CHAPTER V

ELECTRICITY INVADES INDUSTRY

Up to the opening of our period the greatest contribution electricity had made to the country's economic life was the telegraph - swift communication. The telephone as we have seen soon complimented and multiplied this service. But two vast new developments of forcing momentous changes in ways of doing things confronted industry - electricity for lighting and for power.

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By 1878 small beginnings in both incandescent and arc lights had been made and all over the land in High Schools, Colleges, private laboratories, experiments were going on and here and there men with money were becoming interested. The first spectacular demonstration of the arc light for town purposes came in April 1880 when Wabash, Indiana turned on what was known as the Brush Arc Light.

The inventor of this light, Charles F. Brush, was a University of Michigan graduate who like so many scientifically-minded young men of the period had taken up one or another problem of electricity. Working at his country home he developed in 1876 an electric dynamo which applied to an electric lamp with carbon point gave a brilliant light.

The Brush dynamo 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.

As was to happen so often in the development of electric lighting it was necessary to invent something else in order to use satisfactorily what an inventor had already developed. Here was Brush with the most effective dynamo then in existence, but no satisfactory arc light. Therefore, he made one. He made one so satisfactory that the Telegraph Supply Company of Cleveland which had been backing his experiments

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immediately began to place it commercially. John Wanamaker used it in his store windows on Chestnut Street, Philadelphia. "The Blue Moon," it was called. (1)

Rapidly the Brush light spread from town to town. Cleveland put up towers two hundred fifty feet high; in San Francisco in 1879 the California Electric Light Company was incorporated with a capital of $500,000. (2)

Hearing that Wabash, Indiana, was considering lighting itself by gas the Telegraph Supply Company persuaded the town council to try a Brush light. Four lamps, each of three thousand candle power, two hundred feet above the ground on cross arms, attached to the dome of the Court House were to light the whole city from this single point. There was great public interest in the affair, an interest which the Telegraph Supply Company carefully nurtured. The lights were to be turned on at eight o'clock in the evening of April 17, 1880. Before that moment the town was filled up with strangers, among them the representatives of all the big and little middle West papers as well as some of those from the East. The newspapers all contained more or less dramatic description of the moment the lights blazed.

"Your correspondent," wrote the Chicago Tribune man, "went up into the dome, right under the light, where he beheld

1) Hammond, J. W. History of the General Electric Company - Manuscript - Chapter I, "The Pre-electric Era." It was in connection with his work on the News Bureau of the General Electric that the history of the concern was prepared. Mr. Hammond died in 1934, and his manuscript has never found a publisher. This manuscript was based not only on a full knowledge of printed materials on the development of electricity available to the public but on the private records of the concern's consolidation and an acquaintance with the important characters involved.

2) Idem. Page 94 For the Brush light as a feature of urban progress see Schlesinger, A. M. Rise of the City, 98-99

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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 arc light system was not the only successful one in the field by 1880. One of the Judges who in 1877 had declared the Brush dynamo to be the best on the market Elihu Thomson of Philadelphia had by this time, one equally efficient ~~one on the market~~. Thomson had made his way by the time he was twenty one to be a full Professor in the Philadelphia Central High School. Here and in the Franklin Institute he had given popular scientific lectures in which experiments were performed from the platform by the speaker. One of Professor Thomson's experiments which had been particularly exciting to the public was a little direct current, arc light dynamo of his own design. From this he developed a system which soon became so successful that the commercially-minded who believed a great business in electric lighting was opening up with chances for investors began to buzz around him. Among others were a group of men from New Britain, Connecticut, who persuaded him to let them organize a company around the patents of himself and his fellow inventor - Professor E. J. Houston.

