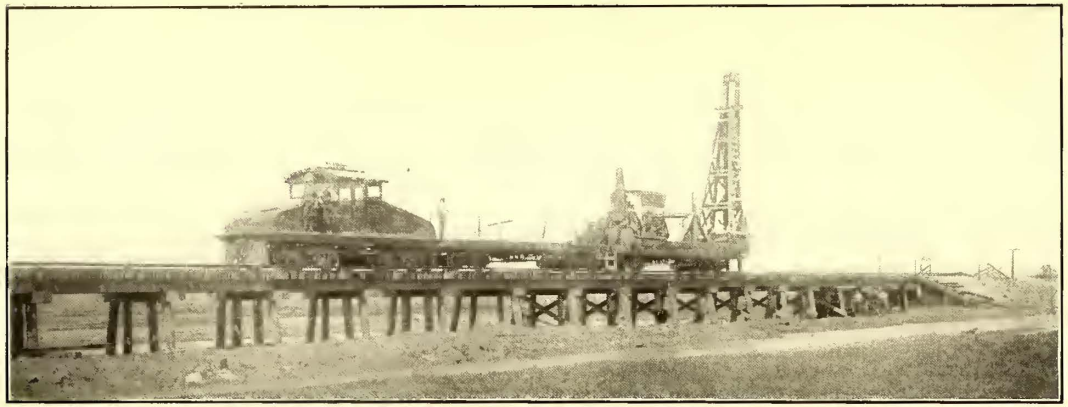
The inspector was located at the Cleveland end of the road. The shops and car barn were in charge of a master mechanic who had charge of all the equipment, with the usual foremen, both day and night. The line work was in charge of a line foreman, with the usual linemen distributed as necessary.

The power houses were in charge of a day and night engineer, the day engineers in each case being the chief engineers of the respective houses.

The traffic was in charge of a passenger agent, who also had charge of all tickets and rate-sheets, etc., and whose entire time and attention were devoted to the traffic and excursion business of this property.

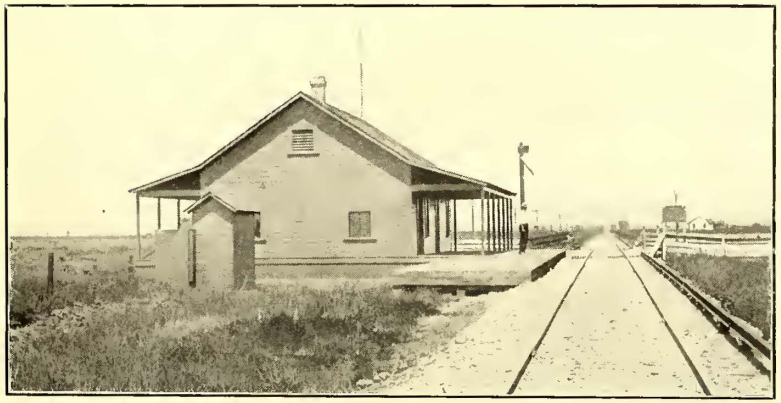
The United States mail was carried on the cars under contract. The American Express Company had the express privileges on the property. Traffic arrangements existed with the Akron Street Railway for entrance into Akron, and with the Cleveland Electric Railway for entrance into Cleveland.

Important features of the construction and operation were: The early installation of the d.c.-a.c. generators in the power houses, having in mind the future use of transmission lines, substations, etc.; the installation and use of No. 0000 trolley wire and No. 0000 feeder wire; the location of the two power stations 12 miles apart and tied together, so that they could feed into the same feeder wires; the dispatching of cars by telephones from the dispatcher's office, together with installation of telephones in booths at the sidings, as well as the equipment of each car with a car telephone, and the installation also of connection boxes located on the poles every 1000 ft.; the development in air brakes, ranging from axle-driven compressors to independent motor-driven compressors for straight air application, and also automatic air application; the development in trucks from rigid bolster trucks to swing bolster trucks; the development from the use of two motors to an equipment



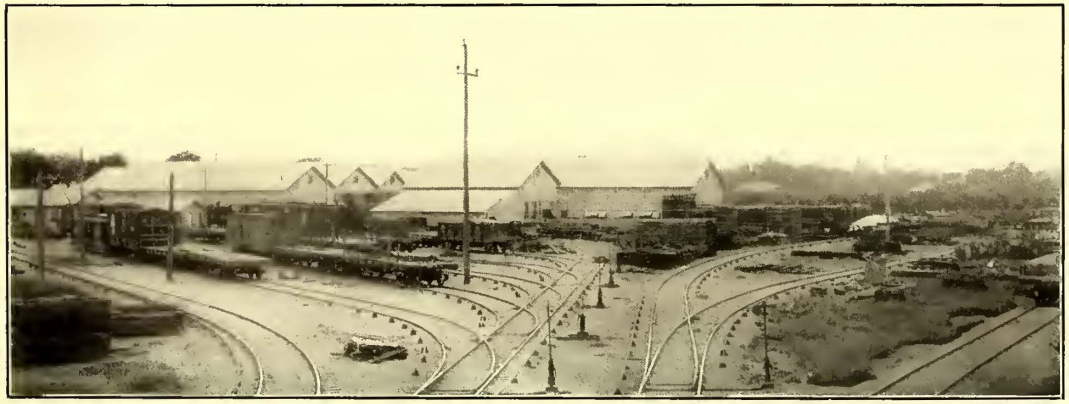
Northern Electric Railway—Bridge Construction Train

Northern Electric Railway—Type of Shelter Station



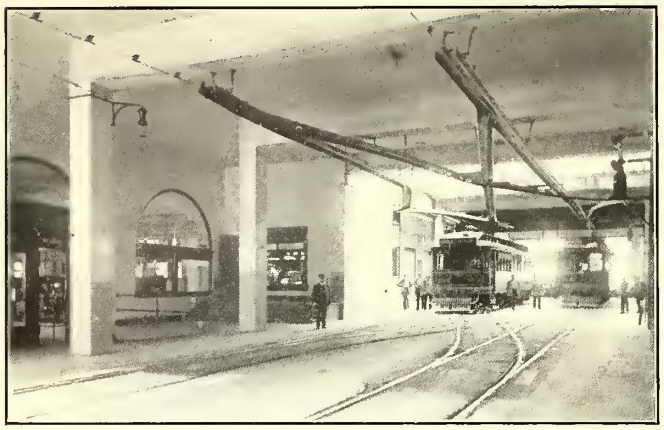
Northern Electric Railway—Type of Depot

Northern Electric Railway—Third-Rail Track

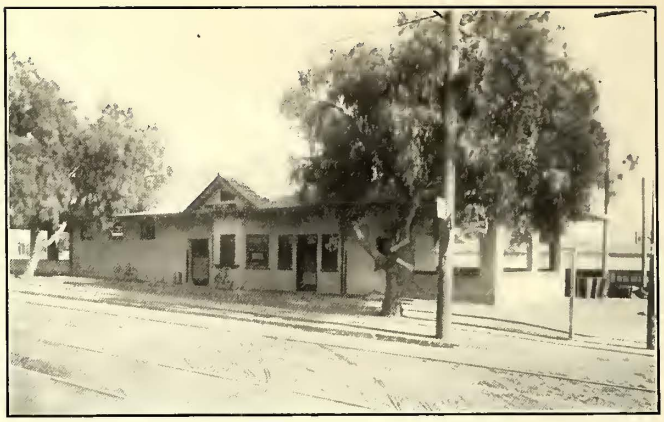


Northern Electric Railway—Material Yard and Shops

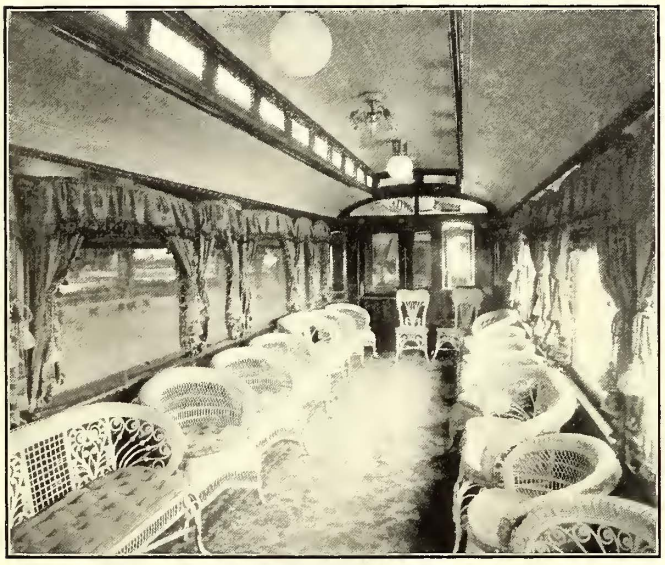
Northern Electric Railway—Nicolaus Concrete Substation



Pacific Electric Railway—First Floor of the Los Angeles Terminal Station

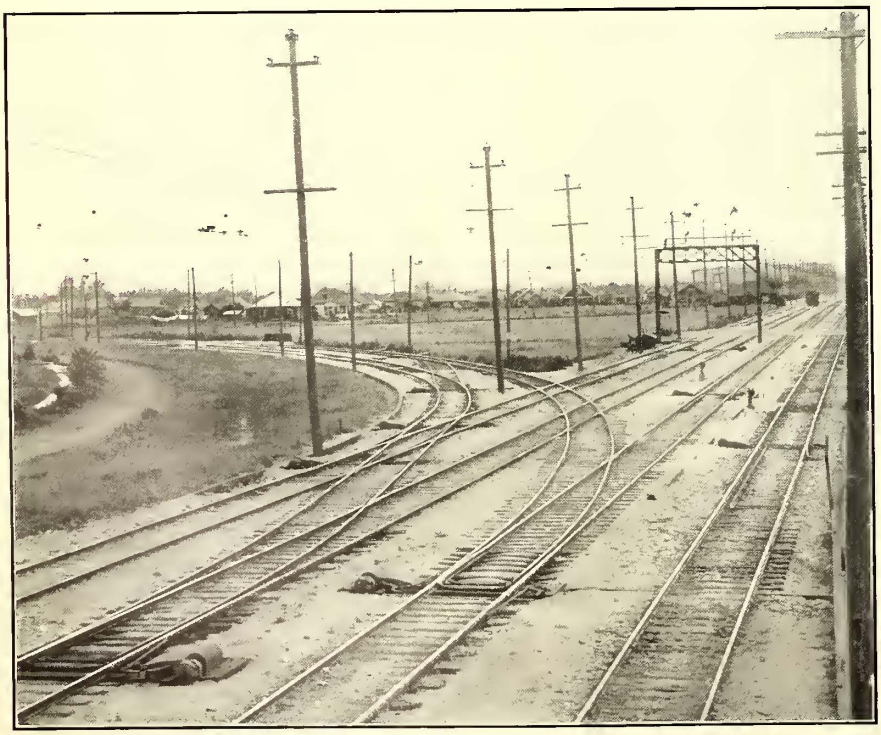


Pacific Electric Railway—Type of Station with Open Waiting Room

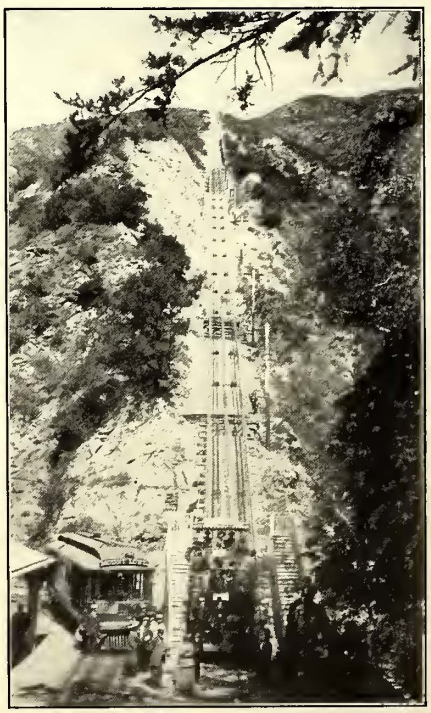


Pacific Electric Railway—Interior of Special Party Car

Pacific Electric Railway—View on Alpine Division

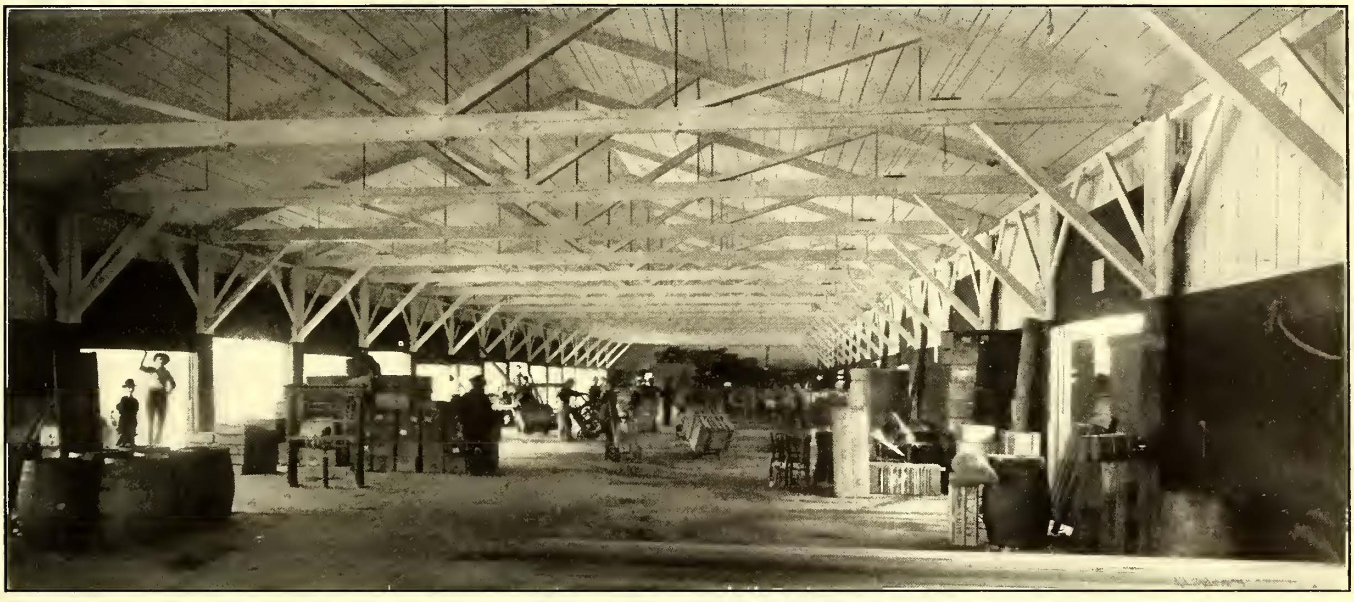


Pacific Electric Railway—Four-Track Entrance to Los Angeles at Branch-Off of Double-Track Line



