CHAPTER IV
ELECTRICITY INVADES INDUSTRY

Apart from giving the country a comprehensive system of swift communication, electricity provided this generation with a vital new source of light and power. Inventors on both sides of the Atlantic had earlier glimpsed the possibilities, but until the late seventies little definite progress had been made. Before the problem of electric lighting could be solved, however, it was necessary to devise an efficient dynamo. Charles F. Brush, a young Ohio engineer and graduate of the University of Michigan, found the answer. His invention had the stamp of quality put upon it in a contest of dynamos held in 1877 at the Franklin Institute of Philadelphia, the judges deciding it to be the most effective for practical purposes.[1]

The next step was to invent a light. This Brush accomplished by hitching his dynamo by wires to two sticks of carbon placed in a vertical relation to each other and driving a current through them. The result was a brilliantly luminous arc formed of

1 J. W. Hammond, The History of the General Electric Company, chap. i. It was in connection with his work on the news bureau of the General Electric that this history of the concern was prepared. The author died in 1934, and his manuscript has never found a publisher. It is based not only on a full knowledge of printed materials but also on the private records of the concern's consolidation and an acquaintance with the important characters involved.

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particles of carbon leaping from one rod to the other. Moreover, by the new system, sixteen lamps could be maintained on a single wire. Brush's arc light was so satisfactory that the Telegraph Supply Company of Cleveland, which had been backing his experiments, immediately placed it on the market. The enterprising John Wanamaker promptly put it in his department-store windows on Chestnut Street, Philadelphia. "The Blue Moon," as the new light was popularly called, was chiefly useful, however, for outdoor illumination. Rapidly it spread from town to town.[1] Cleveland put up towers two hundred and fifty feet high; in San Francisco the California Electric Light Company was incorporated in 1879 with a capital of five hundred thousand dollars.[2]

The Telegraph Supply Company overlooked no opportunity to push its new product. Hearing that Wabash, Indiana, was considering the installation of gas lights, it persuaded the town council to try the Brush system. Four lamps, each of three-thousand-candle power, attached to cross-arms on the dome of the court house two hundred feet above the ground, were to provide light for the whole city. There was great public interest in the affair, an interest which the Telegraph Supply Company carefully nurtured. Before the lights were turned on at eight o'clock in the evening

[1] See A. M. Schlesinger, The Rise of the City (A History of American Life, X), 98-99.

[2] Hammond, History of the General Electric Company, 94.

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of April 17, 1880, the town was filled with strangers, among them representatives of all the big and little Middle-Western papers as well as some from the East. "Your correspondent," wrote the Chicago Tribune reporter,

> went up into the dome, right under the light, where he beheld a scene of magnificent splendor. For a mile around, the houses and yards were distinctly visible, while the far-away river flowed like a band of molten silver. . . . Wabash enjoys the distinction of being the only city in the world lighted by electricity.[1]

But Brush's was not the only successful arc-light system in the field by 1880. Elihu Thomson, who had been one of the judges in 1877 to declare Brush's dynamo the best on the market, now had devised an equally efficient mechanism. As a teacher and lecturer in the Philadelphia Central High School and the Franklin Institute he had long been interested in electrical experimentation. One of his devices which had particularly excited the public was a small, direct-current, arc-light dynamo. From this he in time developed a system which by 1879 was so successful that business men who saw a great future for electric lighting began to buzz about him.[2]

Among others were some men from New Britain, Connecticut, who persuaded Thomson to let them organize a company around the

[1] Hammond, History of the General Electric Company, 104.

[2] K. T. Compton, "An American Faraday," Technology Rev., XXXIII, 183-184, ~~no. 4, 3-4.~~

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patents of himself and his fellow inventor Edwin J. Houston, also of the Central High School. This company, the American Electric, with a capital stock of $87,000 locally subscribed, set out in the fall of 1880 to manufacture Thomson-Houston dynamos and arc lights. After three years' experience in New Britain, Thomson and his active partner, E. W. Rice, exercised the right their contract gave them to withdraw when convinced that the products were not being energetically pushed. They then joined a new concern organized by Charles A. Coffin, a shoe manufacturer of Lynn, Massachusetts. Coffin himself knew little about electrical matters at the time, but he had a genius for organization and the ability to surround himself with the best technical men in the field. The new company, organized in 1883, was called the Thomson-Houston Electric Company. It started with a capital of $250,000 which nine years later was increased to $10,000,000. In the year 1892, when it was consolidated with the Edison General Electric Company of New York, its profits were $2,700,000. Coffin's faith in electricity as a money-maker had been richly justified.

