RAILWAY SUPPLY & CURTAIN CO.—614-618 S. Canal St., Chicago, Ill. Manufacturer of electric car curtains and other fittings.

RAILWAY TELEPHONE MFG. CO.—9 S. Clinton St., Chicago, Ill. Manufacturer of telephone train dispatching systems.

RAILWAY TELEPHONY.—This comprises telephone train dispatching, telephone service for company's business locally and between centers, and emergency telephones. Another form known as railway composite is the addition of a telephone set to a telegraph line (single wire) for emergency telephoning. The noise is great, but it can be worked if necessary. Signaling is done by means of a "howler." Also see Telephone and Telegraph composite systems.

RAILWAY TRACK-WORK CO.—3132 E. Thompson St., Philadelphia, Pa. Manufacturer of railway track grinders, bonding tools, etc. Business established 1910. President, William D. Gherky; vice-president, A. M. Nordine; secretary and treasurer, William B. Goodall.

RAILWAY TRAIN DISPATCHING SYSTEMS.—See Train dispatching systems, telephone.

RAILWAY UTILITY CO.—151 W. 22nd St., Chicago, Ill. Manufacturer of electric railway heat regulators and car ventilators. President and treasurer, E. J. Magerstadt; vice-president and secretary, W. J. Pine.

RAILWAYS, ELECTRIC, DEVELOPMENT OF.—The development of electric railways in America dates back to the experiments of Thomas Davenport, of Vermont, who operated a toy motor on a small railway in 1834. From this time on numerous experiments were conducted until 1880 when Thomas A. Edison built a small experimental railway at his Menlo Park laboratory.

Between 1880 and 1890 a great many experimenters were active along this line. In 1881 Frank J. Sprague conducted experiments with a motor with two armature circuits, using plug connections by which series-parallel combinations could be used. This experiment later developed into series-multiple control commonly used on all motor cars. In 1883 Leo Daft constructed an electric locomotive which ran on the Saratoga & Mont McGregor Ry. where it pulled a full-sized car. In August, 1885, Daft began his work on the Hampden branch of the Baltimore Union Passenger Ry. One of the early electric railways was in Mansfield, Ohio, which was built by the Daft Electric Trolley Systems Co. and the trial runs made as early as Aug. 8, 1887. The current was carried by positive and negative overhead wires and a four-wheeled trolley collector was used. From this device flexible leads brought the current down to the car and two additional wires, one attached to the front end of the car and the other to the rear, towed the collector along and prevented it from running ahead or behind the car as it stopped or started.

In May, 1887, the Sprague Electric Railway & Motor Co., which had previously been formed by Frank J. Sprague, secured the contract to build and equip the Richmond Union Passenger Ry., of Richmond, Va. This installation, because of its size and importance, is usually credited with being the first electric street railway built in this country. This contract called for 12 miles of track, a 375-hp. power plant and 40 cars with two motors each, together with all appurtenances. Among the features of this installation was the employment of an overhead trolley wire with an underrunning trolley making contact and from which the present type of underrunning trolley has been developed. The road was completed so that trial runs were made in November, 1887, but owing to difficulties that had to be overcome the line was not put into regular operation until Feb. 2, 1888. The contract price was $110,000 and the Sprague company claimed to have lost about $75,000 on the contract, but the operation of this road brought out many difficulties that could not be foreseen and which were gradually overcome so that, while not of immediate financial gain, it was a big step ahead in electric railway operation and ushered in the era of street-railway construction which swept over the country in the next few years. The ten-year period from 1888 to 1898 is often referred to as the period of electrification of city horse and cable-car lines and the next ten-year period, from 1898 to 1908, as the period of interurban railway development.

