

Pictorial History of the Development of the Electricity Industry



From lower left: Thomas Edison, Nikola Tesla, George Westinghouse, Charles Steinmetz

Prepared for:

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Committee

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Why Should We Look Back To Move Forward ?



Historical Perspectives Enable Us To Learn and Build Onto What Other's Have Accomplished.

- “...the Coming of Electricity Ultimately Expanded the Whole Human Sense of Time, Energy, and Possibility. Great, Indeed, Has Been the Power of Electricity.”
- - - from book: Empires of Light, by Jill Jonnes
- The Vast Networks of Electrification Are the Greatest Engineering Achievement of the 20th Century.
- - - from U.S. National Academy of Engineering

Some Key People Who Developed The Field of Electricity



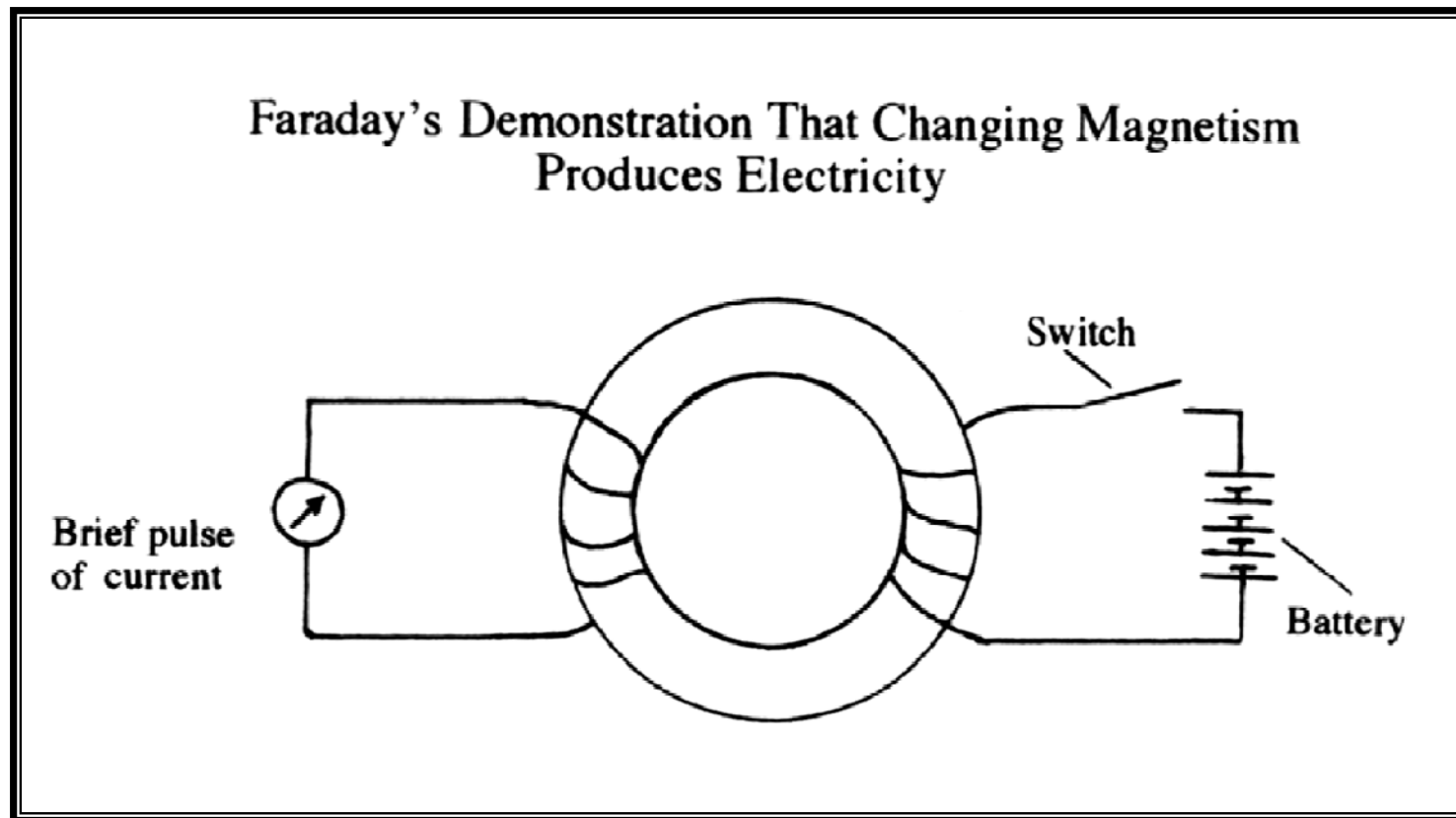
- Benjamin Franklin (1706-1790), American
- Charles A. de Coulomb (1736-1806), French
- James Watt (1736-1819), Englishman
- Count A. Volta (1745-1827), Italian
- Andre' M. Ampere (1775-1827), Frenchman
- Hans C. Orsted (1777-1851), Danish
- Carl F. Gauss (1777-1855), German
- George S. Ohm (1789-1854), German
- ❖ Michael Faraday (1791-1867), Englishman

Some Key People Who Developed The Field of Electricity, Continued



- Joseph Henry (1797-1878), American
- James P. Joule (1818-1899), Englishman
- Gustav R. Kirchhoff (1824-1889), Prussian/German
- James C. Maxwell (1831-1879), Scotsman
- ❖ George Westinghouse (1846-1914), American
- ❖ Thomas A. Edison (1847-1931), American
- ❖ Nikola Tesla (1856-1943), Serbian/American
- Heinrich Hertz (1857-1894), German
- ❖ Charles P. Steinmetz (1865-1923), German/American