1) Hammond, J. W. History of the General Electric Company - Manuscript. Page 104

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This company, the American Electric, with a capital stock of $87,000.00 , locally subscribed, set out in the fall of 1880 to manufacture dynamos and arc lights. After three years experience in New Britain Thomson and his active partner, E. W. Rice, who had joined him on leaving High School preferring the connection to college and who had proved himself an engineer of first rank were throughly dissatisfied with the management of the company and exercised the right their contract gave them to withdraw when convinced that the products were not being energetically pushed. They left to go into a new concern organized by Charles E. Coffin, a shoemaker of Lynn, Massachusetts, with Mr. Coffin was which ~~had~~ convinced ~~him~~ that electricity was not only the light but the power of the future. He regarded /the sound inventor as the crux of its development, and believed /Elihu Thomson to be such a one. The new company which Coffin organized was called the Thomson-Houston Company. It started with a capital of $250,000 which nine years later had been increased to $10,000,000. In that year, 1892, the profits of the Thomson-Houston Company were $2,700,000. Mr. Coffin's faith in electricity as a money-maker had been amply justified.

The arc light which Brush and Thomson and others were developing had a weakness/es always recognized, in its size and the fact you could not sub-divide the light. It was as it was called, "A Blue Moon." The problem of sub-division by the

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invention of a successful incandescent light, was something that men had been working on for many years. The invention finally came with the prestige of Thomas Edison, now thirty-two years old, having to his credit many of the useful electrical inventions to date. In order of their patenting they were - the electric vote recorder - the universal stock ticker - the quadruplex system of telegraphy - the carbon telephone transmitter - the phonograph. Edison had arrived at a point where he was developing and manufacturing at his own laboratory set up in 1876 in Menlo Park, New Jersey.

In these years when 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 been really awakened to the need of doing something himself in lighting until in September of 1878 he visited Ansonia, Connecticut to see what a well known dynamo inventor, William Wallace was up to. Here he saw eight electric lights run by dynamos which in turn were run by the power of the river. Coming back to New York he was interviewed.

"I have let the other inventors get the start of me in this matter somewhat, because I have not given much attention to electric lights, but I believe I can catch up to them now.....Now that I have a machine 'Wallace's' to make the electricity, I can experiment as much as I please."

"If you can make the electric light supply the place of gas, you can easily make a great fortune," the reporter

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suggested. "I don't care so much for a fortune," Mr. Edison replied, "as I do for getting ahead of the other fellow." (1)

It may be that Mr. Edison was hurried to a decision by the knowledge that in 1878 there had been organized in New York City a company known as the Electric Dynamo Light Company, its object being:- "The production of light and power by means of electricity; the lighting of streets, buildings and other places; producing, conducting, and distributing electrical currents for lighting and other purposes, and the manufacture and sale of all machinery necessary for or adapted to accomplish the purposes named." (2)

This ambitious program was built around the intentions of two young men - William E. Sawyer and Albon Man. One of their patents twelve years later was to be the deciding factor by which one of the greatest and the most desired contracts of the period was to be taken from Mr. Edison's own concern.

Mr. Edison lost no time after his visit to Ansonia in preparing to "get ahead of the other fellow." (3) In 1879 Henry Villard who had contracted for a steamer with John Roach for his Oregon Railway and Navigation Company ordered Edison's incandescent electric lighting system installed. Roach opposed it, but Villard insisted. It was the first electric

1) Westinghouse, George. North American Review. Dec. 1889
N. Y. Tribune, Sept. 28, 1878. Interview quoted by Westinghouse

2) Westinghouse, George. Page 3 Reply to Mr. Edison

3) For Edison's worldwide search for a suitable filament for the bulb see Schlesinger, A. M. Rise of the City. Page 100

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plant on a sea going vessel. (1)

By November of 1880 Edison had what he believed was a commercial light. At least he was ready to turn it on. "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 the Edison residence. Not the least important point in the exhibit was that the power was carried not by overhead wires but underground mains. The light was a success and Edison was soon turning out lamps in quantity at Harrison, New Jersey, the first factory for the purpose in the country. At the same time he was busy with everything back of the lamp - the dynamo - proper underground conductors - installation - fixtures - meters - everything he saw that would be necessary for commercial incandescent lighting system which was to be at once attempted in a down town section of New York City.