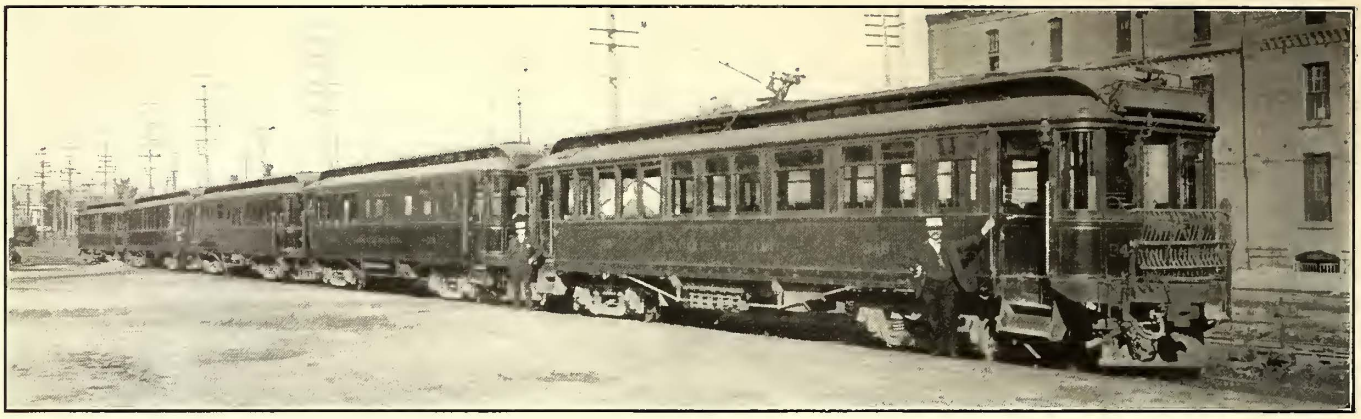
Pacific Electric Railway—Mt. Lowe Incline Railway

Pacific Electric Railway—Exterior of Los Angeles Freight Station

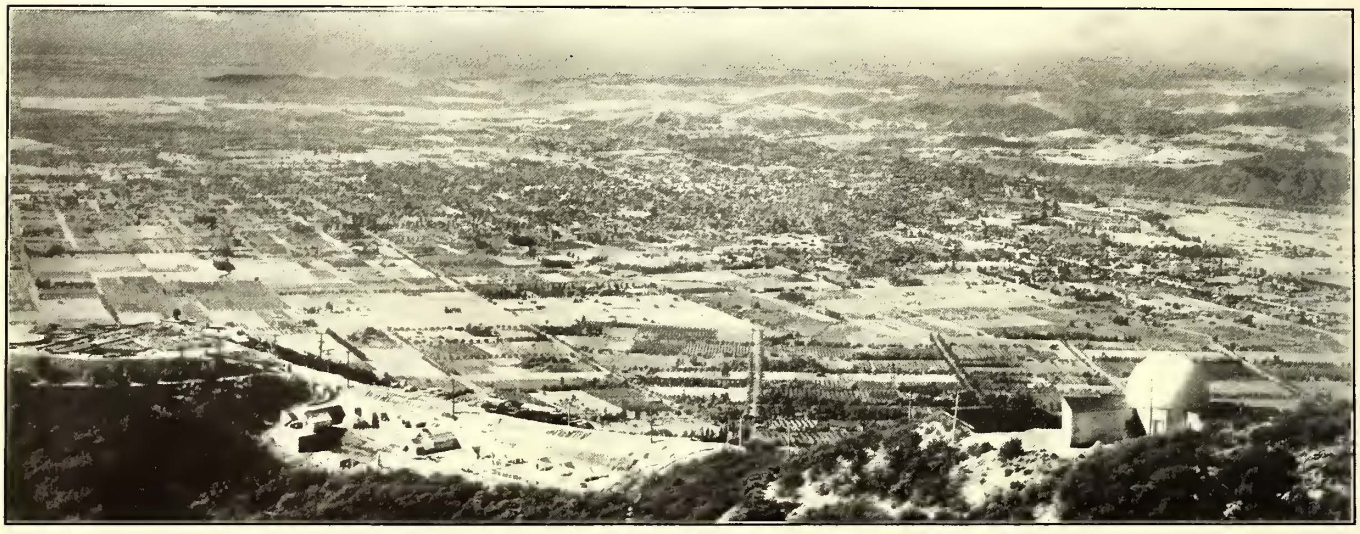


Pacific Electric Railway—Interior of Los Angeles Freight Station

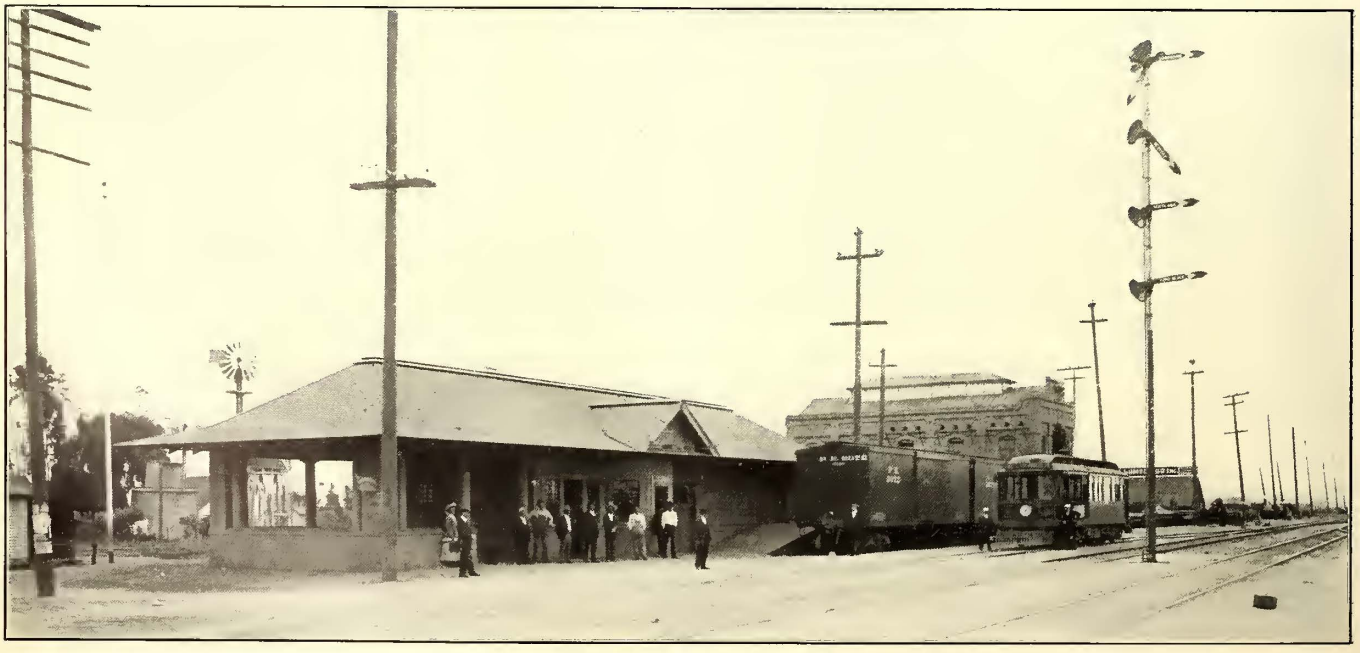
Pacific Electric Railway—Oneonta Junction on Double-Track Pasadena Short Line



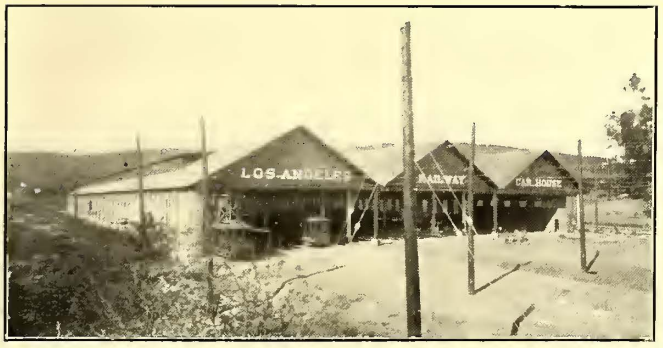
Pacific Electric Railway—Five-Car Train as Regularly Operated



Pacific Electric Railway—Pasadena and the San Gabriel Valley from Mt. Lowe

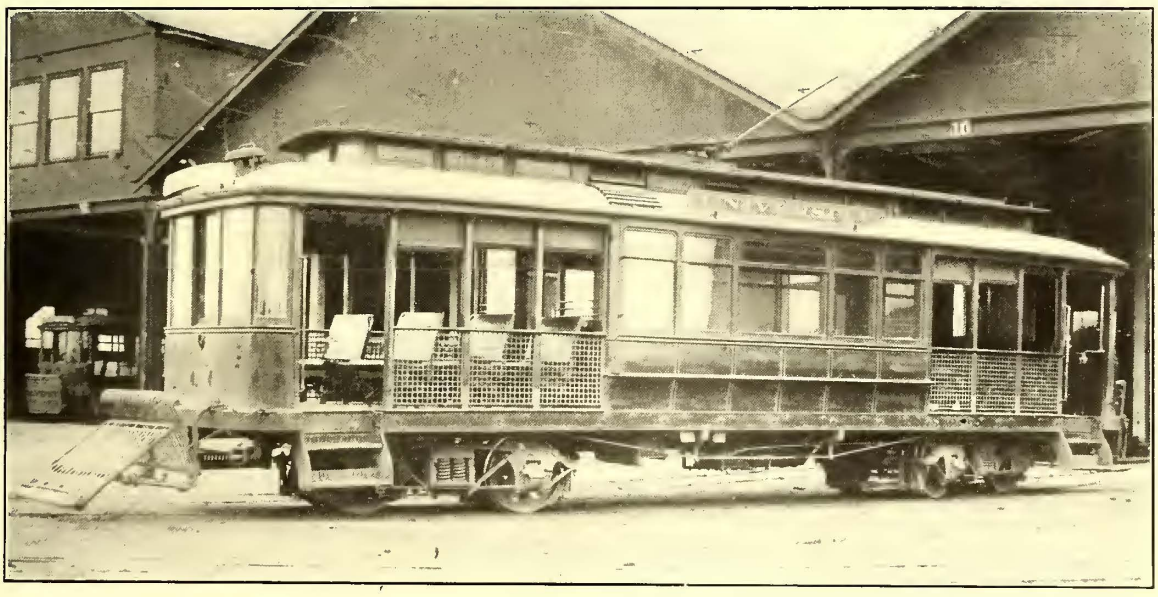


Pacific Electric Railway—Passenger and Freight Station and Substation at Watts

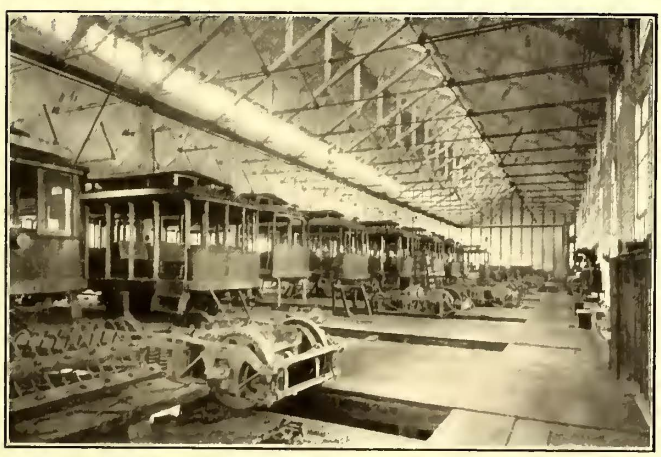


Los Angeles Railway—New Car House at North End of the City

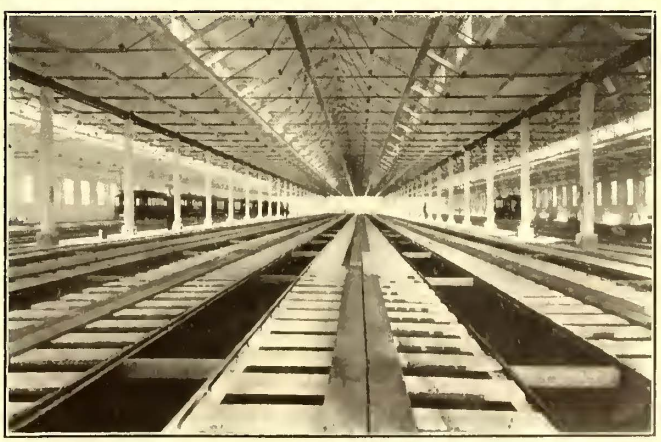
Los Angeles & Mount Washington Railway—Car on Cable Railway