The arc lamp which Brush, Thomson and others were developing was ill adapted for indoor use because the light could not be subdivided. The problem of subdivision was ~~something~~ one that men had been working on for many years. The solution came with the invention of a practicable incandescent bulb in 1879 by Thomas A. Edison who had already to his credit many other useful electrical

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devices.[1] While the arc light and the dynamo behind it had been making such great strides, Edison had been busy improving his phonograph and seems not to have concerned himself with the possibilities of electric illumination until September, 1878, when he visited Ansonia, Connecticut, to find out what a well-known dynamo inventor, William Wallace, was up to. Here he saw eight electric lights operated by dynamos which in turn were run by river power.

"I have let the other inventors get the start of me in this matter somewhat," he told a newspaper reporter on his return to New York, "because I have not given much attention to electric lights, but I believe I can catch up to them now." "If you can make the electric light supply the place of gas, you can easily make a great fortune," the reporter suggested. "I don't care so much for a fortune," Edison replied, "as I do for getting ahead of the other fellows."[2]

He lost no time in preparing to "get ahead of the other fellows." With characteristic energy he prosecuted endless experiments in his laboratory at Menlo Park, New Jersy. Before he had quite reached his goal, Henry Villard, who had contracted

[1] See Allan Nevins, The Emergence of Modern America (A History of American Life, VIII), 87; and Schlesinger, Rise of the City, 95, 97, 99-101, 302.

[2] Interview in N. Y. Tribune, Sept. 28, 1878, quoted by George Westinghouse, jr., "A Reply to Mr. Edison," N. Am. Rev., CXLIX (1889), 655.

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with John Roach for a steamer for his Oregon Railway and Navigation Company, ordered Edison's incandescent lighting system installed. Roach opposed it, but Villard insisted. It was the first electric plant on a sea-going vessel.[1] ¶ In January, 1880, Edison took out his patent, but it was not until the eve of the national election that he was ready to give an impressive public demonstration of what he had accomplished. "If Garfield is elected," he told his lieutenant, "light up that circuit; if not, do not light it."[2] Garfield was elected, the switch was closed, and a long row of lamps beamed out along the street in front of Edison's residence. Not the least important point in the exhibit was the fact that the power was carried not by overhead wires but by underground mains.

Edison was soon turning out bulbs in quantity at Harrison, New Jersey, the first factory for the purpose in the country. At the same time he was busy improving the supplementary equipment: the dynamo, underground conductors, installation, fixtures, meters -- everything, in fact, necessary for setting up a commercial lighting system such as was being contemplated in a down-town section of New York City.

The Brush arc light had already been established in a section of Broadway and had been adopted by certain business concerns; but

[1] Henry Villard, Memoirs (Boston, 1904), II, 290.

[2] Hammond, History of the General Electric Company, 141.

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Edison and his backers believed that his system was superior. The great banking house of Drexel, Morgan & Company was now willing to organize the Edison Illuminating Company and let it demonstrate what it could do. In order to be close to the generating plant, known as the Pearl Street Station, Edison moved to New York, setting up his office at ~~sixty-five~~ 65 Fifth Avenue, an office occupied by him ~~up to~~ until his death. Practically everything ~~that was~~ used in the plant was developed by Edison himself. He not only invented, but watched with untiring attention the ~~making of things~~ processes of manufacture. "I used to sleep on piles of pipes in the station," he once said with reference to the tubing ~~that was made~~ for the conductors. "I saw every box poured and every connection made on that whole job. There wasn't anybody else who could superintend it."

The Pearl Street Station was ready to operate on September 4, 1882. Nobody knew as well as Edison that the least slip might ruin the whole undertaking, imperiling life as well as property. But, as he later said in telling the story, "I swallowed my heart and gave the word."[1] The current was turned on and it worked -- worked not only in the district to be illuminated, but at the banking house of Drexel, Morgan ~~and~~ & Company which had found the money for the experiment; on the stock exchange where shares ran high; at the offices of the New York Times and the New York

[1] Hammond, History of the General Electric Company, 181.