The Brush arc light had already been set up in a section of Broadway and had been adopted by certain business concerns but Mr. Edison and his backers believed his system

1) Memoirs of Henry Villard. VII. Page 290

2) Hammond, J. W. The History of the General Electric Company Manuscript. Page 141

Digital Image, 2011, The Ida M. Tarbell Collection, 1890-1944, Allegheny College Pelletier Library.

superior at least. Drexel Morgan & Company were now willing to organize the Edison Illuminating Company and let it demonstrate what it could do. In order to be close to the installation known as the Pearl Street Station Edison, himself, came to town setting up his office at 65 Fifth Avenue, an office continually occupied by him up to his death.

Practically everything that was used in the first Edison electric plant was developed by Mr. Edison himself. He not only invented, he watched with untiring attention the making of things.

"I used to sleep on piles of pipes in the station," he once said, talking of the tubing that was being 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 light station was not ready to begin its work until September 5, 1882. Nobody knew so well as Edison that the least slip might ruin the whole undertaking, cause loss of life as well as property, so that as he once said in telling the story of starting the work, "I swallowed my heart and gave the word." (1)

The current was turned on and it worked, worked not only in the district illuminated but at the banking house of

1) Hammond, J. W. History of the General Electric Company Manuscript. Page 181

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Drexel Morgan and Company who had found the money for the experiment, on the stock exchange where shares ran high; at the office of the New York Times; the New York Herald and in scores of smaller places. There was no question from September, 1882, but that the incandescent light was a success. (1)

What the country now had was two systems of electric lighting carried on from central generating plants, private or public. The chief limit to the future of these lights lay in the current itself. The field of distribution by the direct was limited in practice to one or two miles. This meant that in a city of size there must be many generating plants. Plans for the city of New York called for about sixty separate ~~insolated generating~~ stations, each with a group of 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)

This limitation was emphasized by the discovery of ~~that~~ what is known as the alternating current and ~~could by means of a convertor or transformer be sent for long distances.~~ The first experiments to attract attention on this side of the water were those of a French man, Gaulard, and an Englishman, Gibbs.

1) Dyer, F. L. & Martin, T. C. Edison (N. Y. 1910) Chaps. XVI-XVII

2) Skinner, C. E. Lighting the World's Columbia Exposition 1893. Paper read before Historical Society of Western Pennsylvania.

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The meaning of Gaulard and Gibbs' work was not lost on alert inventors in the electric field. Elihu Thomson saw it and at once began experimenting. By 1887 he had an alternating current dynamo on the market. (1) But the most aggressive protagonist of the new current was George Westinghouse of Pittsburgh, Pennsylvania.

Westinghouse at this time was known chiefly to the country as the inventor of railroad brakes and signals which were rapidly reducing the awful toll of life that had been charged up against the railroad since their beginning. When only a boy he had seen a head-on collision which he believed could have been prevented if the old fashioned cumbersome chain brake had not been so slow acting. He set out at once to invent a steam power brake taking out his first patent in 1871. (2)

By 1881 it was in use on over three thousand one hundred sixty four locomotives and seventeen thousand two hundred ninety cars in various foreign countries, ranging from over one thousand eighty seven locomotives and seven thousand seven hundred nineteen cars in Great Britain and one thousand four hundred sixteen locomotives and seven thousand one hundred ninety three cars in France, down to one locomotive and six cars in Sweden. In the United States, three thousand four hundred thirty five locomotives and twelve thousand seven hundred ninety

1) Hammond, J. W. Manuscript History of the General Electric Company. Page 370

2) Prout, Henry G. A Life of George Westinghouse. Page 332
Nevins, Allan. The Emergence of Modern America, A History of American Life, VIII, 98-99

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cars were equipped with it." (1)

In spite of its wide use there were other brakes in the field making excellent showings, and the arbitrator of the situation known as the Master Car Builders' Association decided to subject ~~the organization~~ them to a series of tests - The Battle of the Brakes - as it was called. Westinghouse went into the contest with characteristic spirit. The tests went on for two years until finally in 1888 the Car Builders Association declared that the conditions which they had set down for a universal brakeshad been met by no inventor except Westinghouse.

All of this had recommended the man to the country - any development in which he interested himself was sure to attract attention and arouse confidence.