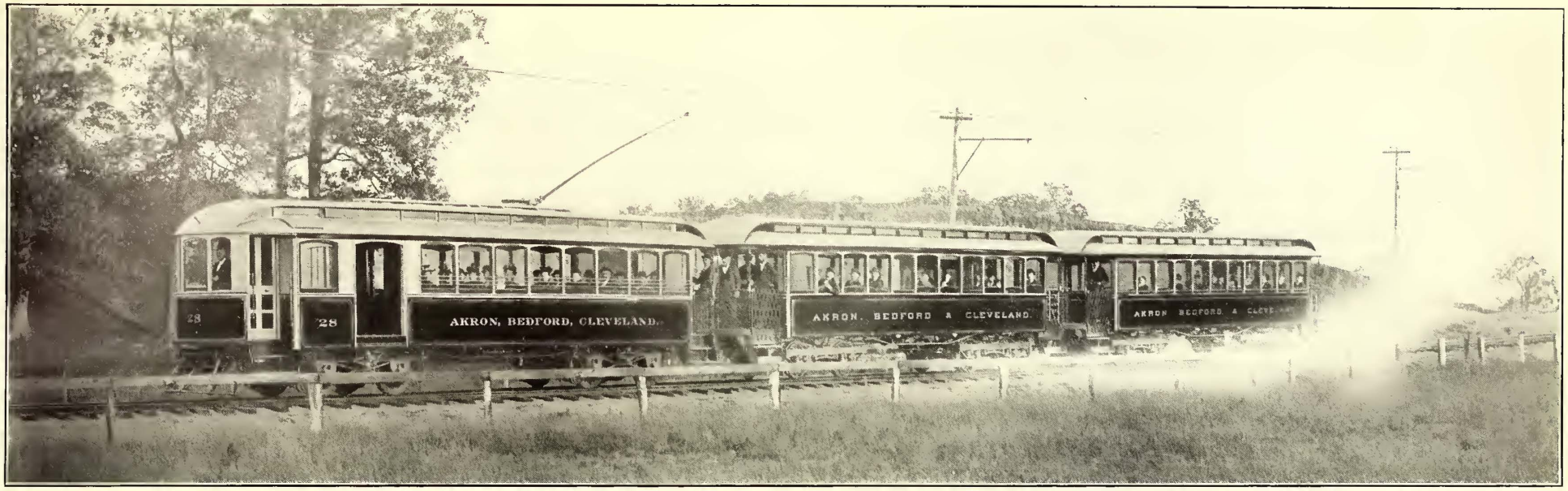
Los Angeles Railway—California Type Car, with Closed Center Section and Two Open Ends



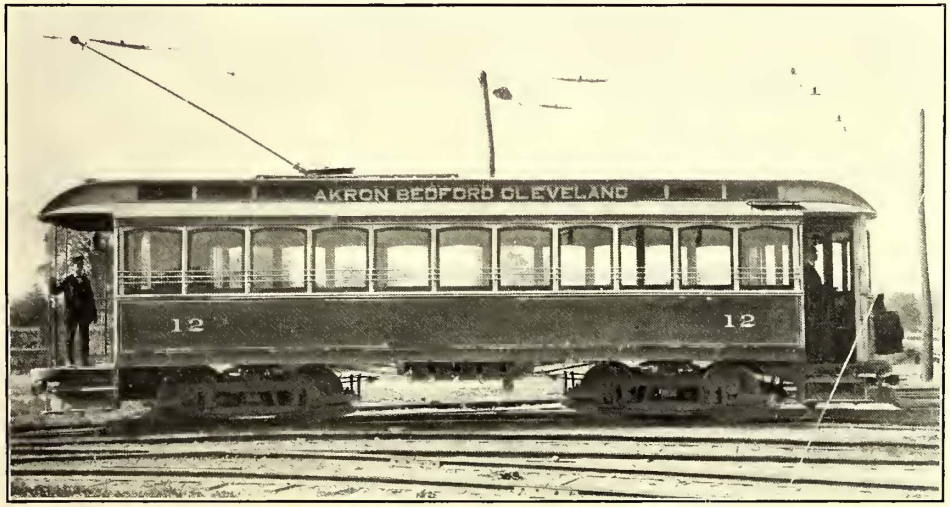
Los Angeles Railway—Interior of Repair Shop



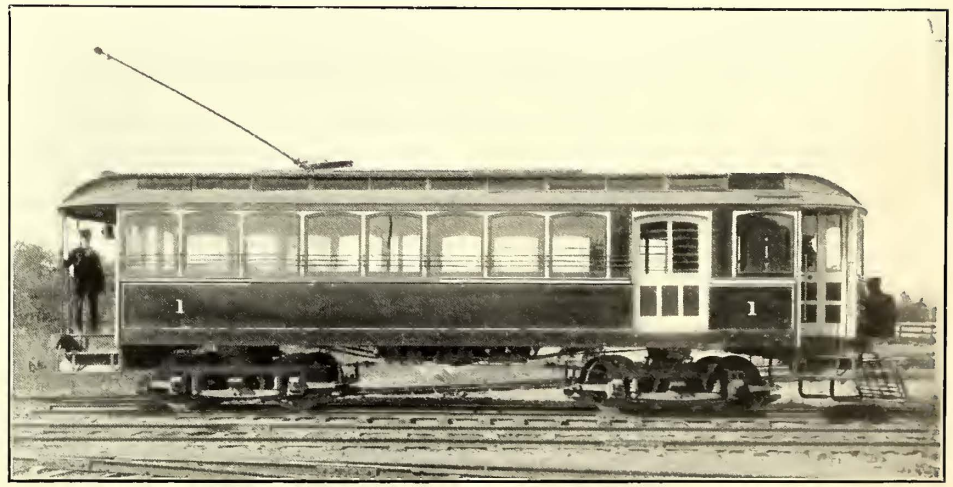
Los Angeles Railway—Interior of Car House



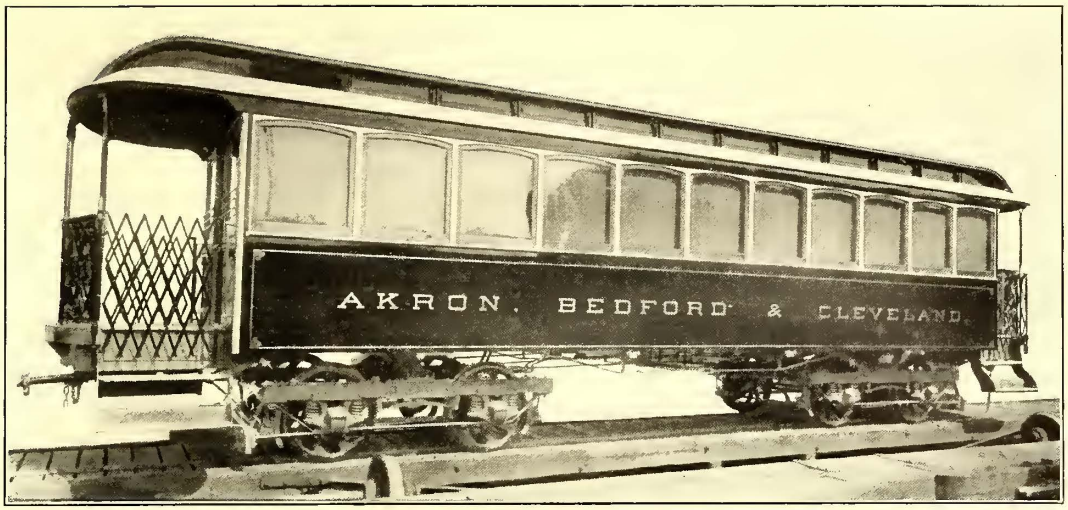
Akron, Bedford & Cleveland—Motor Car with Trailers Operated in 1895



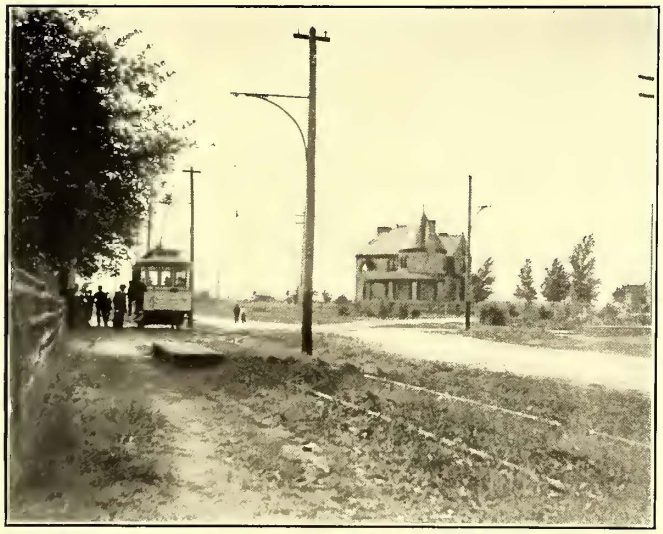
Akron, Bedford & Cleveland—Motor Car Purchased in 1896, One Year After Operation of Road Was Started



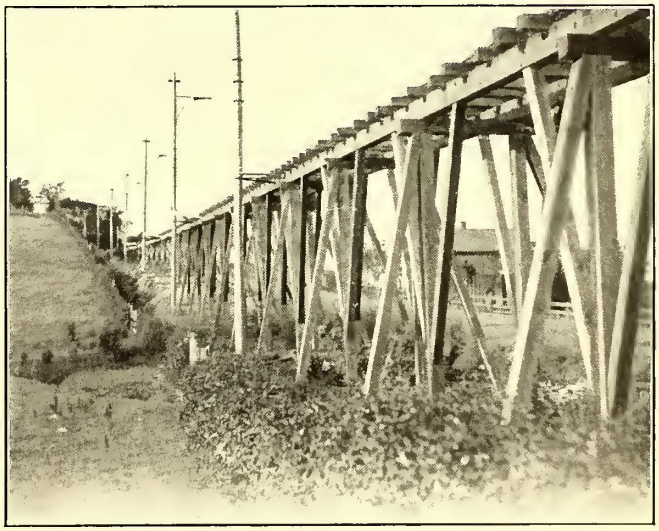
Akron, Bedford & Cleveland—Passenger Car with Baggage Compartment, Built in 1895



Akron, Bedford & Cleveland—Trail Car Built in 1895



Sandusky, Milan & Norwalk—Junction of Interurban and City Line



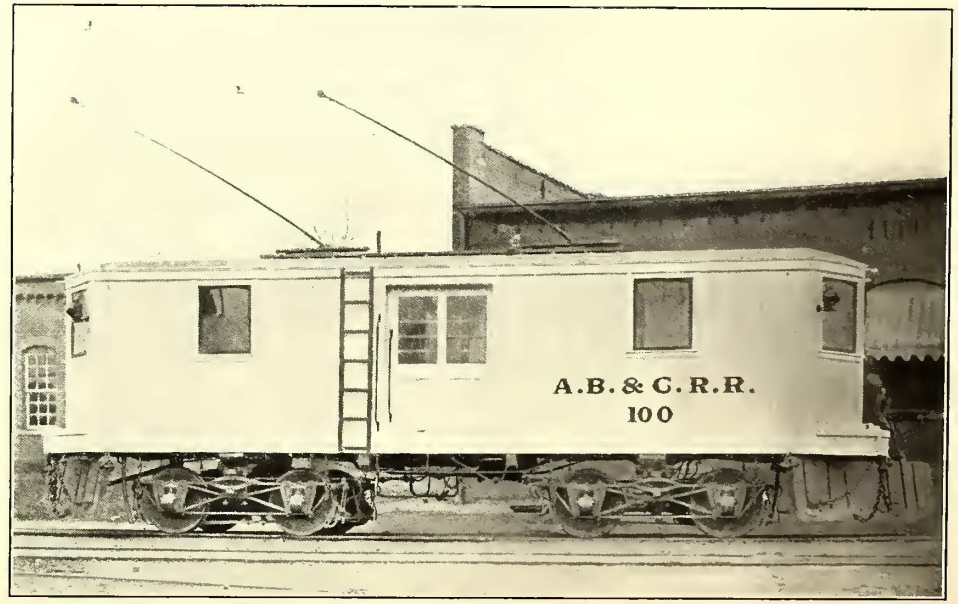
Sandusky, Milan & Norwalk—Old Type of Timber Trestle Constructed at Avery, Ohio

Cleveland & Berea—Early Types of Single-Truck Cars

Sandusky, Milan & Norwalk—Soldiers' Home Station, Beginning of Line to Norwalk

Akron, Bedford & Cleveland—Interior View, Taken in 1899, of Cuyahoga Falls Power House

Akron, Bedford & Cleveland—Exterior View, Taken in 1899, of Car House and Power Plant at Cuyahoga Falls



Akron, Bedford & Cleveland—Snow Plow Used on Interurban Line in 1899

to quadruple equipment, and the application also of the electric brake in connection therewith; the construction of a large motor car or electric locomotive, as stated; and the development in large interurban cars provided with smoking compartments, express compartments, plush seats, toilet rooms and water coolers, all cars being equipped with iron pilots instead of fenders.