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Herald, and in scores of smaller places. There was no question from after September, 1882, but that the incandescent light was a success.[1]

What the country now had was two systems of electric illumination carried on from central generating plants. The chief limit to the future of these lights lay in the current itself. The field of distribution by direct current was limited restricted in practice to one or two miles. This meant that in a city of considerable size there must be many generating plants. Plans for New York called for about sixty separate stations, each equipped with small engines and generators and each generator supplying a certain area from its own independent circuit. Satisfactory service to scattered communities seemed to be commercially out of the question.[2]

To remedy this grave defect, inventors began to give attention to developing the alternating current. Basing his experiments on earlier discoveries by Faraday and Henry, an eccentric Frenchman named Gaulard, backed by a sporty Englishman Gibbs, demonstrated in 1884 that, by means of a crude "secondary generator," or transformer, an electric current could be sent

1 F. L. Dyer and T. C. Martin, Edison; His Life and Inventions (rev. edn., N. Y., 1929), I, chaps. xvi-xvii.

2 C. E. Skinner, "Lighting the World's Columbian Exposition," Western Pa. Hist. Mag., XVII, [illegible] 15.

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many miles.[1] Elihu Thomson at once appreciated the importance of the discovery and began experimenting. By 1887 he had an alternating-current dynamo of his own on the market.[2]

The most aggressive protagonist of the new system, however, was George Westinghouse of Pittsburgh. He was known at this time chiefly as the inventor of railroad brakes and signals.[3] Hitherto he had worked little in electricity, his only practical application of the current being to the control of his braking and signaling devices. But when he heard of what Gaulard and Gibbs had done he at once took fire. With such a current the future of electricity for power and light exceeded anything he had dreamed. Purchasing the American rights of Gaulard and Gibbs, he set his brilliant staff to work. By 1886 they were ready to put on the market an electric-light system using the alternating current.[4]

~~At once~~ The use of the alternating current for commercial purposes met the strongest scientific opposition in both America

[1]Waldemar Kaempffert, ed., Modern Wonder Workers (N. Y., 1924), 524-525.

[2]Hammond, History of the General Electric Company, 370.

[3]See Nevins, Emergence of Modern America, 98-99.

[4]H. G. Prout, A Life of George Westinghouse (N. Y., 1921), 102. An able young engineer, William Stanley, jr., was chiefly responsible for the type of transformer that Westinghouse installed in his first alternating-current station, the one at Buffalo in 1886. Kaempffert, ed., Modern Wonder Workers, 525-526.

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and England. Here it was Thomas A. Edison; there it was Sir William Thomson (later Lord Kelvin). The objection which excited the public was the constant danger to human life. But back of this objection was the tremendous pressure brought against the alternating current by those who had great sums invested in private and public plants using the direct current. Westinghouse was quite within the facts when he wrote, ~~later,~~ "the struggle for the control of the electric light and power business has never been exceeded in bitterness by any of the historical commercial controversies of a former day. Thousands of persons have large pecuniary interests at stake, and, as might be expected, many of them view this great subject solely from the stand-point of self-interest."[1]

Edison, cast in an unfamiliar rôle, led the fight against the alternating current. To such lengths did the controversy go that experiments on living animals were performed before public audiences. "In 1889, I witnessed the execution of a horse and a calf in the Edison Station of Columbus, ~~this execution being~~ staged before the Ohio State Legislature," says Dr. Charles E. Skinner.[2] The purpose was to demonstrate the greater danger of the alternating current as compared with the direct. One of the most important contributions to the discussion was a paper

[1] Westinghouse, "A Reply to Mr. Edison," 654.

[2] Skinner, "Lighting the World's Columbian Exposition," 18.

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by Edison in the North American Review for November, 1889, in which he voiced his personal desire to prohibit the use of the alternating current. To this article Westinghouse made a well-argued and temperate reply. He could speak calmly because by this time the alternating current was rapidly outstripping the direct in central stations for incandescent lighting.

The possibility of replacing the early small generators by one central plant and of carrying the power long distances put an entirely new face on problems of electric illumination. It meant the consolidation of interests and refinancing on a large scale. It set men with money to working with fresh energy to secure control of street franchises in all the larger cities and, incidentally, added greatly to the burden of municipal corruption.[1] Central electric power stations increased from 8 in 1881 to 2774 in 1898.[2] Some of these involved interesting experiments in municipal ownership. The electric-light plant which Chicago built in 1887 had become the largest municipal lighting system in the world by 1898 and had nearly paid for itself out of the difference between its operating expenses and what it would have cost the city to buy the same amount of current from a private company.[3] At the same time Allegheny, Pennsylvania, was paying

[1] See Schlesinger, Rise of the City, 389-392.

[2] Bureau of the Census, Central Electric Light and Power Stations, 1902 (Special Rep.), 106-107.

[3] U. S. Industrial Commission, Report (Wash., 1900-1902), XIX, 683.