Up to this time he had worked but little in electricity, his only practical application being for an electric circuit for control of brakes and signals. 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 was far beyond anything he had dreamed.

He at once arranged to buy the American rights of the Gaulard and Gibbs patents (2) and set his brilliant staff at work.(2) By 1886 they were ready to put on the market an electric light system using the alternating current.

1) Leupp, Francis E. George Westinghouse. His Life and Achievements. Page 90

2) Prout, Henry G. A Life of George Westinghouse. Page 102

A brilliant young engineer, William Stanley, Jr. was chiefly responsible for the type of transformers that Westinghouse installed in his first alternating current station at Buffalo in 1886. Waldemar Kaempffert ed. Modern Wonder Workers (N.Y. 1924) 525-526

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But at once the alternating current as a commercial system met the strongest scientific opposition in this country and in England. Here it was Thomas Edison, there it was Sir William Thomson, later Lord Kelvin. The objection which the public seized upon was that the alternating current could not be used without constant danger to human life. But back of this objection tremendous pressure was 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 days. Thousands of persons have large pecuniary interests at stake, and as might be expected, many of them knew this great subject solely from the standpoint of selfishness." (1)

Thomas Edison led in the fight on the alternating current. To such length 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 Skinner. (2) Edison himself

1) Westinghouse, George. A Reply to Mr. Edison. North American Review, December 1889

2) Skinner, C. E. Consulting Engineer of Pittsburgh. Lighting the World's Columbian Exposition 1893. Paper read before Historical Society of Western Pennsylvania. on Jan. 1894 P. 7

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declared that "he had taken life, not human life," in his efforts to demonstrate the comparative danger of the two currents.

Out of the most important contributions to the discussion was a paper by Mr. Edison in the North American Review for November 1889 in which he declared that his personal desire would be to prohibit entirely 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 in spite of the violence of the differences the alternate current was rapidly outstripping the direct in central stations for incandescent lighting.

The possibility of replacing the early small generators by one central station and of carrying the power long distances put an entirely new face on the problems of electric lighting. It meant consolidation of interests and it meant refinancing on a large scale; men with money were working with new energy to secure control of street franchises in all the larger cities. (1) Central electric power stations increased from eight in 1881 to two thousand seventy seven in 1898. In these eighteen years a total of two thousand seven hundred seventy nine had been established. (2) Among them were interesting experiences in municipal management.

1) Schlesinger, A. M. Rise of the City, 389-390

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

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For instance Chicago built an electric light plant in 1887. By the end of our period it was the largest municipal light plant in the world 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 light from a private company. (1) Allegheny, Pennsylvania was paying her municipal plant twenty five percent less than Pittsburgh across the river was paying a private company. (2) It could be done if there was efficient non-political management, ~~Not~~ not so easy to insure as experience in various places was proving.

One of the most picturesque fights to control a utility that went on in this period was in Detroit led by Mayor Hazen S. Pingree, "Potato Patch Pingree", as he later was sarcastically or affectionately, according to point of view, called from the gardens he started in the Panic of '93 in the town's vacant lots. Here with seeds and tools bought from a collection he took up and with an army officer at their head an army of unemployed was set at work - a movement which spread in the '90's and has since become a healthy widespread practice in depressions. Pingree found when he became Mayor in 1889 that Detroit was paying nearly twice as much for gas and electricity as her neighbors - Cleveland, Buffalo, Grand

1) Report of Industrial Commission. Vol. XIX. Page 683

2) Idem

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Rapids. The town had had a longer skirmish to get any electric lighting. Like most towns her first sight of the new illuminant, the arc light, had been when a travelling circus set the blue moon one up as one of its exhibits. (1)

The Brush Company was the first to set up a plant supplying business houses at sixteen to eighteen dollars a month.