I take this opportunity, and it affords me a pleasure, to state that my connections with the officials and employees of the Akron, Bedford & Cleveland road were pleasant, especially those with Will Christy and James Christy, Jr., who built the road, and later with Will Christy, who became vice-president and general manager, for in those days, in operating a new road of that length with new and untried equipment for interurban service, we had our troubles and not a few dark days, but with Mr. Christy's co-operation and the kindness for which he is noted, many of our troubles, through his co-assistance and guidance, were worked out satisfactorily.

REMINISCENCES OF EDWARD W. MOORE

EDWARD W. MOORE, of Cleveland, who has devoted a number of years to the construction, financing and operation of electric railways with Henry A. Everett, gave some reminiscences of his early experience to the ELECTRIC RAILWAY JOURNAL. Mr. Moore's first financial interest in railways was acquired when he became associated with Henry A. Everett and his father, A. Everett, in the East Cleveland Railroad, which was operated by horse power at the time. The Everetts decided to equip the line for electrical operation and Will Christy was given the contract for the overhead work in connection with this improvement. Subsequently, when Mr. Christy had effected an organization to build the Akron, Bedford & Cleveland Railroad he interested Mr. Moore and Mr. Everett in that property. Starting with their interest in the Akron, Bedford & Cleveland line Messrs. Everett and Moore planned a great system of interurban railways independent of their extensive holdings in urban projects. Mr. Everett devoted his time largely to operation while Mr. Moore was interested chiefly in the banking and financial features of the companies.

In speaking of the Akron, Bedford & Cleveland line, Mr. Moore said:

The distance between Akron and Cleveland by the existing steam railroads was 39 and 41 miles respectively. It was 35 miles by the new electric line. We had great difficulty in selling the first mortgage bonds on this property. We tried to interest bankers and capitalists in Cleveland and throughout Ohio, as well as in New York City and other financial centers, but without success at first. In connection with my various efforts to dispose of some of the bonds in the various properties, I made a number of trips to New York and visited one large banking house when the Akron, Bedford & Cleveland road showed net earnings applicable to interest of twice the fixed charges on the entire authorized and outstanding amount of bonds. The head of this firm said that the business was derived from novelty riding and assured me that passengers would not continue to patronize the electric lines when they could use the steam railroad. Finally E. H. Gay & Company agreed to make an effort to sell the bonds on commission; they were unwilling to buy the securities outright and took them up by degrees as they found a market. We were obliged to carry these bonds a couple of years before any were sold.

In later years, as the prospects of the interurban electric railways became less speculative, and the securities more stable, we had less difficulty. We sold the Lorain & Cleveland bonds outright to E. H. Gay & Company, who organized a syndicate, in which Canadian banking houses had an interest, to take the entire block at once.

LORAIN & CLEVELAND RAILWAY

(Now a Part of the Lake Shore Electric Railway)

THE promoters of the Lorain & Cleveland Railway began in 1895 to acquire property for a private right-of-way on the south shore of Lake Erie between Cleveland and Lorain, Ohio. More time was required to purchase the necessary right-of-way than is usually the case, for the reason that the farms in that section were composed of narrow strips extending north and south and the railway wanted to acquire a right-of-way running east and west. Land was secured for a right-of-way with a minimum width of 40 ft., extending to 66 ft. at various points. Construction was started in 1896 and the line was completed on Oct. 1, 1897, and the first regular car was operated four days later.

Those who were interested principally in the promotion and the construction of the line were Henry A. Everett, E. W. Moore and B. Mahler and their associates. The company secured its charter under the general railroad act with permission to use electricity as a motive power. Mr. Mahler stated in an interview with a representative of the ELECTRIC RAILWAY JOURNAL at Cleveland that he believes this was the first line to adopt standard railroad methods of construction for electrical operation, and that the first experience with a high-speed interurban line constructed entirely on private right-of-way was that of this company. Mr. Mahler was a night telegraph operator on the Lake Shore & Michigan Southern Railway in 1868 and 1869. The trainmen who gathered in his station at night argued problems relating to railroad construction and operation, and as the Lake Shore road had only a single track at that time, many long delays for trains resulted, and the reasons therefor and possible remedies were discussed thoroughly.

During these frequent talks Mr. Mahler concluded that a railroad, in order to be more successful, should operate with higher speeds, greater power and rates that would be a material reduction from those in effect during the early years; when he became interested in interurban construction some years afterward, he remembered his early experience and conclusions. He was associated wtth the Everett-Moore interests in Toronto and in Detroit, but returned to Cleveland in 1895 to take up the project for the construction of the line between Lorain and Cleveland.

In speaking of the construction of the Lorain & Cleveland road Mr. Mahler said:

The suggestion that the line be constructed on private right-of-way was novel and did not meet with favor at the outset. Finally, it was accepted and the line was built following regular steam railroad methods of construction. We employed A. E. Arnold, a steam railroad engineer, to supervise the work of construction. The road was built with a comparatively level bed, the maximum grade not exceeding 3/4 of 1 per cent. Rails of 60 ft. length were laid, notwithstanding the criticism of those who maintained that it would be impossible to operate successfully with rail sections of this length and that the space necessary for expansion would not permit smooth operation. All the culverts were of stone and steel. We eliminated grade crossings, passing under the right-of-way of other steam railroads. No switches were installed of less than 1500 ft. in length because we concluded to forestall the possible discomfort and criticism of passengers when a car would stop on a switch.

I believe that we were the first to install four motors on our cars. Our earliest cars had four General Electric No. 57 motors of 200 hp. In using four motors we had to overcome strong objections. It was stated to us that cars operated by electricity needed a pushing power rather than a pulling

power and that therefore any power placed on the front axles would be wasted. In answer to these arguments, I pointed out the illustration furnished by a draft horse, the front legs of which carry the horse while the rear legs pull the weight. This road was the first interurban line which used standard railroad trucks in equipping the cars. Our first schedule speed was 30 m.p.h. with trains reaching 50 to 55 m.p.h. between stations. This was the highest rate of speed which had been attempted up to that time by an electric railway.

Directly after starting operation we found that the high-speed electric cars did not have sufficient weight to give them traction power. On one occasion, within a short time after operation was begun, I went over the road and the problem seemed so serious that on my return I suggested placing a bar of pig iron under each seat in the car, in order to give weight enough to afford sufficient traction. J. A. Brill, the head of the company which furnished the first cars, came to Cleveland and went over the line about that time. He said that the cars had been built for a street railway and he had not realized that they were really intended for a railroad. Mr. Brill declared that it would be necessary to add 2500 lb. to the weight of each car. This was done immediately and satisfactory performance of the cars resulted.

Mr. Mahler said that the rates of fare which were placed in effect at the time the line started operation were still maintained, and that the traffic results which were entertained by the promoters had been fully realized. In addition to the direct traffic between Lorain and Cleveland, the lake shore property in the district has been used for summer homes by residents of Cleveland. Mr. Mahler states that while the property directly on the lake front, convenient to the line, could have been purchased for $100 an acre before construction of the road, it is now selling at from $1,000 to $4,000 an acre, while land south of the nearby highway and even south of the electric line has sold as high as $300 to $400 per acre.

No great difficulty was experienced in financing the property; the bonds were purchased by E. H. Gay & Company. Discussing the financial results of operation, Mr. Mahler gave figures for the first three full years of operation as follows:

STATISTICS PER CAR MILE

Year Ended Dec. 31	Gross From all Sources	Operating Expenses	Expenditure for Maintenance	Total Car Mileage
1898	$21.06	$9.07	$2.74	346,000
1899	24.96	10.59	3.53	371,000
1900	24.88	11.08	3.77	387,000
Total 3 years	$70.90	$31.31	$10.04	1,104,000
Average per year	26.63	10.46	3.34	368,000

The maintenance expenditures shown in the foregoing table were applied principally to the equipment, as the requirements of way and structures were light during the early years of operation. The car-mileage was increased as indicated in order to develop additional business and it was found at an early date that the communities developed so rapidly that improved service was followed immediately by enhancement in the gross earnings.

F. W. Coen, vice-president and general manager of the Lake Shore Electric Railway, was the first assistant secretary of the Lorain & Cleveland Railway. Mr. Coen said that when operation was first begun the company paid for its coal 5 cents a ton at the mine, plus freight of 80 cents a ton. The present cost is 50 cents at the mine, plus $1.50 per ton for delivery.

UNION TRACTION COMPANY OF INDIANA

(Now a Part of the Indiana Union Traction Company)

A PIONEER in interurban railway construction is Charles L. Henry, receiver of the Indianapolis & Cincinnati Traction Company. Mr. Henry first became interested in railways when on June 20, 1891, he purchased the mule line in Anderson, Ind., for which he paid cash. He was interested with Philip Matter, of Marion, in a tract of land in Anderson, and in April, 1892, they constructed an electric line from the central business district to the locality in which the property was situated. During the same year the line which Mr. Henry had purchased in 1891 was converted for electrical operation.

Shortly afterward Mr. Henry began to consider the possibilities for the development of interurban electric railways.

Estimate of Daily Receipts From Passengers on an Early Interurban Line, Compiled by Charles L. Henry in 1894.

Anderson-Elwood Line			
Elwood to Anderson	150 at 25c.	$37.50	
Anderson to Elwood	150 at 25c.	37.50	
Elwood to Frankton	50 at 10c.	5.00	
Frankton to Elwood	50 at 10c.	5.00	
Frankton to Anderson	75 at 15c.	11.25	
Anderson to Frankton	75 at 15c.	11.25	
Passengers to and from Florida and other intermediate points		20.00	
Total			$127.50
Anderson-Marion Line			
Marion to Anderson	30 at 50c.	$15.00	
Anderson to Marion	30 at 50c.	15.00	
Marion to Fairmount	75 at 15c.	11.25	
Fairmount to Marion	75 at 15c.	11.25	
Fairmount to Anderson	15 at 35c.	5 25	
Anderson to Fairmount	15 at 35c.	5.25	
Summitville to Anderson	50 at 25c.	12.50	
Anderson to Summitville	50 at 25c.	12.50	
Alexandria to Anderson	150 at 15c.	22.50	
Anderson to Alexandria	150 at 15c.	22.50	
Linwood to Anderson	10 at 10c.	1.00	
Anderson to Linwood	10 at 10c.	1.00	
Travel to and from intermediate points not itemized		50.00	
Total			$185.00
Anderson-Muncie Line and Anderson-Indianapolis Line			
Muncie to Indianapolis	20 at 80c.	$16.00	
Indianapolis to Muncie	20 at 80c.	16.00	
Muncie to Anderson	75 at 25c.	18.75	
Anderson to Muncie	75 at 25c.	18.75	
Muncie to Yorktown	30 at 10c.	3.00	
Yorktown to Muncie	30 at 10c.	3.00	
Travel to and from intermediate points between Muncie and Anderson		25.00	
Anderson to Indianapolis	100 at 50c.	50.00	
Indianapolis to Anderson	100 at 50c.	50.00	
Anderson to Pendleton	75 at 15c.	11.25	
Pendleton to Anderson	75 at 15c.	11.25	
Pendleton to Indianapolis	20 at 40c.	8.00	
Indianapolis to Pendleton	20 at 40c.	8.00	
Travel to and from intermediate points not specified between Anderson and Indianapolis		75.00	
Total			$314.00
Summary of Daily Passenger Traffic			
Anderson-Elwood line		$127.50	
Anderson-Marion line		185.00	
Anderson-Muncie and Anderson-Indianapolis line		314.00	
Total			$626.50

As he was familiar with conditions in southwest Missouri, his first plan was to build an electric railway connecting the cities of Joplin, Webb City and Carthage. In order to promote this project, he visited these cities in November, 1892, and secured a contract for the purchase of the Carthage Street Railway, which was operated by horse power at the time. As he failed to secure a contract for the Webb City and Joplin properties, Mr. Henry abandoned the plan and returned to Indiana to consider the prospects for construction of an electric railway connecting what were known as the gas belt cities. The panic of 1893 followed directly and Mr. Henry postponed further action temporarily, but in the winter of 1893-94, he made the first estimates of cost and prospective earnings for an electric railway from Anderson to Marion, Anderson to Elwood and Muncie via Anderson to Indianapolis. He also made a map showing these lines, which were built afterward in accordance with this arrangement, except that the line to Elwood was actually constructed west from Alexandria instead of through Frankton,

as planned originally; and subsequently he began to secure options on land for a private right-of-way for a line from Anderson to Alexandria and from Anderson to Elwood. Although Mr. Henry was impressed more and more as time passed with the desirability of the enterprise he was unable to interest the necessary capital and did not make substantial progress before the financial depression and accompanying campaign of 1896 developed.

