Attachment A

Thomas Edison’s 1882 Pearl Street Generating Station

By: Carl Sulzberger

For most of the 19th century, inventors in Europe and in North America worked to bring about electrical lighting. Electric arc lighting was first demonstrated in 1808 by Sir Humphry Davy, the British chemist and physicist. Arc lighting, with its open electric arc leaping between two carbon electrodes, the frequent need to renew the carbon tips, and brilliant and glaring light, was best suited to outdoor use or for very large indoor spaces. While arc lighting achieved commercial acceptance on both sides of the Atlantic Ocean by the 1870s, it was recognized early in the 1800s that incandescent electric lighting would be needed for homes and for most other indoor applications.

Thomas Alva Edison (see Figure 1), working at his laboratory in Menlo Park, New Jersey, turned his attention to electric light in mid-1878, a relative late-comer in the quest for practical incandescent lighting. By that time, many inventors and experimenters had contributed to the development of dynamos, devices for maintaining constant voltage, lamp technology, and other individual components needed to provide incandescent electric light.

The story of Edison's development of the first practical incandescent light in October 1879 after thousands of experiments with filament materials has been often told and is well known. From the outset, Edison realized that he would have to develop an entire system to generate, deliver, and utilize electric energy. Building on the work of other inventors in some cases and drawing on his own vision and ingenuity, Edison and his associates developed a parallel circuit to use his high-resistance filament lamp, an improved constant voltage dynamo to provide power to the parallel circuit, junction boxes and other components of an underground conduit system, safety fuses and insulating materials, and the necessary consumption meter, light fixtures, and switches. Edison then set up companies to manufacture most of the needed equipment and components.

Having invented and created an entire incandescent lighting system, Edison's task as an entrepreneur and industrialist was to demonstrate his low-voltage direct current (dc) system to the public. Edison's first commercial installation on land was at the printing firm of Hinds, Ketcham & Company in New York City. This installation went into service in January 1881 and, like other small, isolated systems subsequently installed by Edison, served one customer from a dynamo in the basement of the building. Having patterned his incandescent lighting system on then long-established and economical gas lighting systems, Edison's plan was to combine a central power station with a system of conductors to distribute electricity to the end users. He proved the technical feasibility of the central station concept with an installation under the Holborn Viaduct in London, United Kingdom, that operated successfully for about two years beginning in January

1882. Shortly after announcing his intended development of a practical incandescent lamp in late 1878, Edison began to lay out his vision of a full-scale central station system for installation in New York City to conclusively prove that his dc system worked and was commercially viable. The result was the legendary Pearl Street station, the first permanent central power station for supplying incandescent lighting.

The Beginning of dc Electric Service: Pearl Street, 1882

Edison carefully chose the service area and location for his first full-scale central station after conducting extensive market research. He wanted a densely populated area having a mix of commercial and residential uses. He also well understood the value of newspaper publicity and the need to impress and interest his present and potential financial backers. The area selected, known as the First District, was a rectangular area bounded by Wall Street on the south, by Nassau Street on the west, by the East River on the east, and by Spruce Street and the former Ferry Street on the north. This area is shown in Figure 2. The First District included much of the high-profile downtown business district, the financial capital of the United States. It was also home to the city's influential newspapers, including the *New York Times.*

Edison formed the Edison Electric Illuminating Company of New York, a direct predecessor of the present Consolidated Edison Company of New York (Con Edison) in December 1880 to undertake the project. In April 1881, he secured a franchise from the New York City Board of Aldermen to install electric conduits and wires in the public streets. Edison purchased adjoining buildings at 255 and 257 Pearl Street, just south of the intersection of Pearl and Fulton Streets, for the Pearl Street generating station. Each building measured 25 ft by 100 ft and had four floors. He strengthened the structure of 257 Pearl Street to carry the weight of the dynamos and other heavy equipment on the upper floors, while 255 Pearl Street was held in reserve for possible future expansion of the station (see Figure 3).