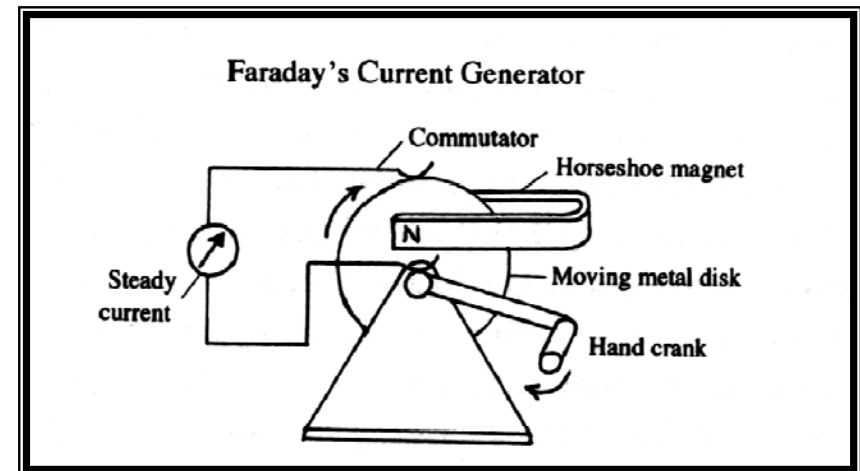
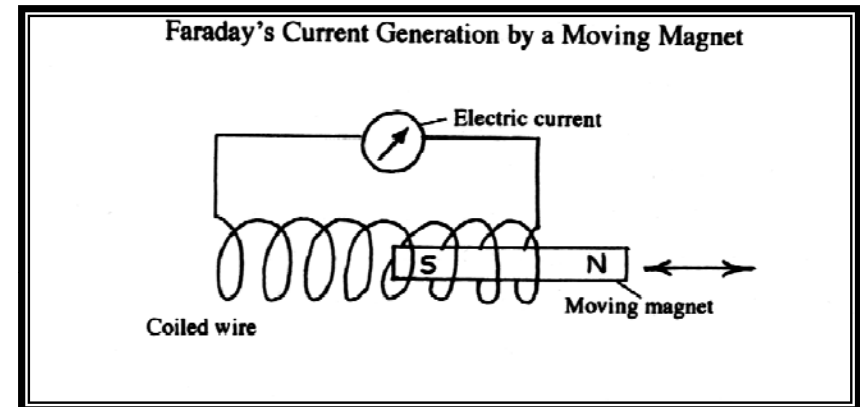
August 29, 1831: Faraday Demonstrates How to Make Electricity From a Change in Magnetism



Faraday's Electric Accomplishments



Faraday described his epic discovery of the world's first electric dynamo in "A New Electric Machine" paper presented to The Royal Society in London (Nov. 23, 1831). Orsted showed how to create magnets with electricity, while Faraday revealed the other, even more mysterious and momentous half of electromagnetism - how to generate electricity with magnets.



Menlo Park, NJ: Edison's "Invention Laboratory"

(Does this look like an EPRI, circa 1879 ?)



World's First Industrial R&D Laboratory, Which Started In 1876 (Menlo Park, NJ). The electric light bulb was invented and tested in this building. It was first shown to the public 12/31/1879.

Note: This Building Was Transported In 1929 By Industrialist Henry Ford To His Greenfield Village Museum In Dearborn, Michigan.

Edison With His Team At Menlo Park, NJ (circa 1880)



The Menlo Park, NJ work force on the front steps of the Edison Laboratory building (circa 1880).

Top row (standing), left to right: Albert Herrick, Francis Jehl, Samuel Edison (Edison's father), George Crosby, George Carman, Charles Mott, John Lawson, George Hill, Ludwig Boehm.

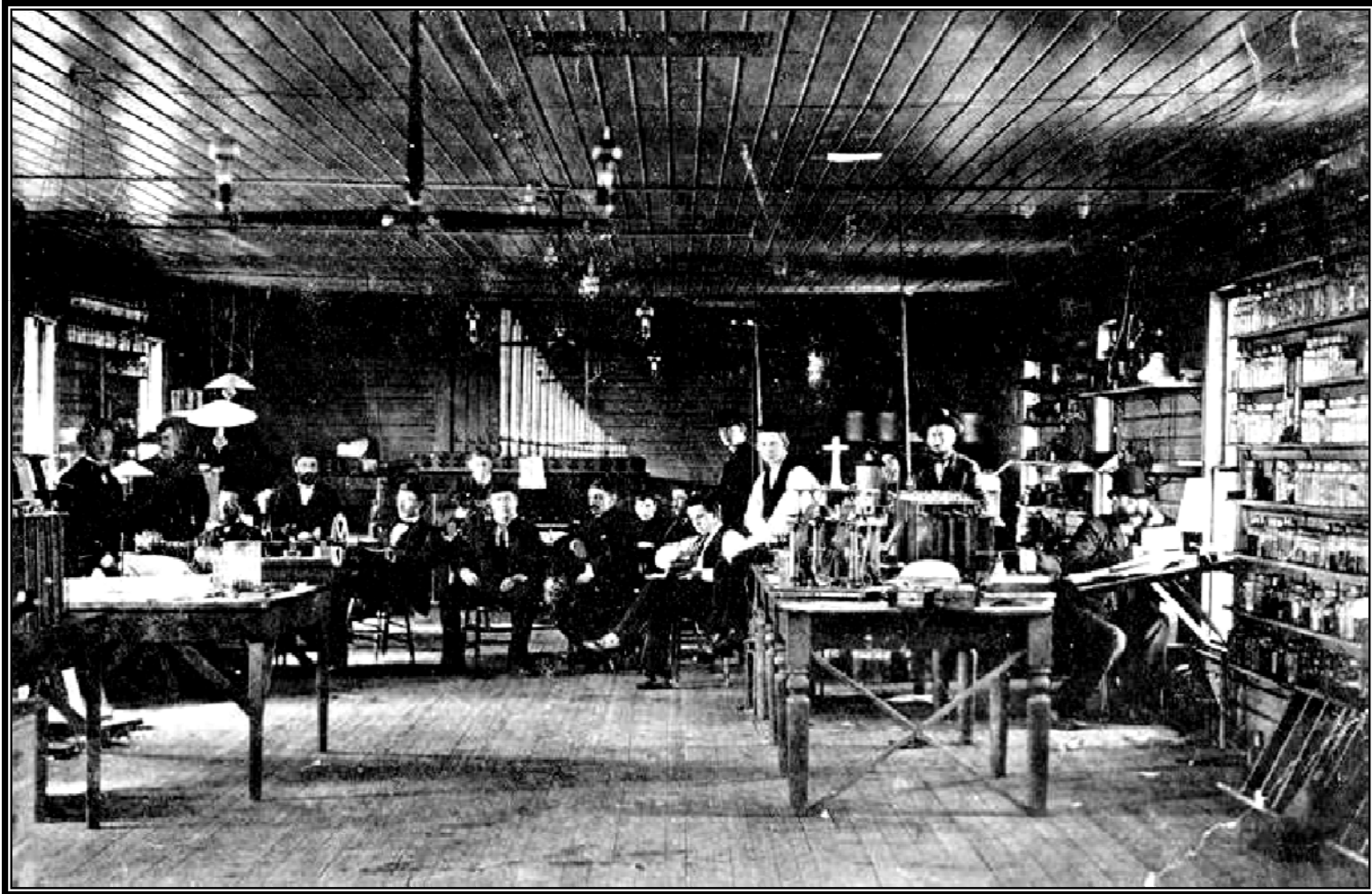
Middle row: Charles Batchelor, Edison, Charles Hughes, William Carman.

Bottom row: William Holzer, James Hipple.