Among the early types of construction, the third-rail scheme of conducting current to the motor-driven cars instead of the trolley wires was tried out. This method employs an auxiliary rail which is usually mounted between or alongside the running rails a short distance from them and insulated from the ground by various forms of insulation. Various forms of rail and methods of support have been considered. The earliest of which there is record was an experiment by Stephen D. Field in 1879 and the Baltimore Union Passenger Ry. built by Daft in 1885 employed this method of supplying current to the cars. The underrunning type adopted by the New York Central R. R. has probably been the most largely used. This construction employed a bullhead rail, i. e., a rail having a double head and rolled of a soft steel giving fairly high conductivity—a ratio of about one-sixth the conductivity to about one-tenth or one-eleventh that of copper. The method of supporting the third rail consists of a pair of porcelain blocks which engage the head of the rail and the blocks are in turn supported by means of a forged yoke-bolt which attaches to the bracket casting. This leaves the under surface of the rail unobstructed for the current-collecting shoe. The rail is protected from accidental contact by various forms of guards, the formed fiber type being quite common. In this latter type the formed fiber is sprung over the upper head of the rail, thus enclosing the top and sides of the rail and leaving the lower surface exposed.

The development of storage-battery cars has been interesting, as a self-contained unit, without necessity of third rail or overhead wire, possesses considerable advantage. Experiments were made as early as 1880 to 1883 both in Europe and this country and storage-battery cars were tried out in New York City between 1887 and 1888. These early experiments did not prove successful owing to the weight of the batteries, the difficulty of recharging and to the objectionable fumes in the cars. In recent years improvements in batteries have largely removed these objections so that storage-battery cars are now being used for certain classes of work successfully.

Chas. L. Henry, first president of the American Electric Railway Association, is often referred to as the father of the interurban electric railway of this country. He built the Anderson-Alexandria interurban which began operation in 1898 and was the start of the Union Traction Co. of Indiana, although the line from Akron to Cleveland, Ohio, was in operation a short time earlier. Mr. Henry is credited with first applying the name "interurban" to this class of railway and has been a pioneer in this field. He later built the first single-phase railway in this country—the Indianapolis & Cincinnati Traction Co., which opened a line from Indianapolis to Rushville in December, 1904. This road used catenary overhead construction in which the trolley wire was suspended from a messenger wire and was kept practically horizontal, i. e., without sag, by spacing the supporting hangers close together (10 ft.) and making them of such length as to compensate for the sag in the supporting messenger wire. The trolley wire carried 3300 volts and the catenary system permitted greater ease in insulating for this voltage than would have been possible with ordinary direct suspension. This was accomplished by means of large flat porcelain insulators which were mounted on the end of the pole brackets over which the messenger wire passed. A bow type trolley was used to collect the current, this being also the first application of that type of current collector in this country and a form which has been largely superseded by the pantograph type now commonly used on high-speed interurban and steam-road electrifications.

Multiple-unit control was a big forward step in electric railway operation permitting two or more motor cars to operate in trains. This development was the result of Mr. Sprague's experiments in which two cars were successfully operated on the tracks of the General Electric Co. (which had absorbed the Sprague Electric Co.) in July, 1897. In November of that year, a five-car train was tried out on the Chicago Southside Elevated and by February, 1898, the entire system of 120 cars was so equipped and in regular operation. Multiple-unit train operation has since become quite general on elevated and subway lines and electrified suburban lines of steam railroads, 8, 10 or 12 cars being quite common.

The first electric railway voltages were usually 500. This voltage was gradually raised until 750 was reached which was considered the highest practical direct current. The advocates of alternating current considered 750 volts to be too low to be practical and that the economies of high-voltage alternating current on the trolleys would cause its adoption. After the Indianapolis-Cincinnati line was built with its 3300-volt trolley, other lines were built with still higher voltages. The New York, New Haven & Hartford, which originally consisted of a d-c. third-rail installation at 500 volts, went to 11,000 volts alternating current and adopted very heavy bridge catenary construction. It was on this line that the triangular catenary was used, two messenger wires being employed to support each trolley wire, and the hangers were of rigid triangular form. The result was a very rigid overhead which gave excessive wear on the trolley wire. To overcome this defect a steel contact wire was installed about two inches under the copper wire, from which it was suspended by means of clips spaced midway between the regular triangular hangers. This gave a greater flexibility to the overhead and improved the operating condition, but on later construction the triangular catenary has been abandoned in favor of more simple and flexible construction.