To supply electric power to the lights within Pearl Street's service area, Edison and his team developed the 27-ton "Jumbo" constant-voltage dynamo, named for a circus elephant then owned by P.T. Barnum. This dynamo was adapted from an earlier design by Werner Siemens in Germany. Each of the six dynamos installed at Pearl Street had a capacity of about 100 kW and could supply about 1,200 lamps. Figure 4 shows one of the "Jumbo" dynamos. The six dynamos were driven by Armington & Sims reciprocating steam engines supplied by four coal-fired boilers.

The project involved the installation of about 80,000 ft of underground conductors in a manhole and conduit configuration (see Figure 5). The original system consisted of two wires in the form of twin half moon shaped copper conductors, separated within the conduit by rope and insulated with beeswax, linseed oil, and asphaltum (see Figure 6 and Figure 7). The original system operated at 110 V dc. Because of the large amount of costly copper (the main and feeder distribution system was the most expensive component of the entire project) required, Edison quickly supplanted the two-wire configuration with a 220-V, three-wire design that greatly reduced the amount of copper needed for the conductors. This resulted in a significant cost saving.

Edison served as his own chief engineer on all phases of the design and construction of the project. The Pearl Street station was finally completed and put into

commercial operation on the afternoon of 4 September 1882. Edison was standing in the office of J. Pierpont Morgan of Drexel, Morgan & Company, one of his principal investors, when he gave the signal to John W. Lieb, chief electrician, to close the switch to start delivering dc power to customers in the First District. While the six dynamos could supply up to 7,200 lamps, there were only some 85 customers having a total of about 400 lamps on the first day of operation.

The events of 4 September 1882 were reported the next day in the *New York Times*, one of Edison's first incandescent light customers. Perhaps not fully comprehending the world-changing significance of the birth of the electric age, the newspaper published the unnamed reporter's eyewitness account under "Miscellaneous City News." The verbatim account from the 5 September 1882 *New York Times* can be found on Attachment 1.

While the Pearl Street project was not an immediate financial success, it conclusively proved that Edison's system worked and demonstrated the enormous benefits of comprehensive electrification. The initial 400 or so lamps in service in the First District serving fewer than 90 customers on 4 September 1882 grew to about 10,000 lamps serving 513 customers within a year. Similar Edison dc low-voltage central-station electric systems were built in other parts of New York City, and many were licensed for installation in cities and towns throughout North America, Europe, South America, and Japan during the next decade.

The Pearl Street Station Site Today

The Pearl Street station faithfully delivered electric power to its customers from 4 September 1882 to 2 January 1890 with only one interruption, that lasting for three hours. This established an early standard for utility system reliability. A major fire on 2 January 1890 caused extensive damage to the station, but Edison and his coworkers worked around the clock and were able to restore electric service in 11 days. The Pearl Street station was rebuilt after the fire but was retired and dismantled in 1895. Edison sold the buildings at 255 and 257 Pearl Street, and they were later demolished. Of the "Jumbo" dynamos built by Edison for Pearl Street and similar power stations, only "old number nine," a survivor of the 1890 fire, remains and is on display at the Henry Ford Museum at Greenfield Village in Dearborn, Michigan.

The Pearl Street station site today is a public parking facility. In 1917, the American Scenic and Historic Preservation Society and the New York Edison Company (now Con Edison) placed a bronze plaque at the site to commemorate the seminal achievement that took place at that location (see Figure 8. The image at the top of the plaque is a drawing of the Pearl Street dynamo room. This drawing, shown more clearly in Figure 9, appeared in the 26 August 1882 issue of *Scientific American* magazine.

The Advent of ac Electric Service

The Pearl Street station and its distribution network was the prototype for central-station electric utility systems, and, in the early years of large-scale electrification, hundreds of Edison systems modeled on Pearl Street and improved versions of the Pearl Street design were installed. However, a low-voltage dc system has inherent disadvantages, the chief one being high line losses that limit the distance that the dc electric power can

be economically transmitted. As a result, each dc system was destined to serve a relatively small geographic area having high load density.