Edison With His Team At Menlo Park, NJ (circa 1880) - - “Candid Photograph” - -



Thomas Edison (Front Left, Dark Cap) and His Menlo Park Crew In The Second Story Of His Menlo Park, NJ, R&D Laboratory



***Picture Taken Soon After The New Electric Lights Were Installed
(February, 1880)***

Edison's Family Homes

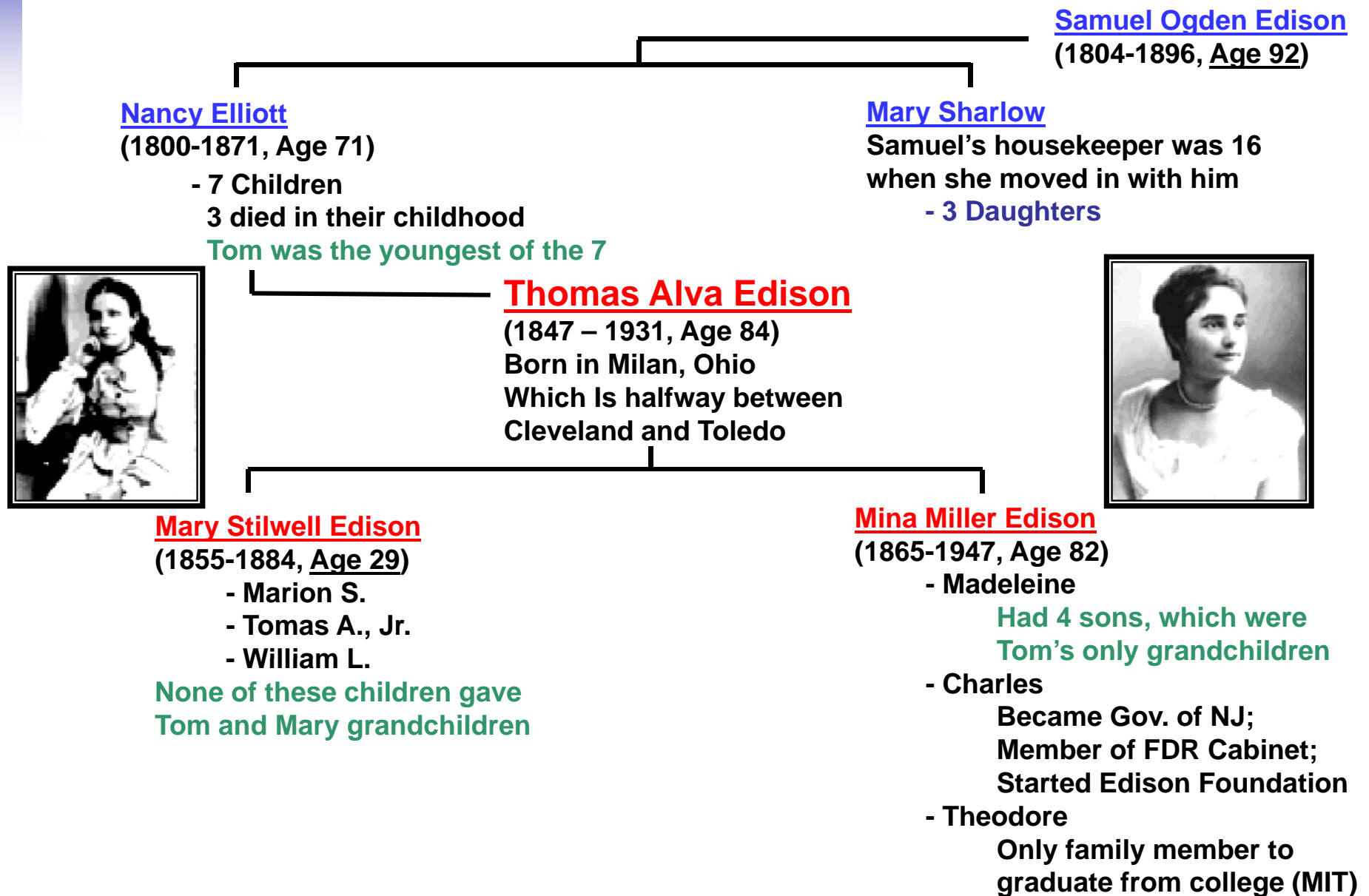


*Edison's Home With First Wife, Mary (Circa 1880)
Edison Had Three Children With His First Wife.
She Died At Age 29, Five Years After Edison
Invented The Electric Light Bulb.*



*Edison's Home With Second Wife, Mina,
and Their Three Children (Circa 1900)*

Edison's Family Tree



Thomas Edison At His Desk Dictating Into The “Edison Business Phonograph”