With the improvement of conditions which followed the election, Mr. Henry secured sufficient capital to proceed. He borrowed on his personal credit enough money from Philip Matter, of Marion, to construct an interurban line from Anderson to Alexandria. This property was owned by the original Union Traction Company of Indiana, which was organized by Mr. Henry in September, 1897. On Jan. 1, 1898, the first car was operated from Anderson to Alexandria, a distance of 11 miles. Early in the following year the road was extended to Summitville, making a total distance of 17 miles. Connection was made afterward at Summitville with the line built south from Marion, which was owned by the Marion Street Railway and was 17 miles in length. It made a continuous road of 34 miles from Anderson to Marion, owned by two different companies. The $450,000 of first mortgage bonds issued by the Union Traction Company of Indiana were purchased by the Indiana Trust Company of Indianapolis.

Estimates on Early Interurban Construction, Compiled by Charles L. Henry in 1894.

Addition to Equipment of Anderson Power House.		
One 300 horse-power Corliss engine	$4,000.00	
Foundation for and setting engine	500.00	
Two dynamos, 150 horse-power each, including switchboard instruments, foundations for and setting dynamos	6,000.00	
Line shaft, pulleys and belts	3,000.00	
One battery, two 275 horse-power water-tube boilers with steel stack, ready for steam pipe connections	10,000.00	
Steam pipe and fittings erected	500.00	
One 500 horse-power open heater and exhaust pipe, including setting	700.00	
Boiler feed pump and connections	400.00	
Steam pipe covering	75.00	
Total		$25,175.00
Car House at Anderson		
Brick building, 50 x 200 ft., iron truss roof frame and steel roof	6,000.00	
Curves and car house track and overhead work	2,000.00	
Total		$8,000.00
Repair Shop at Anderson		
Brick building, 65 x 225 ft., iron truss roof frame and steel roof; containing three tracks full length of building; machine shop, carpenter shop, paint shop, all of sufficient capacity for repairs for entire road	7,500.00	
Curves, tracks and overhead work	1,500.00	
Machinery and tools	7,500.00	
Total		$16,500.00
Total additions necessary at Anderson station		$49,675.00

As the success of this early line was demonstrated, Mr. Henry suggested to George F. McCullough, of Muncie, who owned the electric railway in that city, that they combine their interests and construct a line from Muncie by way of Anderson to Indianapolis. On Jan. 1, 1896, Hugh J. McGowan went to Indiana as a representative of the Dolan-Morgan syndicate, which had recently purchased the Indianapolis street railways. Shortly afterward Mr. Henry met Mr. McGowan and thereupon presented his project for interurban development, which was taken up later by Mr. McCullough and Mr. Henry with Randal Morgan of Philadelphia. A thorough inspection of the property was made by David Young, of Jersey City, representing Mr. Morgan and associates, who thereupon decided to join Mr. Henry and Mr. McCullough in the organization of the Union Traction Company of Indiana. This company was organized in June, 1899, and was designed to include the electric railways in Muncie, Anderson, Marion and Elwood, the interurban lines connecting these cities, and also to build the proposed line from Muncie, by way of Anderson, to Indianapolis. Directly after organization was effected the construction of the line from Indianapolis to Muncie was started. On Jan. 4, 1901, the first interurban car was operated into the city of Indianapolis on this completed line. During this period the line between Elwood and Alexandria had been completed, perfecting the system substantially as it had been planned by Mr. Henry in 1893 when the necessary capital for construction could not be attracted. The completed system as indicated reached this important point just three years and three days after the first car was operated from Anderson to Alexandria.

Mr. Henry sold his interest in the Union Traction Company of Indiana in March, 1901, and retired at that time from the position of general manager. In an address in Indianapolis on Jan. 11, 1906, at a banquet of the Indiana Electric Railway Association, Mr. Henry gave the following interesting reminiscences of his early experiences:

Looking forward to the completion of the line into Indianapolis as early as 1894 I took up the subject of a contract with the local company for running cars into this city, and in February, 1895, I secured a contract with the Citizens Street Railway Company, then controlled by what was known as the McKee & Verner syndicate of Pittsburgh. The contract was executed by Augustus L. Mason as president of the city company, and by me for the benefit of the interurban company thereafter to be organized. It provided that the city company should take charge of the cars at the city limits, collect and retain the city fares and redeliver the cars to our company again at the city limits. It also provided for the handling of mail, express matter and freight upon terms as to price to be thereafter agreed upon, and upon failure to agree, then to be fixed by arbitration.

The first corporation formed to construct an interurban electric railway was the Indianapolis, Greenwood & Franklin Railroad Company, organized Nov. 9, 1894, under the steam railroad law, and promoted by Henry L. Smith, of Indianapolis. The road from Indianapolis to Greenwood was afterward built by this same organization under the ownership of Joseph I. and Wm. G. Irwin, of Columbus, Ind., who took charge of the company in June, 1899, and it was this road that ran the first interurban car into Indianapolis on Jan. 1, 1900. This company was succeeded by the Indianapolis, Columbus & Southern Traction Company, controlled by the Messrs. Irwin.

Estimates for Early Interurban Construction, Compiled by Charles L. Henry in 1894.

Roadbed and Track		
Securing right of way	$500 00	
Grade and ditches	500.00	
Four 3-10 tons, 60 lbs. "T" rail at $23.50 delivered	2,216.05	
355 four-hole angle bar joints at 35c	124.25	
1,4207-8 bolts at 1½c	21.30	
2,113 oak ties, 30 in. centers, 6 x 8 x 8 ft., 40 cents each	845.20	
31 kegs of spikes, 9-16 x 5½ in., 6,200 lbs., at $1.65 per hundred	102.30	
355 copper rail bonds, 40 cents each	142.00	
Constructing and bonding, including delivery of material	600.00	
Gravel	300.00	
Total		$5,351.10
Overhead Construction		
90 cedar poles, 30 ft. x 7 in., top, $2.25 each	$202.50	
1,687 lbs. No. 0, H. D. copper, 11 cents	185.57	
45 insulators and hangers complete, 60 cents each	27 00	
1,600 ft. 5-16 steel strand span wire, 60 cents	9.60	
Labor, including delivery of material	150.00	
Total		$574.76
Total for roadbed, track and overhead work		$5,925.77
Estimate for Motor and Trailer Car for Interurban Electric Road.		
Motor Car		
One car body, 32 ft. inside, 36 ft. over all, with lavatory and heater	$1,500.00	
One set of double trucks with steel tired wheels	500.00	
One double motor equipment, two 50 horse-power motors	1,200.00	
One set of air brakes with electric motor and pump for operating same	750.00	
Motor car, complete		$3,950.00
Trailer Car		
One car body, 28 ft. inside, 36 ft. over all, two platforms with trucks and air brake attachments complete	$1,500.00	
		$1,500.00
Motor and trailer complete		$5,450.00

The construction and equipment of the first interurban lines presented many interesting questions. Perhaps the most serious in the beginning was the distribution of power, for at that time the idea of one central power station transmitting current at high voltage to various substations, where the voltage should be reduced, had not been tried. In the power station at Anderson, in order to enable us to have sufficient voltage on the Alexandria-Summitville section of our road, we installed a "booster," a generator developing electric current at 750 volts. This we transmitted by a separate line to the Alexandria-Summitville section and the drop of the voltage by transmission was sufficient to give us approximately 500 volts on that part of the line.

When the Union Traction Company of Indiana was formed the great central power station at Anderson was erected with substations, a system which has since been generally followed.

The wonderful growth of the electric railway business is illustrated by the fact that the first generator equipment in the Anderson station in the fall of 1891 was a 75-hp bipolar Edison machine belted to a 125-hp Corliss engine, operating two cars on a 2-mile run to North Anderson.

Our first interurban line was operated at the beginning by a block signal system, but this caused too many long delays, and, not proving satisfactory, the line was soon equipped with telephone service.

We realized that if high speed with heavy cars was to be attained it would be necessary to have a more satisfactory brake equipment than that operated by hand. For this reason, in the original estimate covering the equipment proposition, although such a thing was not then made, provision was made for an electric motor-driven air compressor, and its estimated price fixed at $750 per car. Since then this system of brakes has been brought to perfection and is now common on interurban cars. Steel tired wheels were also included in this estimate.

I invented the word "interurban" for this class of railroads, and though it is not perhaps well selected it has come into general use. One of the Anderson newspapers, becoming piqued at some act on the part of the management relating to free transportation, dignified the new name by calling it "inter-ruben," and this name in jest clung to the road quite a while.

Supplementing these remarks, Mr. Henry stated to a representative of the Electric Railway Journal that he thought the intramural road at the World's Fair in Chicago in 1893 suggested the title interurban. "The original Union Traction Company," Mr. Henry added, "secured its charter under the street railroad law, although interurban roads are now described as such in the statutes of Indiana. People laughed at me for constructing this line on private right-of-way. Our earliest rates of fare averaged about 1 1-4 cents a mile and were much too low to meet the requirements of a business that was destined to develop into high-speed service of the most remarkable degree of convenience that has ever been afforded to the public. The Christensen Air Brake Company furnished what we wanted in the way of air brake equipment."

The accompanying statements, showing the estimates compiled by Mr. Henry in 1894, are interesting as indicating the low costs fixed for this early property and the volume of traffic anticipated.

Mr. Henry said that the line as built originally from Anderson to Alexandria had no ballast and that the service was indifferent. The prospects, however, were encouraging, as the gross revenue amounted to $100 a day. The first cars used on the lines were purchased from the Barney & Smith Car Company. They had been built in April, 1896, for the Columbia & Maryland Railway, but, owing to financial difficulties in which that enterprise became involved, they remained in the shops at Dayton until purchased by Mr. Henry. These cars, Mr. Henry says, are still in use as trailers on the lines of the Indiana Union Traction Company.

EXPERIENCES OF J. R. NUTT

J. R. NUTT, now Secretary of the Citizens' Savings & Trust Company, of Cleveland, has been identified prominently with the financing of some of the early interurban lines. Mr. Nutt's first experience of this character was in the construction, in the year 1897, of the line between Cincinnati and Hamilton, for which he and Will Christy and associates furnished the major part of the capital. This line is now a part of the Ohio Electric Railway main line from Cincinnati to Dayton. Construction with unusual economy was possible because of the prevailing low prices of rails and electrical equipment in that year.

Mr. Nutt stated that some of the bonds issued under first mortgage on several of the first interurban railways are in good demand constantly, and that during the last panic these bonds fluctuated less and could be sold more readily, with less sacrifice in price, than high-grade steam railroad bonds listed on the New York Stock Exchange.

THE HISTORY OF THE PAST HALF DECADE

THE history of the street railway reaches back to 1832, when the first horse car was operated on the New York & Harlem line, and the fifty odd years which elapsed between that time and the later eighties can be considered the dark ages of the street railway industry. There was no contemporary chronicler to record the trials and achievements of the street railway manager and inventor during this period, and it is very probable that the lack of progress which characterized this half century of darkness may be ascribed to this lamentable fact. It was not until the eventful year of 1884 that a combination of three occurrences led to the promise of better things. As Macaulay would undoubtedly have said, had it been his lot to have written the history of the street railway, any school boy knows that in 1884 Vanderpoele at the Toronto Exposition operated his first electric car which was the direct predecessor of the modern electric car; Bentley and Knight put in service in Cleveland the first electric car to use direct power from a generator on a public street; and the STREET RAILWAY JOURNAL was founded. It would not do for the publishers of this paper to express an opinion as to which of these three events was the most important. Suffice it to say that each of the three, although perhaps not appreciated at its full worth at the time, was destined to exercise an important influence upon the future development of the street railway industry.