By the mid-1880s, alternating current (ac) systems began to compete with Edison's dc system. Inventors such as Nicola Tesla, William Stanley, Michael von Dolivo-Dobrowolsky, Elihu Thomson, Lucien Gaulard, John Gibbs, and others working in Europe and North America all contributed to ac technology. The invention of the ac transformer permitted the economical and efficient long-distance transmission of electric power at high voltages, thereby resolving the major disadvantage of low-voltage dc systems. Promoted by industrialists such as George Westinghouse and others, the advantages of ac electric utility service became obvious, and, by the end of the 19th century, dc systems began a gradual and inevitable decline.

figure 1. Thomas Edison ca. 1880 at about 33 years of age (photo courtesy of the Edison National Historical Park, U.S. Department of the Interior, National Park Service).

figure 2. Map of lower Manhattan showing the original area served by the Pearl Street station and its distribution system (courtesy of the Consolidated Edison Company of New York).

figure 3. Artist's conception of the exterior of the Pearl Street station, circa 1882 (courtesy of the Consolidated Edison Company of New York).

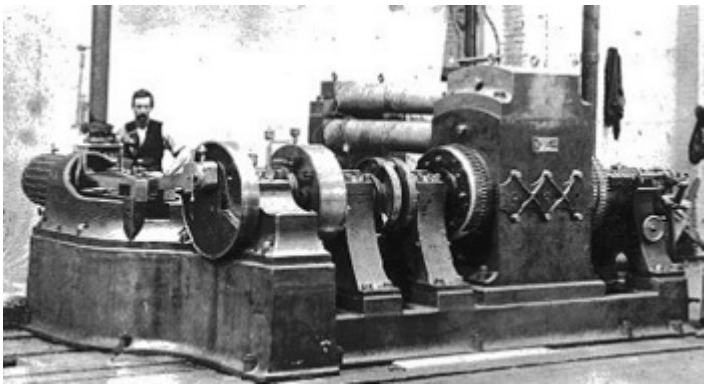

figure 4. Edison's 100-kW engine-driven "Jumbo" dynamo of the type installed at the Pearl Street Station (photo courtesy of the Edison National Historical Site, U.S. Department of the Interior, National Park Service).

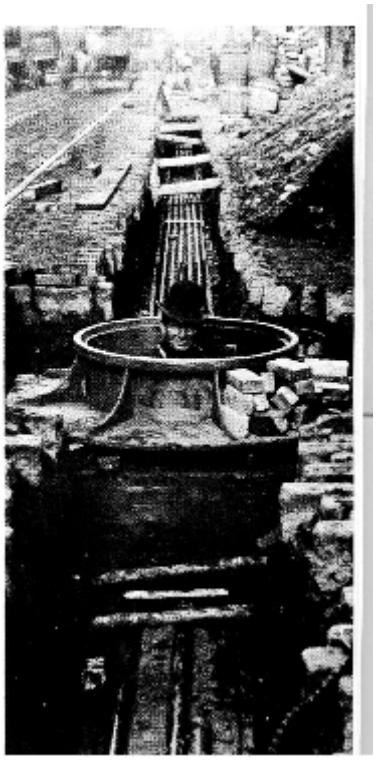

figure 5. Installation of the manhole and conduit distribution system associated with the Pearl Street Station, 1882 (photo courtesy of the Smithsonian Institution).

figure 6. Original Edison two-wire dc distribution line showing the half-moon cross section of the conductors and the conduit and insulation used (photo courtesy of Robert Lobenstein).

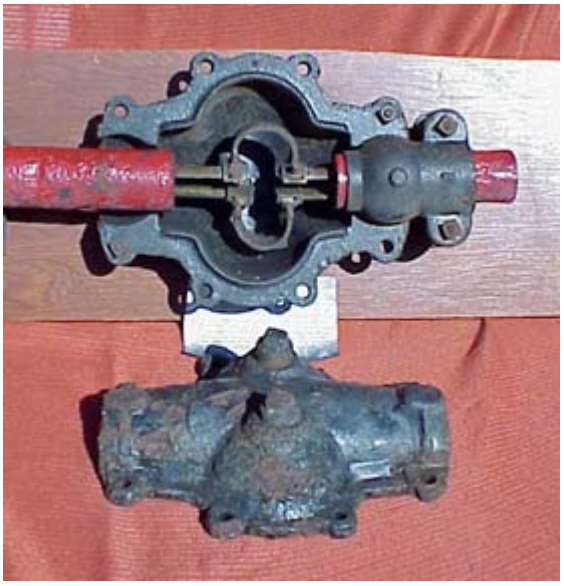

figure 7. Edison 1882 junction box showing how the individual sections of distribution line were connected (photo courtesy of Robert Lobenstein).

