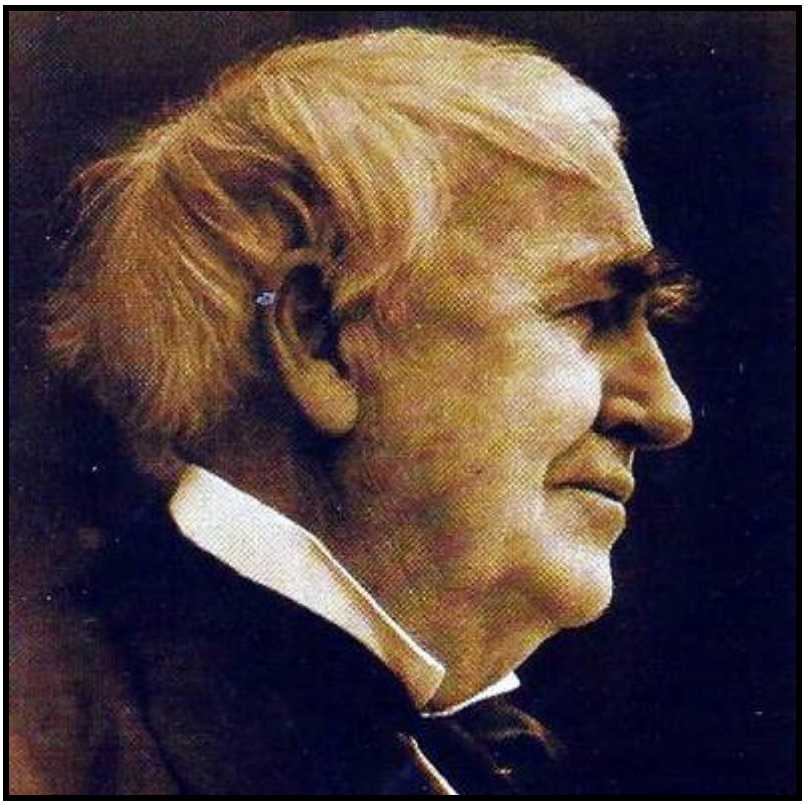
THOMAS ALVA EDISON and THE INCANDESENT LAMP

by Brian Roberts, CIBSE Heritage Group



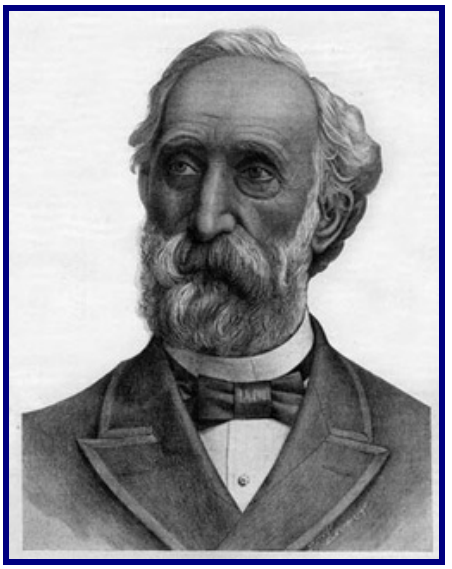
Thomas Alva Edison 1847-1931

Thomas Alva Edison was born in Milan, Ohio and grew up in Michigan, spending only three months at school, being taught at home by his schoolteacher mother and being essentially self-educated. At the age of 12 he started work by selling newspapers. In 1862, he trained as a telegraphist, rapidly becoming an expert operator and a repairer of machines. In 1868, he settled in Boston working for Western Union and inspired by the work of Faraday spent his free time carrying out experiments in electricity. In 1869, he invented an improved ticker-tape machine for the stock market and began manufacturing high speed printing machines in Newark, New Jersey. With the monies now earned, in 1876, he set up an industrial research laboratory at Menlo Park, New Jersey, moving to West Orange, NJ, in 1887.

With his research team, he invented the photograph and a dictating machine and improved on the telephone of Alexander Graham Bell. In 1879, he patented the first *successful* incandescent light-bulb using a carbon filament in a vacuum. Perhaps his most significant contribution, in 1882, was the establishment of a complete electrical generating and direct current distribution system for lighting a district of New York. This included generators, cabling, switches, plugs, meters and light bulbs

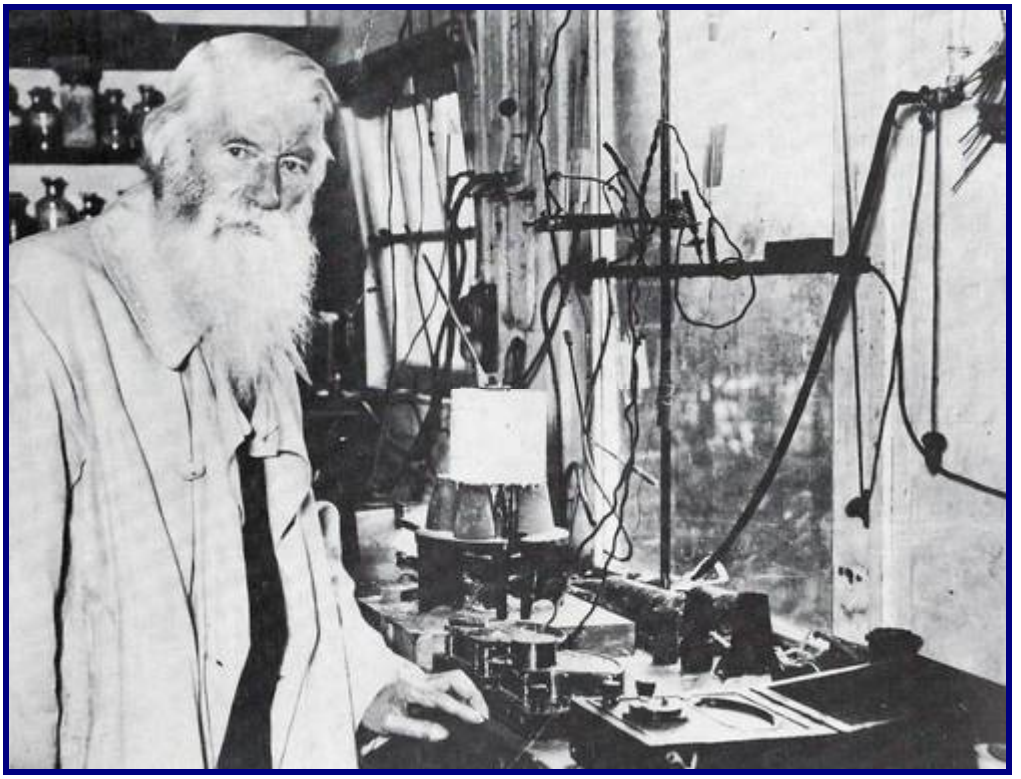
LAMP PIONEERS: DE MOLEYNS, STAITE & SWAN

Edison was not the first researcher to see the possibilities of using an electric incandescent lamp for lighting. In 1841, before Edison was born, the Englishman, Frederick De Moleyns secured a British Patent for an incandescent lamp and in 1848 Wilson Edwards Staite of Bristol also developed an incandescent lamp. Both used platinum as the filament, but this was too expensive for commercial use and only electricity from batteries was then available. Other lamp pioneers include De La Rue (1820), Groves (1840), Starr (1845) and Roberts (1852). However, it was in Gateshead that Joseph Wilson Swan experimented with filament lamps from 1848 to 1860 and was partially successful in 1878 and 1880. Though his lamps lit up, the filaments rapidly burnt out.

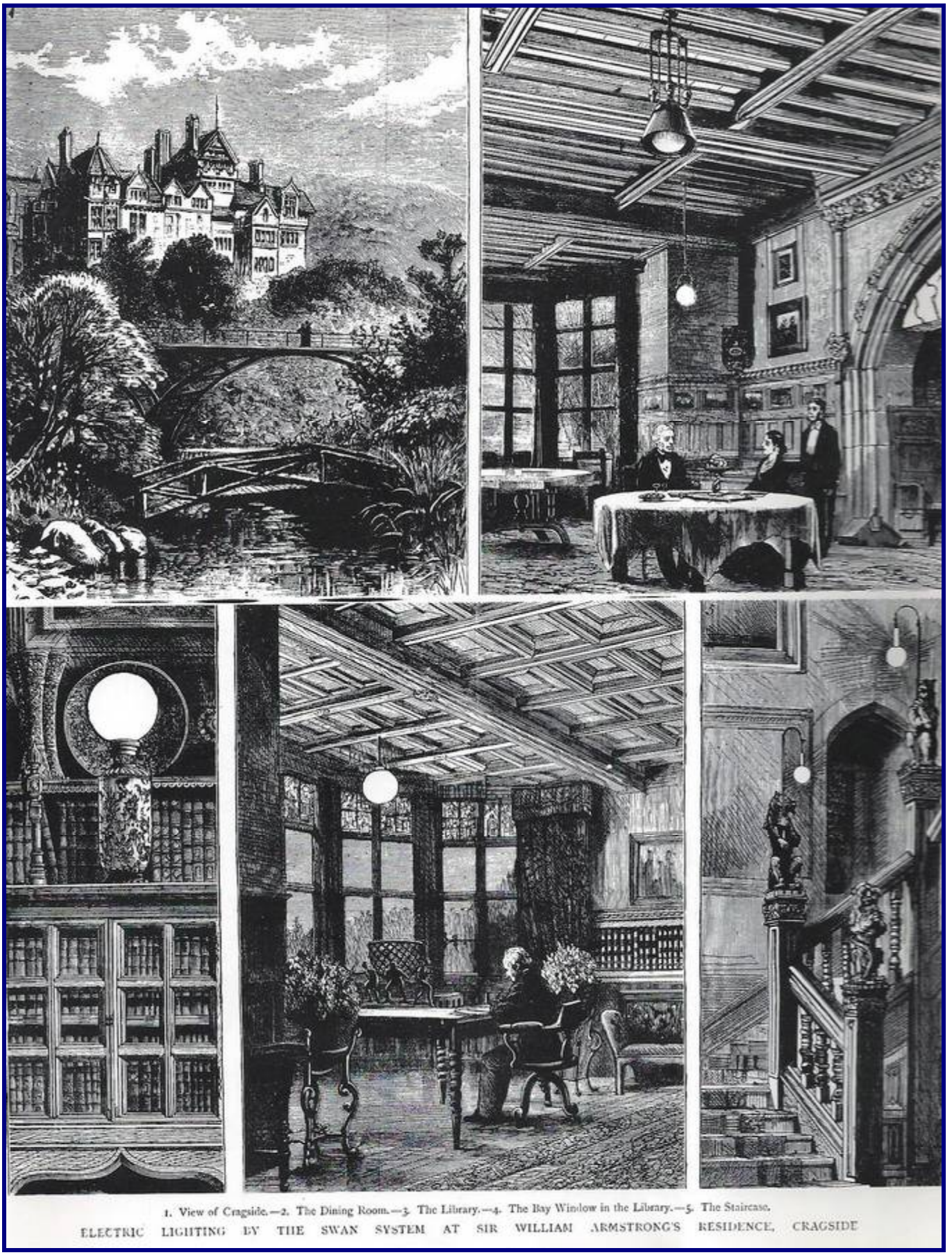


Frederick De Moleyns, d.1854

Wilson Edwards Staite, 1808-54

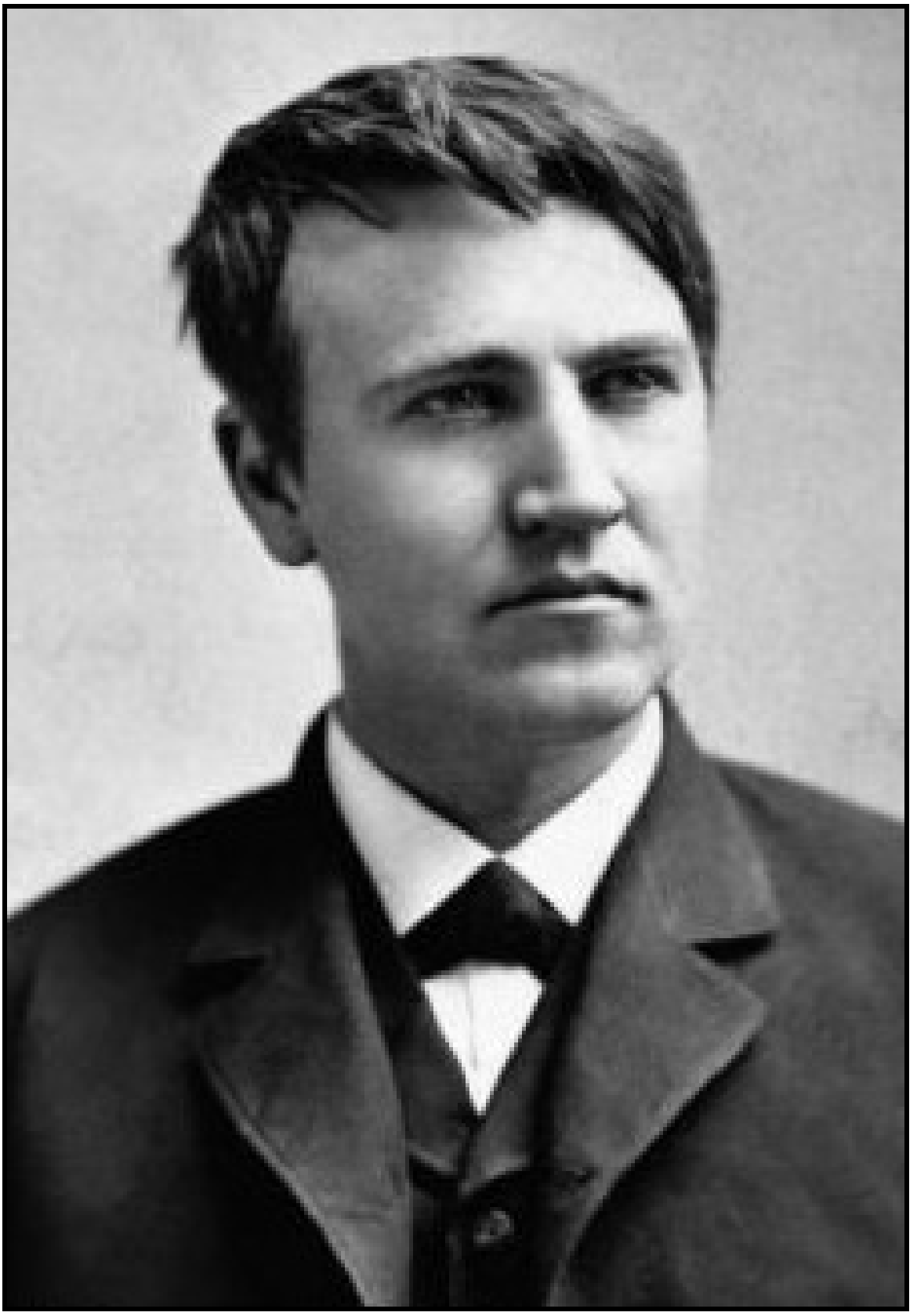


Sir Joseph Wilson Swan, 1828-1914



Swan's electric light was provided at Cragside in Northumberland in 1880. This was the first English country house to be lit by incandescent lamps, the electric power coming from a water turbine powering a Siemens dynamo. In 1895, the installation was enlarged by the addition of a Parker dynamo, this work carried out by Drake & Gorham

