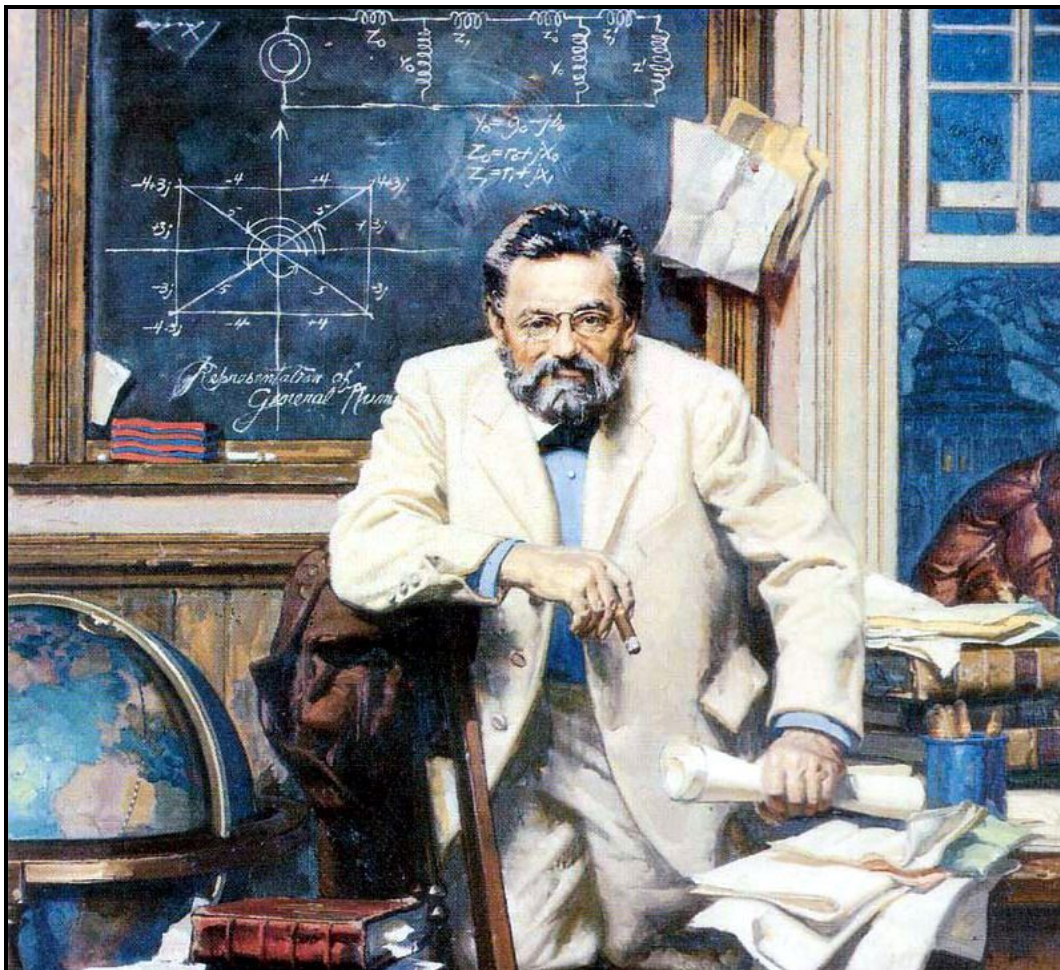


CHARLES PROTEUS STEINMETZ PIONEER OF ALTERNATING CURRENT

by Brian Roberts, CIBSE Heritage Group



Charles Proteus Steinmetz, 1865-1923

Steinmetz was born Karl August Rudolph Steinmetz on the 9th April, 1865, in Breslau, Province of Silesia, Prussia, (now Wroclaw, the largest city in western Poland), the son of Caroline (Neubert) and Karl Heinrich Steinmetz. He suffered from dwarfism, hunchback and hip dysplasia (abnormal growth) as did his father and grandfather. He attended the Johannes Gymnasium and astonished his teachers with his proficiency in mathematics and physics, then going to the University of Breslau in 1883.



The main square in Breslau in the 1890s

While on the verge of completing his doctorate in 1888, Steinmetz came under investigation by the German police for his socialist university group activities and articles he had written for a local socialist newspaper. (Later, it was claimed he was behind with his studies and unhappy at home). He fled to Zurich to escape possible arrest, but with his visa due to expire, in 1889, he emigrated to the United States. There, to sound more American, he changed his first name to Charles and chose Proteus (from the *Odyssey*) as his middle name.