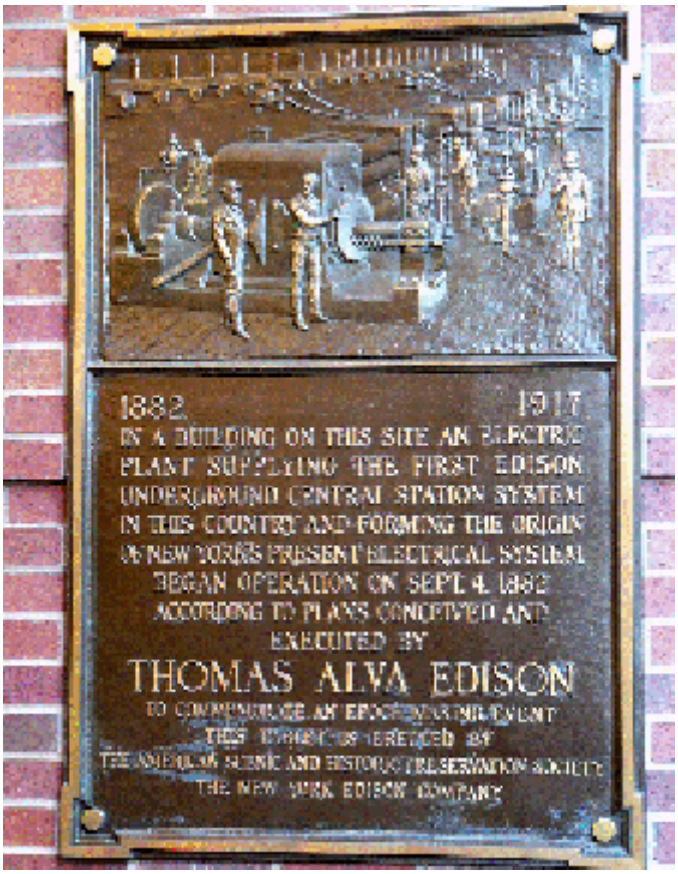

figure 8. Commemorative plaque installed in 1917 at the site of the former Pearl Street station (photo courtesy of Robert Lobenstein).

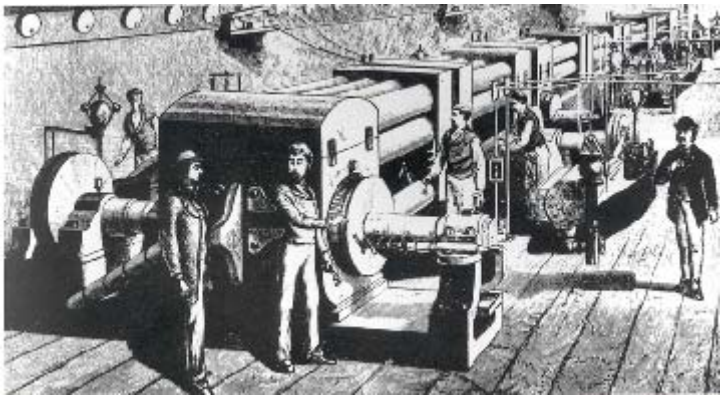

figure 9. Artist's sketch of the dynamo room at Edison's Pearl Street dc central generating station (Sketch courtesy of the Smithsonian Institution).

Attachment 1: *New York Times*, 5 September 1882

"MISCELLANEOUS CITY NEWS

EDISON'S ELECTRIC LIGHT'
"THE TIMES" BUILDING ILLUMINATED BY ELECTRICITY.