THE WIZARD OF MENLO PARK

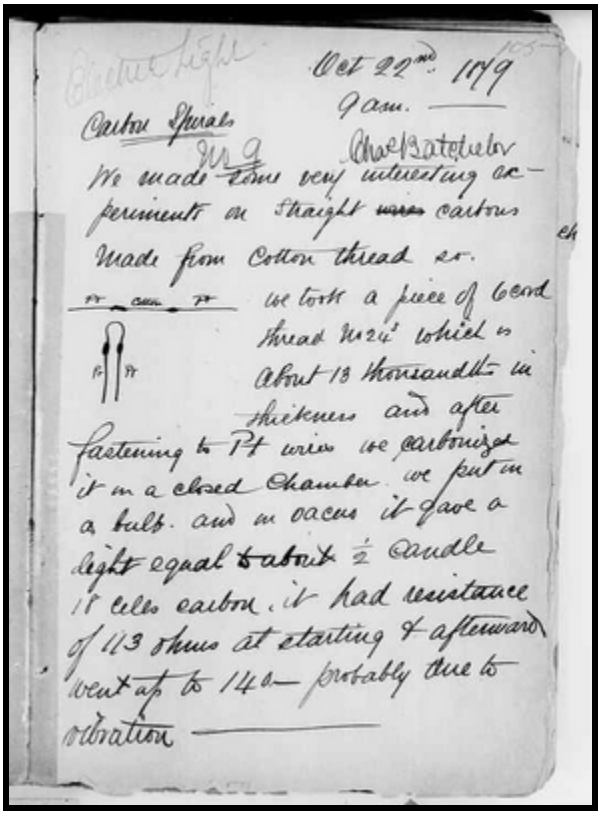


Thomas Alva Edison

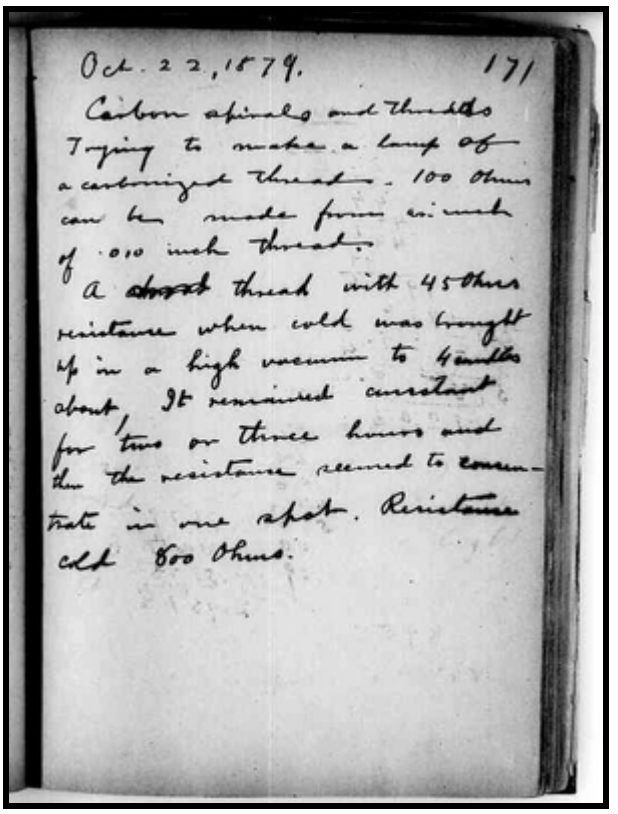
Edison's Menlo Park Laboratory

Edison's team of researchers at Menlo Park, February 1880

Edison's research team on the steps outside the Menlo Park laboratory

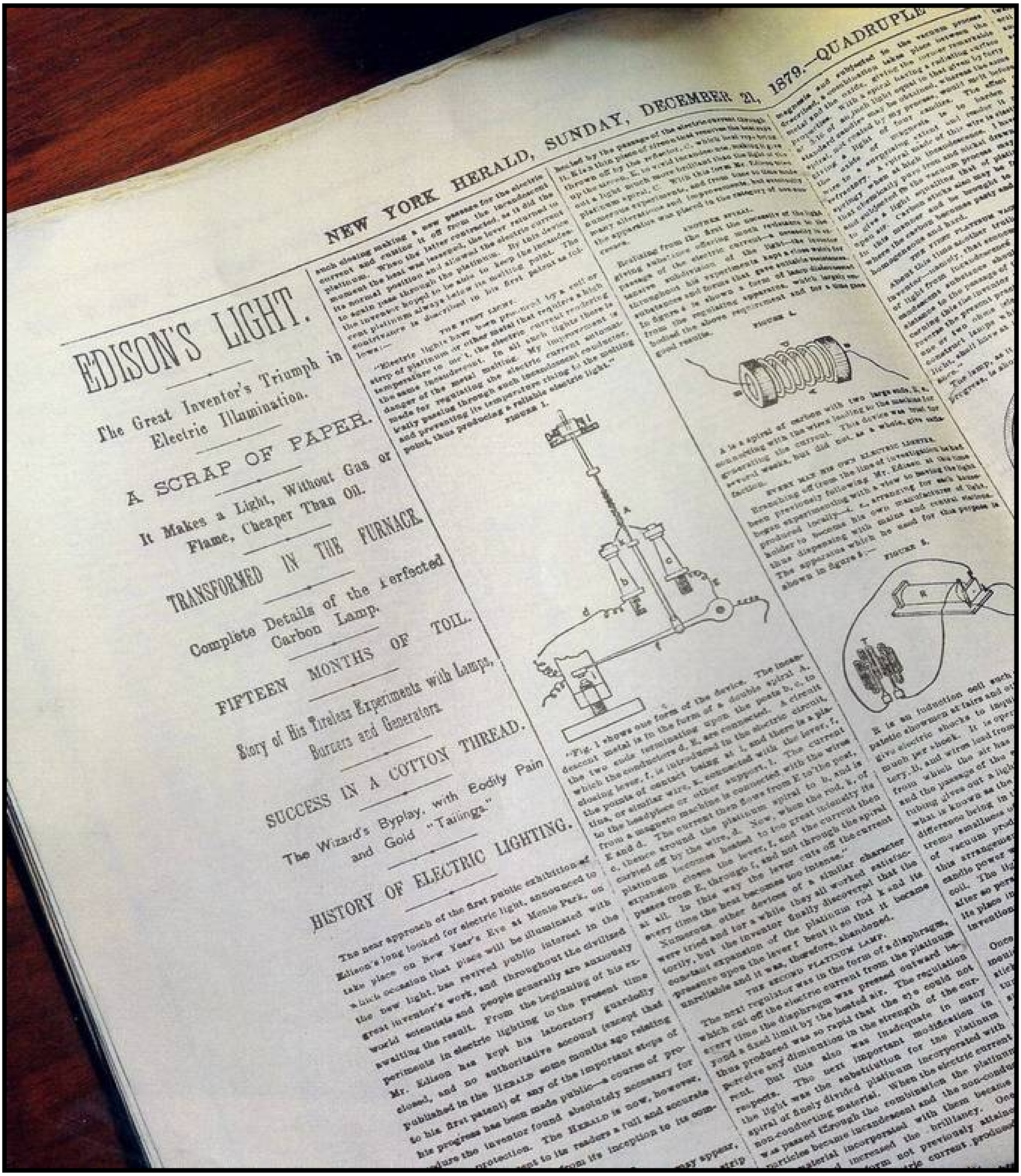


Oct 22nd 1879
9 am.
Carbon Spirals
Chas Batchelor
We made some very interesting experiments on Straight carbons
Made from Cotton thread &c.
we took a piece of Coard thread No24 which is
about 18 thousandths in
thickness and after
fastening to Pt wire we carbonized
it in a closed Chamber we put in
a bulb. and in vacuo it gave a
light equal to about ½ Candle
It tells carbon. it had resistance
of 113 ohms at starting & afterward
went up to 140— probably due to
odbration



Oct. 22, 1879. 171
Carbon spirals and thredds
Trying to make a lamp of
a carbonized thread. 100 Ohms
can be made from a inch
of .010 inch thread.
a thread with 45 Ohms
resistance when cold was brought
up in a high vacuum to 4 ohms
about, It remained constant
for two or three hours and
then the resistance seemed to concentrate in one spot. Resistance
cold 600 Ohms.

Pages from the1879 Menlo Park research notebooks



NEW YORK HERALD, SUNDAY, DECEMBER 21, 1879.—QUADRUPLE

EDISON'S LIGHT.

The Great Inventor's Triumph in Electric Illumination.

A SCRAP OF PAPER.

It Makes a Light, Without Gas or Flame, Cheaper Than Oil.

TRANSFORMED IN THE FURNACE.

Complete Details of the Perfected Carbon Lamp.

FIFTEEN MONTHS OF TOIL.

Story of His Tireless Experiments with Lamps, Burners and Generators.

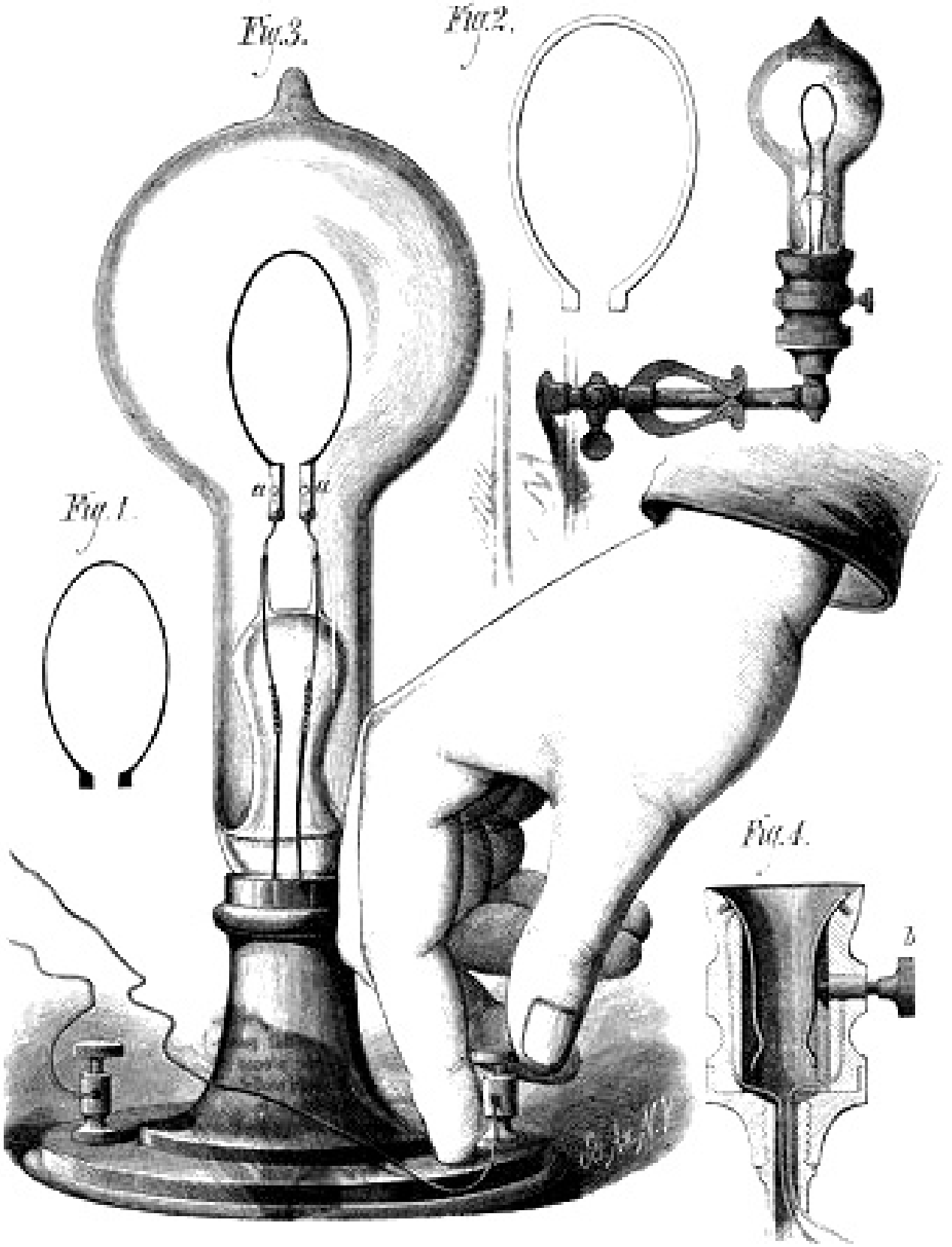
SUCCESS IN A COTTON THREAD.

The Wizard's Byplay, with Bodily Pain and Gold "Tailings."

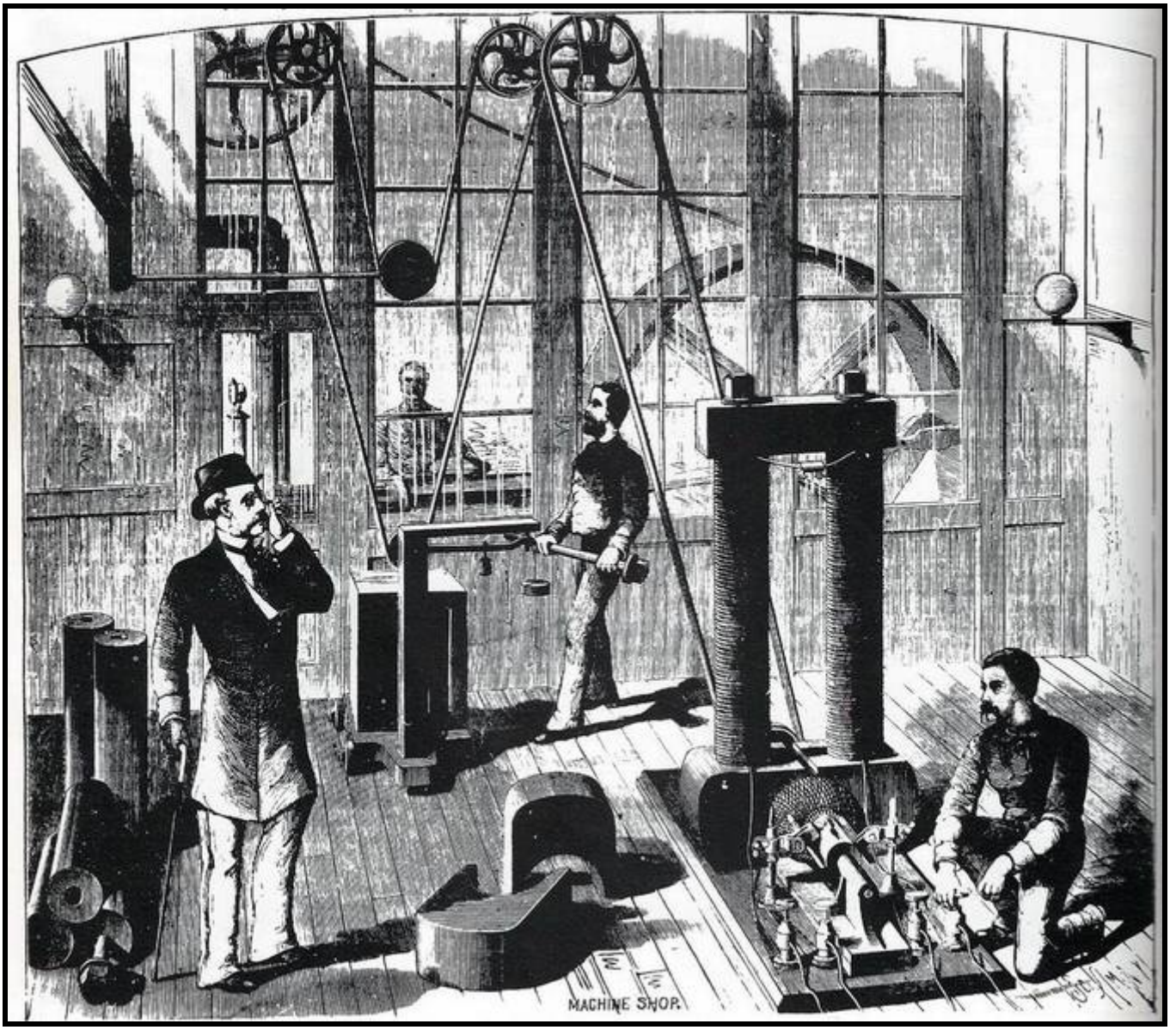
HISTORY OF ELECTRIC LIGHTING.

The near approach of the first public exhibition of Edison's long looked for electric light, announced to take place on New Year's Eve at Menlo Park, on which occasion that place will be illuminated with the new light, has revived public interest in the great inventor's work, and throughout the civilized world scientists and people generally are anxiously awaiting the result. From the beginning of his experiments in electric lighting to the present time Mr. Edison has kept his laboratory guardedly closed, and no authoritative account (except that published in the HERALD some months ago relating to his first patent) of any of the important steps of his progress has been made public—a course of procedure the inventor found absolutely necessary for protection. The HERALD is now, however, ...

New York Herald of Sunday, 21st December 1879 reporting Edison's electric light success



EDISON'S LATEST ELECTRIC LAMP.



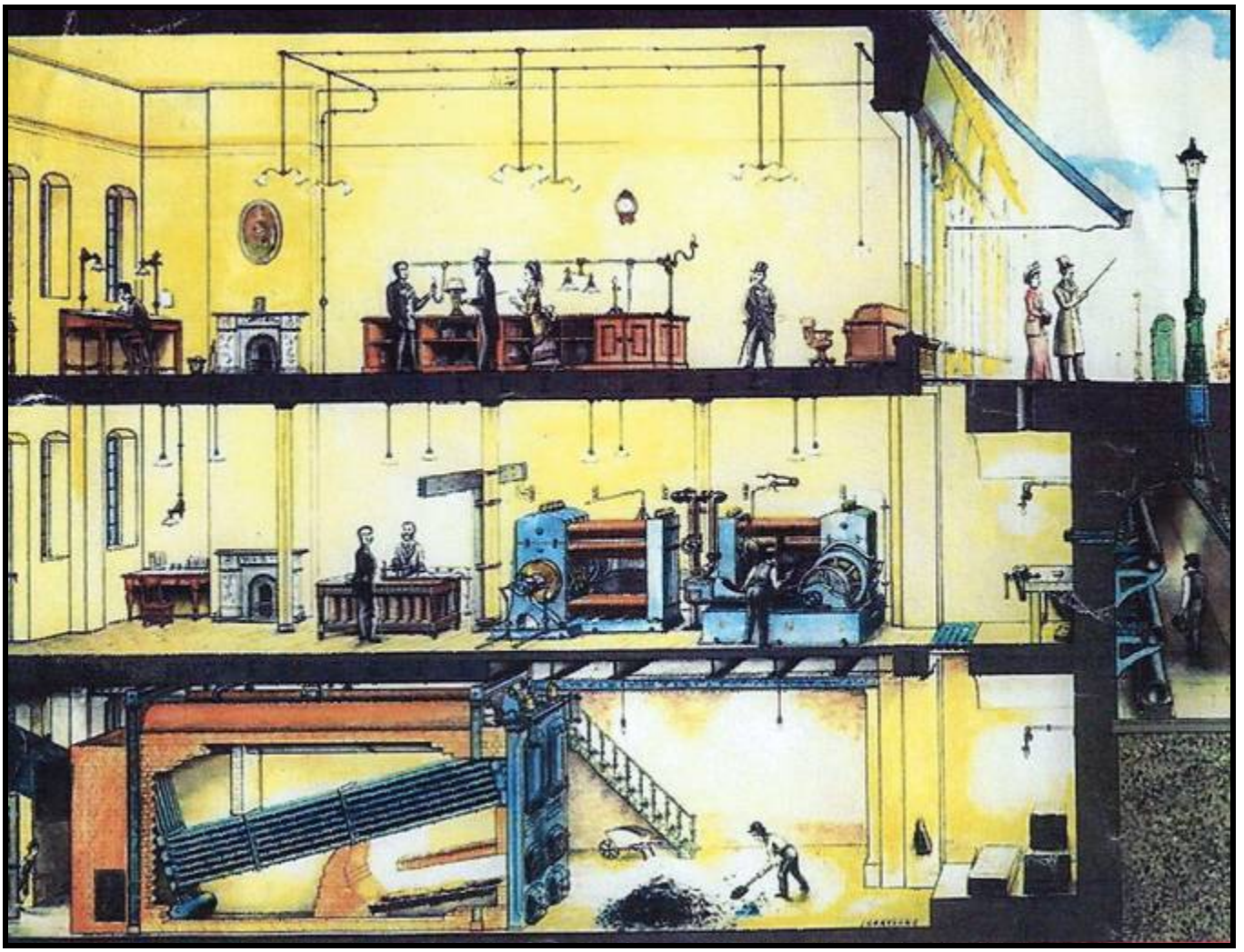
Edison's Machine Shop and his Constant-Voltage Transformer

Michael Faraday invented the transformer in 1831 but it was developed by others, including: Pixii (1832), Hjorth (1855), Siemens (1856), Nollet (1863), Wheatstone (1866) and Gramme (1871).