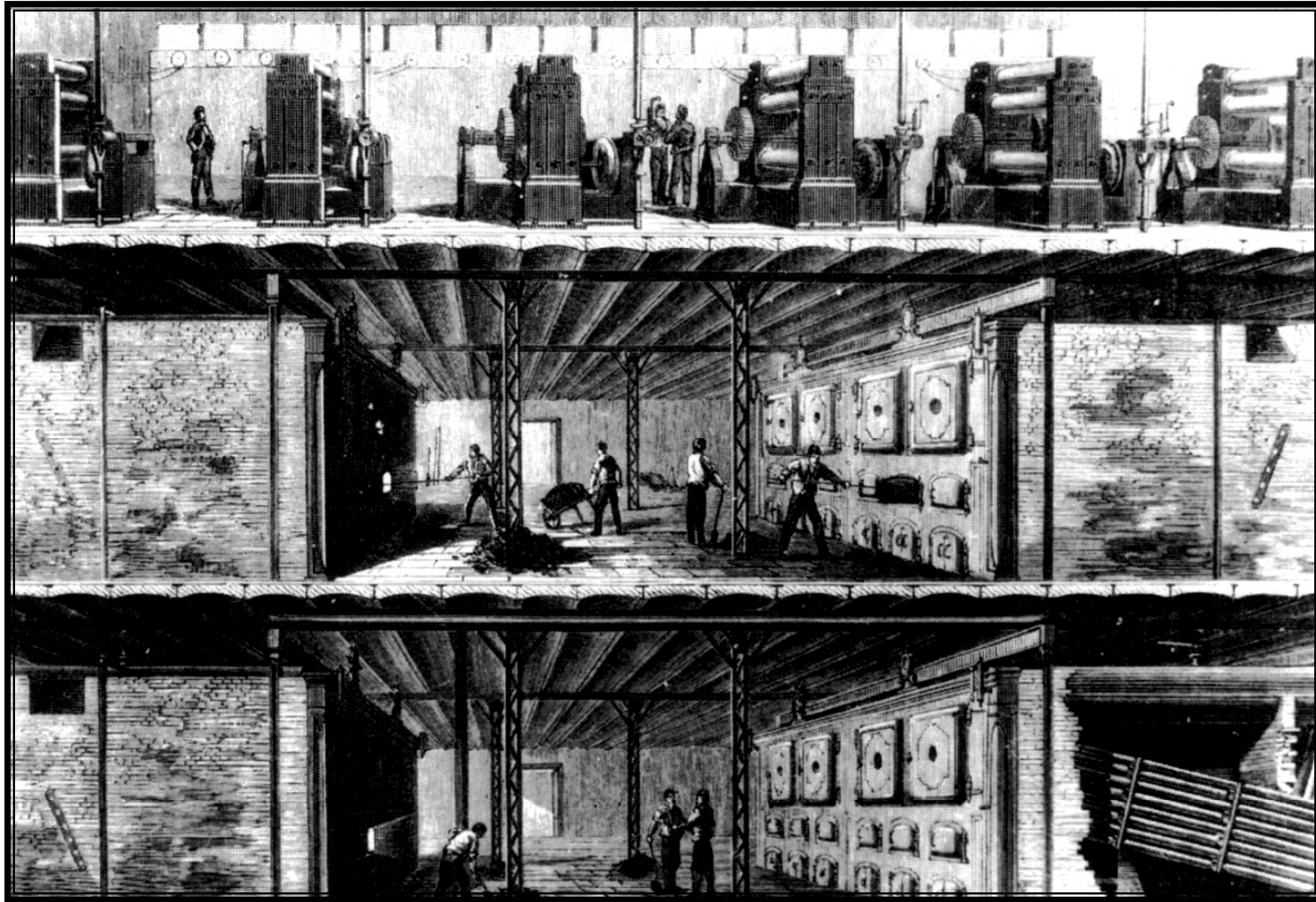


Edison Has More Patents
(1,093) In His Name Than Any
Other Person. Patents Include:

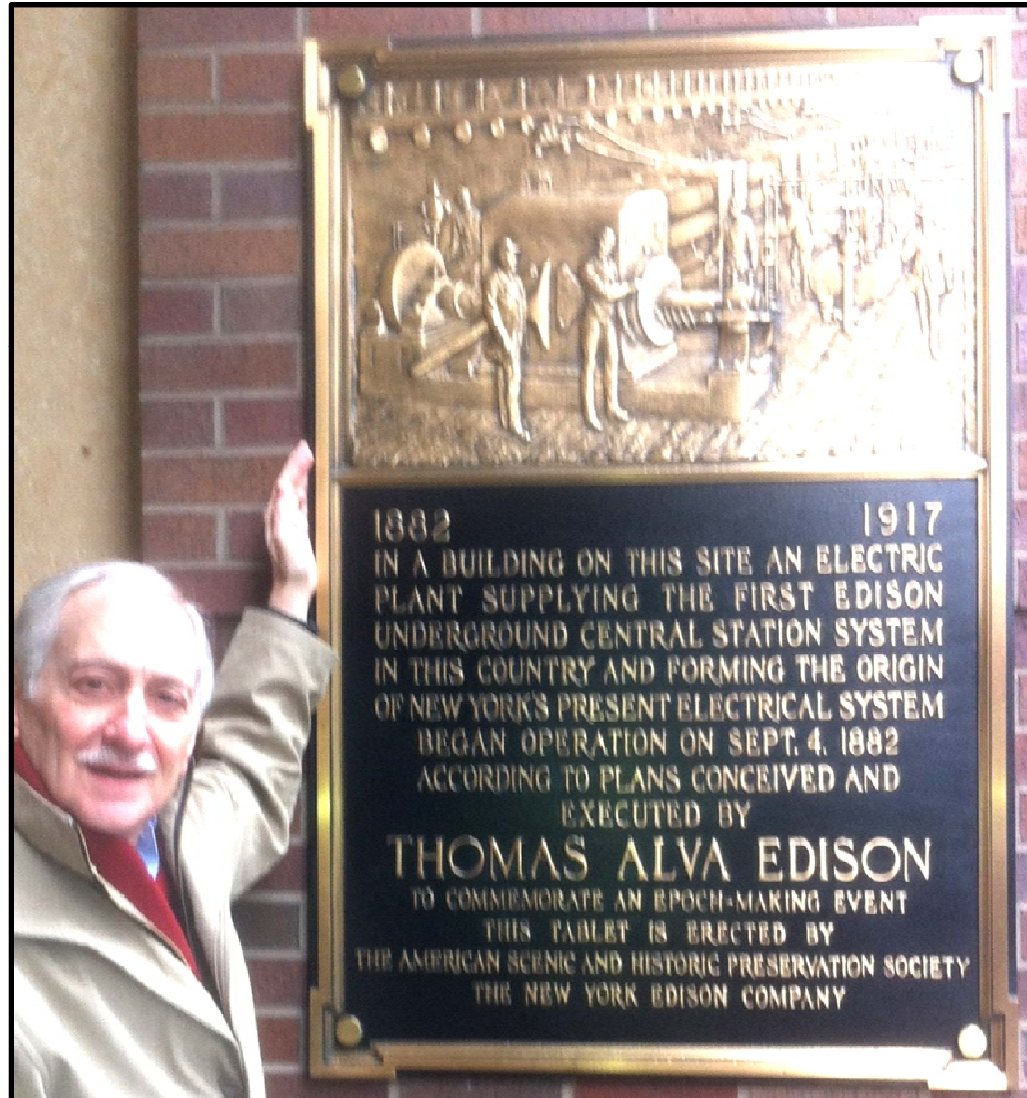
- 389, Electric Light & Power
- 195, Phonograph
- 150, Telegraph
- 141, Storage Batteries
- 34, Telephone
- Kinetograph Motion Camera
- Kinetoscope Motion Viewer
- Magnetic Ore Separator

***By The Time Edison Was In
His Mid 30s He Was Said To
Be The Best-Known Person
In The World.***

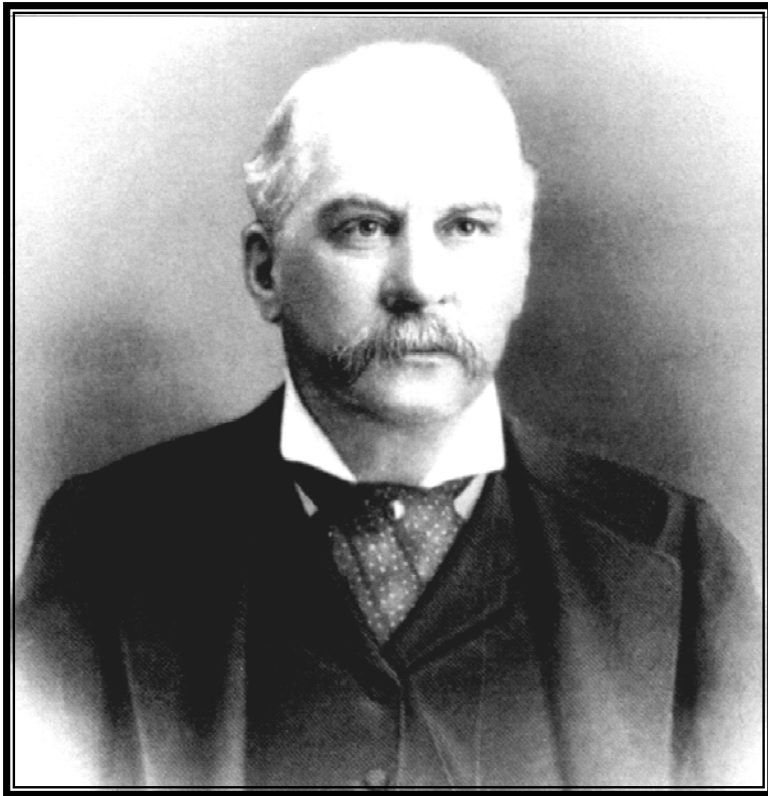
Pearl Street Generation Station (255-277 Pearl Street, NYC, 600 KW): Below Figure Shows the Three Floors of this First Commercial Power Plant For A City. It Had Six Coal-Fed Steam Locomotive Engines Powering Six Direct Current Dynamos. Commissioned Sept. 4, 1882; Heat Rate = 138,000 Btu / kwh. Cost = 24 cents/ kWh, 1882 dollars. At first, it powered 400 lamps for 85 customers.