Edison's central station, at No. 257 Pearl street, was yesterday one of the busiest places down town, and Mr. Edison was by far the busiest man in the station. The giant dynamos were started up at 3 o'clock in the afternoon, and, according to Mr. Edison, they will go on forever unless stopped by an earthquake. One-third of the lower district was lighted up, the territory being within the boundaries of Nassau and Pearl streets and Spruce and Wall streets. During the past few weeks the Edison Electric Illuminating Company has been engaged in completing the installations in the premises of its customers by the insertion of meters and lamps, and in procuring inspection or such premises by the Fire Underwriters. As the Board of Underwriters has but one expert, Mr. Osborne, the progress has been necessarily slow, but such portion as has been inspected was supplied last night. Mr. Edison said that the work will be pushed as rapidly as possible, so that the rest of the district – that lying between Pearl street and the East River and Spruce and Wall streets, will soon be lighted. The laying of the steam-heating pipes, Mr. Edison added, had interfered with some of the pipes of his company, and it might be necessary today to shut off the current in that portion of the district wherein THE TIMES office is situated. The current would be shut off until his pipes could be shored up in that neighborhood.

Yesterday for the first time THE TIMES Building was illuminated by electricity. Mr. Edison had at last perfected his incandescent light, had put his machinery in order, and had started up his engines, and last evening his company lighted up about one-third of the lower City district in which THE TIMES building stands. The light came in in sections. First there came in a series of holes in the floors and walls, then several miles

of protected wires, then a transparent little egg-shaped glass globe, and, last of all, the fixtures and ground glass shades that made everything complete. They were temporary fixtures to give the light a trial, and so were put in with as little tearing and cutting as possible. To each of the gas fixtures in the establishment a bronze arm was attached, and the electric lamps were suspended from the ends of these arms. The lamp is simplicity itself. At the top is a brass circle, from which are suspended the shade and the lamp proper. The latter is a glass globe about four inches long, and the shape of a dropping tear, broad at the bottom, narrow in the neck, in which is inclosed the carbon horseshoe that gives the light. The globe is air-tight, and the air has been exhausted, leaving the carbon horseshoe in a perfect vacuum. When the thumbscrew is turned, and the connection with the electric wires is thus formed, the electric current makes this carbon so brilliant that it would be unpleasant to look at. It is not intended to be looked at, however, being entirely hidden by the ground glass shade. The whole lamp looks so much like a gas-burner surmounted by a shade that nine people out of ten would not have known the rooms were lighted by electricity, except that the light was more brilliant than gas and a hundred times steadier. To turn on the light nothing is required but to turn the thumbscrew; no matches are needed, no patent appliances. As soon as it is dark enough to need artificial light, you turn the thumbscrew and the light is there, with no nauseous smell, no flicker and no glare.

It was about 5 o'clock yesterday afternoon when the lights were put in operation. It was then broad daylight, and the light looked dim. It was not till about 7 o'clock, when it began to grow dark, that the electric light really made itself known and showed how bright and steady it is. Then the 27 electric lamps in the editorial rooms and the 25 lamps in the counting rooms made those departments as bright as day, but without an unpleasant glare. It was a light that a man could sit down under and write for hours without the consciousness of having any artificial light about him. There was a very slight amount of heat from each lamp, but not nearly as much as from a gas-burner – one-fifteenth as much as from gas, the inventor says. The light was soft, mellow and grateful to the eye, and it seemed almost like writing by daylight to have a light without a particle of flicker and with scarcely any heat to make the head ache. The electric lamps in THE TIMES Building were as thoroughly tested last evening as any light could be tested in a single evening, and tested by men who have battered their eyes sufficiently by years of night work to know the good and bad points of a lamp, and the decision was unanimously in favor of the Edison electric lamp as against gas. One night is a brief period in which to judge of the merits or demerits of a new system of lighting, but so far as it has been tested in THE TIMES office the Edison electric light has proved in way satisfactory. When the composing rooms, the press rooms, and the other parts of THE TIMES Building are provided with these lamps there will be from 300 to 400 of them in operation in the building – enough to make every corner of it as bright as day."