Prior to 1878, the only known method of distributing direct electric current was using a *Constant Current Dynamo* with lamps connected in series. However, in 1878, Edison developed his *Multiple System* employing a *Constant Voltage Dynamo* with lamps connected in parallel. Edison went on to produce his giant *Jumbo Dynamo* and in 1882 used two machines in his London Holborn Power Station and then six machines in his New York Pearl Street Power Station.

Later, in 1883, he developed his three-wire system, probably based on John Hopkinson's British Patent of 1882. (Hopkinson was then acting as a consultant to the Edison Company of London and designed the Edison-Hopkinson dynamo which improved efficiency and increased output. Hopkinson later developed a five-wire system).

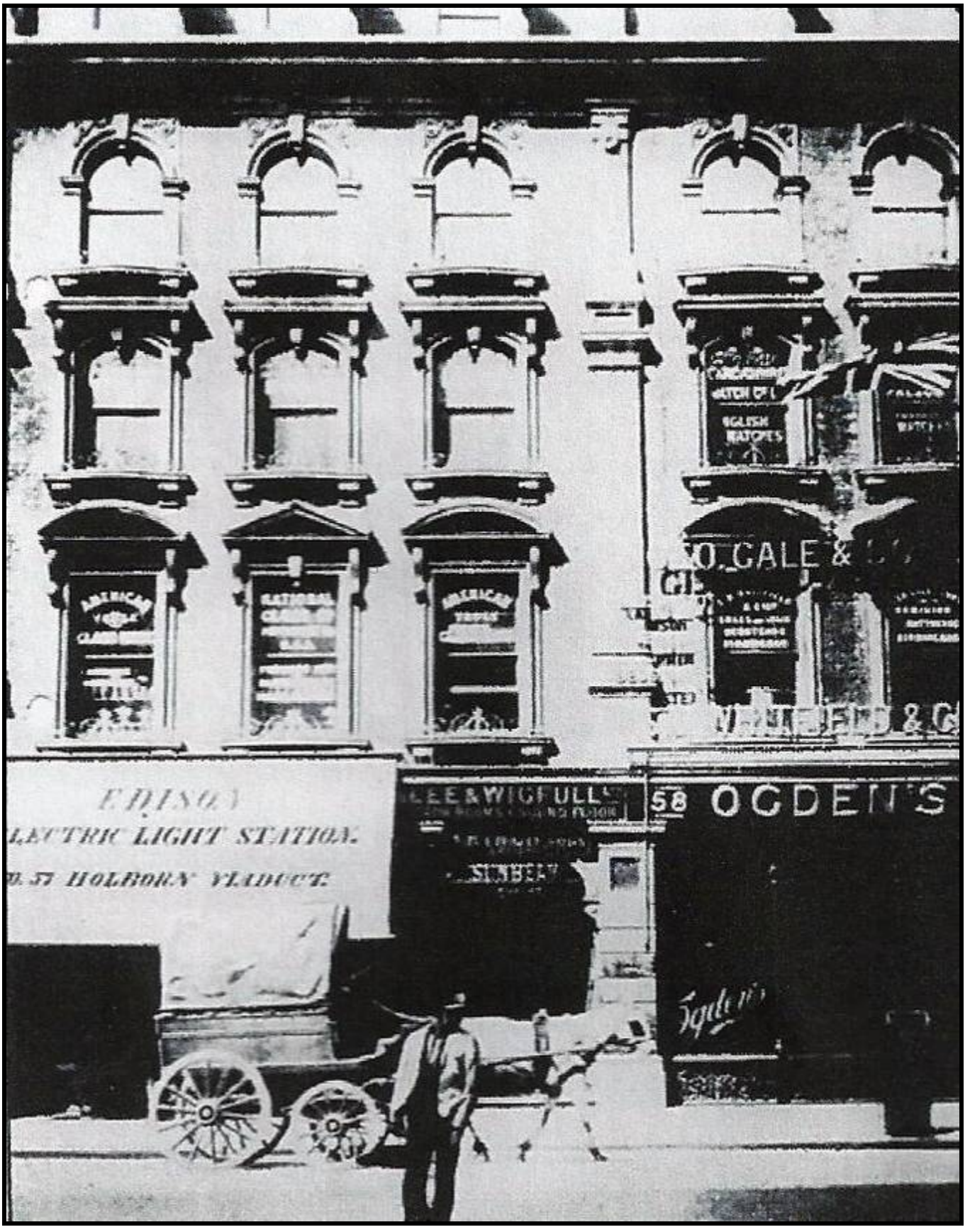
EDISON'S POWER STATION, HIGH HOLBORN, LONDON, JANUARY 1882



The Edison Electric Light Station at 57 Holborn Viaduct in London is believed to be the first public steam power station in the world to cater for the private consumer as well as for public lighting. It started to operate on the 12th January 1882, nearly a year before the much larger and highly publicised Pearl Street Station in New York (often quoted as the first).

One report describes the installation: "Distribution was by DC at about 110 V by the two-wire system. Holborn Viaduct had roomy subways that carried the mains without the expense and legal problems of digging up streets. The two copper conductors were fixed in insulating material and carried in wrought iron pipes. Current for street lamps and for private consumers was taken…….via distribution boxes."

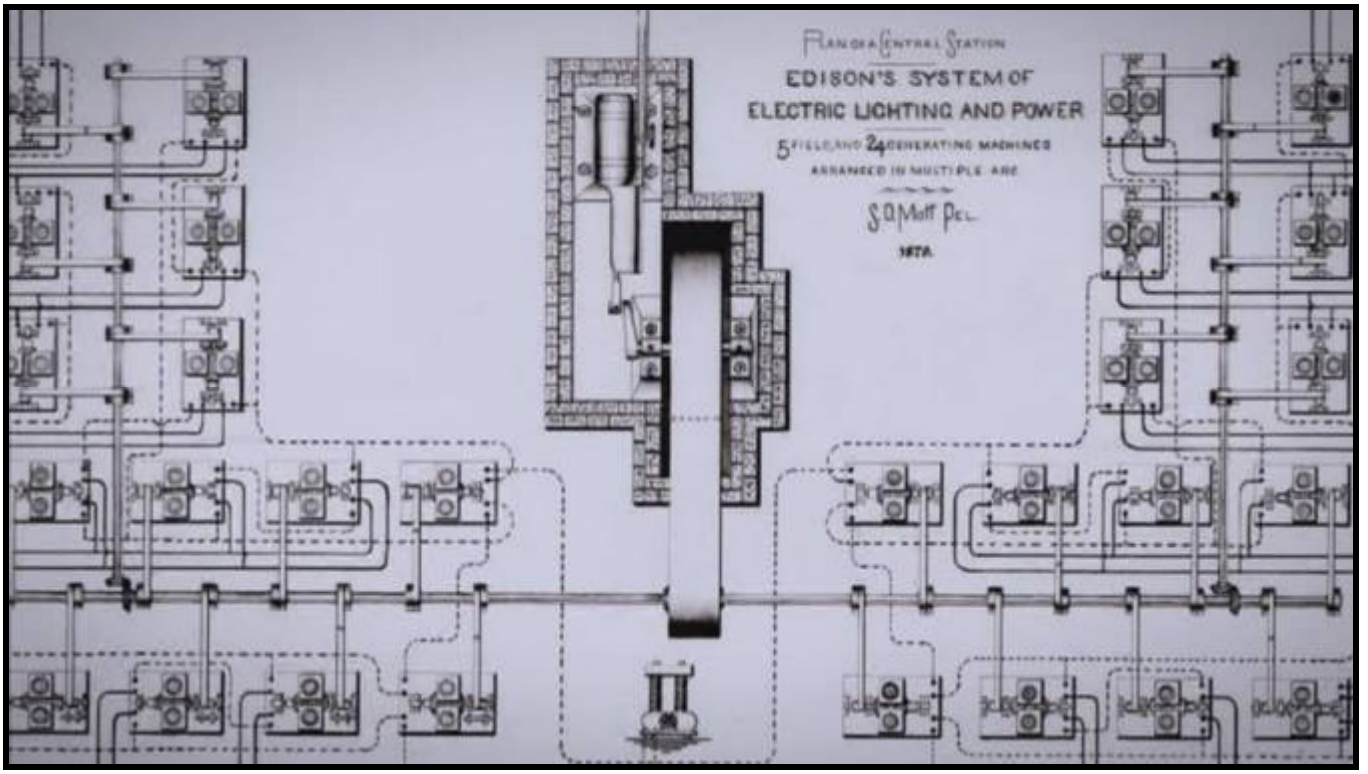
The initial system had 968 lamps (400 being added later) originally supplied from two Edison American built "Jumbo" dynamos, each driven by a 125 horsepower Porter-Allen horizontal steam engine connected to a Babcock & Wilcox water-tube boiler. Edison considered this, his experiment, satisfactory from the technical viewpoint, but it was running at a loss and he closed it down in September 1886.



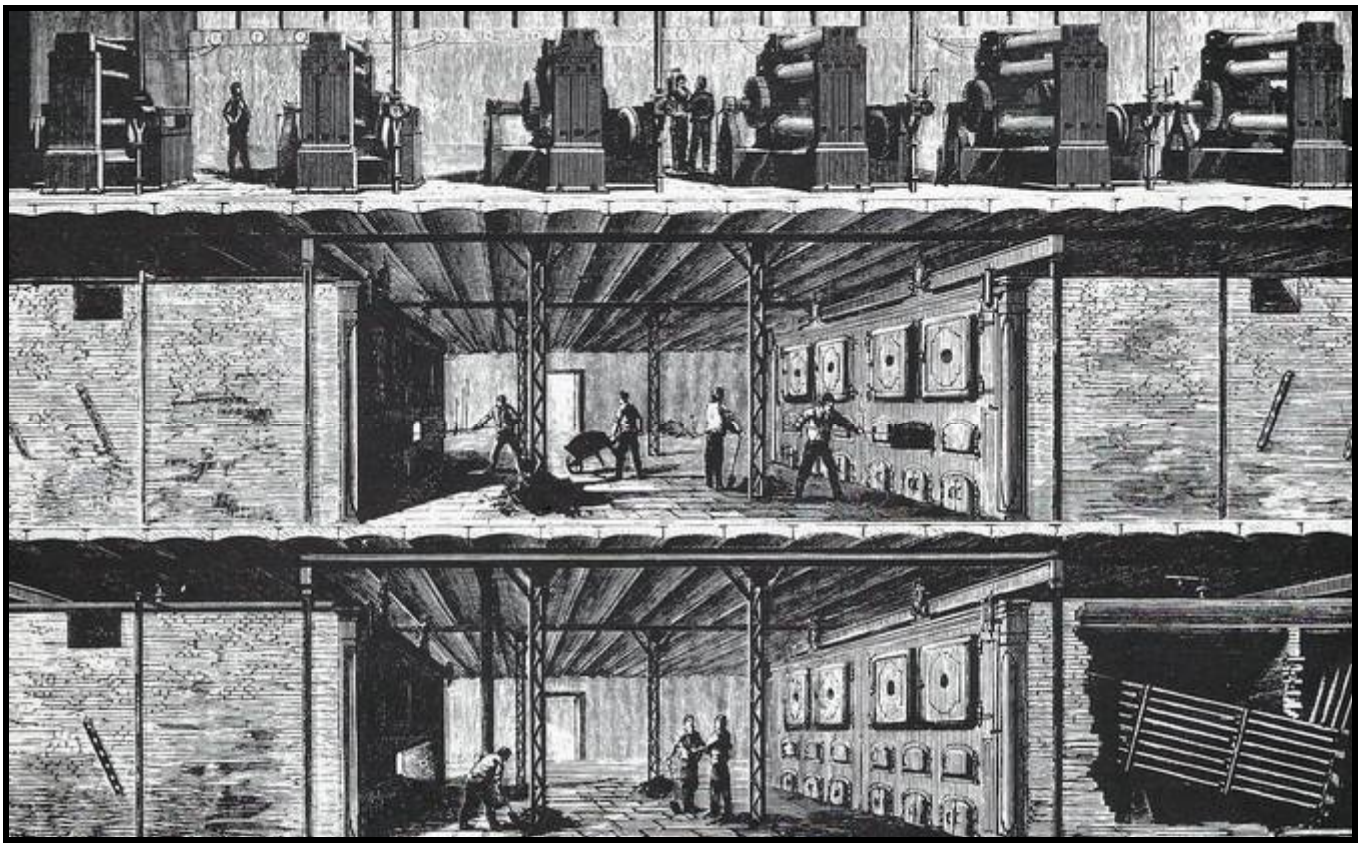
A shop awning advertising the "Edison Electric Light Station" at Holborn Viaduct

PEARL STREET POWER STATION, NEW YORK, SEPTEMBER 1882

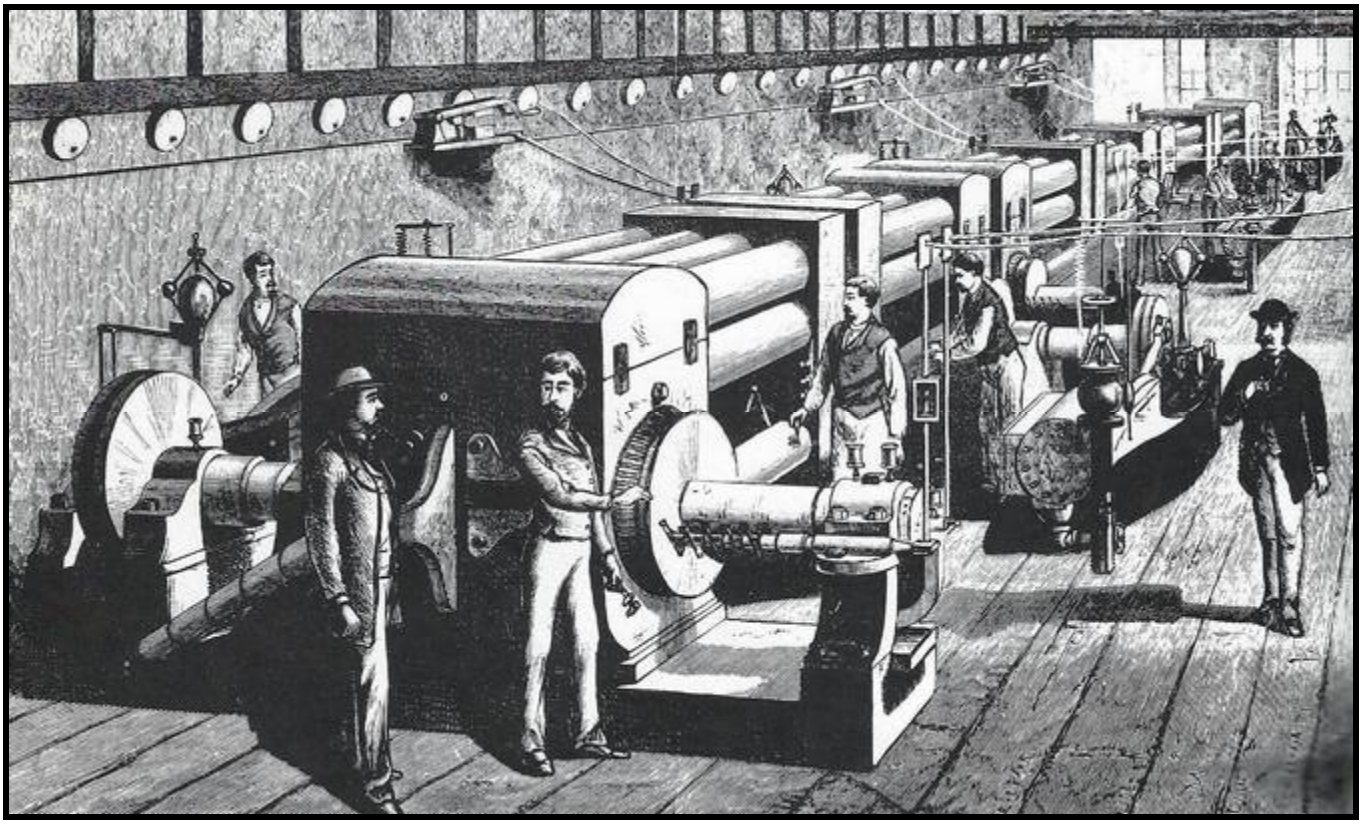
Birth of the incandescent electric lamp



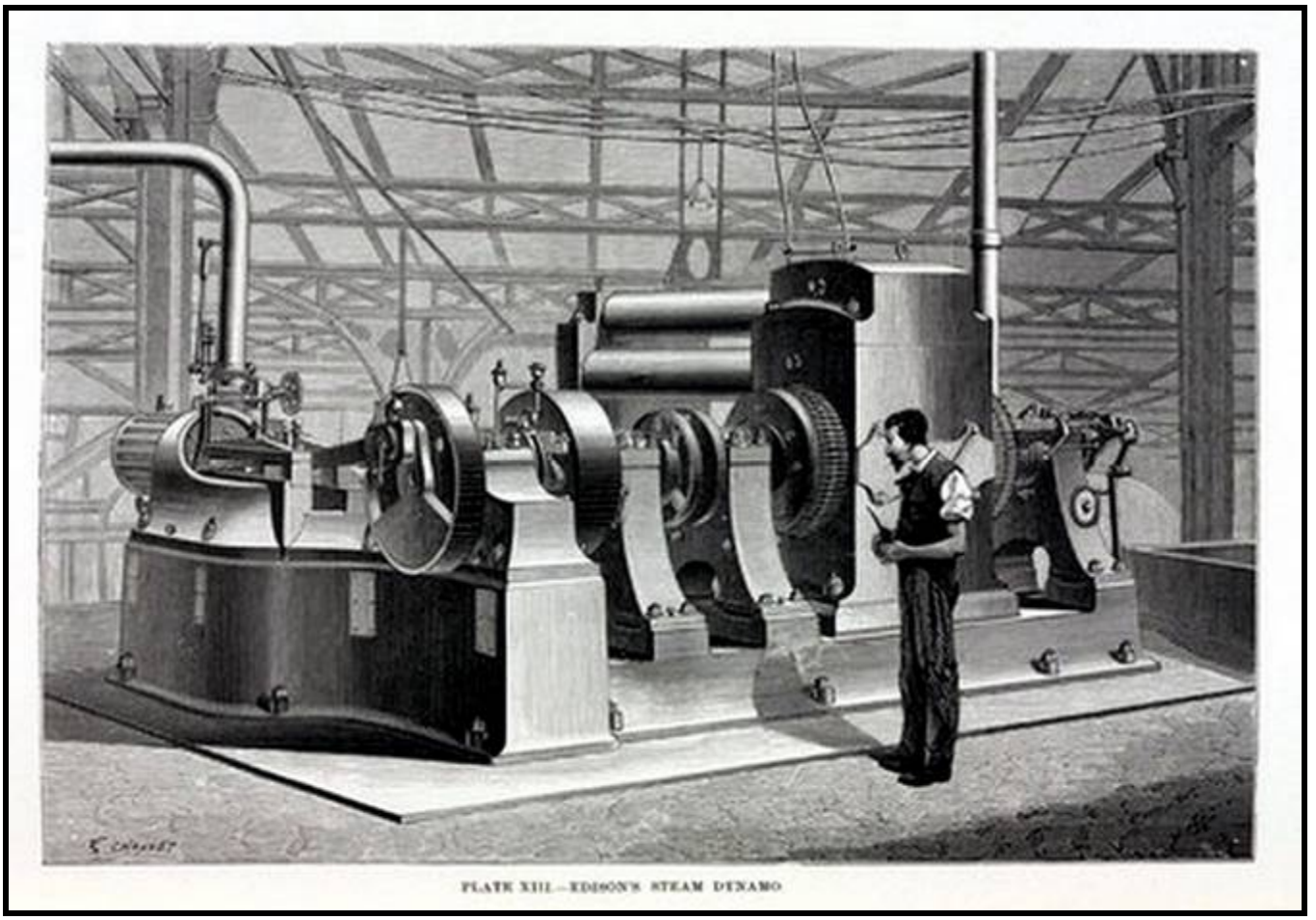
Drawing of Edison's plan for a Central Station distributing electric light and power