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its municipal plant a fourth less than Pittsburgh across the river was paying a private company.

One of the most picturesque fights to control a utility in the public interest occurred in Detroit, led by Mayor Hazen S. Pingree, "Potato Patch Pingree," as he later was called because of the gardens he started during the Panic of 1893 in the town's vacant lots. Pingree found, when he entered office in 1889, that Detroit was paying nearly twice as much for electricity as her neighbors, Cleveland, Buffalo and Grand Rapids.[1] He determined to end this by establishing a municipal plant. Having secured an honest commission and an able Scotchman, Alex Dow, as manager, he contracted for equipment with a company which had no foothold in the town. For two years there was a battle, marked by injunctions, charges of bribery, and misrepresentations from the intrenched gas and electric companies, long enemies but now united in their purpose to prevent the government's intrusion into their field. When Dow finally had his plant running, he furnished light at one half less per year, including interest, depreciation and allowance for taxes, than the city could have secured by a contract with a private company at the time the plant was built.[2] Such results

[1] This was true also of gas. Pingree remedied the abuse in the case of gas by forcing a new franchise through the council, which presently resulted in as low a rate as that in the other cities. G. B. Catlin, The Story of Detroit (Detroit, 1923), 598-599.

[2] Catlin, Story of Detroit, 601-607; U. S. Industrial Commission, Report, XIX, 683.

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could be attained with efficient nonpolitical management, but this was not so easy to insure, as experience in other places showed.

The development of electricity for light and power forced a multitude of changes in all sorts of industries. For example, there was the water-gas industry, which represented an investment of something like ~~sixty-nine million dollars~~ #69,000,000 when electricity began effectually to supplant it. To save itself, it sought new uses, emphasizing heating rather than lighting. In 1890 the Bacchus stove was first put on the market and in four years the demand for it exceeded the supply. Similarly, there was a big investment in the manufacture and sale of oil lamps and gas fixtures. To take advantage of the coming of the incandescent light the trade sought to adapt its equipment to the new luminant. It saw that the wires were at first carried along the brackets of gas chandeliers and the lamp adjusted below the gas socket. If the electricity went off, the customer still had his gas jet. Presently attractive designs for "electroliers" were being made and were in great demand.[1] Electrical appliances multiplied until in 1898 it was estimated that there was a capital of $1,900,000,000 invested.

Side by side with electric lighting there developed electric traction, threatening horse, steam and cable roads in the city

[1]Bureau of the Census, Central Electric Light and Power Stations, 1902, 101; E. W. Byrn, The Progress of Invention in the Nineteenth Century (N. Y., 1900), 60-61.

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streets. As early as 1847 Moses G. Farmer had built an experimental two-passenger car at Dover, New Hampshire, operated by means of a current carried from batteries to a motor connected with one of the axles. Twenty-eight years later a poor mechanic, George F. Green, built a similar railway at Kalamazoo, Michigan. By the mid-seventies there had been developed out of the work of many experimenters a continuous-current, self-exciting, stationary dynamo which could be used for power. This opened up new possibilities. The problem now was how the power the dynamo provided could be transmitted so as to drive a train on rails.[1]

Impetus was given to the search by the first commercial electric railway, installed by the eminent German inventors, Werner and Wilhelm Siemens, at the Berlin Exposition of 1879, which carried passengers successfully day after day. The heads of the great American electric companies were soon pushing their inventors and engineers to attack the problem. Henry Villard, president of the Edison Electric Company, was counseling Edison; Charles A. Coffin was urging Elihu Thomson. Edison exhibited an electric locomotive in 1880 at Menlo Park and delighted in giving visitors a ride in the car. But his experiment came

[1] F. J. Sprague, "Electric Traction in Space of Three Dimensions," Md. Acad. of Sciences, Journ., II, 166-171.

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to nothing commercially; Nor did the later ~~experiments~~ efforts of Edison, or those of Stephen D. Field, a nephew of Cyrus W. Field, who ran a train in Chicago in 1883.[1]

The real advances were made by young, energetic inventors experimenting on their own initiative. One was Leo Daft, an Englishman engaged in manufacturing motors at Greenfield, New Jersey, who in 1883 turned out a locomotive which was used to pull a car over the Saratoga and Mt. McGregor Railroad. Another was Charles J. Van Depoele, a Belgian who had set up a plant in Chicago for making electric-light dynamos and in the fall of 1883 showed an electrically driven car at the Chicago Interstate Fair. It was Daft who in 1885 built the first road which actually carried passengers for fares for more than a year ~~over a period of more than a year~~. This was in Baltimore on a branch of the Baltimore Union Passenger Railway and was successful enough to induce the New York street railways to allow him to experiment on their tracks. Van Depoele was even busier in the West than Daft in the East. South Bend, Minneapolis, Appleton in Wisconsin, Fort Huron, Michigan, all gave him orders to set up his system.