Steinmetz went to work for Rudolf Eickemeyer in Yonkers, New York, an engineer who developed transformers and provided the electric motors for the first Otis electric elevators. In 1892, Steinmetz published a ground-breaking paper on *magnetic hysteresis** which gave him world-wide professional recognition.

{ Hysteresis in a ferromagnetic material is the lag in response of magnetic induction to changes of magnetic intensity, a phenomenon that causes a power loss in motors.}*

STEINMETZ PHOTO ALBUM

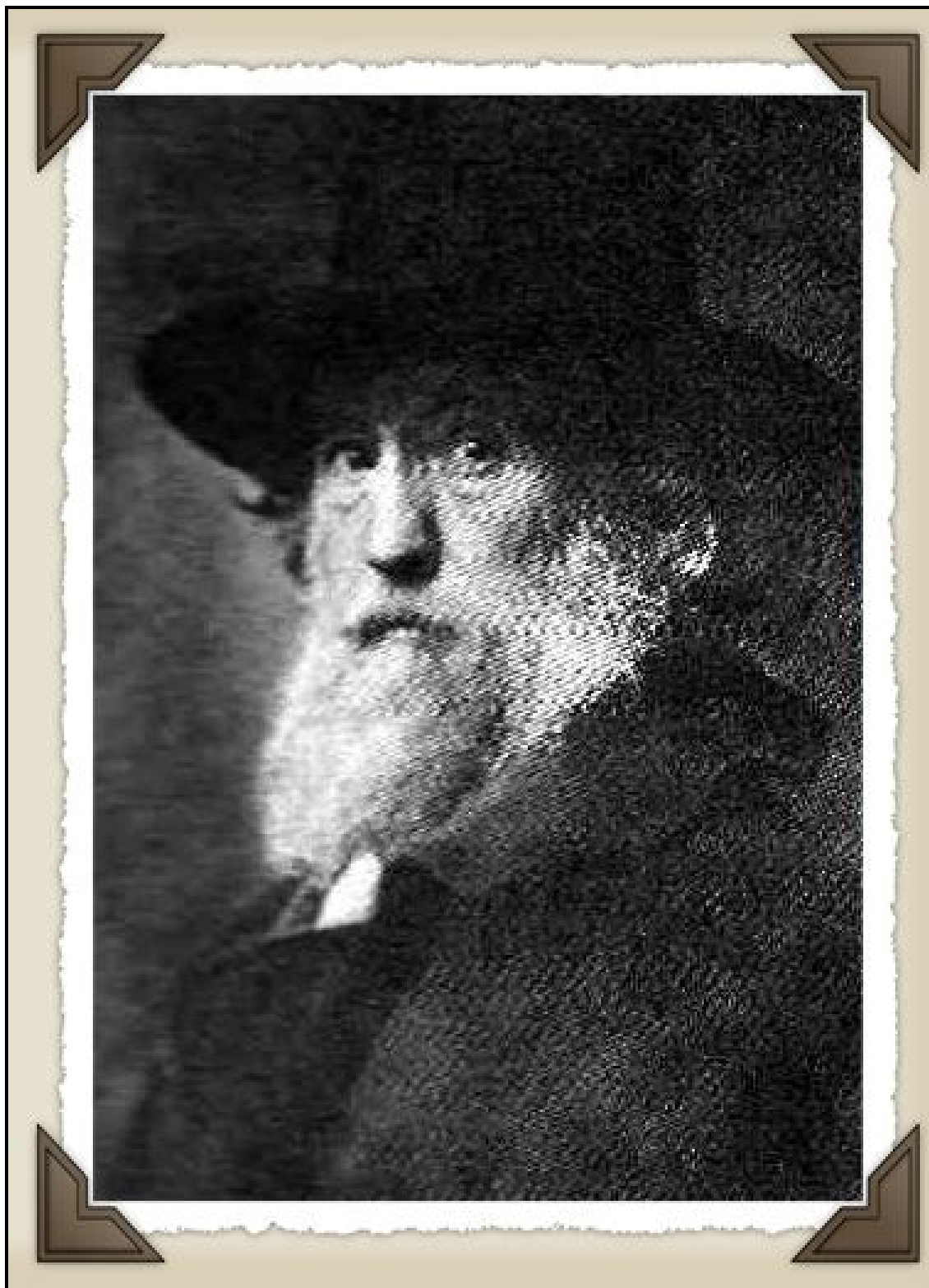


Steinmetz at the age of 3, with his grandmother