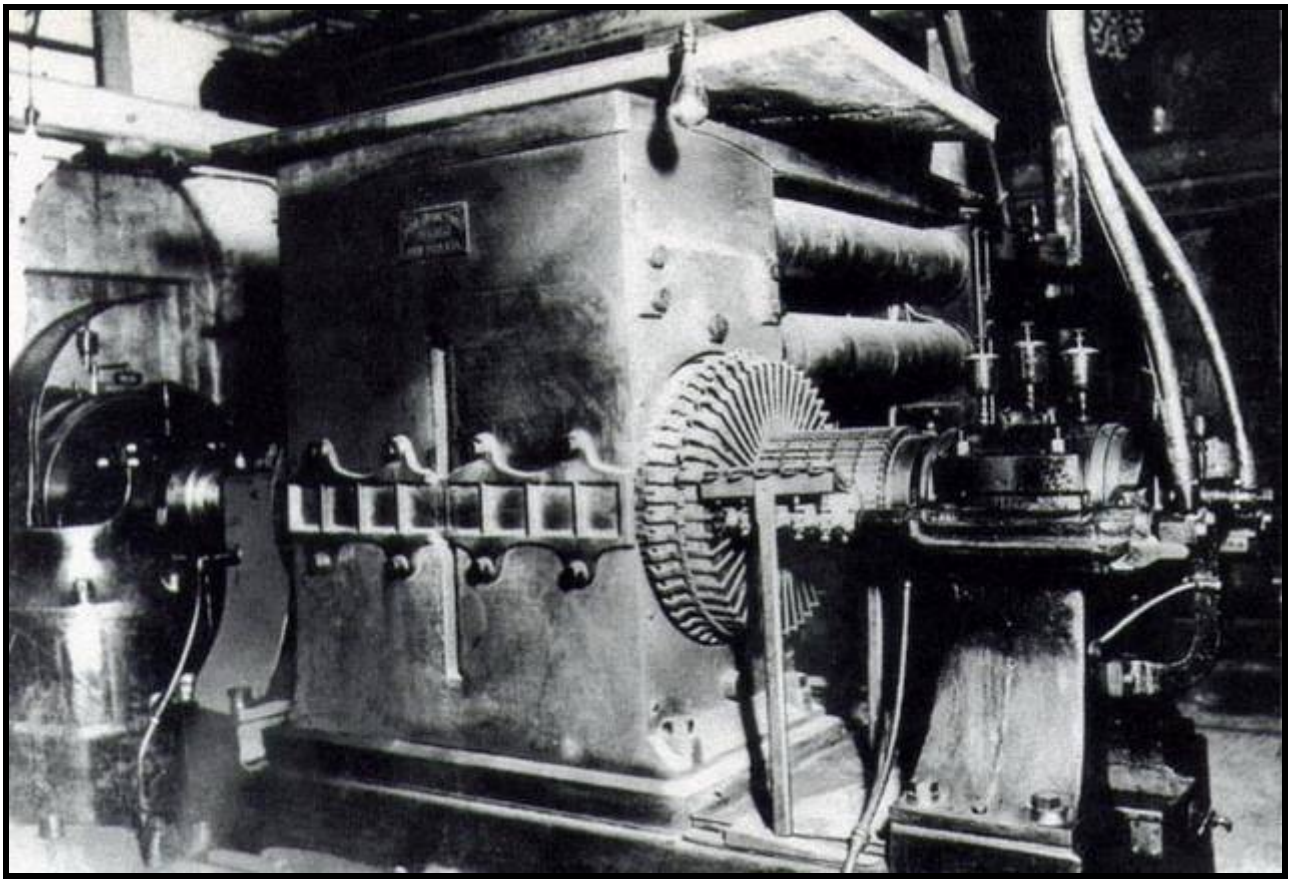
The three lower storeys of Edison's Pearl Street station housing dynamos and boilers, 1882



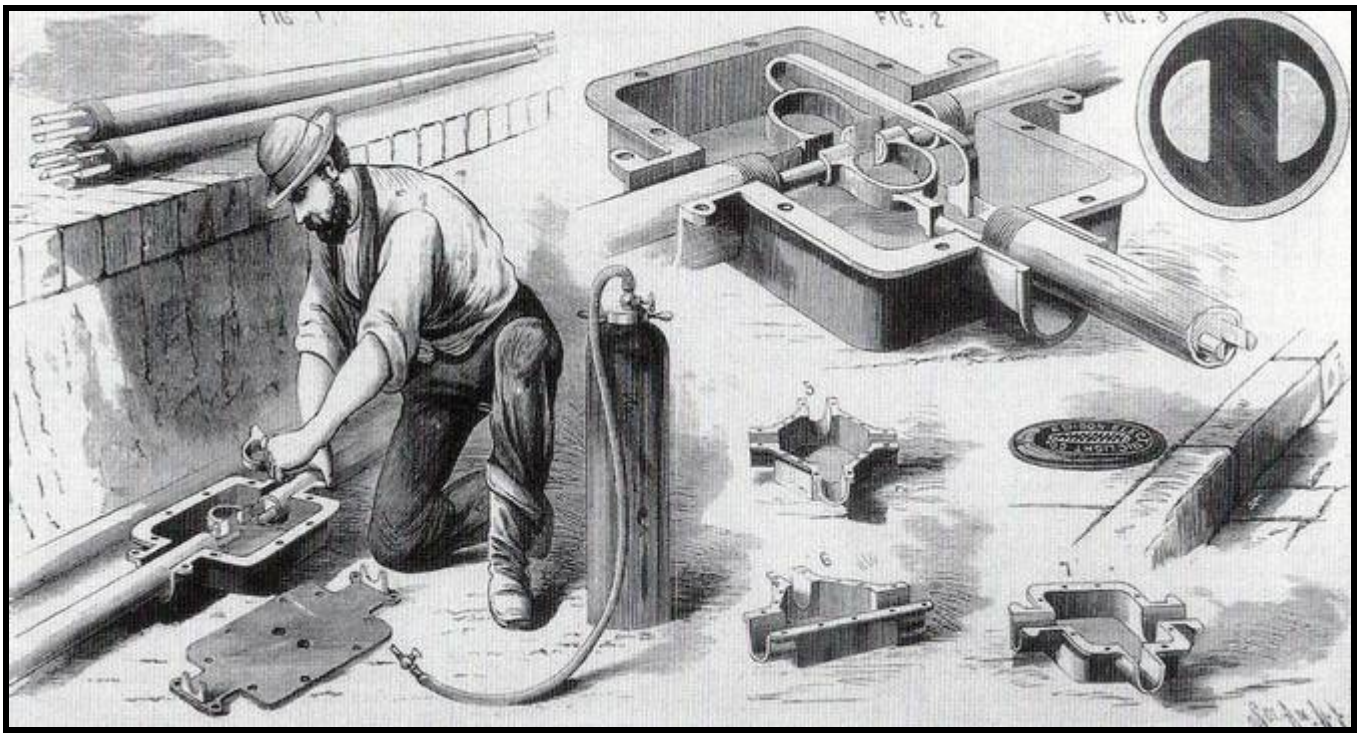
The dynamo room of Edison's Pearl Street Station, 1882