Since 1884, the art of electric railroading has grown so rapidly that neither this paper nor its readers have had much time to look backward and view the paths over which they have trod. The work which has occupied all minds has been that of constructing the future, not of philosophizing over the past. Events of great importance to the industry have followed one another so closely and so many new vistas of possible improvement have been disclosed as each step in advance has been taken, there has been little opportunity to stop simply to review previous achievements. Nevertheless, this is not the most satisfactory way, or even the most profitable way, of making a journey. In any trip or ascent, especially if it is an arduous one, a view of the paths traversed and the recollection of obstacles already overcome will often act as an inspiration for the future. It was for this reason that this paper, in 1894, published a history of the street railway industry up to that time, and a decade later, at the time of its twentieth anniversary, presented an account of the important events which had occurred between 1894 and 1904. The present issue marks the twenty-fifth anniversary of the establishment of the ELECTRIC RAILWAY JOURNAL, and again it seems fitting to devote a few pages of one issue of this paper to a sketch of the most notable events which have occurred since the role of historian was laid aside five years ago.

In many respects the past five years have been more replete with interest than any decade previous to 1904. The electric railway industry, like the JOURNAL, had reached its majority and was capable of more important things than when of more tender years. Until the beginning of the period under discussion nothing more ambitious in electric railway transportation had been attempted than the interurban railway, although the equipment of a few steam railroad branches like the Nantasket and New Britain divisions of the New Haven road indicated the possibilities of electric power for serious consideration in trunk line service. Transmission voltage, at least in the East, was still moderate and the use of Niagara power for electric railway work was confined to the immediate neighborhood of Niagara Falls and Buffalo. The relative advantages of single-phase and direct current for railway service were discussed only in a theoretical way at the meetings of the American Institute of Electrical Engineers. The old American Street Railway Association was still in existence with a constitution and organization unfitted to deal with the problems of the day. An even better idea of the immense distance traversed during the past five years can be gained from the statement that in 1904 the idea of Public Service Commissions, in the modern acceptance of that term, had not been conceived. It was not until three years later than the period we are now considering that they sprang, like Minerva, fully panoplied, from the brow of Jove.

The serial in the popular monthly magazine usually has a reference to the previous number in which the earlier chapters of the story can be found. Following this precedent, the gentle reader is informed that in the issue of the STREET RAILWAY JOURNAL for Oct. 8, 1904, he will find recorded the principal events which occurred in the electric railway industry up to the end of 1903. That year closed with an electric railway mileage of 29,830, upon which 76,186 cars were then in service, and the announcement of the award by the New York Central & Hudson River Railroad Company of contracts for the electrical equipment of its New York terminal.

MANY events occurred during the first part of this year which marked important stages of development in enterprises completed later. On the first day of the year John B. McDonald, contractor for the New York subway, escorted Mayor McClellan and a party of city officials through the subway on a trip made on hand cars. On the same date the City of Vienna took over the operation of its railway system. The same month a single-phase car was tried out in service on the Interworks Railway of the Westinghouse companies. During the same month the Indianapolis & Cincinnati Traction Company announced that it would install the single-phase system on 53 miles of road.

On March 1 the STREET RAILWAY JOURNAL reduced its subscription price from $4 to $3.

On March 31 Harrie P. Clegg issued a call for the meeting to be held at Dayton to organize the Ohio Interurban Railway Association. This meeting resulted in the organization of the association and the election of Mr. Clegg as its first president. One of the first actions taken by the association was the decision to issue a coupon book in which $12 worth of transportation would be sold for $10. Up to this time the interurban roads of the Central States had had no distinctive association, but the organization of the Ohio association was followed about one year later by the formation of the Indiana Electric Railway Association. The consolidation of these two societies into the present Central Electric Railway Association was the result.

Two months later, or on June 4, the preliminary plans of the electric railway motor, designed by the General Electric

Company for the New York Central electric locomotives were published. These plans showed a notable departure from existing electric motor design, as a bi-polar machine was employed in which the armature was not kept concentric in the fields. The boldness of the plan aroused the greatest interest, mixed with some incredulity on the part of certain engineers as to whether such a motor would operate without destructive sparking. Serious doubt was also expressed as to the capacity of the magnetic circuit, as the published diagrams showed only a single motor and not the full course of the magnetic circuit.

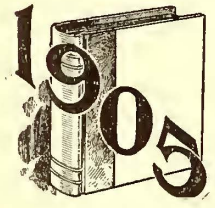
The convention of the American Street Railway Association, the last of that body, was held in 1904 in the city of St. Louis at the time of the World's Fair. The delegates met in the Transportation Hall. At this meeting the articles of organization of the American Railway Mechanical & Electrical Association were changed to admit to membership members of the way-departments of electric railway companies. At this meeting, also, the question of reorganization of the association was for the first time seriously considered in convention, and the president and executive committee were authorized to draw up a working plan. President Ely's address was devoted largely to this subject and he was re-elected president of the association.

The exhibits at the fair were elaborate and well staged, and at the close in November many manufacturers were pleased with the award of various medals, while others found themselves in the class of those who "also ran."

The International Engineering Congress was held in St. Louis just prior to the meeting of the American Street Railway Association and was attended by many prominent electrical engineers from abroad. The recent experiments on the Zossen line were made the subject of considerable discussion, and a paper on this topic was presented by Alexander Siemens.

Early in October the first section of the New York subway was opened for public traffic. This was signalized by the publication of an album by the Interborough Company giving a technical description of the line and articles on the steam plant, electrical system and rolling stock, prepared by the engineers of the company. The subway was put in operation on October 27, from the City Hall to 145th Street on the west side.

The Canadian Street Railway Association held its inaugural meeting, Dec. 20, 1904. W. G. Ross, of Montreal, was elected president.



THE year opened with important changes in the Ohio steam and interurban roads owing to the appointment of receivers for the Appleyard roads, which centered in Columbus. This system now forms an integral part of the Ohio Electric Railway.

The Indiana Electric Railway Association held its organization meeting at Indianapolis, Jan. 12, and elected as its president Charles L. Henry, of Indianapolis, who had taken a prominent part in the development of the interurban roads of that State. Mr. Henry will also be remembered for his early adoption of the single-phase system, which was put in commercial service on his line between Rushville and Morristown, just two weeks after his election as first president of the Indiana Street Railway Association.

On Jan. 20 the first of the series of annual meetings of the New York Railroad Club, devoted to the discussion of the relative merits of a. c. and d. c. traction was initiated by the club. W. B. Potter presented a paper on late developments in electric traction, and those who participated in the discussion included W. J. Wilgus, F. J. Sprague, B. G. Lamme, B. J. Arnold, George Gibbs and J. G. White. The interest manifested was so great that the May meeting of the club was devoted to the same subject, and "electric nights" have formed a feature of every yearly program of the club since that time. The later discussions on the relative merits of these two systems of electric traction have been by no means confined to meetings of the New York Railroad Club. For several years the subject continued to be as fruitful a cause for diverse opinions, and even acrimonious debates, as now promises to rage around the question whether Dr. Cook reached the North Pole.

On Feb. 3 and 4, a joint meeting of the executive committee of the American Street Railway Association with those of the affiliated associations was held at the Holland House, New York, to consider a reorganization of the association. A suggested plan, patterned after that of the American Association for the Advancement of Science, was presented by Richard McCulloch. This plan, afterward revised and elaborated by Prof. H. H. Norris, of Cornell, forms the basis of the present constitution and by-laws of the American Street & Interurban Railway Association and its affiliated bodies.

In March a short strike occurred on the Interborough Rapid Transit system, involving both the subway and elevated lines in New York. For a brief period the surface lines in the city were congested with traffic, but the officials of the company were well prepared for fighting the strike. Many of the men remained loyal, and after the first day the outcome was no longer in doubt. A feeble attempt was made by the men to maintain a semblance of the strike after the second day, but they soon discovered that it was useless, and four days after the gage of battle had been thrown down by the men, most of them were standing in line in front of the company's office applying for reinstatement.

One of the most important events of 1905 was the publication, during May, by the Government, of the census report of street railways from statistics compiled in 1902. The first official census of the street and electric railway industry of the country was made in 1890. The plan then followed was greatly elaborated for the 1902 census and was carried out by experts who were well equipped for the task. Information of the greatest value was secured and published. The important decision was also made not to postpone a similar census for ten years, but to have one every five years. It is notable that one of the two experts in charge of the street and electric railway census of 1902 was Prof. E. Dana Durand, who now has charge of the entire census work of the Government.

To those companies which have recently been considering an increase of fare it may be a surprise to learn that so long ago as April, 1905, the Railroad Commissioners of Massachusetts announced that they would allow companies in that State to charge 6 cents if the roads could not afford to carry people for 5 cents, although the original grant was for the lower fare. In defining its policy on this point, the board said: "When fares prove to be too low to make an enterprise fairly profitable, it is better for all concerned that the company revise its rates and place them upon a footing which enables it to give the accommodation which the public needs, and make a just return to stockholders upon their honest investment."

In May the International Railway Congress held an important meeting in Washington, and in June, 1905, the Montreal

Street Railway Company put its first pay-as-you-enter car in operation on St. Catherine Street.

The three most important events in the latter part of the year were the presentation by B. J. Arnold to the Chicago City Council of a preliminary report on the Chicago traction problem, the decision of the National Civic Federation to appoint a committee to investigate the existing conditions of municipal ownership of public utilities in the United States and Europe and make a comprehensive report, and the opening of the Philadelphia subway. The official inauguration of this latter line occurred Dec. 18, when surface cars were run from the City Hall, in Philadelphia, to the Schuylkill River. Prior to the opening of the road it was inspected by a party of official guests, including prominent representatives of the City of Philadelphia, and railroad managers.

Important announcements made during December, 1905, were plans for the early electrical equipment of the West Shore Railroad, between Syracuse and Utica; of the West Jersey & Sea Shore branch of the Pennsylvania Railroad, between Camden and Atlantic City, and of the Rochester branch of the Erie Railroad, between Rochester and Mount Morris. The year concluded with the publication of letters from Mr. Westinghouse to Mr. Newman, president of the New York Central & Hudson River Railroad Company, in which Mr. Westinghouse recommended that the New York Central's third-rail system be changed to the single-phase overhead system.

THIS year opened with a blaze of glory. The New York Central electrical equipment was under contract and test. The Pennsylvania Railroad, West Shore Railroad and Erie Railroad contracts had just been awarded. The New Haven policy had not been fully defined, but it was known to be expecting to install electric power. The initial electric equipment of the Long Island Railroad was practically completed, and rumors of other important changes in the motive power of trunk line railroads were rife. One was for the equipment of the Sarina tunnel of the Grand Trunk Railway with the single-phase system, the contract for which was announced during the first week in January. This was followed in a few days by the statement that the New York Central Railroad would call for bids for the electrical equipment of its proposed Detroit River tunnel, and that the Erie had appointed a commission of engineers to study the application of electricity to the company's suburban service near New York. These successive announcements raised electrical engineers to a high pitch of enthusiasm. Some of the more sanguine indulged freely in the prediction that the steam locomotive, at least for suburban service, would follow the same fate as overtook the cable in street railway operation and be consigned to the scrap heap. But it still continues to show considerable vitality.

The predictions of glorious success or dire failure to which these events led, and the discussions which followed them, distracted attention from the extensions of the interurban systems which were being made in Indiana and Ohio. But this work was carried on rapidly, and on Jan. 1, a line was opened by the Western Ohio Railway, between Findlay and Lima, which connected the extensive chain of electric railways in the northern part of Ohio and those in central parts of Ohio and Indiana. The last spike of this line was driven amidst considerable ceremony on Dec. 31, 1905, and special parties of electric railway managers traveled to Findlay to witness the event.

The construction of this physical connection between the most important groups of interurban railways in the country was followed within less than a month by the amalgamation of the Ohio Interurban Railway Association and the Indiana Electric Railway Association. This union of interests occurred at the Algonquin Hotel, Dayton, Jan. 25, when a large number of representative managers from the central State were present. The organization of the Central Electric Railway Association was followed by the establishment of a number of through routes between important cities in the Central States. The same week the announcement was made of the organization of the Interborough-Metropolitan Company. This company held large interests in the Interborough Rapid Transit Company, the Metropolitan Street Railway Company and the Metropolitan Securities Company of New York.