**Plaque on Corner of Pearl & Fulton Streets, New York City,
To Commemorate The Location Of The First Power Plant Supplying
Electricity To A City, Which Was Commissioned Sept. 4, 1882**



J.P. Morgan - Financial Backer of Edison Electric Light Co., Which Later Became General Electric Co.

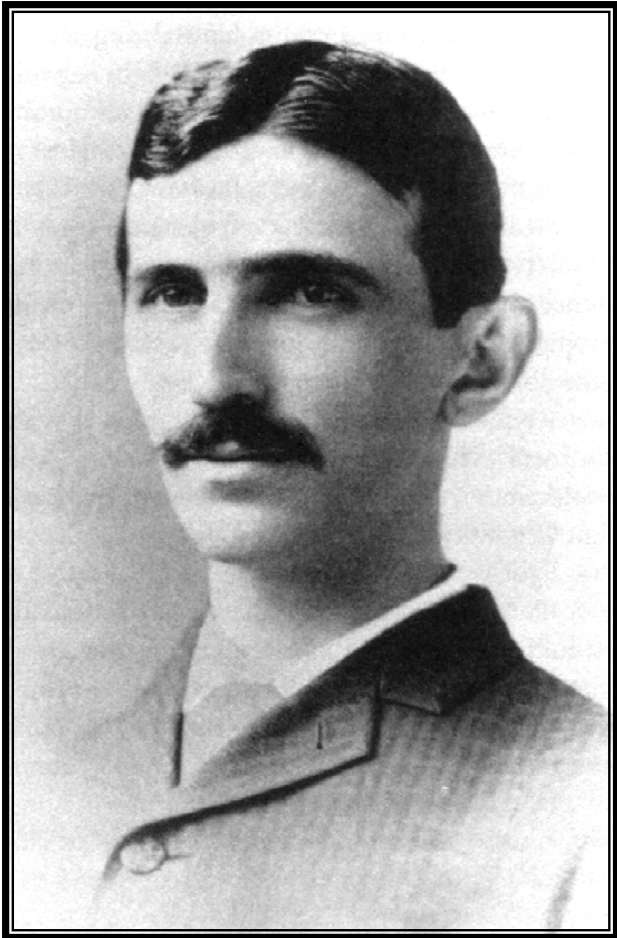


J.P. Morgan's Home Was the First Home to Be Lit by Electricity Using Edison's New Electric Light Bulbs, Powered By An Edison DC Dynamo In Morgan's Home Basement.

After J.P. Morgan found out he could make more money building AC power plants using the Tesla-Westinghouse technology, he bought Edison's shares in the Edison Electric Company and changed its name to General Electric and converted it to an AC machinery and lighting company.*

** Edison's DC system was at 100 volts, whereas the Tesla-Westinghouse AC system was at 1000 volts. Thus, electric losses were 100 times higher for the Edison DC system; and, more capital had to be used to build the Edison plants per mile.*

Nikola Tesla Major Accomplishments



1856 (Smiljan, Croatia) to 1943 (New York City)

*Note: Tesla Was A Good Friend Of Mark Twain
(Pseudonym for Samuel Clemens)*

- Rotating Magnetic Principle
- Polyphase AC Generators, Motors, and Grid Equipment
- AC Induction Motor
- Wireless Communication*
- Tesla High Voltage Coil
- Telephone Repeater
- 700 Other Patents

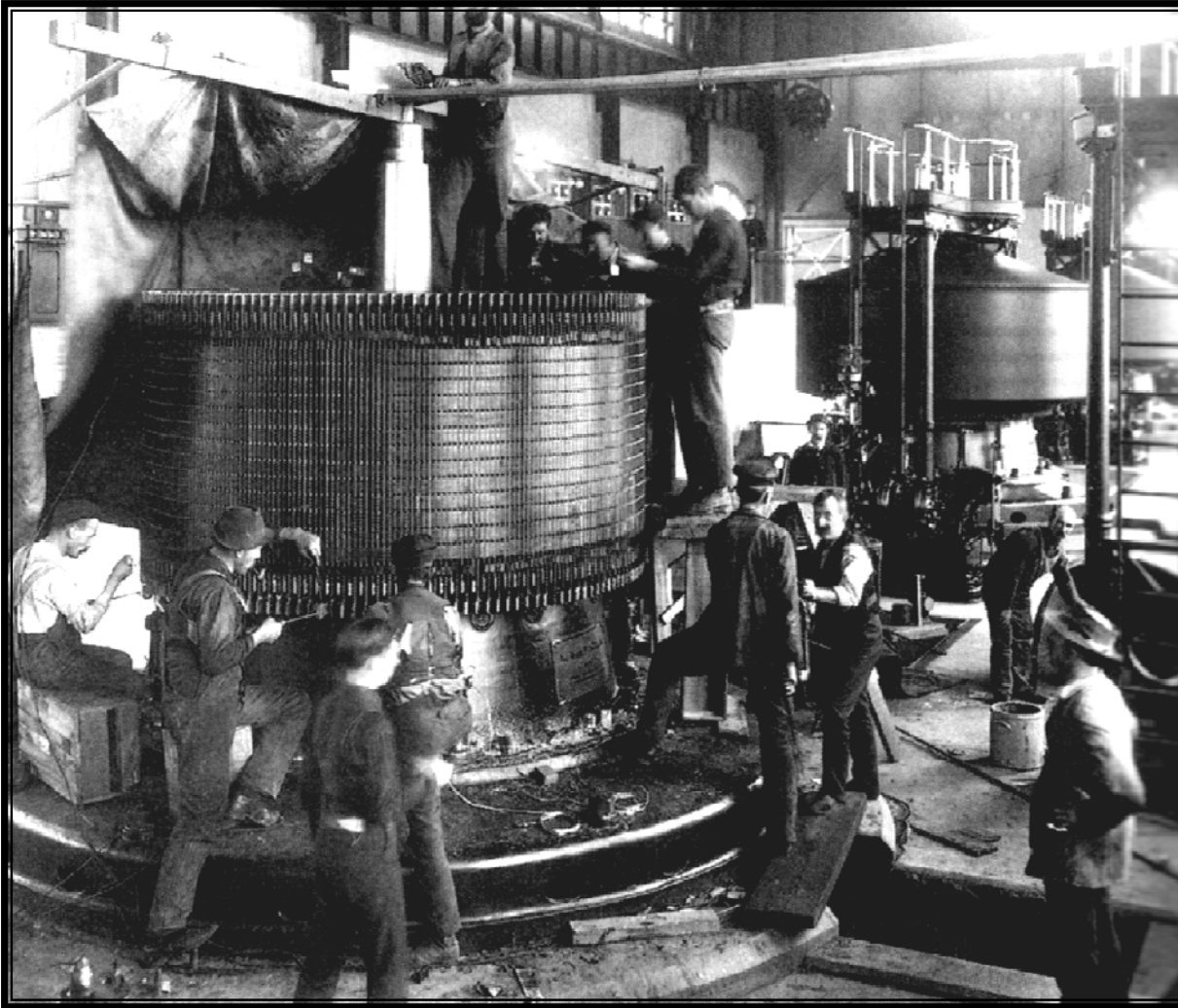
* After Publishing His Ideas On The “Tele-automatic Guided” Boat, When Skepticism Was Voiced, Tesla Proved His Claims Before A Crowd In Madison Square Garden.