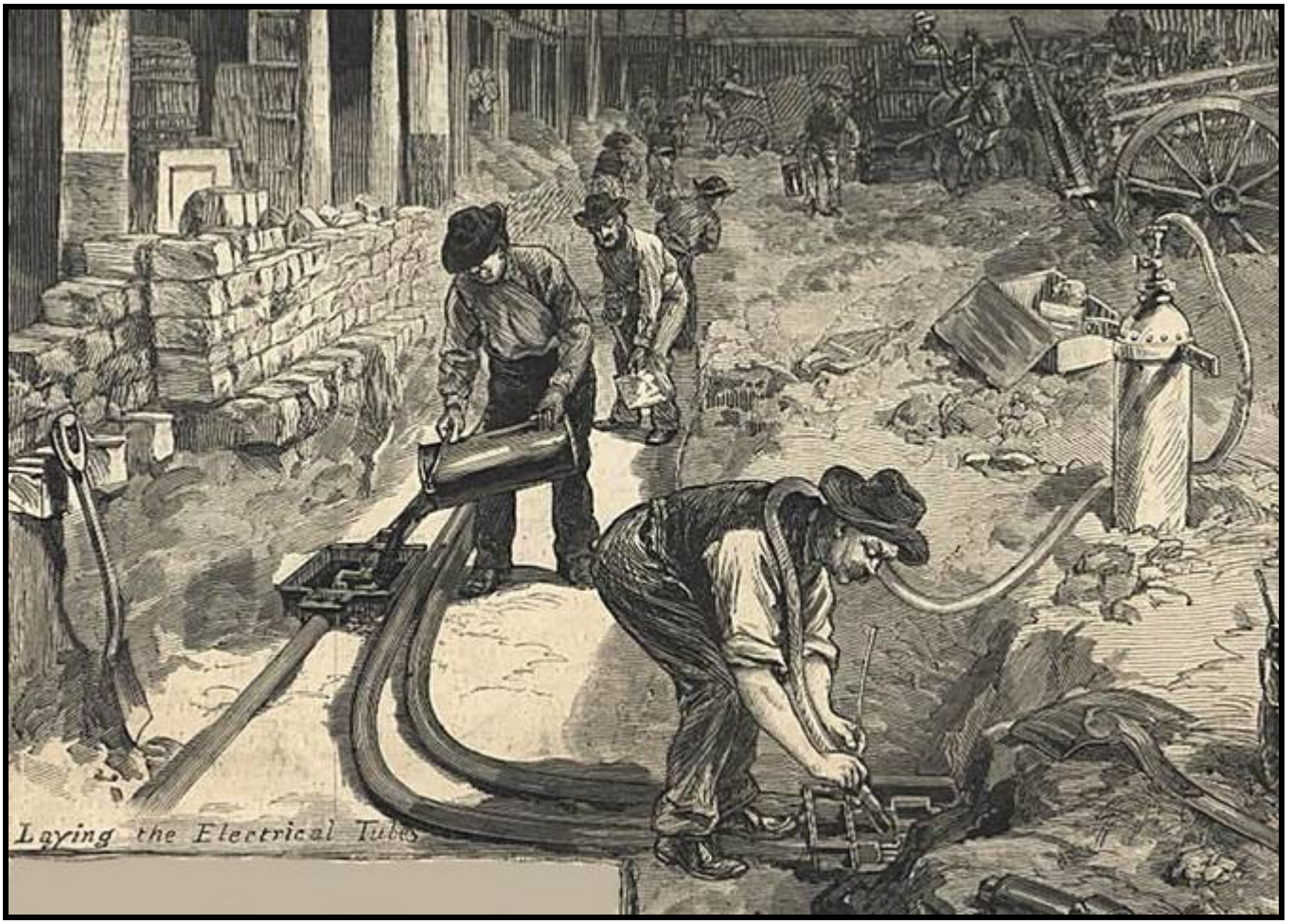
Drawing of Edison's Jumbo steam dynamo



Edison's Jumbo dynamo

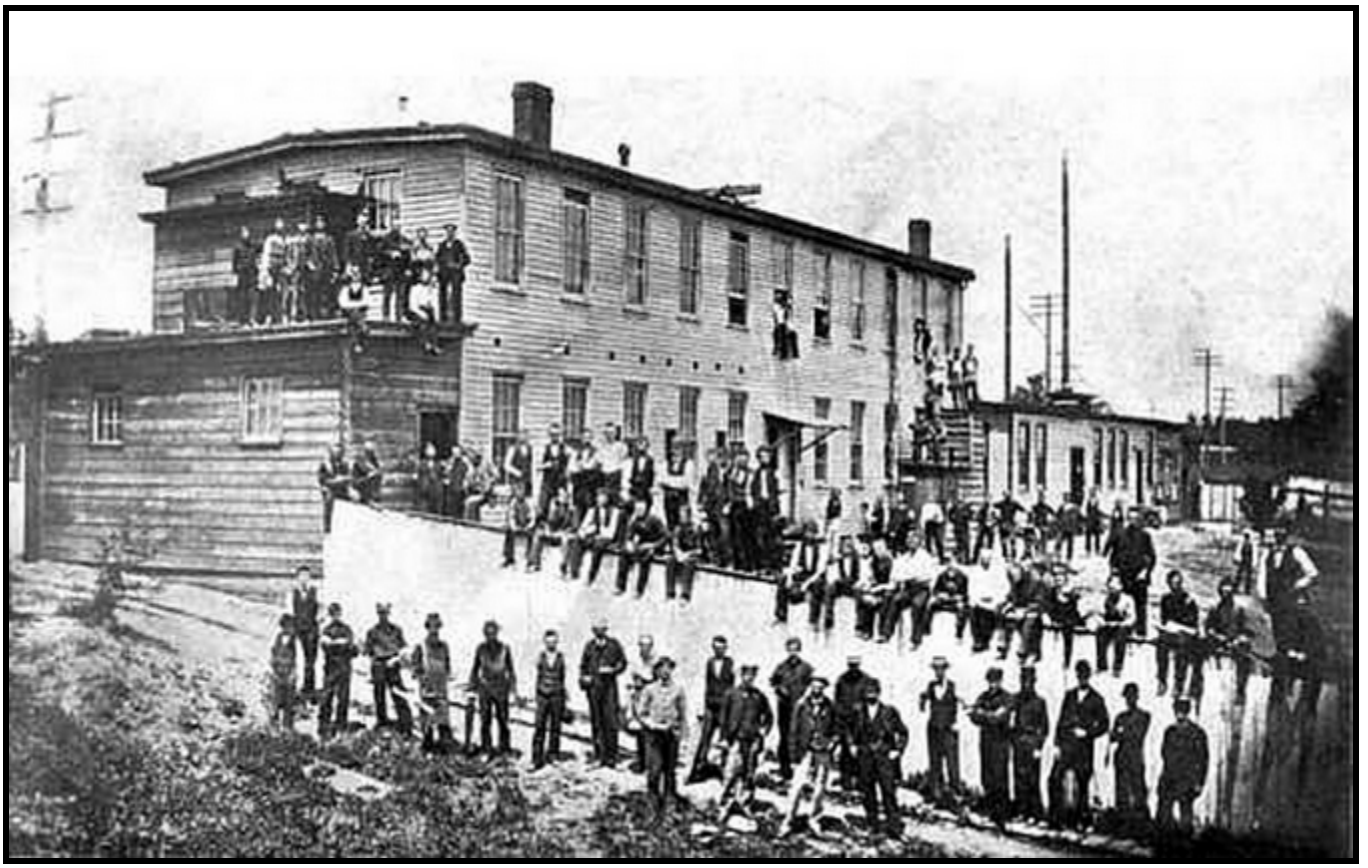


Laying Edison's electric light cables in the streets of New York City



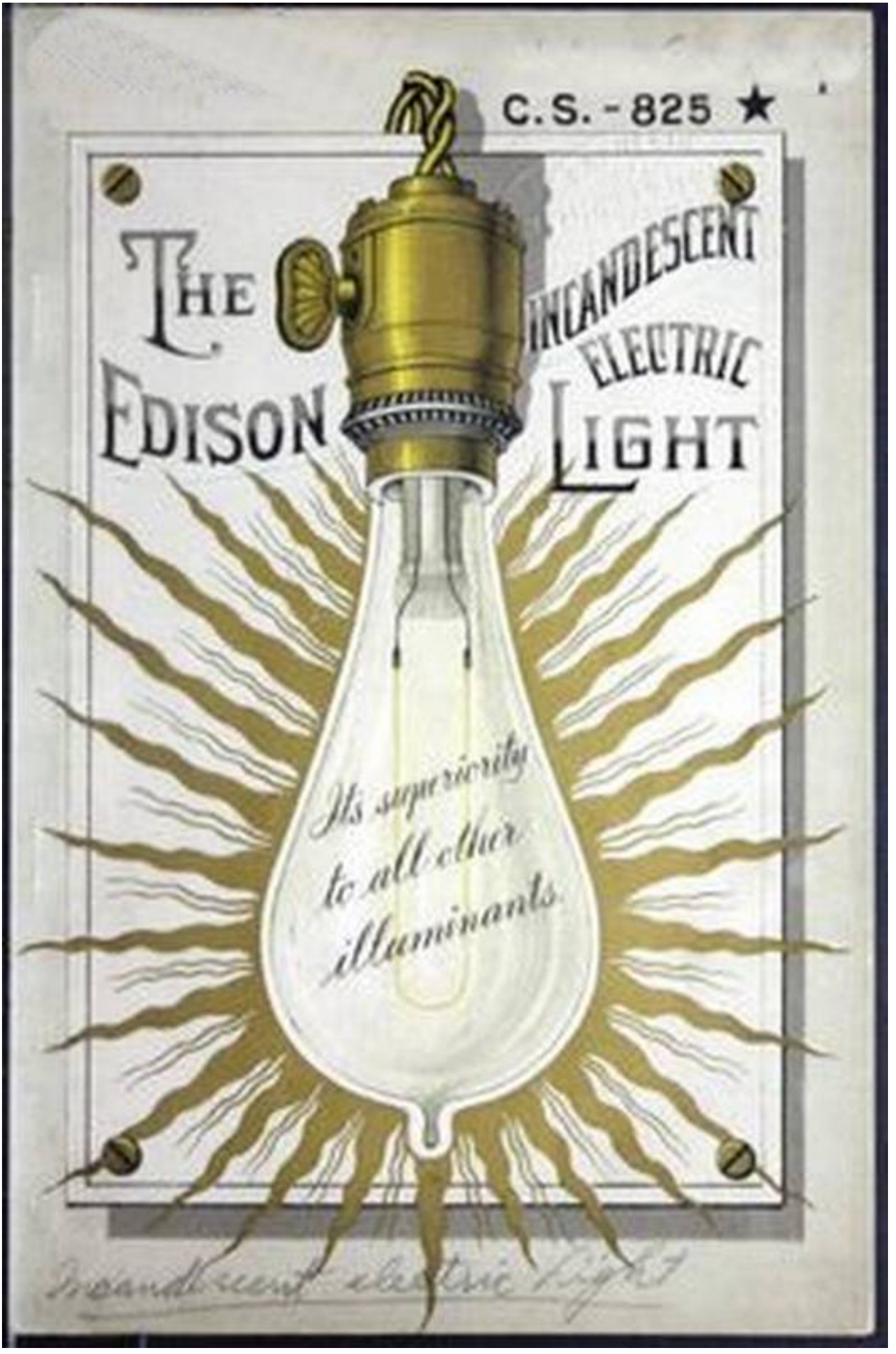
Laying Edison's electric light cables in the streets of New York City

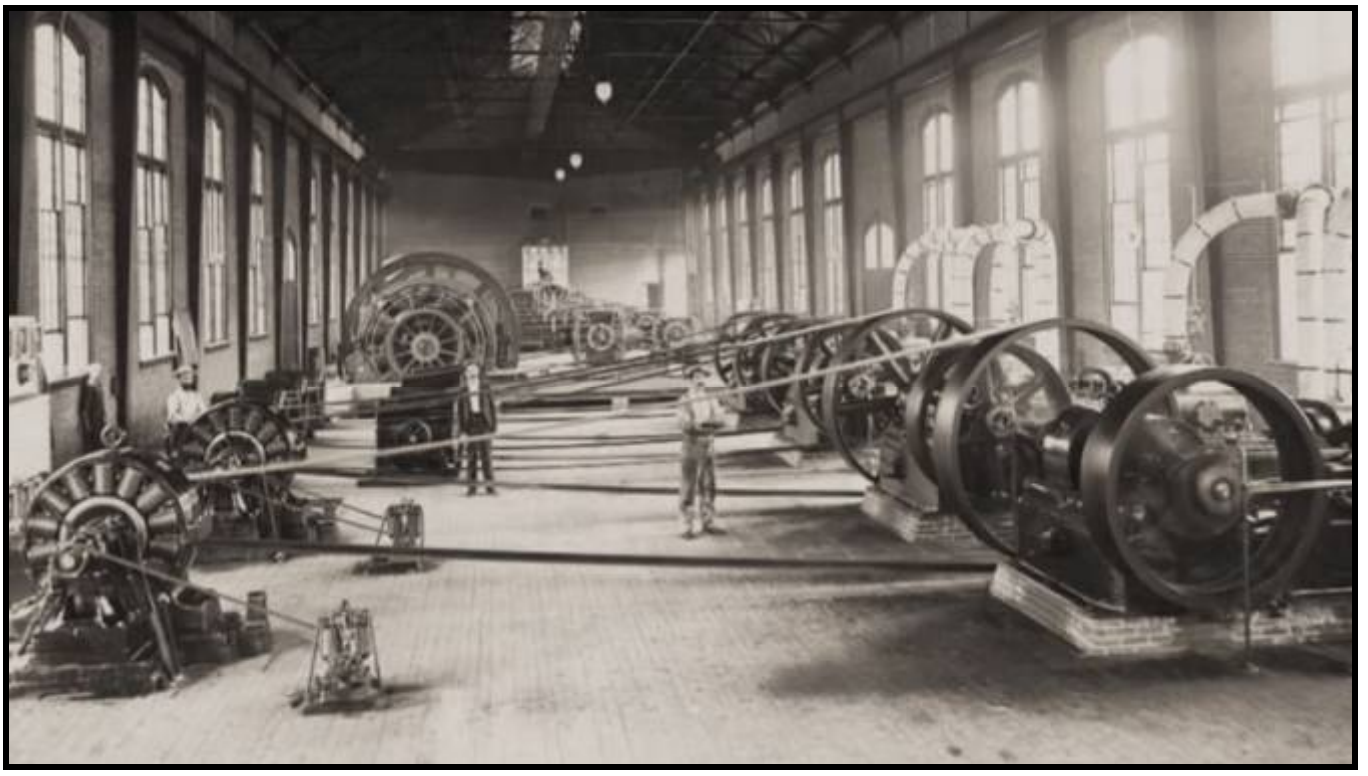
Laying Edison's electric light cables in the streets of New York City



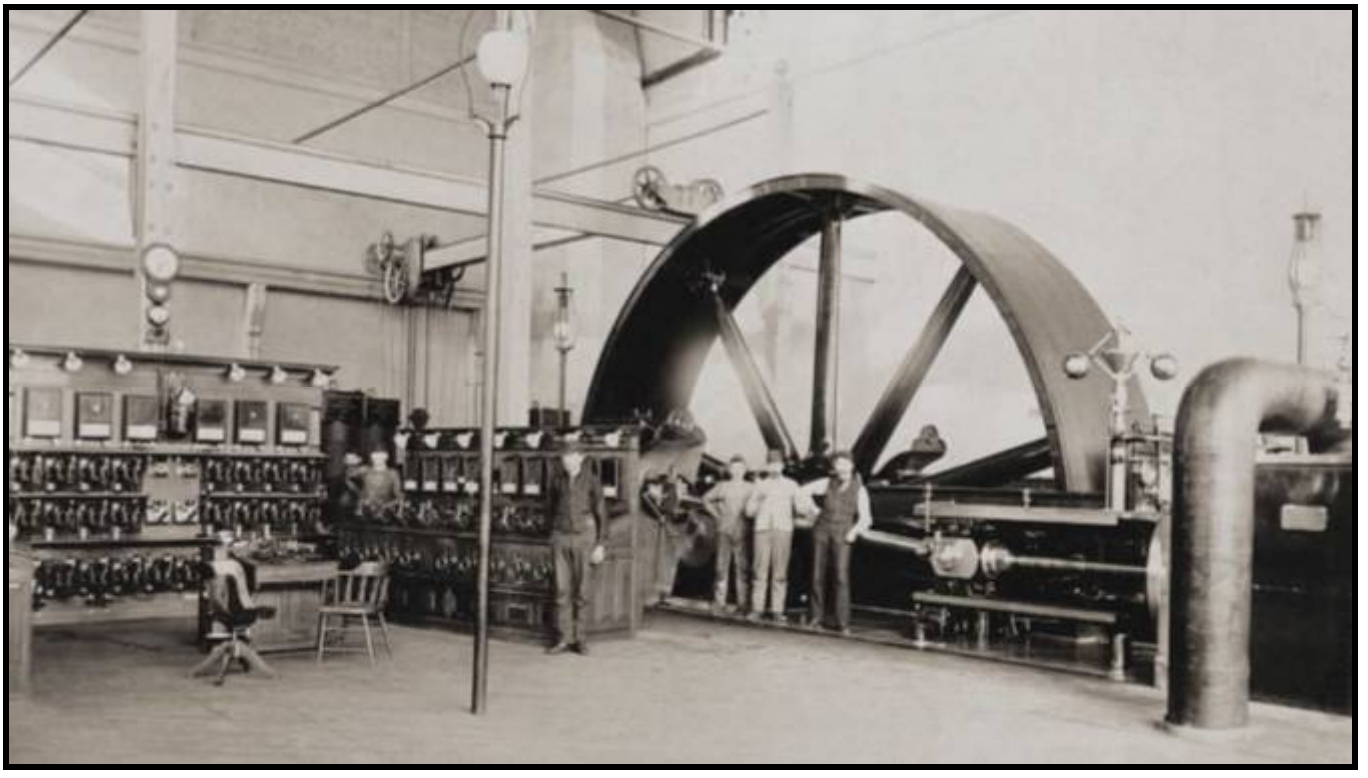
Edison's first electric lamp factory 1881

Edison's Machine Works in east lower Manhattan set up in 1881 to produce Jumbo dynamos

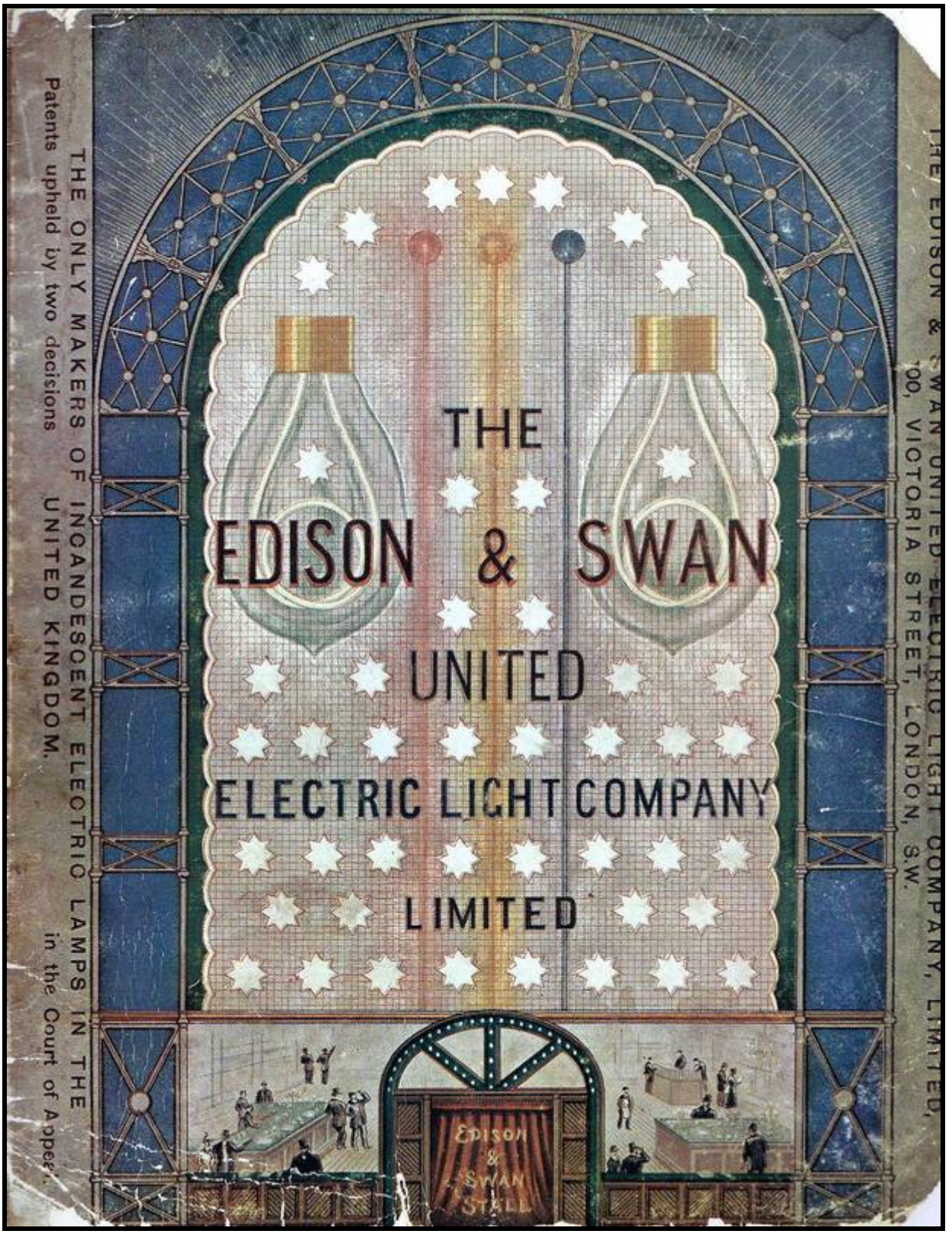

C. S. - 825 ★
THE EDISON INCANDESCENT ELECTRIC LIGHT
Its superiority to all other illuminants.
Incandescent electric light



An early Edison electric light direct current power station



Edison electric light power station



Brochure of the Edison & Swan Company

After initial legal arguments over patents, a possible court battle in Britain between the Edison and Swan companies was avoided when they agreed in 1883 to form the Edison & Swan United Electric Light Company Limited.

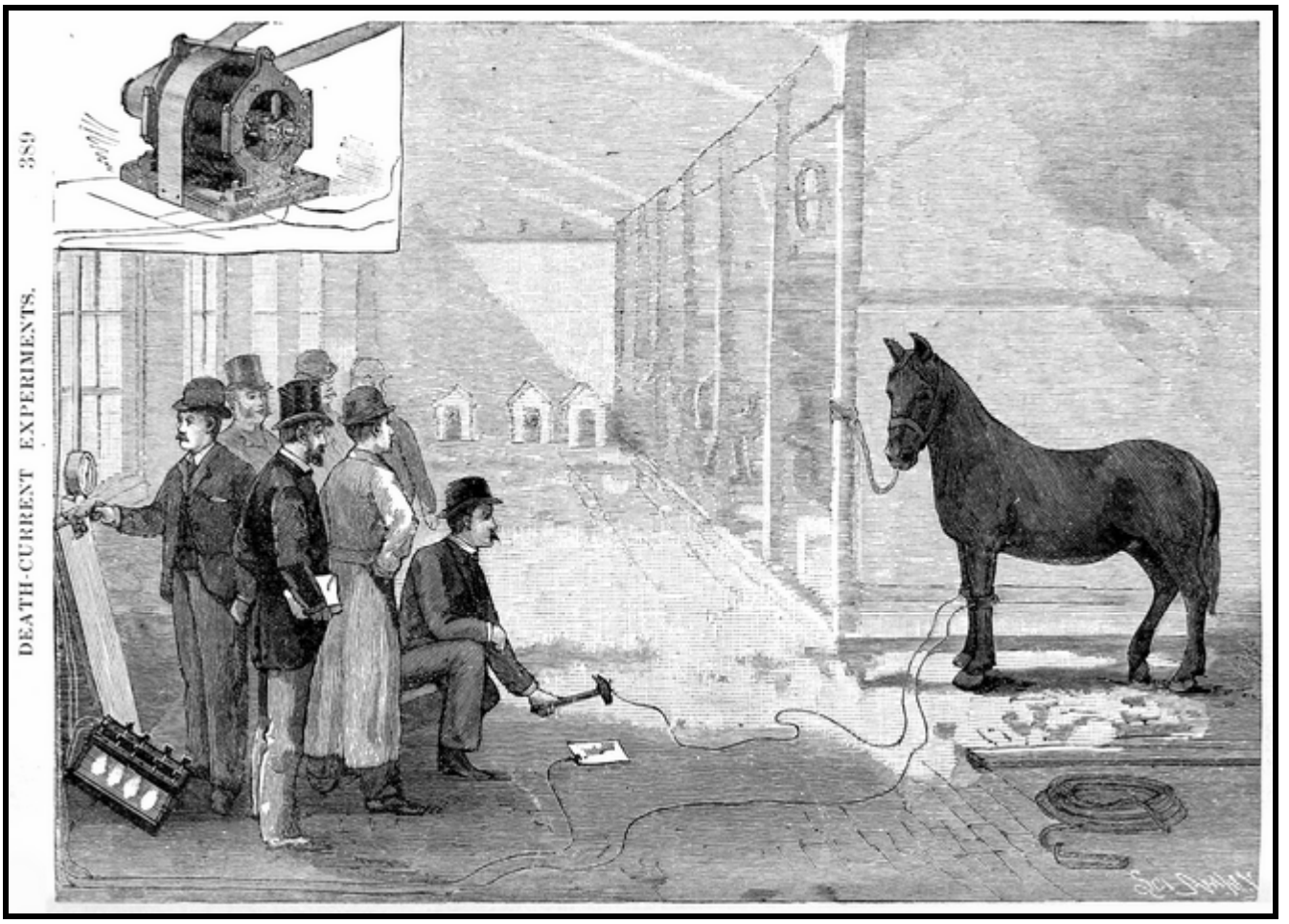
ENTER NIKOLA TESLA: AC versus DC, THE BATTLE OF THE CURRENTS