Although Daft and Van Depoele were recognized as the two most promising electric-traction engineers in the country, neither had demonstrated that an installation superior to the

[1] T. C. Martin, "History and Development of Electric Traction," Bureau of the Census, Street and Electric Railways, 1902 (Special Rep.), 160-167.

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existing horse and cable-operated roads was possible. That soon followed through the work of the man since known as the "father of the electric railway," Frank J. Sprague. He was one of the many who as boys had become infatuated with electricity. Winning a scholarship in the Naval Academy at Annapolis, he had kept up his interest and in his first long cruise in the late seventies made what he called "fifty-seven varieties of inventions." No sooner was he back than he tried to replace the old oil lamps in the navy with incandescent lights. He then went abroad on leave of absence to visit electrical exhibitions in Paris and London. He overstayed his leave, but made so important a report on what he had seen that he escaped court martial.[1]

While in London Sprague began to plan for the operation of street railways by electricity, and one of the ideas for which he applied for a patent on his return was the trailing trolley; but in this Charles Van Depoele had anticipated him.[2] This overlapping of inventions had from the beginning been one of the confusing and provoking features of the development of both electric traction and electric lighting, just as it had been of the telegraph and the telephone. Patent wars were waged incessantly, entailing heavy court expenses and much suspicion and mutual recrimination. An outstanding electric engineer of the time,

[1] Sprague, "Electric Traction," Md. Acad. of Sciences, Journ., II, 178-179.

[2] Kaempffert, ed., Modern Wonder Workers, 120-121.

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Benjamin Garver Lamme, who came fresh from the Ohio State University into the Westinghouse concern, remarked that it was a common experience of technicians to discover that what appeared to them original ideas had been patented years before but never used. "It is surprising too, at times," he declared,

> to note how many people think of almost the same thing at the same time, and how their ideas are yet, unquestionably, independently conceived. One instance occurred in my experience of four different people coming to me, within about one month, with the same scheme, to ask my opinion. Upon investigation, I found that they all had devised the scheme independently; and what is more interesting, it was not a scheme for which there was any particular call at that time. [1]

Whatever the patent complication, Sprague always found a way out. Committed ~~early~~ to the ambition of developing a practical system of electric traction, he left the navy in 1883 and, after a few months with Edison, organized the Sprague Electric Railway & Motor Company with a capital of one hundred thousand dollars on paper. He was allowed to try out his developments on the New York street railways, but the financiers, though they came to look, went away unconvinced. Sprague's chief satisfaction in these fruitless experiments seems to have been that one day Jay Gould was so scared by the blowing out of a fuse that he jumped off the train, never to return.[2]

[1] B. G. Lamme, Benjamin Garver Lamme, Electrical Engineer: An Autobiography (Mansfield Dudley, ed., N. Y., 1926), 140.

[2] Sprague, "Electric Traction," Md. Acad. of Sciences, Journ., II, 190.

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Eight years had passed since the Siemens ran their train in Berlin. Yet there were but nine commercial installations in Europe and ten in the United States. "These installations," says Sprague,

> were characterized by the utmost diversity of practice -- high and low electrical pressures, series and multiple arrangement of motors, traffic rail conductors and conduits, third rails, slotted tubes, single and double overhead wires carrying trolleys with flexible cable connections, as well as upward-pressing arms carried on the cars.

The motors also varied in construction and control. Ordinarily each car had but one motor, carried either on the front platform or in a dummy car, and connected to the driven axle by belt or chain. "Nowhere," he adds, "was there an installation which in extent or character of equipment could form the basis of general commercial exploitation or command the confidence of capital." [1]

In 1887 Sprague's opportunity came to prove that he had, as he believed, a practical system: a contract for a street railway in Richmond, Virginia. The terms were fantastic. Completion was called for in ninety days of a route twelve miles long, (including a hill a mile long), with a central plant of three hundred and seventy-five horse power, an overhead line, and forty cars with eighty motors. This was nearly as many motors as were then giving uncertain railway service throughout the world. If the result was satisfactory the Sprague Company should be paid $110,000. It took

[1] Sprague, "Electric Traction," Md. Acad. of Sciences, Journ., II, 192-193.