University of Breslau in the 19th century

STEINMETZ PHOTO ALBUM



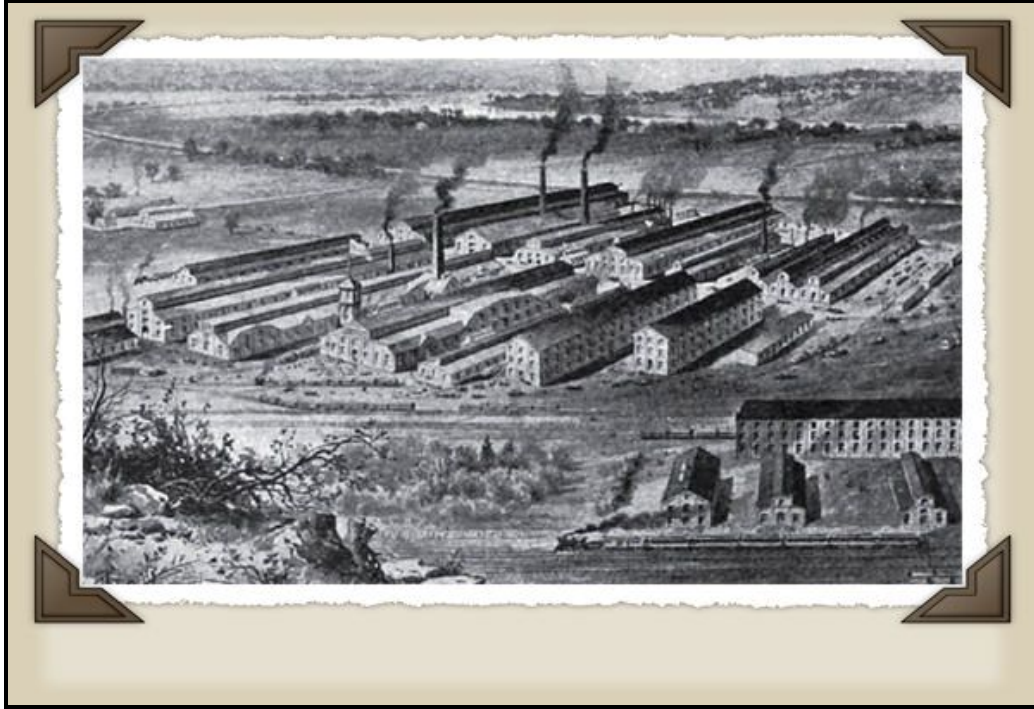
Rudolf Eickenmeyer, about 1890 (HHF)

STEINMETZ PHOTO ALBUM



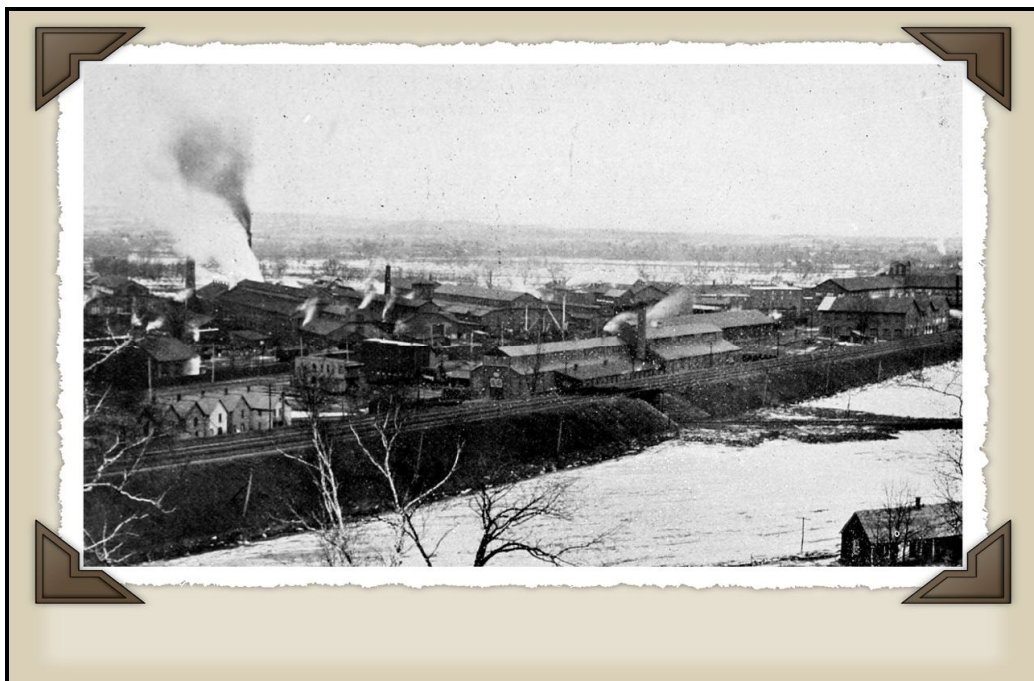
Steinmetz, about 1890 (HHF)

STEINMETZ PHOTO ALBUM



The Edison Works in Schenectady in 1892

In 1893, Eickemeyer's company, with all of its patents and designs, was bought by the newly formed General Electric Company who took over the Edison Company. Steinmetz, now working for GE, quickly became known as *the wizard* in GE's engineering community when he revolutionised AC circuit theory and analysis.