One of the main objections to the a-c. system has been the weight of the cars and equipment necessary to transform and control the high-voltage alternating current which is brought directly into the cars. This objection has been sufficient to hamper its more extensive use and high-voltage direct current has been a later development. The Indianapolis-Louisville Traction Co., built in 1906, was the first to use 1200-volt direct current on the trolley. This road was built by James Bryan, of Pittsburgh, who also laid out the Pittsburgh, Harmony, Butler & New Castle line using this same type of construction. The plans and specifications for this latter road were really prepared first, but the Indianapolis-Louisville line was first built and operated and carries the distinction of being the first road to use this popular form of construction, which has been further developed until the Chicago, Milwaukee & St. Paul Ry. adopted it with a d-c. trolley voltage of 3000 for its extensive trunk-line electrification in the Rocky Mountain divisions.

It is largely due to the electrification of the old horse-car lines and to the clean, rapid transit which resulted that the American cities underwent such a marked development within the last three decades. Previous to rapid transit such large cities as New York and Chicago were merely groups of congested small towns in close proximity, but with rapid transit, it became possible for one to live in upper Manhattan and to conduct business 15 or 20 miles away in lower New York without difficulty. The same development was experienced in all large cities throughout the country, permitting the development of beautiful suburban residence districts which would otherwise have been impossible. The electric railway not only showed its ability to withstand competition from other forms of tramway transportation but supplanted practically all other forms, developing sparsely settled outlying districts and at the same time carrying heavy loads of taxation and other expenses.

The injustice of some of these heavy financial burdens are apparent when one considers such heavy expenses as paving between the tracks which the electric railway does not itself use but which has been a big help to its only rival—the "jitney" bus. Snow fighting is also a big expense which has been borne by the electric railways but which is to the advantage of all other forms of vehicles without expense. It has been the private automobile picking up its miscellaneous load at each corner in the spirit of good-fellowship and the jitney bus, operating usually without financial obligations or liabilities for accidents, without developing outlying territory but merely taking the cream of the short-haul business, without paving or snow-fighting expense or other heavy taxation and operating only during favorable weather and peak loads that has recently put the electric railways in such an unsatisfactory financial condition.

The American city has developed through the reliability of the electric railway and must support it in a way that is attractive to new capital so that necessary extensions and improvements can be made, either by making fares such as to bring adequate return, by lightening such expenses as taxation, paving, sprinkling, etc., or equalizing the burden by imposing a proper share on other forms of transportation benefiting thereby in an equitable manner. The electric railways are capable of competing with all other forms of transportation if put on a proper and just basis, but cannot stand the present high operating expenses and give their patrons the comforts they desire unless protected from improper competition.

The electric railways are vital to the American city and should be properly supported that they may continue to furnish adequate service and to develop properly for the ultimate good of the communities served.

RAILWAYS, ELECTRIC, MINIATURE AND TOY.—Systems with light portable sectional track and locomotives using a small universal type series motor for propulsion and obtaining current from dry batteries or the house lighting circuit through a small toy transformer. Various kinds of trailer cars are used to make up trains. A very popular toy; also used in store window displays, where they serve as a very effective means of attracting both young and old. Switches, crossovers, signals, stations, tunnels, bridges, etc., are furnished with many of the more elaborate outfits.

Manufacturers:

Easton Car & Construction Co., Easton, Pa.
Ives Mfg. Co., The, Bridgeport, Conn.
Lionel Corp., The, 48-52 E. 21st St., New York, N. Y. "Lionel."
Voltamp Electric Mfg. Co., 407-409 N. Paca St., Baltimore, Md. "Voltamp."

RAILWAYS, ELECTRIC, OVERHEAD CONSTRUCTION OF.—See Overhead line construction of electric railways.

RAILWAYS, ELECTRIC, STATISTICS OF.—Beginning with the early electric railways in 1887, there was a very rapid growth until about 1907. The earlier part of this period covered electrification of the major portion of the city roads, while the building of interurban lines came in the later period. This was quite the natural line of development as the city roads were in operation with horse cars or cable cars and served the more congested districts. Operation was already established and electrification was in the nature of an improvement. The interurban railways were mostly new projects requiring complete financing and construction. The enthusiasm of capital to enter this field was responsible for a great deal of promotion that was really not justified. Many roads were built entirely as speculation and paralleled existing steam or other electric roads or traversed sparsely settled territory where travel was too light to support the projects.