1) Catlin, George B. The Story of Detroit. (1923) Page 560

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Efforts to make contracts with the city were at first fought successfully by the existing gas companies and when finally the electric light was established in the town it gave poor and expensive service. Pingree found and determined to end this by establishing a municipal plant. Having secured an honest commission and an able Scotchman, Alexander Dow, as manager he contracted for equipment with a company which had no foothold in the town. For two years there was a battle - injunctions, charges of bribery, misrepresentations from the outraged gas and electric companies, long enemies but willing to join forces in fighting the intrusion of the public into their fields. When Mr. Dow finally had his plant running he furnished light at one half less cost per year including interest depreciation and allowance for taxes than the city could secure by a contract for ten years from a private company at the time the plant was built. (1)

The development of electricity for light and power forced a multitude of changes in all sorts of industries, related and unrelated to lighting and traction. There was the water gas industry.(2) It had had a hard fight in the '70's with the coal-gas industry, but by 1880 the latter was adopting its process and by 1898 it was estimated that seventy five percent of the gas manufactured in the United States was water gas. There was an investment in the business of something

1) Report of Industrial Commission. Vol. XIX. Page 683

2) Schlesinger, A. M. Rise of the City. 101-102

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like $69,000,000 when electricity began effectually to supplant it. To save itself it sought new uses, turned to heating and cooling. In 1890 the Bacchus stove was first on the market and in four years the demand for it exceeded the supply.

There was a big investment in oil lamps and gas fixtures and the coming of the incandescent light set the trade adapting their stock to the new luminant. The incandescent light turned upside down as well as upright so that wires were at first carried along the brackets of gas chandeliers and the lamp adjusted below the gas socket. If the electricity went off you had your gas jet. Attractive designs for "electroliers" were in great demand as were practical suggestions for converting oil lamps into electric lights. It was a new outlet for ingenuity and taste. (1) Electrical appliances multiplied until in 1898 it was estimated that there was a capital of $1,900,000,000 invested.

Electric traction threatening horse, steam and cable roads grew side by side with electric lighting.

1) Census Bureau. Special Report, 1902. Page 101
Byrne Progress of Invention in 19th Century. Pages 60 & 61

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As early as 1841 Professor Moses G. Farmer ran a two passenger car at Dover, New Hampshire by a current carried from batteries through iron rails to a motor connected to the axle of his car; twenty eight years later George F. Greene built a similar railway at Kalamazoo, Michigan - note the geographical spread of the experiment.

By the middle of the '70's there had been developed out of the work of many inventors a continuous current self-exciting electric machine which could be used for light or power. That is, the necessary power was ready. The problem now was how could the power the dynamo provided be transmitted so that it would drive a train on rails. (1)

Impetus was given to the search in 1879 by the first commercial electric railway installed by the eminent German inventors Werner and Wilhelm Siemens at the Berlin Exposition of 1879 carrying passengers successfully day after day.

~~By this time~~ the heads of ~~all~~ the great electric companies were soon pushing their inventors and engineers to attack the problems - "get into electric traction." Henry Villard, the president of the Edison Electric Company was counselling Edison; Charles E. Coffin was urging Elihu Thomson. Edison showed an electric locomotive in 1880 at Menlo Park, and delighted

Electric Traction in Space of 3 Dimensions. Reprinted from

1) Sprague, Frank J. Journal of the Maryland Academy of Sciences. Vol. II, Dec. '31 - Vol. III, July '32. ~~Pages 166 et sq.~~

nos 3 & 4 nos 1, 2, & 3

Digital Image, 2011, The Ida M. Tarbell Collection, 1890-1944, Allegheny College Pelletier Library.

in giving visitors a ride in the car, but it came to nothing commercially nor did the later experiments of Edison and Stephen D. Field, a nephew of Cyrus W. Field who ran a train in Chicago in 1883.

The real advances were being made ~~as they had been made in electric lighting~~ by young, energetic inventors experimenting on their own. There was Leo Daft, a motor builder in a plant at Greenfield, New Jersey who in 1883 turned out a locomotive which was used to pull a car over the Saratoga and Mt. McGregor Road; there was Charles J. Van Depoele, a Dane who had set up a plant of his own in Chicago for building electric light dynamos and in the fall of '83 showed a car electrically driven at the Chicago Industrial exhibit.