The General Electric Works in Schenectady in 1896

STEINMETZ PHOTO ALBUM



Charles Proteus Steinmetz

STEINMETZ PHOTO ALBUM



Steinmetz in a group that included Einstein, Tesla and Marconi, 1921



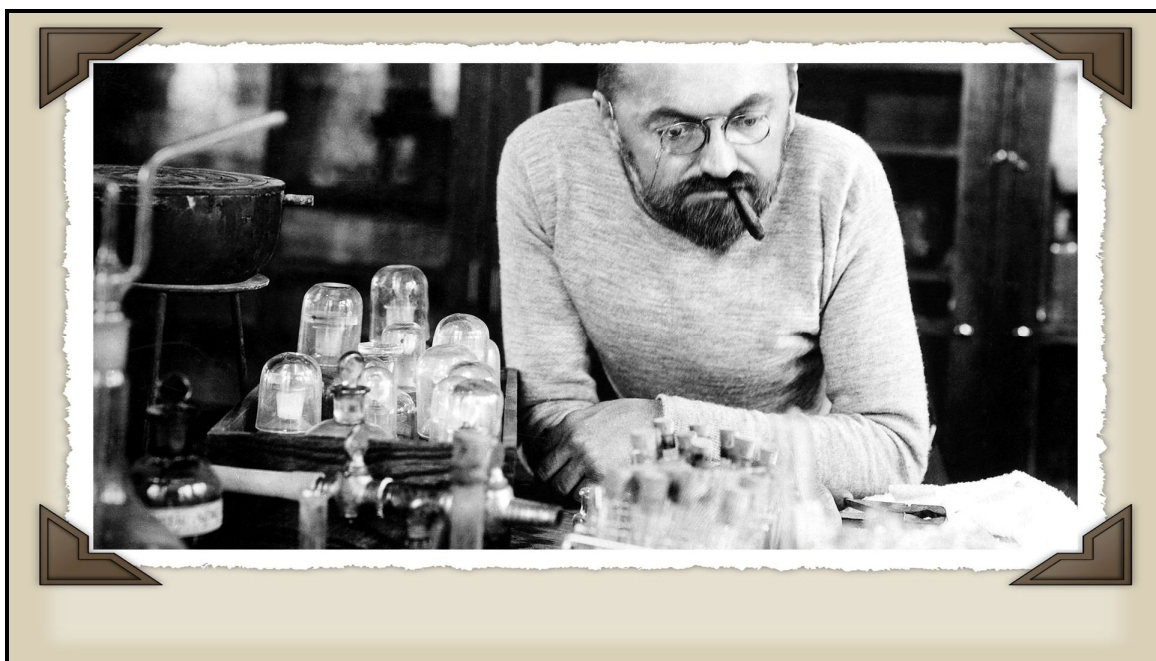
The ever-growing General Electric Factory complex

STEINMETZ PHOTO ALBUM



Steinmetz

STEINMETZ PHOTO ALBUM



Steinmetz in 1922, hard at work, chomping on the inevitable cigar (HHF)