On March 12 the famous report on the Chicago situation by Mr. Dalrymple, of Glasgow, was made public. It will be remembered that Mr. Dalrymple, who was manager of the Glasgow municipal tramway system, was urged by Mayor Dunne to visit Chicago during the height of the debate upon the municipalization of the Chicago railways, in the hope that he would bolster up and give respectability to the movement for municipal operation in Chicago. Whether Mr. Dalrymple expected to find the principles of municipal ownership as advocated in this country and as practised abroad the same, it is impossible to say. If this was the case he was soon undeceived, in spite of strenuous efforts of Mayors Dunne and Johnson, while he was in their cities, to give every aspect of municipal operation a rosy tinge. Soon after Mr. Dalrymple returned to Glasgow he forwarded his report on the Chicago situation to Mayor Dunne, who found it so absolutely opposed to his own views that he refused to disclose its contents. At last, out of justice to Mr. Dalrymple, it was made public by the Council of Glasgow. It proved to be a severe arraignment of municipal methods in the United States, and contained, among other unpalatable truths, the statement to Mayor Dunne that in Mr. Dalrymple's opinion, "there would be great danger in your city attempting to operate without radical change in the methods usually employed in carrying on municipal work by the cities of the United States." The publication of the report attracted the greatest interest throughout the country, and brought consternation into the municipal chambers of many cities and to the politicians who had been using the plea of municipal ownership to gain lucrative positions in city governments. It is not too much to say that Mr. Dalrymple's report did more than any other one factor to establish the present system of railway operation in Chicago, in which the city has an interest in the earnings of the companies, but does not operate the lines. On April 3 a municipal vote was taken and found to be in favor of municipal ownership, but not of municipal operation. This solution of the problem proved impossible because the Mueller law, under which the city was to issue certificates to purchase the railways, was declared unconstitutional.

The entire country was shocked on the morning of April 18 when the announcement was made that San Francisco had been largely destroyed by earthquake and fire. Later reports only confirmed the original estimates of the disaster, and for many days the sympathies from the entire civilized world were centered on the situation of San Francisco, while relief funds and supplies poured into the city from all sides. The electric railway system in San Francisco suffered severely from the convulsion of nature, followed as it was by the conflagration, but its managers immediately set about the work of rehabilitation. They realized that the future of their property, as well as the comfort and prosperity of the citizens of San Francisco

depended largely upon the promptness with which the transportation lines were reopened. Temporary construction was immediately installed, and the energy displayed by the owners of the railway system in this work was a very important factor in the rebuilding of San Francisco, and the transportation of its residents and what was left of their household property to more comfortable habitations. This public duty was poorly repaid by the attitude of the city officials and many of the populace during the subsequent struggle of the company with the labor element, because, soon after the fire, San Francisco again focused the attention of all, this time by its long street railway strike. In this contest the railway company had to bear the brunt of overturning a labor situation which had long been a disgrace to the city of San Francisco, but the combination of corrupt labor leaders and city officials and of misguided employees was finally put down, and the city emerged from the struggle, bleeding and poorer, but better for the afflictions which had come upon it from within and without.

New York, San Francisco and Chicago were not the only cities with traction problems which were being solved during this period. London, whose down-town streets had been planned for the needs of the time of Richard I and had never been adequately supplied with transportation facilities, awoke, during the early part of this decade, to the direct relation of transportation facilities to municipal development. The result was the appointment by Parliament of the Royal Commission on London Traffic, and the visit of this commission to America in 1903. The results of this visit and the other investigations of the commission were made public in the report finally published in 1906. It is not necessary here to review this report, which is the most voluminous of any presented on the transportation problems of any one city, but it may be said the committee was very favorably impressed with the methods found in America, and recommended the adaption of many of them to London conditions.

During all of this year, in fact, during the entire five years which are being considered, Mayor Johnson, of Cleveland, was actively engaged in his philanthropic work of preparing to give the citizens of Cleveland a first-rate street railway service for a 3-cent fare. Early in July, 1906, he announced that the Forest City Railway Company, locally known as the "three-cent fare company," would be leased to the Municipal Traction company, which would guarantee dividends on the Forest City's $2,000,000 of capital stock, part of which was to be sold to the public. It would be tiresome and useless in this place to follow all of the devious movements of Mayor Johnson during the long Cleveland struggle, which culminated a year and a half ago in his obtaining control for a short time of the Cleveland Electric Railway system. The history is a monotonous one of lawsuits and referendums, of destruction of tracks and property, of propositions and counter-propositions, of solemn agreements and broken promises. The subject will therefore be dismissed with the statement that Mayor Johnson's rule has hung like a pall over Cleveland during the past six years or more, and that this shadow will not be removed until the primal cause has disappeared.

A monumental event of the year, which should be mentioned at this place, was the practical completion, in Milwaukee, of the Public Service Building, the largest as well as the handsomest and most complete private building in the world devoted to public utilities.

The convention in 1906 was held at Columbus, O., and the Street Railway Journal devoted its convention issue of Oct. 13, 1906, to a description and analysis of interurban railway operation in the Central States. The series of articles contained in this convention issue, and the visit of the association to Columbus, then, as now, one of the most important centers of interurban railway operation in the United States, supplied convincing testimony of the value and extent of interurban railroading. The convention was held in the State Fair Buildings, which were eminently suited for the purpose —during dry weather.

On Nov. 11 four trains operated by electricity were run out of the Grand Central Station, marking the inauguration of the electrification of the company's suburban lines out of New York.

On Dec. 8 the purchase was announced by the New York, New Haven & Hartford Railroad of the Providence street railway system, and about two weeks later, of the Connecticut Railway & Lighting Company. These purchases, made from the United Gas Improvement interests of Philadelphia, placed practically the entire mileage of the electric roads in Rhode Island and Connecticut in the hands of the New Haven Company.

1907 OPENED with a condition of general prosperity, and closed with a period of business depression from which the country is now only finally emerging. During the early part of the year many extensions to lines were projected, and new undertakings were organized only to bring disappointment to their promoters later in the year, and to be held for a more propitious time for financing or their abandonment altogether.

In Chicago, affairs began to take a more favorable turn. After many years of prostration of the local railways, during which no one but the politicians prospered, order gradually took form out of chaos. The filibustering of Mayor Dunne could not prevent the introduction into the Chicago City Council of what was known as the Chicago traction ordinances, by which the principal Chicago surface railway systems have since been rehabilitated and are now operated. On the passage of these ordinances by the Council, on Feb. 5, they were promptly vetoed by the Mayor, but were repassed by the Council over the veto on Feb. 11, by a vote of 57 to 12. The ordinances were dependent for their adoption upon a referendum vote at the coming April election. At this referendum the ordinances were accepted by the electorate at large, and Frederick A. Busse, who had favored them, was chosen mayor over Mayor Dunne, who was a candidate for re-election.

An unfortunate accident occurred, Feb. 16, from a dislodged rail on the electrified division of the New York Central Railroad, and gave rise to a very long investigation into the holding power of spikes as well as the effect of locomotive design on the stability of track.

On March 2 the Philadelphia Rapid Transit Company officially opened its elevated division, west from the Schuylkill River to its magnificent terminal station at Sixty-ninth Street, Philadelphia. On June 15 the official opening of the electrified section of the West Shore Railway, between Syracuse and Utica, occurred.

In the early part of June Governor Hughes signed the Public Service Commission bill, by which New York State was divided into two districts, and the public utilities in each district were put under the control of five commissioners. These commissioners were appointed June 28, and took office July 1. It was perhaps more than a coincidence that the appointment of these commissioners, the defeat of the municipal ownership idea in Chicago and the publication of the preliminary

reports of the committee appointed by the National Civic Federation to investigate the subject of public ownership and operation of public utilities in the United States and Great Britain should have occurred within a few months of each other. The main facts contained in the National Civic Federation examination were given to the press during the early part of July, and while it was of course too much to expect that the investigators should agree on all points, representing as they did such wide shades of opinion, yet the number of conclusions in which they were able to unite was remarkable. The general effect of the publication of these reports was to make municipal operation of street railway systems in this country, at least, a dead issue so far as serious consideration was concerned.

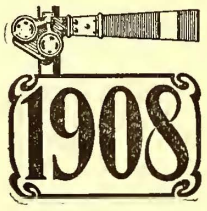
In the meanwhile, the Public Service Commission of New York, First District, began actively to engage in an investigation of the transit conditions in New York City. William M. Ivins, a well known attorney, was engaged to act in the capacity of what might be called prosecuting attorney, and a most rigorous investigation was conducted into the finances and operating methods of all the New York City companies. The condition of the New York City Railway Company had been going from bad to worse, and in the early part of this investigation by the Public Service Commission, application was made by several creditors of the company to Judge Lacombe in the United States Circuit Court to appoint a receiver. This was done on Sept. 24. Receiverships for the Metropolitan Street Railway Company and the Third Avenue Railroad followed not long after. These appointments, however, in no respect put a quietus on the activity of Mr. Ivins.

On July 24 the New York, New Haven & Hartford Railroad began the operation of trains over its electrified line between the Grand Central Station and New Rochelle with a service of 10 trains a day, five in each direction. This service was extended as rapidly as conditions warranted, until in the following year the entire passenger service out of New York was operated by electricity.

The last quarter of 1907 began with the Atlantic City Convention, which exceeded in attendance all previous conventions in the number of exhibits and practical results secured. The souvenir issue published by the STREET RAILWAY JOURNAL this year was devoted entirely to subjects connected with trunk line electrification. Accounts had been published in a number of the technical papers of the construction features of the New York Central, New Haven, Long Island and other electrically equipped steam railways, but in the 1907 convention issue the operating organizations and technical details of these roads were thoroughly described for the first time. An extended article also appeared on the newly equipped Rochester Division of the Erie Railroad.

The following month Tom L. Johnson was re-elected Mayor of Cleveland for the fourth, and it is hoped for the last time. The rule in baseball that a man who has been given three chances to hit the ball and has failed is declared out could well be incorporated in the charter of the City of Cleveland.

Interest in street railway circles during the latter part of the year centered about the question of a standard classification of operating expense accounts. The original classification of the Street Railway Accountants' Association of America adopted in 1898 had been outgrown, and at the meeting of the Accountants' association at Atlantic City in 1907 a revised classification, prepared by the committee on the classification of accounts, had been tentatively adopted, but shortly after the Interstate Commerce Commission indicated its intention of prescribing its own classification of electric railway accounts for use by interstate railways. This announcement gained importance from the fact that some of the State railroad commissions had decided to adopt any classification of electric railway accounts recommended by the Interstate Commerce Commission. Representatives of the electric railway companies immediately asked for a hearing, and a meeting was held in Washington, Nov. 22, at which the tentative classification of the commission was compared with that of the Accountants' Association. A second meeting, held in Washington, Dec. 17, 18 and 19, was more largely attended by electric railway representatives. The commission did not issue its tentative classification of electric railway accounts, embodied in the famous circular No. 20 until early in the following year.



THE first important event in 1908 was the operation of an electric train, Jan. 4, through the tunnel of the Hudson & Manhattan Railroad. On Feb. 25 the uptown tunnel of the Hudson & Manhattan was opened to the public with elaborate ceremonies in which the Governors of New York and New Jersey and the officials of New York and Jersey City participated.

Throughout all of the States a great deal of interest was manifested in the experiment of governing public utilities by commission being conducted in New York. Public utility bills were introduced in many Legislatures, but very few passed.

The segregation of the separate properties forming the Metropolitan Street Railway system, which began with the abrogation of the lease of the Third Avenue Railroad early in the year, was continued in later months and with it came the discontinuance of the issue of transfers at a great many points in New York City. This action gave rise to considerable complaint among those who had to pay two fares instead of the one to which they had been accustomed, and was another instance of the fact that a street railway monopoly in a city is not always a grinding one.

In the meantime, the movement for higher fares in Massachusetts continued. After careful hearings the Railroad Commissioners of the State gave permission to charge higher fares on certain lines, and there is increasing popular acceptance in Massachusetts that these 6-cent fares are justified.

While this movement for higher fares was going on in Massachusetts steps were being taken in Cleveland to inaugurate the real thing in the way of a 3-cent fare line. The negotiations in that city between the municipal authorities and the railway company had finally reached the stage where the latter was willing to lease its road to the Municipal Traction Company which was organized to operate on a 3-cent fare basis. The property was formally turned over to the Municipal Traction Company April 27. On April 28, after the manner of the old days when wine flowed through the city fountains, everybody in Cleveland was invited to ride free. Then 3-cent, 4-cent, and 6-cent fares were charged. In less than a month later the employees struck and the beginning of the end was in sight.

In their issue of May 16 the publishers of the STREET RAILWAY JOURNAL announced its purchase of the ELECTRIC RAILWAY REVIEW, its principal competitor, and that these two papers would be consolidated to form the ELECTRIC RAILWAY JOURNAL. On June 6 the first issue of the consolidated paper was published.

F. W. Whitridge, who had been appointed receiver of the Third Avenue Railroad during the year, proved to have many

original ideas and his unique methods in railroad operation and his caustic humor in dealing with the Public Service Commission soon attracted attention. One of the plans adopted by him to increase the gross receipts of the company was to place a poster in the cars with the Biblical injunction not to steal, directed to passengers who did not pay their fares and to conductors who did not turn in all the money collected. Later considerable difference of opinion developed between Mr. Whitridge and the Commission over the utility of the appraisal of the local electric railway properties decided upon by the Commission during the year and since undertaken.