**Westinghouse-Tesla Polyphase Exhibit In The “Electricity Building”
At The Chicago World's Fair (1893). Westinghouse’s AC Bid Won
Over Edison’s Bid For The Fair’s Power & Lighting Contract.**



**WESTINGHOUSE
ELECTRIC
&
MANUFACTURING CO.
TESLA
POLYPHASE
SYSTEM**

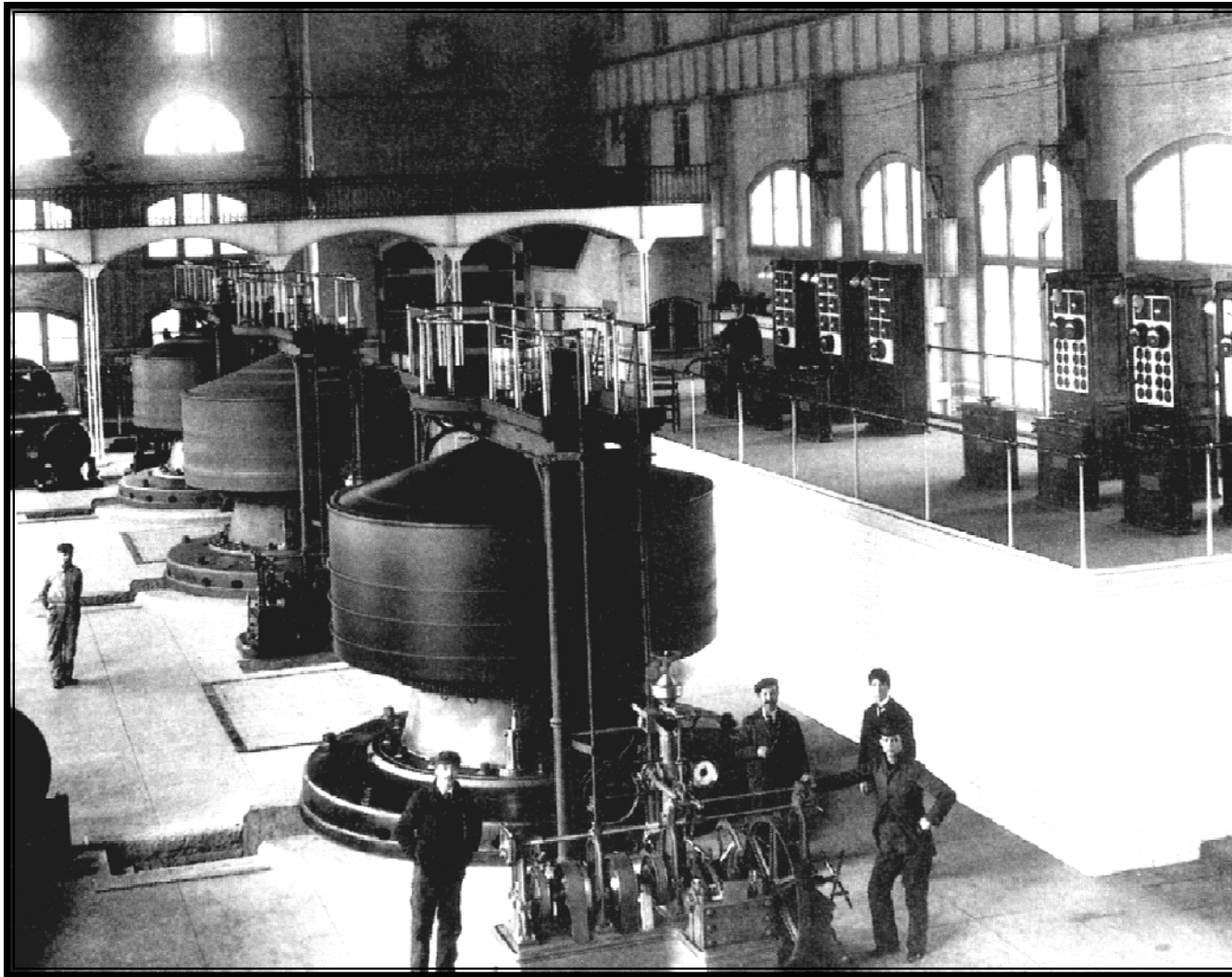
Westinghouse Niagara Falls Power Company Generators Being Built In Pittsburgh In 1894 (Note: Westinghouse Won This Contract Over An Edison Bid.)



- Each of Three Generators Were Two Phase, 25 Hz AC at 3.8MW's
- The Largest Size Generator in the World, At The Time
- Engineer / Designer: Nicola Tesla
- Manufacturer / Engineer: George Westinghouse

The First Three Westinghouse Dynamos in Stanford White's "Cathedral of Power" at Niagara Falls (Photo Taken April 6, 1896)

Note: Stanford White was murdered in Madison Square Garden by Harry Thaw, who found out his girlfriend had an affair with White.