It was Daft who built the first road which actually carried passengers for fares over a period of more than a year. This was 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 with commercial installation. South Bend, Indiana, Minneapolis, Minnesota, Appleton, 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 existing horse and cable operated roads was possible.

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That soon followed by the work of the man since known as the Father of the Electric Railway, Frank J. Sprague. He was one of the many boys of the period who early in their schooldays became infatuated with electricity. He had won a scholarship at Annapolis and in his first long cruise in the late '70's made what he called "fifty seven varieties of inventions." No sooner was he back than he tried to get incandescent lighting into the Navy to replace the old oil lamps. He sought orders which would take him abroad to electrical exhibitions in Paris and London. He over-stayed his leave but made so important a report on what he had seen that he was not court martialled. (1)

Sprague began while in London to plan for the operation of street railways by electricity and one of his ideas for which he applied for a patent on his return was the trailing trolley, but Charles Van Depoele was ahead of him. This over-lapping of inventions had been from the beginning one of the confusing and provoking features of the development of electric traction and of electric lighting as it had been of the telegraph and telephone. Patent wars were waged incessantly - a grave expense and a futile cause of suspicion and recrimination.

One of the ablest electric engineers of this period Benjamin Garver Lamme who came as a boy just out of college into the Westinghouse concern beginning his career by rubbing brass says that it was the common experience of engineers to discover

1) Sprague, Frank J. Reprinted from the Journal of the Maryland Academy of Sciences. Vol. II, Nos. 3 & 4. Dec, 1931. Page 179

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that what appeared to them fundamental ideas had been patented years before but never used. And he illustrates from his own experience. Again good patents could have been obtained if the inventor had not supposed what he had hit upon to be well known already in use. (1)

"It is surprising too, at times," says Lamme, "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. (2) At times the doors seem closed in whatever direction we turn; and this sometimes means that we have to start out in an entirely new direction in order to reach the desired result." (3)

Whatever the patent complication a way had to be found Sprague always found a way out. Committed to the ambition of developing a practical system of electric traction he left the Navy and after a few months with Edison went on his own, organizing the Sprague Electric Railway & Motor Company with a capital of $100,000 on paper. He was allowed to try out

1) Lamme, Benjamin Garver. An Autobiography, Page 140

2) Idem.

3) Idem. Page 141

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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 seem to have been that one day Jay Gould was so scared by the blowing out of a fuse that he jumped off the train and never returned. (1)

Eight years had gone by since the Siemens ran their train in Berlin and 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 pressure, 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 varied in construction and control, and generally required two sets of brushes for reversal of movement. Ordinarily there was but one motor to a car, this being carried on the front platform or in a dummy car, and connected to the driven axle by belt or chain. Nowhere 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. But there was still the ever growing

1) Sprague, Frank J. Reprinted from the Jouranl of the Maryland Academy of Sciences Vol. II, Nos. 3 & 4, Dec. 1931 Page 190

Digital Image, 2011, The Ida M. Tarbell Collection, 1890-1944, Allegheny College Pelletier Library.

activity of the pioneer inventors, each struggling for a satisfactory and acceptable equipment." (1)

In 1887 Sprague's opportunity came to prove he had as he believed a practical system - a contract for a street railway in Richmond, Virginia. The terms were fantastic. A route twelve miles long including a hill a mile long with grades of from four to ten percent had to be laid out, tracks put down, a central plant of three hundred seventy five horse power set up, an overhead line constructed, eighty motors, two hundred forty cars built - all in ninety days. If the result was satisfactory the Sprague Company was to be paid $110,000.

It took more than ninety days but by the Fall of 1887 experimental trains were taking the hills and corners of the Richmond road something that in the opinion of John Stephenson, the vetern street railway builder of the day, an electric train could never do. In February of '88 it was carrying passengers for fares and financiers were looking it over. Chief of these was Henry M. Whitney, president of a Boston street railway for which he was considering a new equipment - cable probably - but before he decided he came to Richmond to see what the Sprague Company had done.