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more than ninety days, but by the fall of 1887 experimental trains were taking the hills and corners of Richmond, something that in the opinion of John Stephenson, the veteran street-railway builder of the day, an electric train could never do. By February, 1888, the road was in commercial operation, and financiers were looking it over.[1]

Chief among these was Henry M. Whitney, president of a Boston street railway for which he was considering new equipment -- cable probably -- but, before he decided, he journeyed to Richmond to see what Sprague had accomplished there. In particular, he wished to ascertain whether the system could operate a large number of cars simultaneously. To clear away any doubt Sprague determined upon a dramatic demonstration. The visitor was asked if he would like to see an attempt made at midnight to move a large number of cars then bunched at the terminal. On Whitney's assent, Sprague relates,

> orders were given at the central station to put on extra safety catches, to run the potential up to ~~five hundred~~ 500 volts, and to keep the engines going no matter what happened. At the appointed time, on signal the motormen of the ~~twenty-two~~ 22 cars started as rapidly as they could get clearance headway, but although the potential drop was so great that the car lights could hardly be seen, every car got away and was soon hustling out of sight.[2]

[1] Kaempffert, ed., Modern Wonder Workers, 124-125.

[2] Sprague, "Electric Traction," Md. Acad. of Sciences, Journ., III, 6-7.

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The test was conclusive. On his return to Boston Whitney presented the case so eloquently to the board of aldermen that he obtained permission to put in a composite line, one part, near the old Providence Depot, of conduit construction, and the ~~balance~~ remainder, to Allston, of overhead construction. Sprague motors were used on all the cars. Sprague's achievement was celebrated far and wide. Other cities quickly followed the example set by Richmond and Boston.[1] The intense popular interest was picturesquely shown in the case of New Orleans. There a mass meeting, called in favor of replacing the mule with the new system, had as its slogan:

Lincoln Set the Negroes Free!
Sprague Has Set the Mule Free!
The Long-Eared Mule No More Shall Adorn Our Streets.

These successes induced the Edison Electric Company to absorb the Sprague Company. But when Sprague saw that the merger meant changes in his system of which he did not approve and also the dropping of his name from his machines, he resigned. He could not give up his interest in electric traction, however. By 1895 he had developed a new idea, a means of making up long trains by a combination of car units, without regard to number or sequence, some but not all of them equipped with motors. By the new scheme it was possible to control the trains from either end of any car through master switches

1 See Schlesinger, Rise of the City, 92-93.

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connected to the common train line.[1] He had hit on the "multiple-unit" system which soon became almost universally used in electric traction.

As Sprague found himself absorbed, so did Van Depoele who by 1887 had installed electric roads in perhaps twenty American cities. When Charles A. Coffin told Elihu Thomson early in 1888, "We ought to get into street car electrification" and asked, "Who has done the pioneer work?" Thomson replied, "Van Depoele."[2] Coffin immediately sought him out, bought his company, paying for its patents on a royalty basis as was his custom, and added Van Depoele to the engineering staff. It was Van Depoele who solved, not only for the Thomson-Houston Company but also for Sprague in Richmond, one of the most troublesome problems connected with the installation of motors: the sparking of the commutator. The metal brushes or blocks hitherto used to take care of the annoyance had yielded poor results. "Try carbon," suggested Van Depoele. Though everybody was skeptical carbon worked. Elihu Thomson was to say later that "the carbon brush was the most important invention

[1] Sprague, "Electric Traction," Md. Acad. of Sciences, Journ., III, 19.

[2] Hammond, History of the General Electric Company, 435.

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ever made in the electric railway field."[1]

From the first the Thomson-Houston Company was highly successful in electric railways. This was due less perhaps to the excellent quality of its equipment and the care and integrity of its installations than to the salesmanship of Coffin and his method of financing local plants, a method which he had used with success in electric lighting. His practice was to take the bonds of newly formed concerns in part payment for equipment. As a result, the holdings were scattered all over the country and companies rapidly multiplied.

In its many new applications electricity had come to touch the life of the people at countless points. It was the modern miracle, lighting homes and public places, carrying the human voice great distances, propelling passenger cars through city streets, lifting swift elevators in high office buildings, and promising innumerable benefits as yet undeveloped. As in other economic fields, however, once the period of crude experimentation passed, this new instrumentality of social well-being had tended to fall under the control of a few great capitalists. Increasingly the electrical industry became a component part of the consolidated national business order.

1 Hammond, History of the General Electric Company, 458.

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