George Westinghouse: He Had Ability To Transform New Ideas To A Manufactured Commercial Reality While Allowing For Relatively Simple Maintenance Practices

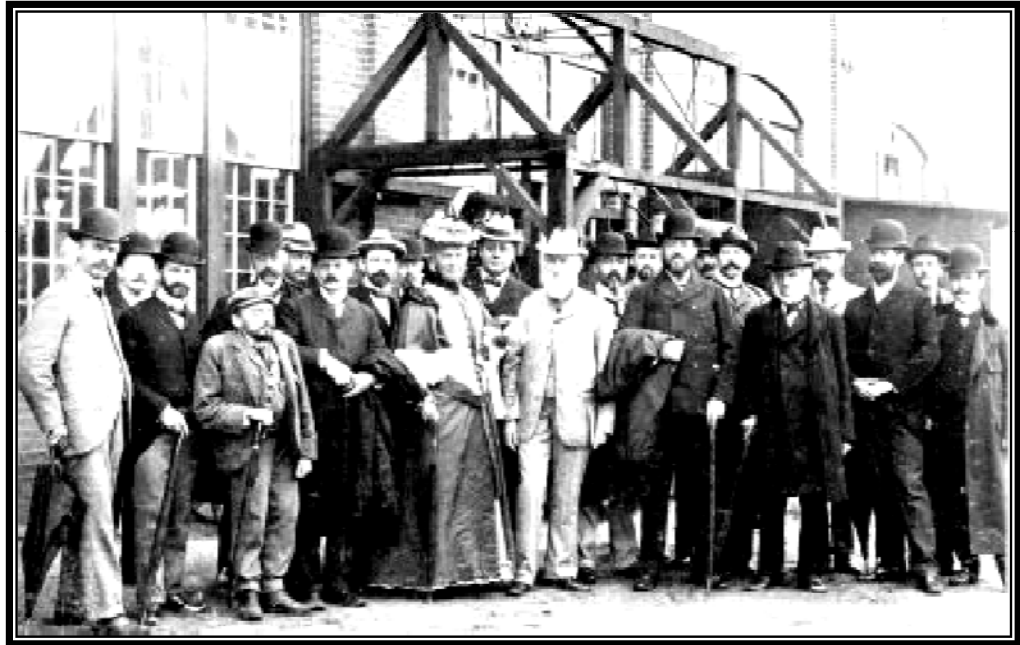


- **Invented Railroad Air Brake and Signaling Equipment; Had Many Patents on Natural Gas Piping Systems & Equipment**
- **Bought Numerous Electricity Patents from Tesla**
- **Commercialized AC Generation & Transmission Systems; Battled Edison Over AC vs. DC Generation & Grid Applications**
- **When Tesla Needed Money, Westinghouse Paid for Tesla's Room & Board at the Waldorf Astoria Hotel, NY City**

Charles Steinmetz: Invented Complex Algebra Applied To AC Machine and Network Performance Calculations



*Charles Proteus Steinmetz, 1890
A German-American mathematician
and electrical engineer. He fostered
the development of alternating current
machines that made possible the
expansion of the electric power
industry in the United States.*



*Lord Kelvin (i.e., William Thomson) and Group on Visit to
General Electric Schenectady Works, 1897
(Steinmetz is fourth from left)*

Steinmetz Was Recognized As One of the Great Inventors and Minds of the 1900's



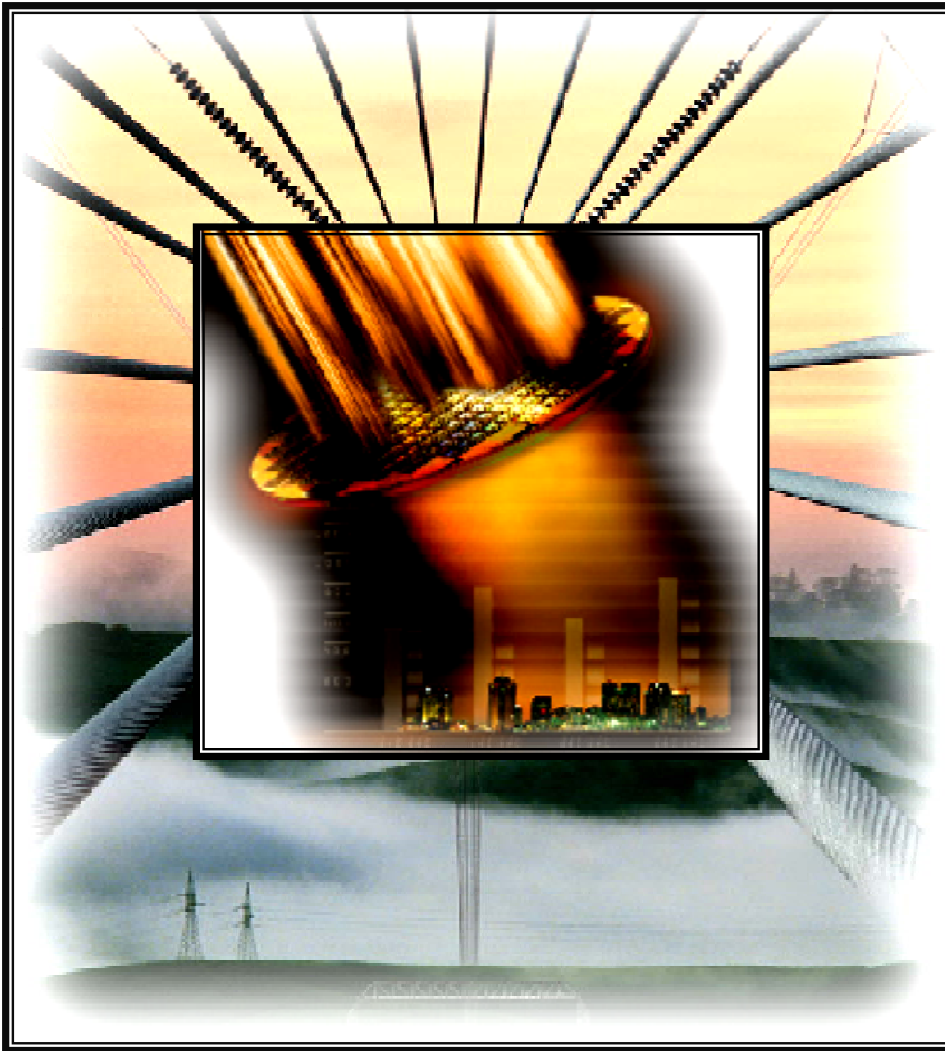
Among Steinmetz's Distinguished Visitors Was Marchese Guglielmo Marconi, "Inventor" of the First Practical Radio System and Recipient of the Nobel Prize for Physics in 1909. (Note: Telsa Received the Original Patent for the Invention of the Radio.)



Other of Steinmetz's Distinguished Visitors Were Albert Einstein and Nikola Tesla Who in 1921 Came to Schenectady. It Was in That Year Einstein Received the Nobel Prize in Physics. Steinmetz Discovered the Laws of Magnetic Hysteresis and Laws of Traveling Electromagnetic Waves.

Note: The above are composite photographs.