Could they move a long train of cars? What would happen if there was a necessity of clearing up a congestion of cars? Sprague had never used a long train but he believed

1) Sprague, Frank J. Reprinted from the Journal of the Maryland Academy of Sciences Vol. II, Nos. 3 & 4, Dec. 1931 Pages 192 & 193

Digital Image, 2011, The Ida M. Tarbell Collection, 1890-1944, Allegheny College Pelletier Library.

it could be done.

"So," as he tells the story, "I determined upon a practical trial of somewhat dramatic character...Near midnight, after he had retired, Mr. Whitney was asked if he would like to see an attempt made to move a large number of cars which had been bunched at the terminal, and on his assent orders were given at the central station to put on extra safety catches, to run the potential up to five hundred volts, and to keep the engines going no matter what happened. At the appointed time, on signal the motormen of the twenty two 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.

"This test was conclusive, and Mr. Whitney on his return to Boston appeared before the Board of Aldermen, and after a glowing eulogy of what he had seen obtained permission to put in a composite line, a part near the old Providence depot of conduit construction, and the balance, to Allston, of overhead construction, Sprague motors being used on all the cars." (1)

Sprague's achievement was celebrated far and wide by experts in electricity, by financiers, by an immediate intense competition[2] but no where so graphically as in New Orleans where a mass meeting was called in favor of replacing the mule

1) Sprague, Frank J. Reprinted from the Jouranl of the Maryland Academy of Sciences. Vol. III, Nos. 1, 2 and 3, July, 1932 Pages 6 & 7

2) For the rapid adoption of electric traction by other cities see Schlesinger, Rise of the City 92-93

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by Sprague motors. The call was headed:-

"Lincoln Set the Negroes Free!

"Sprague Has Set the Mule Free!

"The Long-Eared Mule No More Shall Adorn Our Streets."

The success of the Richmond road, the adoption of the system of Whitney in Boston, stirred the Edison Electric Company to absorb the Sprague Company, but when Sprague saw that this meant not only changes in his system of which he did not approve as well as the dropping of his name from his machines he resigned, but he could not give up electric traction and in a few years, 1895 he had a new idea to make up trains of any length by the combination of car units, without regard to number, end relation or sequence, a part of all of them equipped with motors but all with train lines, and to control the trains from either end of any car through master switches connected to the common train line." (1) He had hit on the "multiple-unit" system which today is in almost universal use in electric traction.

As Sprague found himself absorbed so did Van Depoele who by 1887 had installed electric railroads in perhaps twenty different American cities, but was crippled for money. When Charles E. Coffin told Elihu Thomson in January 1888, "We ought to get into street car electrification," and asked, "Who has done the pioneer work? "There is Van DePoele," Thomson said. (2)

1) Sprague, Frank J. Reprinted from the Journal of the Maryland Academy of Sciences. Vol. III, Nos. 1, 2 and 3, July 1932 Page 19

2) Hammond, J. W. Manuscript. A History of the General Electric Chapter XLV "Visions and Acquisitions." Page 435

Digital Image, 2011, The Ida M. Tarbell Collection, 1890-1944, Allegheny College Pelletier Library.

Coffin immediately went after him, bought his company, including patents, the latter 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 for Sprague in Richmond, one of the most troublesome of the many problems connected with the installation of motors - the sparking of the commutator. Metal brushes or blocks had been used to take care of the annoyance with poor results. "Try carbon," suggested Van Depoele. And though nobody believed in it carbon worked. Elihu Thomson was to say later that "the carbon brush was the most important invention ever made in the electric railway field." (1)

From the first the Thomson-Houston Company was highly successful in electric railways, this not only or perhaps chiefly due to the ~~industrial~~ quality of its equipment and the care and integrity of its installations - Elihu Thomson and its partner Rice would never tolerate careless or unsafe performance - it was due to the salesmanship of Charles A. Coffin and his method of financing local plants - a method which he had been using with success in electric lighting. This was to take the bonds of newly formed concerns in part payment for equipment. The holdings were scattered all over the country and multiplying, a financial practice good enough in prosperous times but as we shall see disastrous in slumps.

1) Hammond, J. W. Manuscript. A History of the General Electric. Chapter XLVII. "Salvation---Carved in Carbon" Page 458

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