It was about the time of the financial depression of 1907 that many of these roads reached a point where their unprofitable financial condition became generally apparent and financial people began to look to other fields for investments. So many electric roads were forced to go into the hands of receivers or to reduce or pass dividends or interest on their bonds that the situation reflected discredit to the entire industry and the roads that were in better position financially due to location and management had difficulty in raising the necessary funds for their growth and improvement.

The following data show the approximate growth of street and electric railways in the United States from 1890 to date.

Date	Number of oper'g companies	Capitalization (millions)	Number of employees
1890	770	$ 350	71,000
1895	780	1,350	75,000
1900	810	2,100	123,000
1905	880	3,400	180,000
1910	970	4,300	261,000
1915	960	4,730	296,000
1920	830	5,680	315,000

Date	Mileage of single track	Number of passenger cars	Millions of passengers carried
1890	8,100	32,000	2,000
1895	15,000	45,000	2,800
1900	20,000	57,000	4,000
1905	30,000	68,000	6,200
1910	38,000	72,000	8,800
1915	43,000	78,000	10,700
1920	48,000	87,000	12,400

Note. Data taken from curves based on Bureau of Census figures of 1890, 1902, 1907, 1912, 1917 and recent figures from the technical press.

The capitalization given above is not to be taken as the cash expenditure for construction, as this is impossible to ascertain. Many of the early roads were built as a speculation and later sold. In many cases construction companies were organized to handle the building of new roads and extensions, while in other cases mergers and consolidations have added to the confusion in this respect so that the figures are relative only when compared to cost of construction. It is interesting to note that the capitalization for electric lines per mile has increased until the present figure exceeds the similar figure for steam roads. Although the electric roads avoid some expenses for roadway that are figured for steam roads, the electric roads do carry other heavier expenses not required in steam road construction. There are the power houses and substations, the overhead conductor system or third rail, the feeder circuits and bonding of return circuits, the paving in city streets, and, in some of the large cities, the expensive elevated and subway construction.

The above data include all roads other than steam roads. In 1890 about 84% of the track mileage was not electrically operated. In 1902 this percentage had decreased to 3%, in 1907 to 1%, and since then to about 0.3%. In 1890 the railways other than steam roads were distinctly street railways, being confined largely to the cities. With the rapid growth of the electric railway not only were these urban lines electrified but large extensions and new lines, mostly interurban, were constructed. Thus it may be seen from the table that with the introduction of the electric railway track mileage almost doubled in the five years from 1890 to 1895 and from 1890 to 1920 has increased almost 600%. The most striking comparison showing the rapid growth followed by the slowing up of the industry, is given by a comparison of the percentage of increase of miles of single track between census periods as follows:

	Percentage of Increase
1890-1902	177.9%
1902-1907	52.3%
1907-1912	19.4%
1912-1917	9.2%

(Data taken from census figures of 1890, 1902, 1907, 1912, 1917.)

With the first enthusiasm of electric railway construction the natural result of overbuilding also tended to reflect on the financial status, but with the slowing up that has followed communities have caught up with the development until now many outlying lines are earning fair returns on the investments.

The high costs of operating have been a tremendous burden, but the original idea that five cents represented a street-car ride has given way as it did earlier with the five-cent loaf of bread or the five-cent quart of milk. The improved fare condition is tending to put the roads on a better basis and this condition is further helped by the dropping out of "jitney" competition in most cases. In some cases the city governments have restricted jitneys to certain streets, forced them to pay license fees and assume certain obligations which together with the deterioration of their machines and the heavy operating expenses has largely eliminated them from street-railway competition.

Many of the electric railways operate light and power companies in connection with their railway lines and attempts to separate the revenue from these respective sources are sometimes difficult. However, the Bureau of the Census does make this separation in its reports and its figures may be of interest. In 1907 the revenue from railway operations is given as $400,896,000; in 1912, 535,996,000, and in 1917 650,150,000, representing an increase in revenue from 1907 to 1917 of 62.2%. Due to the many changes in rates and other conditions no attempt can be made to estimate the corresponding figures for 1920.

There is every indication that the electric railways of the country are entering a sounder, more generally stable and satisfactory, financial period than they ever before enjoyed, free from the "high-financing" abuses of the early days and with better returns than they have enjoyed for the last few years.

RAILWAYS, ELECTRIC, TRACK CONSTRUCTION OF.—See Track work, tangent, for electric railways; also Track work, special, for electric railways.