The Future of Electric Grid Technologies

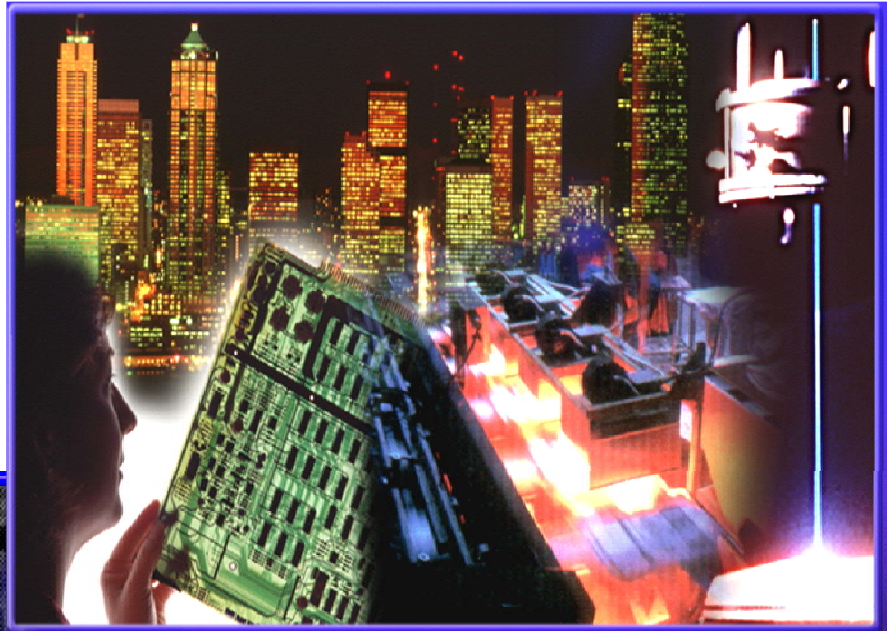


Until Solid-State Devices Were Applied to the Electric Grid and EPRI's Development of Flexible AC Transmission Systems (FACTS), The Electric Grid Throughout the World Was Based on the Work of the People Shown in This Pictorial History. Through Deployment of FACTS Technologies, We Are In The Process of Adding to Their Legacy.

Conclusion: We Can Continue To Work Together While “Standing” On The Shoulders Of “Giants”, To Provide Immense Public Benefits

Lessons-Learned:

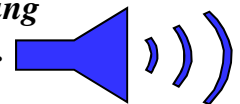
- *Learn From Failures & Don't Repeat Them*
- *Commercializing New Technology Is Usually Expensive and Requires Wealthy Risk Taking First Users Who Want to Make More Money*
- *Success Usually Depends On Long Term Collaboration of Engineers And Investors*



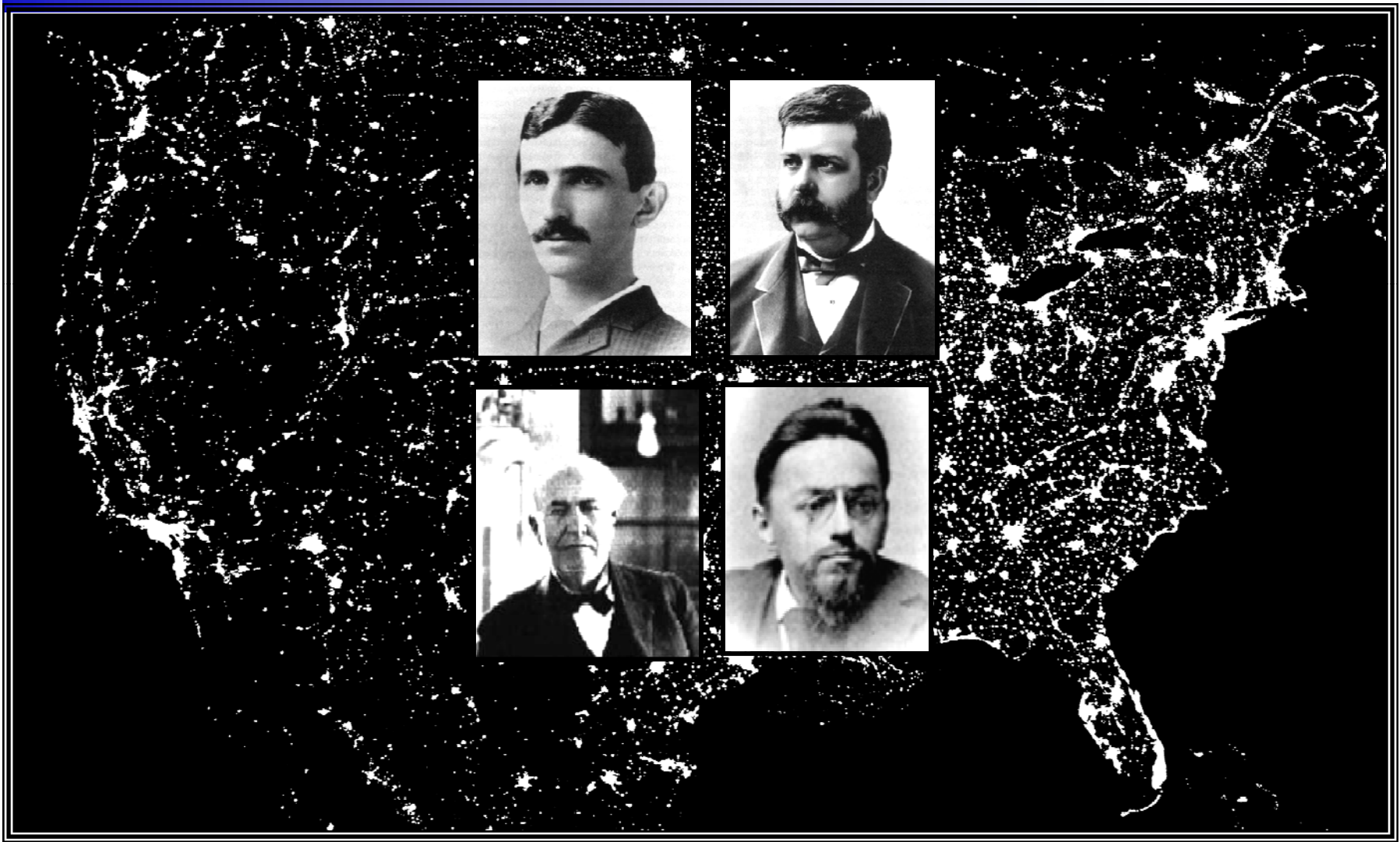
One of Edison's Most Famous Quotes:

“In Periods of Profound Change, The Most Dangerous Thing Is to Incrementalize Yourself Into The Future.”

*Oct 3, 1908 Edison Recording
at NY City Electricity Expo.
He was 62 at the time.*



The Public Benefit Light Show Of Electricity Is On. . . . Every Night !



The Public Benefit Light Show Of Electricity Is On. . . . Every Night !