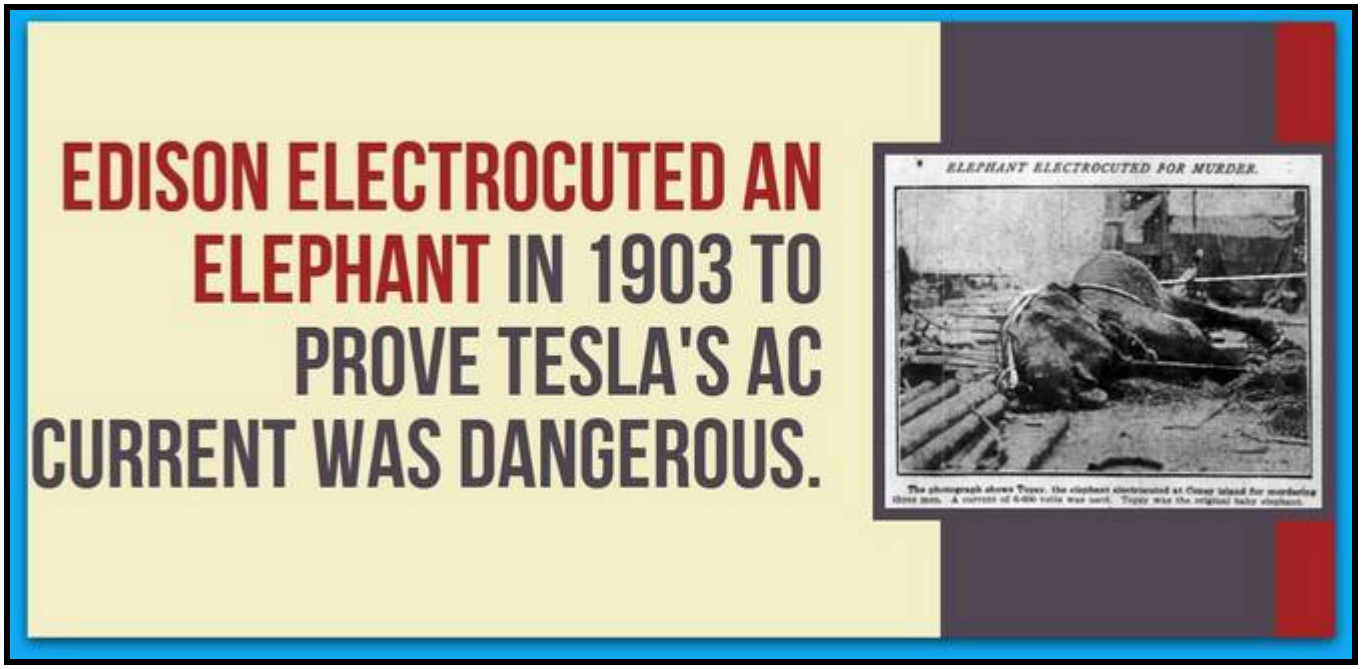
Nikola Tesla 1856-1943, took up American Citizenship in 1891

Alternating current was produced by the Frenchman Pixii in 1832 based on the principles set out by Michael Faraday. Other early researchers include Duchenne (1855) and Sebastian Ferranti who employed his alternating current systems at London's Grosvenor Gallery Power Station in the 1880s. In Hungary, the Ganz factory and ZDB developed high efficiency AC transformers and in 1886 installed a steam-powered AC power station in Rome. However, the widescale introduction of alternating current was due largely to Nikola Tesla and George Westinghouse in the United States.

Tesla was born on the 10th July 1856 in Serbia and gained experience in electrical engineering before emigrating to the United States in 1884 and working for Thomas Edison in New York City. Edison refused to accept new ideas and, probably because of his poor understanding of mathematics, could not fully comprehend the workings of the alternating current system. It appears that after Tesla was not given a promised bonus he resigned, which turned out to be a big mistake on Edison's part.

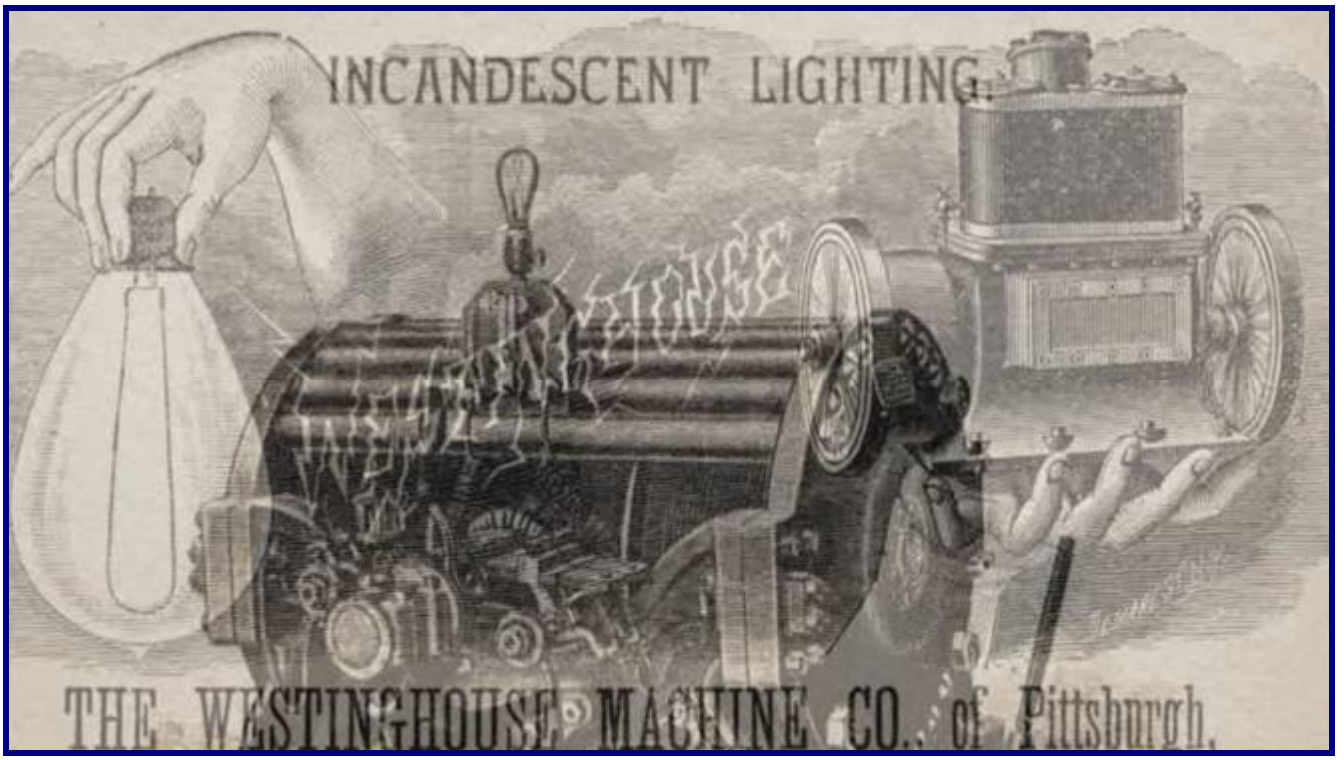
George Westinghouse, who made his fortune by inventing the railway air brake, saw the possibilities in alternating current systems and bought up Tesla's and various European patents and went into competition with Edison who waged a vitriolic campaign against AC. The battle ended in defeat for Edison since DC systems could only supply customers up to a mile from the power station while high voltage AC could be transmitted several hundred miles.



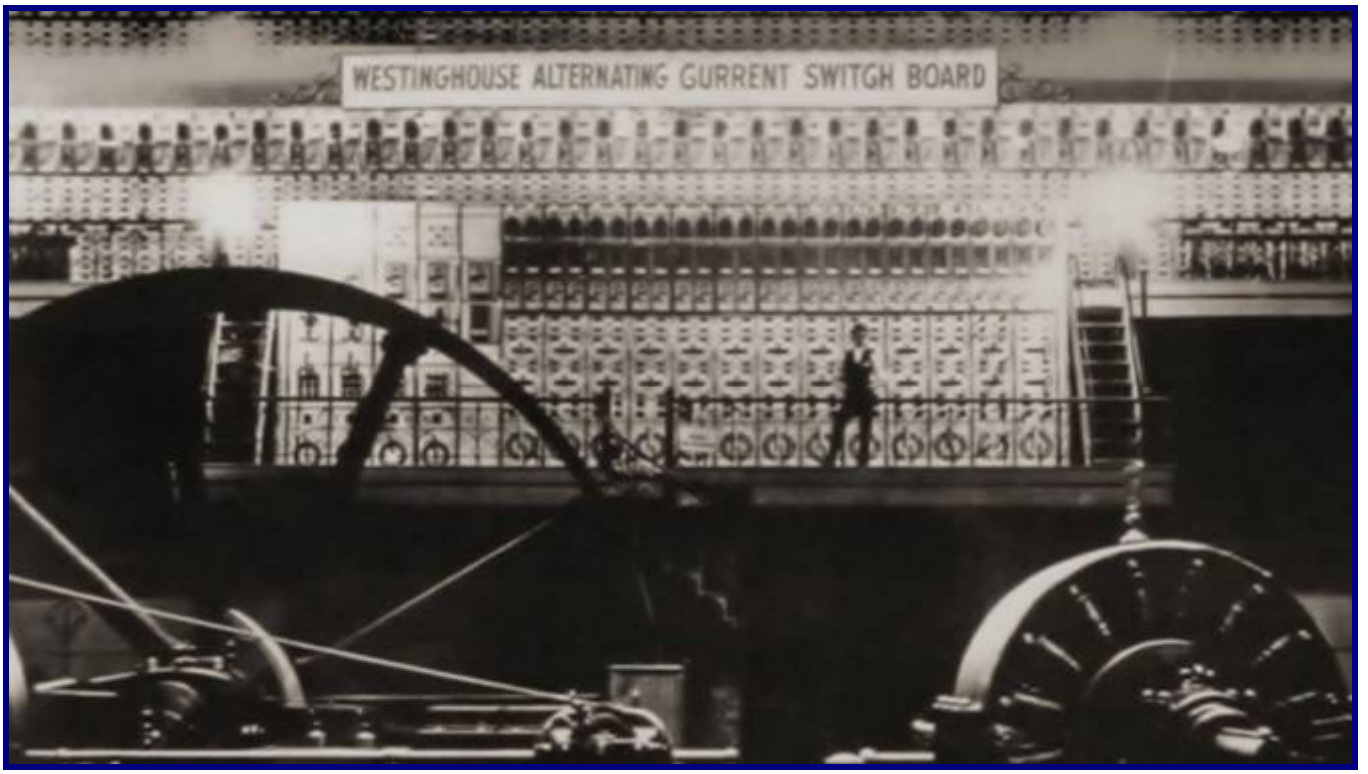


As part of his campaign against the introduction of the alternating current, Edison arranged demonstrations killing dogs, horses and even a rogue elephant by electrocution

George Westinghouse 1846-1914



The Westinghouse Electric & Manufacturing Company (later Westinghouse Electric Corporation) was founded in 1886



Westinghouse demonstrated his AC system at the Chicago World's Fair in 1893

The success of AC was assured when in 1896 the Niagara Falls hydroelectric power station went on-line with the first four of ten Tesla-Westinghouse 5000 horsepower generators providing 3-phase distribution lines to Buffalo, some 22 miles away

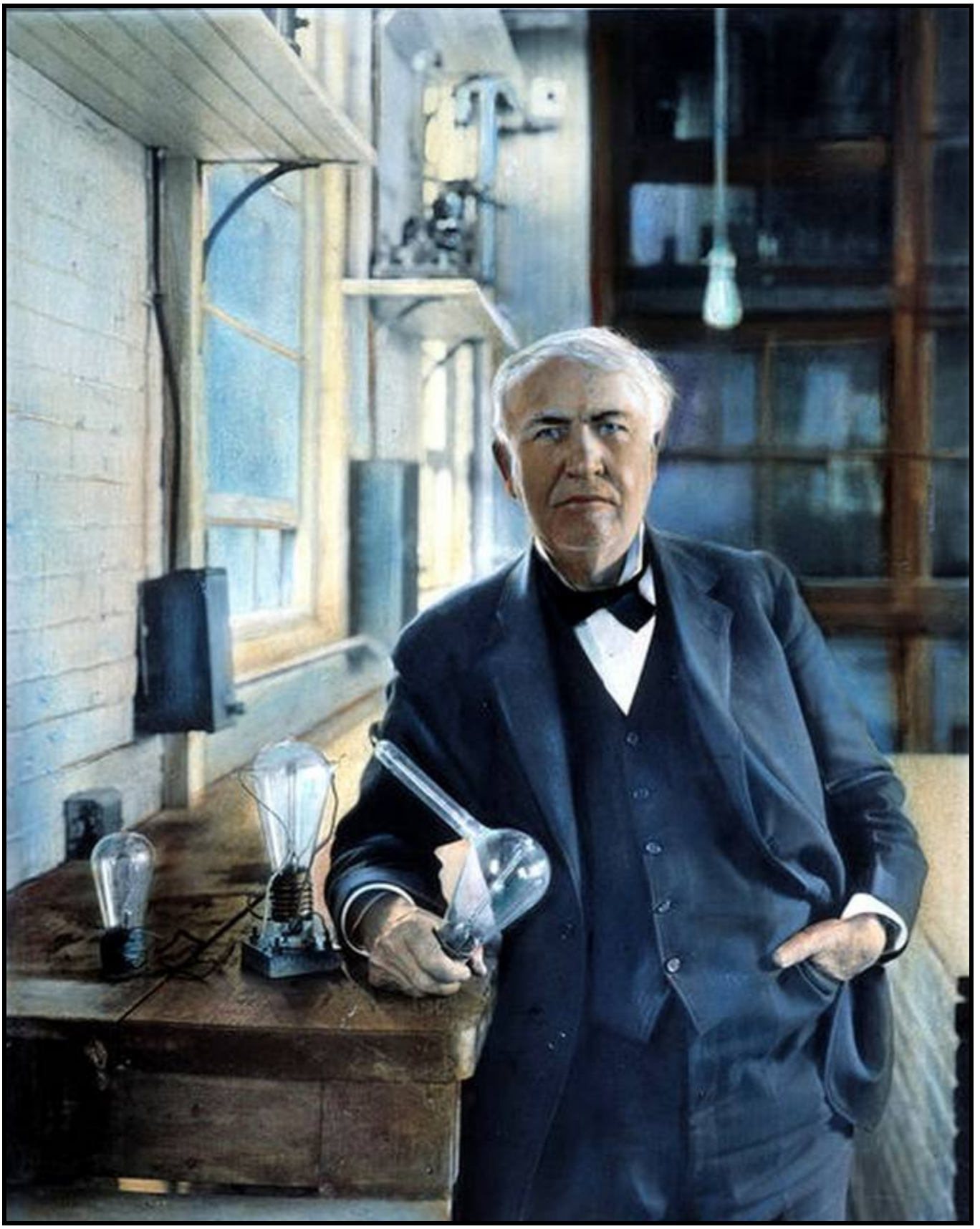
The Westinghouse Company and Thomson-Houston (with a Westinghouse licence) built more and more AC power stations. Edison's financial backers urged him to convert to AC but he refused. So they merged the Edison Company with Thomson-Houston and the General Electric Company was established in 1892.

Edison’s first wife, Mary Stilwell 1855-84

Edison’s second wife, Mina Miller 1865-1947

Having lost interest in electric lighting, Edison spent the next ten years and two million dollars of his own money devising a process for the crushing of low grade iron ore from boulders to small particles and then using a magnetic separation process. It failed financially when large deposits of high grade ore were discovered elsewhere in the United States.

Edison lying in state at his West Orange Research Laboratory



This Room Is Equipped With

Edison Electric Light.

Do not attempt to light with match. Simply turn key on wall by the door.

The use of Electricity for lighting is in no way harmful to health, nor does it affect the soundness of sleep.

APPENDIX: EDISON'S EARLY LAMP PATENTS

T. A. EDISON.
Electric-Lights.

No. 214,636. Patented April 22, 1879.

Fig. 1.

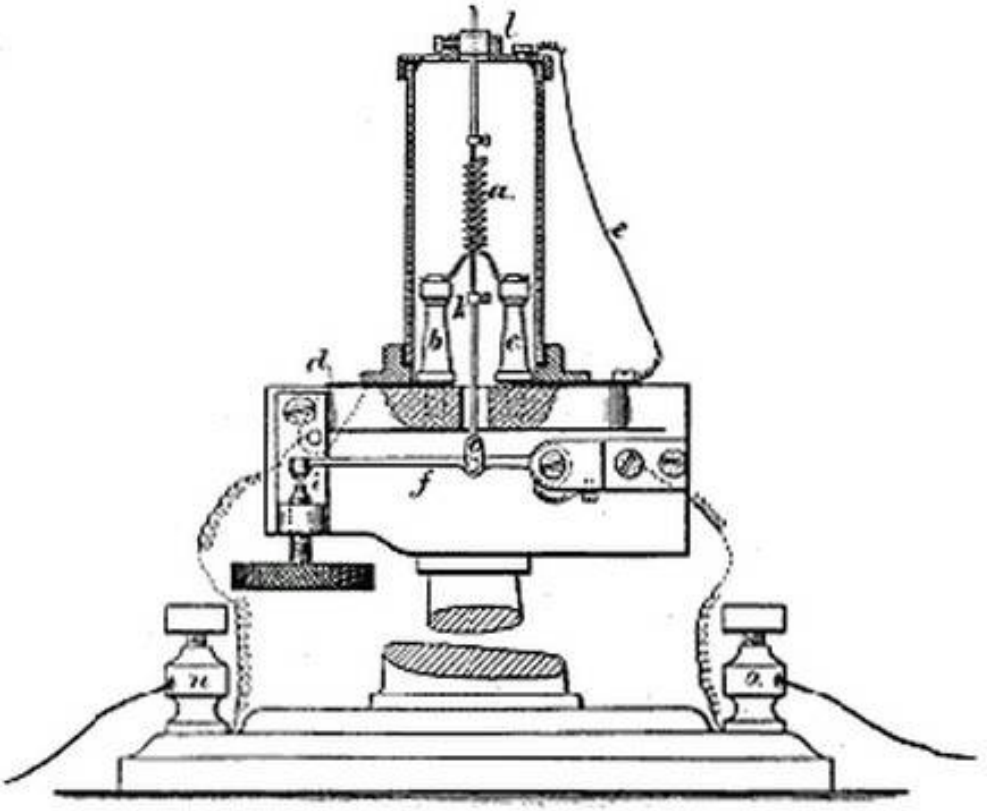
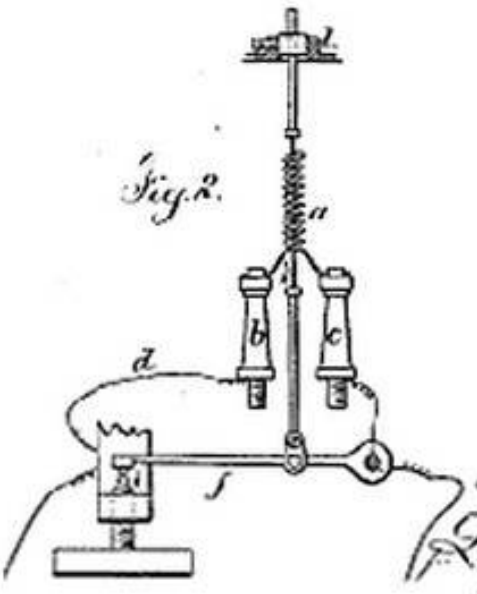


Fig. 2.