RAILWAYS, INDUSTRIAL, POWER HOUSE, ETC.—These railways are narrow-gage, the car equipment being commonly small scoop, dump, or platform cars. Locomotives or other haulage systems may be used or, particularly where the loads are light, the cars may be pushed or pulled by one or two men. They are used in factories, contracting operations, foundries, in power plants for handling coal and ashes, warehouses, docks, etc., in fact wherever a reasonable quantity of material must be handled over the same route, that is, where a fixed route is practical. Though most of these roads employ standard type cars, many types of cars are made for special purposes, such as tank cars, special cars for heat-treating and baking ovens, etc.

Manufacturers:

Atlas Car & Mfg. Co., Cleveland, Ohio.
Easton Car & Construction Co., Easton, Pa.
Indianapolis Switch & Frog Co., Springfield, Ohio.
Koppel Industrial Car & Equipment Co., Koppel, Pa.
LINK-BELT CO., 329 W. 39th St., Chicago, Ill.
Turl Iron & Car Co., Inc., The, 50 Broad St., New York, N. Y.

RAINAUD CO., THE H. E.—Meriden, Conn. Manufacturer of portable electric lamps. Business established 1913. President, H. E. Rainaud; vice-president, L. B. Rainaud; secretary, M. A. Lyman; treasurer and sales manager, H. A. Lyman. Main office, Meriden, Conn. Branch office, 139 5th Ave., New York, N. Y. Sales representatives, Lyman Sales Service, 141 E. 4th St., Cincinnati, Ohio; Ira A. Jones Co., 17 N. Wabash Ave., Chicago, Ill.

RAINBOW.—Trade name for electric flashing signs manufactured by the Chicago Electric Sign Co., 2219-2229 W. Grand Ave., Chicago, Ill.

RAINBOW.—Trade name for electric washing machines manufactured by the Bernard E. Finucane Co., 296 Franklin St., Rochester, N. Y.

RAJAH.—Trade name for spark plugs and automobile terminals made by the Rajah Auto-Supply Co., Bloomfield, N. J.

RAJAH AUTO-SUPPLY CO.—Bloomfield, N. J. Manufacturer of spark plugs and automobile terminals. President and treasurer, David B. Mills; secretary, W. D. Washburn; general manager, H. R. Bunten.

RALCO.—Trade name for receptacles manufactured by the Central Electric Co., 316 S. Wells St., Chicago, Ill.

RALUMINUM.—Trade name for high-tensile alloy of aluminum manufactured by the Mirete Metal Co. of Mass., Inc., 225 Main St., Springfield, Mass.

RAMAPO IRON WORKS.—Hillburn, N. Y. Manufacturers of railroad track equipment. President, William W. Snow; vice-presidents, James B. Strong, J. Edgar Davidson, Elmer J. Snow; secretary, R. J. Davidson, Jr. Main office, Hillburn, N. Y. Factories, Hillburn, N. Y., and Niagara Falls, N. Y. Branch offices, 200 Devonshire St., Boston, Mass.; 30 Church St., New York, N. Y.; Niagara Falls, N. Y.

RAMEY MFG. CO.—Columbus, Ohio. Manufacturer of electric yacuum cleaners.

RANDALL, FRANK E.—248 Ash St., Waltham, Mass. Manufacturer of micrometer gages. Business established 1896.

RANDALL CO., A. L.—180 N. Wabash Ave., Chicago, Ill. Manufacturer of portable electric lamps, shades, bases and fountains. President and treasurer, A. L. Randall; vice-president, H. A. Banske; secretary and general manager, Frank M. Johnson; sales manager, E. G. Galavan.

RANDALL GRAPHITE PRODUCTS CORP.—711-721 Fulton St., Chicago, Ill. Manufacturer of graphite sheet lubricator and bronze and cast iron bushings. President, W. P. Thatcher; treasurer and general manager, R. H. Whitely.

RANDALL SIGN CO.—Eau Claire, Wis. Manufacturer of electric signs. Business established 1881. Copartnership, Adin A. Randall and Everett H. Randall. Factories, Eau Claire and Chippewa Falls, Wis. Branch office, Chippewa Falls, Wis.