During this period also there was heroic pruning of the Metropolitan Street Railway system in the hope that by lopping off some of the weak branches it would be possible to keep vitality in the main stem. The Central Park, North & East River Railroad and the Twenty-eighth & Twenty-ninth Street Crosstown line were first requested to start business on their own account. Other unprofitable branches soon suffered the same fate. The increase in the average fare, secured by this segregation of lines, produced a great deal of dissatisfaction on the part of those who were accustomed to receive free transfers from one line to another. Appeals were made to the Public Service Commission to restore the old order of things, because the Public Service law authorized the Commission to establish "joint rates and through routes," although the companies claimed that the Commission was without jurisdiction. A hearing was conducted in the Central Park case and on Oct. 30 the Commission ordered the companies to make "a joint rate of fare of 5 cents" on the Fifty-ninth Street line and on any north and south Metropolitan line between Thirty-fourth Street and 116th Street. The order was to take effect Nov. 22, but the case was carried to the courts by the companies and is now before the Appellate Division of the Supreme Court.

In the fall of 1908 the Public Service Commission, First District, conducted two very valuable series of public tests of fenders and wheel guards. One was carried out in September at the works of the General Electric Company at Schenectady, and the other during November at the works of the Westinghouse Electric & Manufacturing Company, at Pittsburgh. Manufacturers and inventors of fenders and wheel guards were invited to present their devices for practical demonstration and some valuable records were secured. The devices which stood highest in the list proved, without exception, to be those which had already been given the endorsement of adoption by railway companies, showing that there was no wonderful principle in fender construction which had not up to that time been discovered and recognized. The cost of these fender tests was $10,000, and it was money well expended.

In the meantime the Massachusetts Railroad Commission was engaged in considering the reasonableness of higher rates of fare than 5 cents on different roads. Hearings were given to decide this question and in a number of cases the increase was upheld.

Again, the convention this year was held at Atlantic City, and it was the first time in the history of the association that the same place was selected for a meeting during two successive years. Again also the convention was most successful from every standpoint. The convention issue of the Electric Railway Journal this year was devoted to a comparison of electric railway practices upon operating subjects. A daily edition of the paper was also issued.

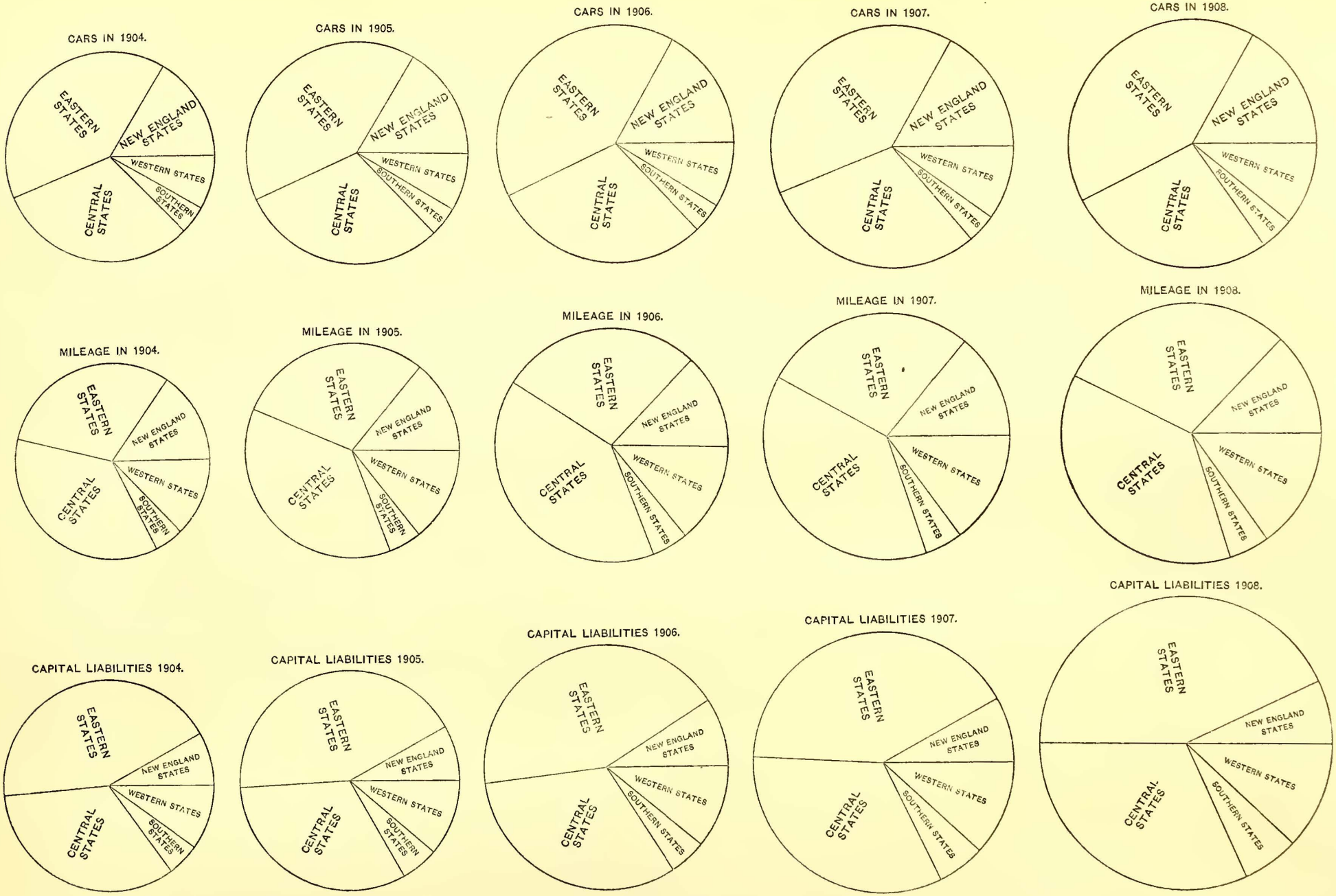
On Nov. 30 the Washington Street Subway, built by the Boston Transit Company and leased to the Boston Elevated Railway, was put in operation. The following month, William S. Murray made public at a meeting of the American Institute of Electrical Engineers the New Haven electric log. Engineers of other beliefs have taken several hacks at it, but it has proved pretty strong timber.

STATISTICS compiled by the Electric Railway Journal during the latter part of 1908 and published in the first issue of 1909 showed a considerable falling off in electric railway mileage built and cars purchased by electric railway companies during 1908, as compared with 1907. Nevertheless, the electric railway companies met the storm of the industrial depression much better and showed far fewer decreases of gross earnings than the steam railroads. The preliminary report of the Census Bureau for the year ended Dec. 31, 1907, published in January, 1909, proved that this comparative cessation of electric railway construction was temporary only. As compared with the statistics of June 30, 1902, the electric railway mileage had increased over 50 per cent, the earnings from operation nearly 70 per cent.

One of the events of technical interest during the year was the investigation made regarding the desirability of different designs of cars in rapid transit service in New York. The original cars in the New York subway were similar in their arrangement of platforms, doors and seats to those used on the Manhattan Elevated lines, but experience after the subway commenced operation showed that the use of side doors would prove desirable. Hence, the Interborough Rapid Transit Company provided for the subsequent introduction of side doors in cars later constructed, though the doors were not actually installed. During the investigation of Mr. Arnold into methods of increasing the traffic-carrying capacity of the subway, he recommended the introduction of double end doors, and a series of tests was conducted under the supervision of the Public Service Commission to determine the relative merits of each type of car. The center side door could not be used on trains operated on local tracks and this was advanced as an important reason by the Commission for the adoption of the double end door car, but the preference of the company for the center side door was so strong that it was adopted as standard for cars to be used in express trains.

The January meetings of the executive committee of the American Street & Interurban Railway Association were held in New York on the last days of January and were well attended. At that time it was decided to hold the 1909 convention in some city west of the Mississippi River and a subcommittee was appointed to decide upon the exact location. At this time Secretary Swenson handed his resignation to the executive committee of the association and it was received with regret.

An aphorism is to the effect that that country is happy which has no history. Assuming that this is true, it is unfortunate that the affairs in Cleveland, Detroit and Toledo during this period cannot be passed over without comment. In the Forest City, however, a turn had come in the tortuous course over which the railway affairs had had to travel. Under the wise supervision of the receivers who had been appointed to administer the affairs of the Municipal Traction Company the earnings of the Cleveland Electric Railway system had begun slowly to improve. Good service combined with a living fare constituted in this case the secret of success, and, while it would be improper to state that the company's troubles have passed, yet under the protecting arms of the Federal Court there has been at least a temporary relief.



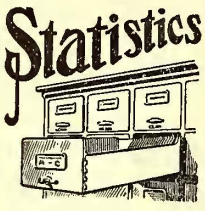
Diagrams Showing Statistics of Cars, Mileage and Capitalization of Electric Railway Companies in the United States, 1904 to 1908, Inclusive

Detroit, although a close neighbor of Cleveland, seems not to have gained the full measure of the benefit which the experience of the latter city should have taught. Expiring franchises have brought the railway situation in that city to a serious condition and there are undoubtedly some agitators there who would like to see in Detroit a repetition of the Johnson 3-cent fare experiment in Cleveland. A Committee of Fifty has been appointed to investigate the subject and it is hoped that wiser counsels will prevail. A somewhat similar condition exists in Toledo, and there also there is a chance for a choice between the adoption of a constructive or a destructive policy. Fortunately for these two sister cities of Lake Erie, the consequences of the latter course have been amply exemplified at Cleveland.

In the meantime a history-making hearing was being conducted in Milwaukee. Two years ago the Wisconsin Railroad Commission was appointed with extremely broad powers, but up to 1909 it had given most of its attention to the other public utilities of the State. Time had been taken, however, to make a valuation of the property of the Milwaukee Electric Railway & Light Company, and this valuation was cited in a case between the city and the company, in which the former endeavored to secure a reduction to 3 cents of the passenger charge on the city lines. Experts for both the city and the company gave testimony as to the proper items to be included in operating expenses, to the amount to be charged to depreciation and reserves, the extent of the wear on equipment, and in general as to the cost of providing an adequate service on the basis of the passengers carried and car miles run in Milwaukee. The scope of the investigation of these economic questions in Milwaukee, though broader than any previously made, is characteristic of the thought and spirit of the year. In fact, these financial problems of electric railway operation are the ones which now loom largest on the horizon, being forced upon the railway companies by the undoubtedly large increase in the cost of operation, plus, in many instances, added exactions in the form of taxes and other burdens.

Among the other cities where the fare question became acute during the present year was Philadelphia, where an attempt was made by the daily papers and politicians to hold the company to the sale of six tickets for 25 cents, a rate which the company had introduced voluntarily as an experiment some time previously. Various efforts were made by the railway officials, before abandoning this rate, to restrict its use in a legitimate way by not making the tickets purchased at this low rate transferable. But it was found impossible to carry out this plan satisfactorily, and the abandonment of the tickets altogether was followed by a decision of the Supreme Court of Pennsylvania that such action was legal.

The course of the present year has only partly run. The time to come before the last day of December may contain events of far greater moment to the street railway industry than any which have been chronicled. It would seem better, therefore, having brought this history to the middle of 1909, not to attempt to sketch the events of the last few months, for has not appropriate mention of them appeared in the recent issues of this paper?—and hence is available to the latest subscriber.



BEFORE closing the chapter devoted to this history a few statistics will be given of the progress of the industry. The publication of the Red Book annually provides opportunity for the ready compilation of the statistics of the electric railway industry by years. The reports of individual properties contained in that annual are summarized as soon after its publication in June as possible and issued in tabular form in some issue of the Electric Railway Journal published during the latter part of the summer, this year in the issue of Sept. 4.

The accompanying diagrams show the relation between the number of cars, miles of track, and capitalization of electric railway properties, as given in the last five compilations of statistics to which reference has been made. The circumference of each circle is drawn to represent proportionately the total number of cars, mileage or capitalization in the country during each year. The lengths of the arcs of each sector correspond proportionately to the amount of this mileage, cars and capitalization, included in each of the several groups of States.

For convenience the actual figures are appended below.

Miles of Track

	1904	1905	1906	1907	1908
N. E. States.....	4,609	4,783	4,948	5,124	5,390
Eastern States...	9,301	9,715	10,190	10,960	12,063
Central States....	10,872	12,375	14,612	14,860	14,723
Southern States..	1,543	1,672	1,862	1,917	1,975
Western States...	3,862	4,605	5,320	5,951	6,096
Total.....	30,187	33,150	36,932	38,812	40,247

Cars

N. E. States.....	12,288	13,044	14,728	15,177	15,210
Eastern States...	30,605	32,620	33,304	34,773	35,951
Central States....	23,738	24,416	25,066	24,034	24,350
Southern States..	3,016	3,179	3,428	3,669	3,773
Western States...	6,257	6,492	8,206	9,551	9,932
Total.....	75,904	79,751	84,732	87,204	89,216

Capital Liabilities in Thousands of Dollars

N. E. States.....	$254,723	$263,148	$327,602	$330,582	$330,492
Eastern States...	1,401,344	1,443,295	1,589,081	1,694,667	1,974,257
Central States....	1,052,989	1,106,581	1,220,911	1,354,473	1,449,154
Southern States..	172,059	186,588	201,889	239,125	254,328
Western States...	335,976	369,325	425,835	504,987	548,904
Total.....	$3,217,092	$3,368,937	$3,765,318	$4,123,835	$4,557,136