Witnesses
Chas. H. Smith
Fred. P. Fish

Inventor
Thomas A. Edison
Samuel W. Sewall

T. A. EDISON.
Electric-Light.

No. 219,628. Patented Sept. 16, 1879.

Fig. 1.

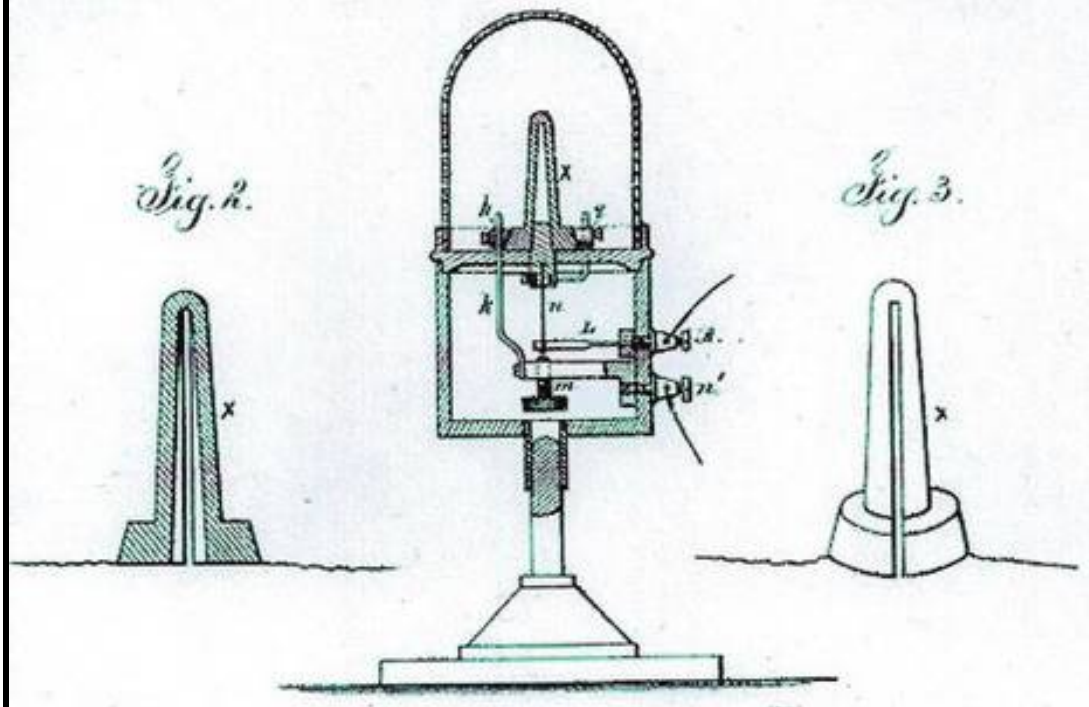
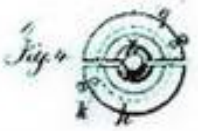


Fig. 2.

Fig. 3.

Fig. 4.



Witnesses

Chas. H. Smith
Geo. J. Pinckney

Inventor

Thomas A. Edison.

per Lemuel W. Serrell

atty

T. A. EDISON.
Electric-Lights.

No. 227,227. Patented May 4, 1880.

Fig. 1.

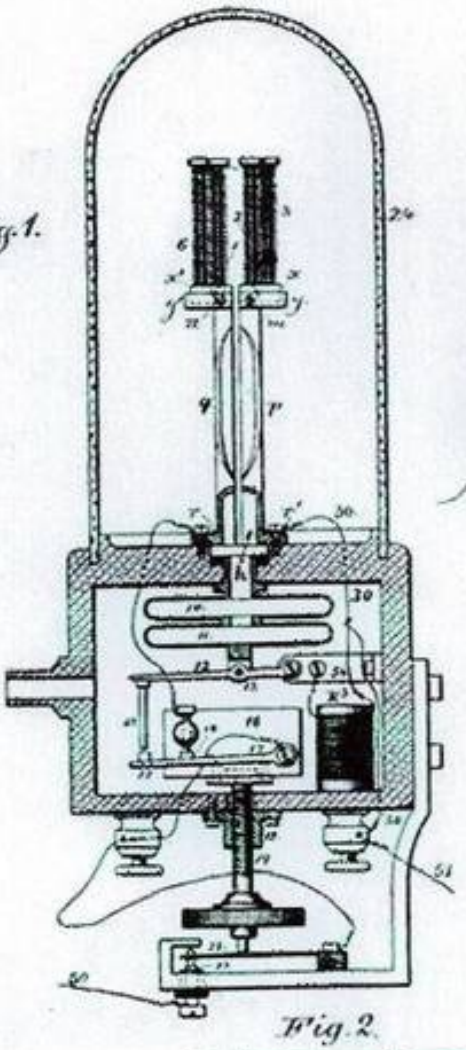


Fig. 3.

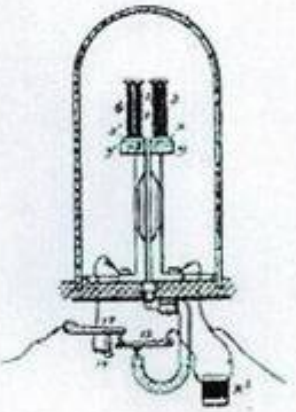
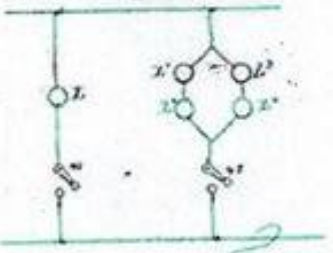


Fig. 4.

Case No. 179.

Fig. 2.



Witnesses
Chas. H. Smith.
Geo. T. Pinckney

Inventor
Thomas A. Edison
per Lemuel W. Serrell
atty.

T. A. EDISON.

Electric-Lamp.

No. 223,898. Patented Jan. 27, 1880.

Fig 1

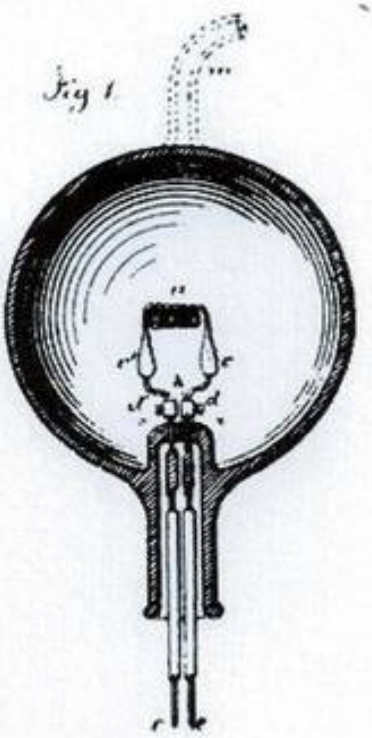


Fig 2

Fig 3

Witnesses

Chas. H. Smith

Geo. D. Pinckney

Inventor

Thomas A. Edison

per Lemuel W. Serrell

atty.

T. A. EDISON.

Electric-Lighting Apparatus.

No. 224,329. Patented Feb. 10, 1880.

Fig. 1.

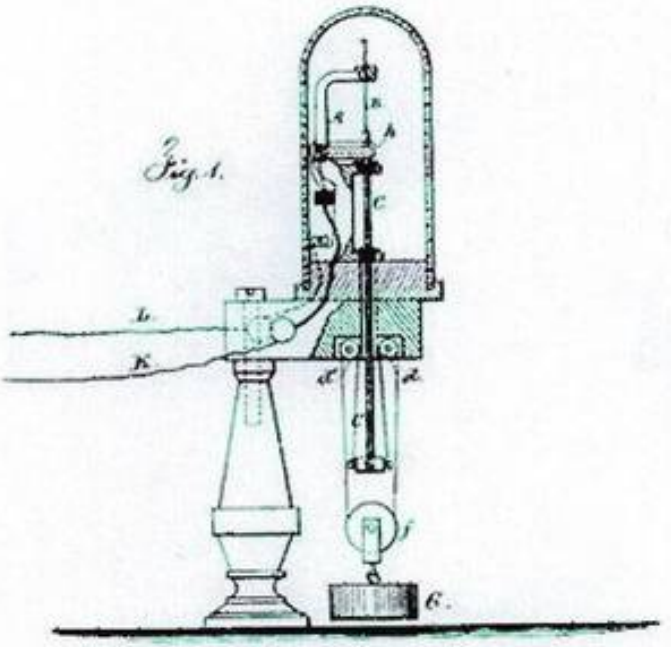


Fig. 3.

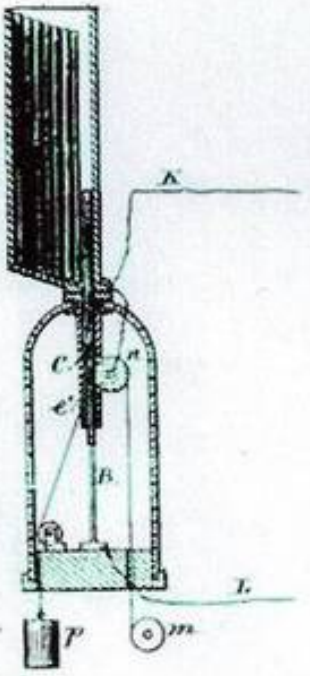
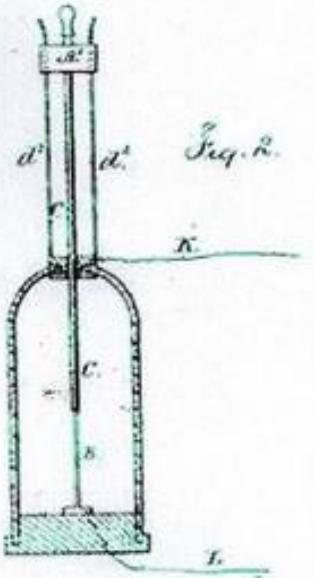


Fig. 2.



Witnesses

Chas. H. Smith

Geo. T. Pinckney

Inventor

Thomas A. Edison

for Samuel W. Gerrell atty

(No Model.)

T. A. EDISON.

Incandescing Electric Lamp.

No. 239.149. Patented March 22, 1881.

Fig. 1.

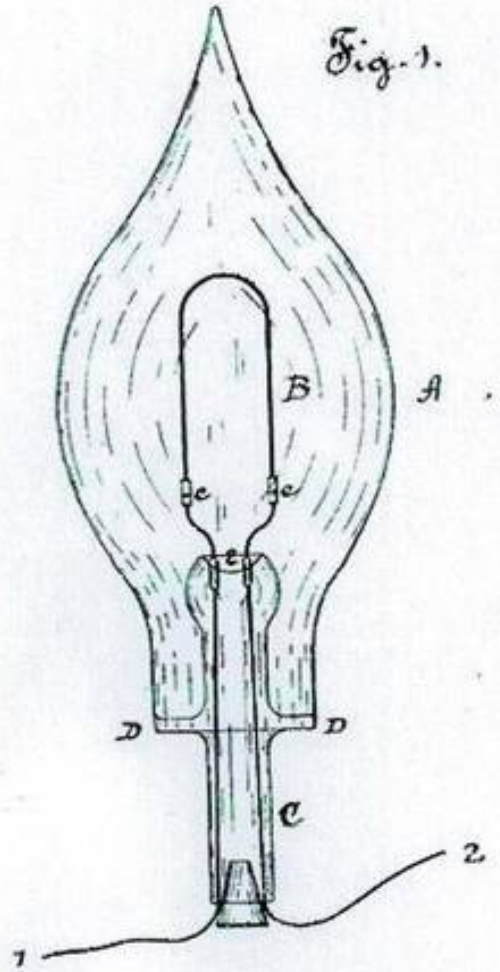
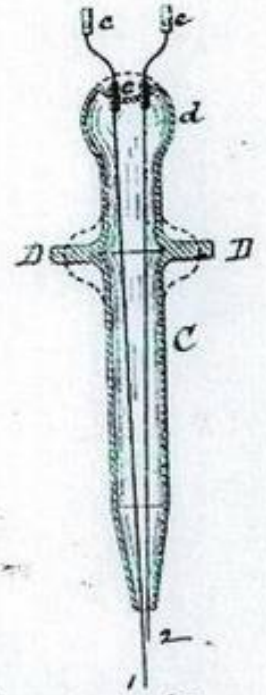


Fig. 2.



Attest:

O. D. Mott

E. H. Howard

Inventor:

Thos. A. Edison

per Dyer & Wilber

Attys.

(No Model.)

T. A. EDISON.

LAMP BASE.

No. 438,310. Patented Oct. 14, 1890.

Fig. 1.

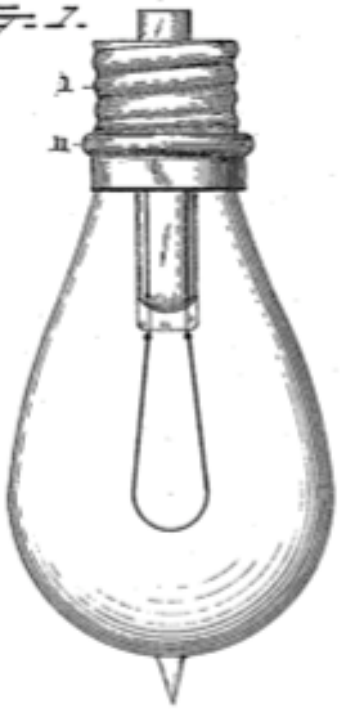


Fig. 2.

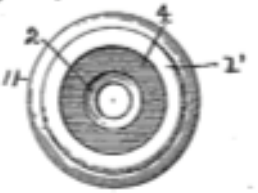


Fig. 3.

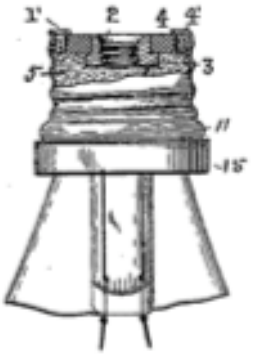


Fig. 4.

Fig. 5.

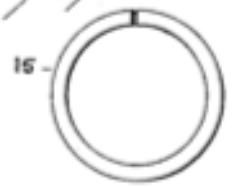


Fig. 6.

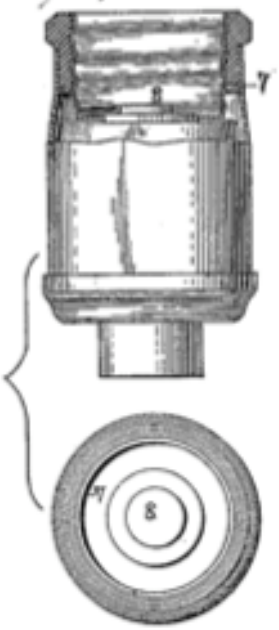


Fig. 7.

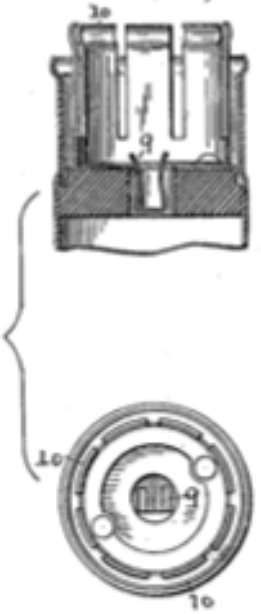
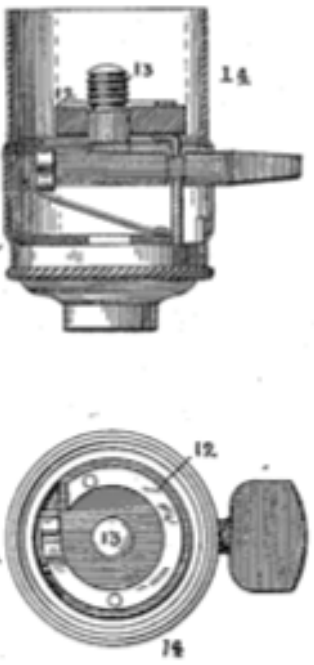


Fig. 8.



Witnesses
Norris A. Clark.
Charles M. Catlin.

Inventor
By his Attorneys T. A. Edison.
Dyer & Seely.

BIBLIOGRAPHY

1927 *History of the Incandescent Lamp* (reprint), John W Howell, Forgotten Books, California

1929 *Edison's Electric Light*, A Collectors Reprint of the 1929 Book Commemorating THE GOLDEN ANNIVERSARY of Edison's Incandescent Lamp, National Electric Light Association, USA

------ *T A Edison*, US Patent Office Records

------ *The Pageant of the Lamp (The Story of the Electric Lamp):* The Edison Swan Electric Company Ltd, London (undated)

------ *A History of Electricity*, Edward Tatnall Canby, (from the Swiss), Third British Edition, Leisure Arts, London (undated)

------ *Joseph Swan 1828-1914 (A Pictorial Account of a North Eastern Scientist' Life and Work),* Diane Clouth, Gateshead Metropolitan Borough Council, Department of Education (undated)

1969 *R E B Crompton (An Account of his Electrical Work),* Brian Bowers, Science Museum, HMSO, London

1970 *John Hopkinson (Electrical Engineer),* James Greig, Science Museum, HMSO, London

1973 *Victorian Inventions*, Leonard de Vries, (from the Dutch), *Electricity*, pp. 86-105, John Murray, London

1976 *Thomas Edison Professional Inventor*, Thomas P Hughes, Science Museum, HMSO, London

1978 *J W Swan and the Invention of the Incandescent Lamp*, C N Brown, *Swan's Knowledge of Edison's Work,* pp. 25-31, Science Museum, London

1979 *Seizing the Moment (Age of the Inventor-Entrepreneur)*, EPRI Journal, Electric Power Research Institute, pp.11-29, Palo Alto, California, March (100th Anniversary of Edison's Invention)

1979 *Machines: An Illustrated History*, Sigvard Strandh, Chapter 6 *Prime Movers*, AB Nordbok, Gothenburg, Sweden

1979 *Electric Lamps- 100 Years On*, Cyril Phillips, Thorn Lighting, London

1979 *Edison Lamp Centenary*, Joh Jansen, International Lighting Review, Vol. 20, No. 1, Amsterdam

1982 *The Electricity of Holborn*, Jack Harris, New Scientist, Vol. 93, No. 1288, pp. 88-90, 14 Jan. 1982, London

1989 *The Macmillan Dictionary of Biography*, Barry Owen Jones & M Vibart Dixon, *Edison, Thomas Alva (1847-1931),* page 266, PAPERMAC, London

1991 *Domestic Engineering at Cragside*, Geoffrey A Irlam (reprint of two papers by the author), The Association for Industrial Archaeology, Telford

1997 *The Quest for Comfort*, Brian Roberts, *Electric Lighting*, pp. 59-67, CIBSE (Chartered Institution of Building Services Engineers) Centenary Publication, London

1999 *Tesla: Master of Lighting*, Margaret Cheney & Robert Uth, Metro Books, USA

2007 *The Wizard of Menlo Park; How Thomas Edison Invented the Modern World*, Randall E Stross, Three Rivers Press, California (reprint)

2011 *Edison's Pearl Street Station Recognised with Milestone (IEEE honours the world's first central power station),* Ania Monaco, e-magazine The Institute, USA, 27 July

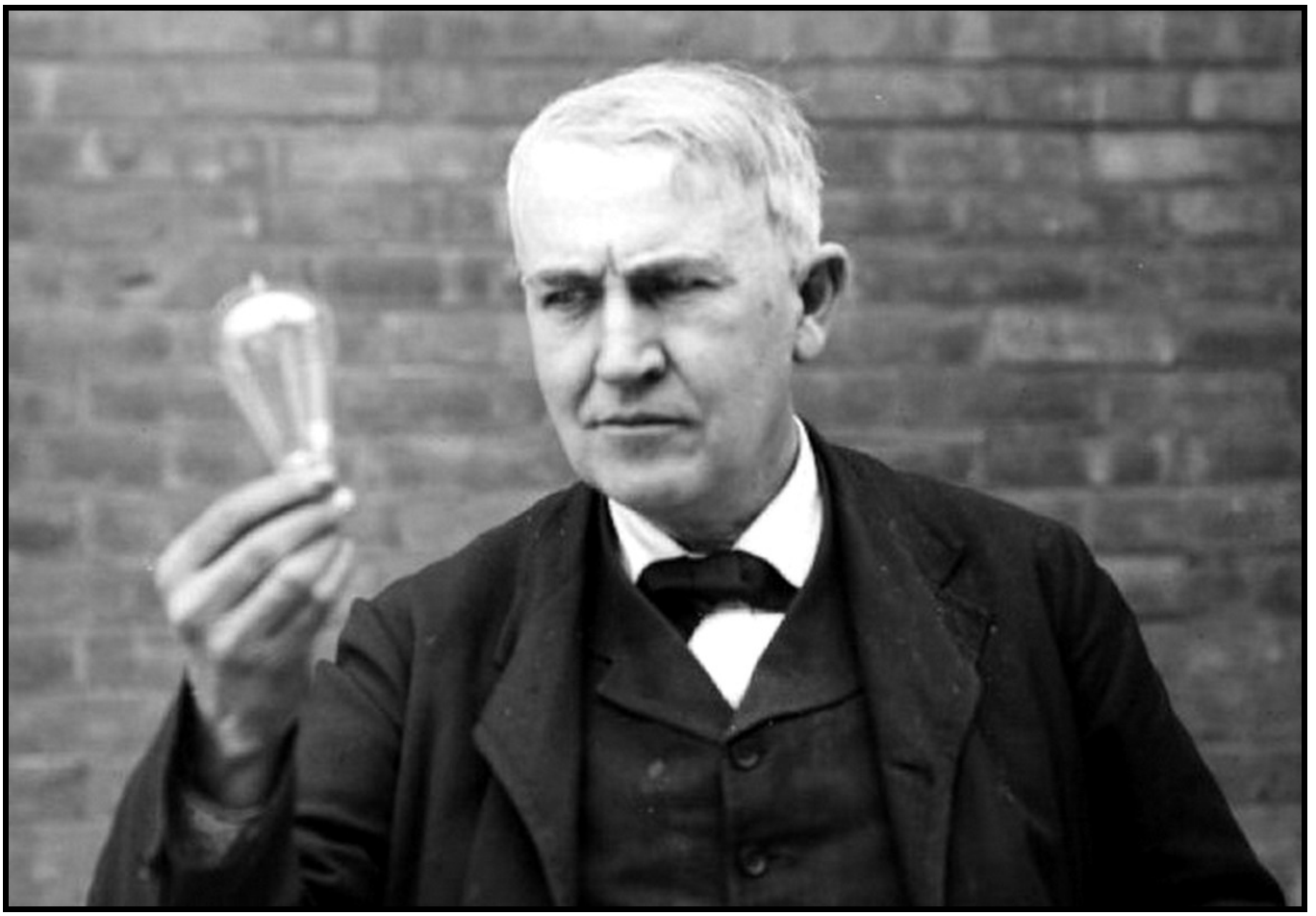
2015 *Edison: the Father of Invention*, a DVD by PBS (Public Broadcasting Service) America
Available in Region 2, PAL format

http://edison.rutgers.edu/bio-long.htm *The Thomas Edison Papers, Detailed Biography*, Rutgers University, USA

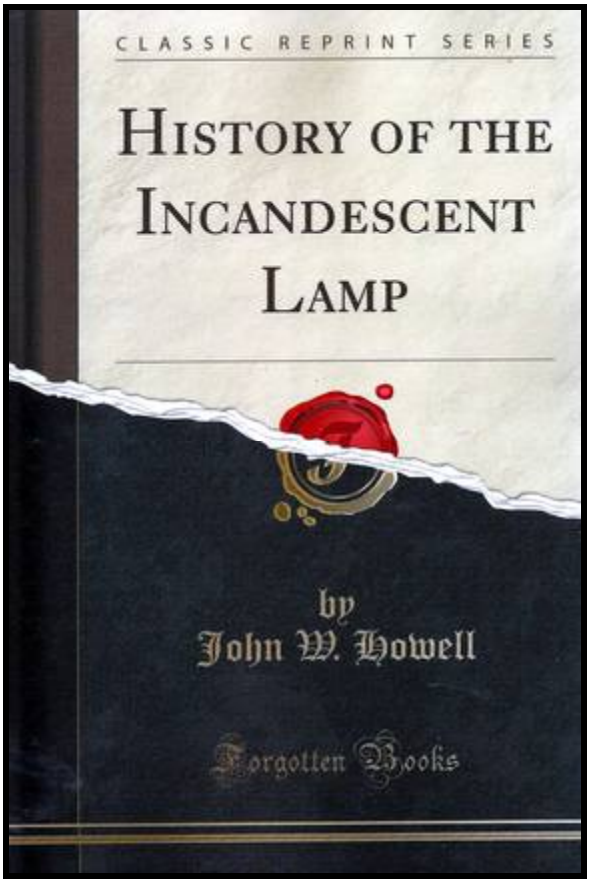
http://edison.rutgers.edu/list#Lightdom *The Thomas Edison Papers, Electric Light Domestic & Foreign*, (List of Edison Companies), Rutgers University, USA

Note: Also available are *The Papers of Thomas A Edison* in 8 giant volumes (to date) compiled by Rutgers University and published by John Hopkins University Press, USA

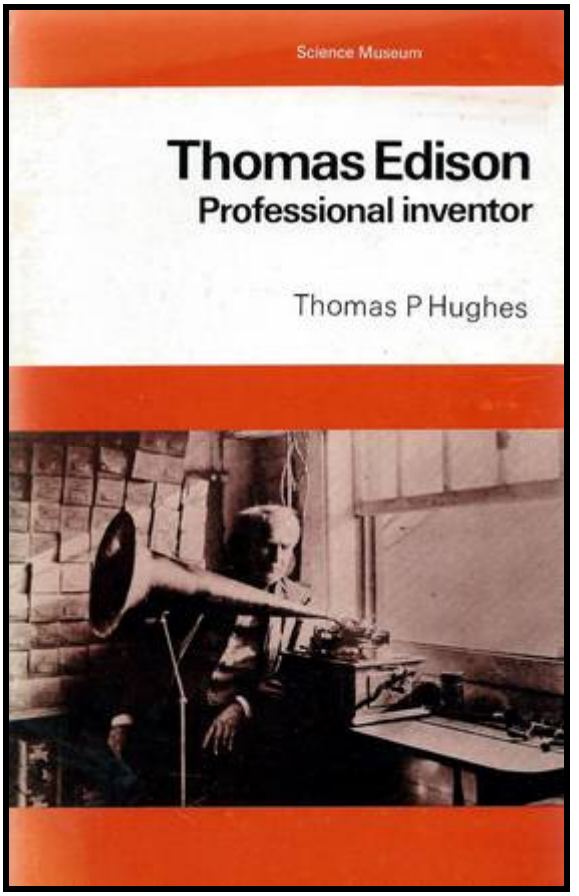
A complete listing of Edison's US Patents with Drawings is available on the internet



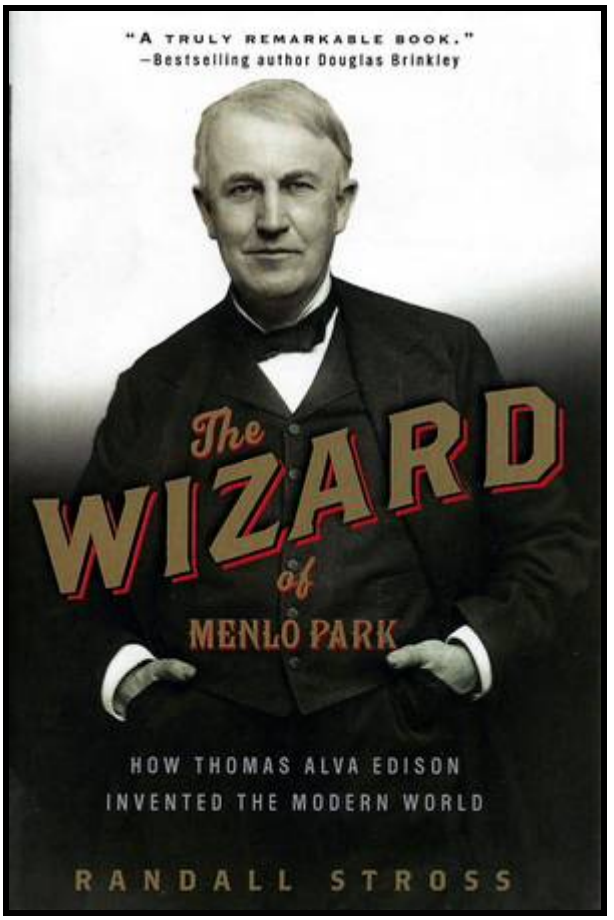
POSTSCRIPT: FURTHER READING and VIEWING



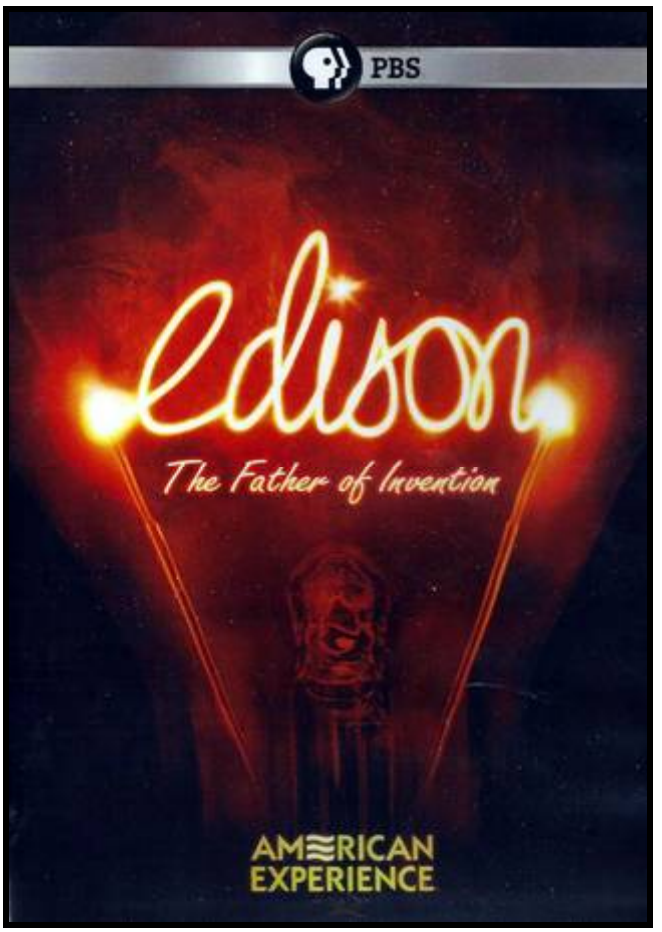
1927



1976



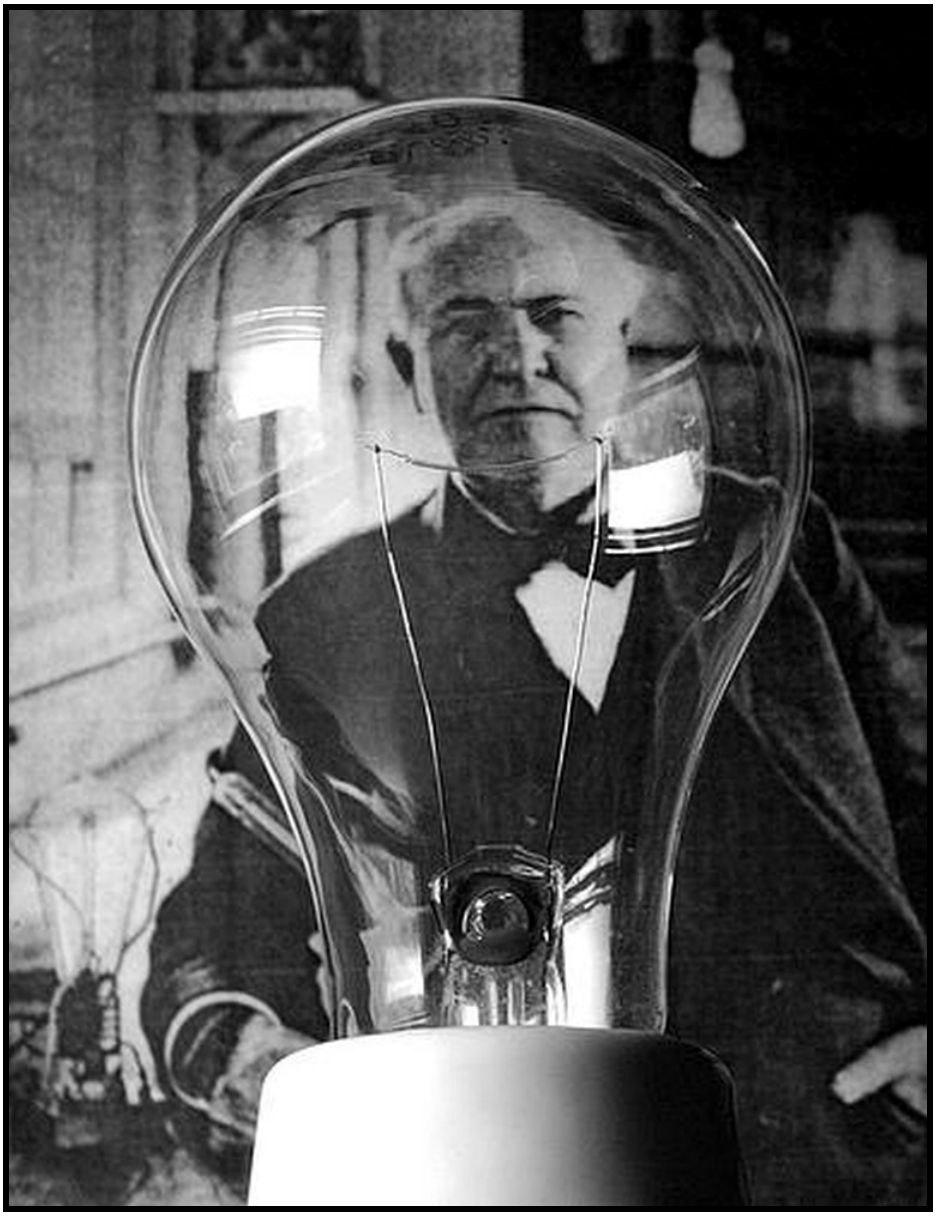
2007



2015 DVD

EPILOGUE

It appears that Edison saw out his days as a celebrity and elder statesman being feted wherever he went. He died in 1931 and one evening, shortly afterwards, the lights in New York were switched off for a few minutes to honour his memory.



Thomas Alva Edison's accomplishments were many. With his research laboratories at Menlo Park and later West Orange he secured 2332 patents world-wide with 1093 being in the United States. Companies in his name were established around the world.

In addition to a practical incandescent lamp and the associated power station and distribution network, he was responsible for improved telegraph apparatus, the phonograph, kinetoscope (a system of moving pictures) and the dictaphone.