Corinne Hayden, next to Steinmetz, with unidentified couple

STEINMETZ PHOTO ALBUM

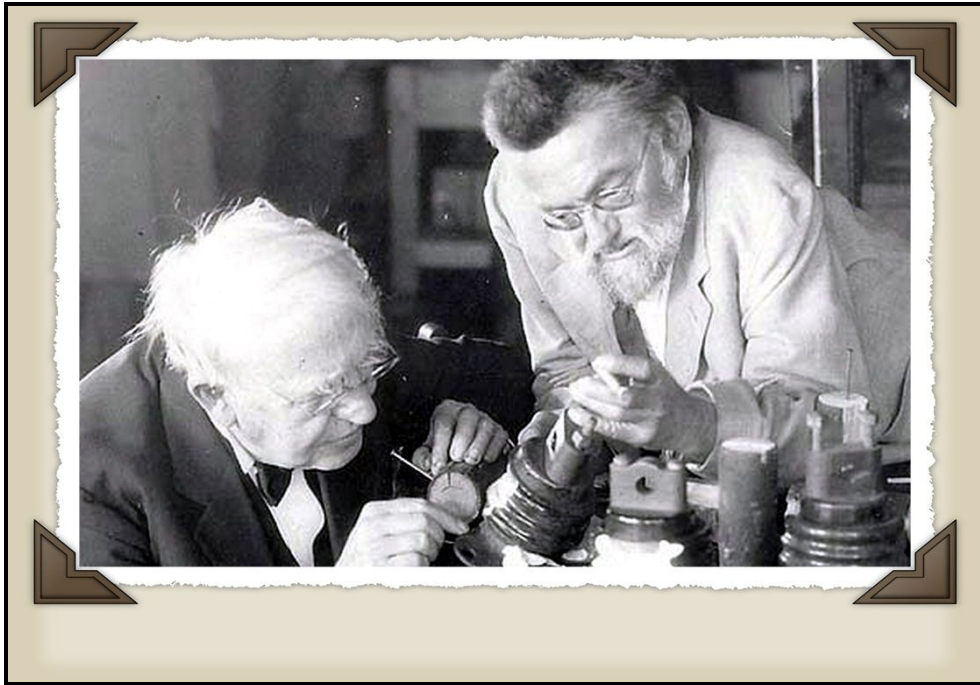


Steinmetz, who never married, legally adopted his laboratory assistant, Joseph Hayden, and finally had a son and soon a daughter-in-law and grandchildren



Steinmetz and family going motoring, 1914, in a Henry Ford electric car (HHF)

STEINMETZ PHOTO ALBUM



Edison and Steinmetz in 1922



The Steinmetz family

STEINMETZ PHOTO ALBUM



Steinmetz with Presidents of the American Institute of Electrical Engineers (AIEE)



Steinmetz in his "office" at Camp Mohawk, about 1929 (HHF)

EDISON AND THE GENERAL ELECTRIC COMPANY

Thomas Edison created not only a practical incandescent lamp, but developed an entire system of generation, distribution and control for a DC electrical network. However, the engineer Nikola Tesla invented an alternative AC electrical system. This had the important advantage of allowing long distance power transmission, not achievable with DC. Tesla had worked for Edison for a while and talked about the benefits of AC, but it seems that Edison could not or would not fully grasp the mathematical concepts. After a dispute, Tesla left and gained the backing of George Westinghouse to develop AC electricity,

Edison then waged a vitriolic campaign but, in the *battle of the currents*, Tesla and Westinghouse were the outright winners. Another company delivering AC systems was Thomson-Houston, but when Edison's financial backers suggested a possible merger, he stubbornly refused to have anything to do with AC. His backers redrew their support, Edison losing control of the Edison Company, which became the General Electric Company.

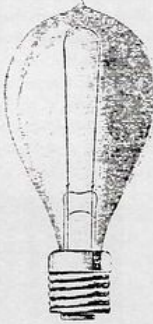
CASSELL'S **Electric Lamps** MAGAZINE

GENERAL ELECTRIC COMPANY,

44 BROAD ST., NEW YORK CITY. 620 ATLANTIC AVE., BOSTON, MASS.

THE EDISON INCANDESCENT LAMP

IS THE ONLY
LAWFULLY



INCANDESCENT LAMP
MADE.

The right of the
to an injunction
has been
by
U. S. Circuit

Edison Company
against infringers
determined
the
Court of Appeals.

ALL OTHERS INFRINGE THE EDISON PATENTS AND ARE COUNTERFEITS.

See decision of U. S. Court of Appeals in case of Edison Electric Light Company vs. United States Electric Light Company, decided October 4th, 1892.
See decision U. S. Circuit Court of Appeals, December 15, 1892, in case of Edison Electric Light Co. and Edison General Electric Co. against Sawyer-Mann Electric Co.
Copies of these decisions will be sent on application.

BRANCH OFFICES.

620 Atlantic Ave., Boston, Mass.	44 Broad Street, New York.
173 and 175 Adams Street, Chicago, Ill.	509 Arch Street, Philadelphia, Pa.
264 West Fourth Street, Cincinnati, O.	1333 F Street, N. W., Washington, D.C.
Gould Building, Atlanta, Ga.	401-407 Sibley Street, St. Paul, Minn.
15 First Street, San Francisco, Cal.	Masonic Temple, Denver, Colo.

GE continued to manufacture and promote the Edison lamp.

CHARLES PROTEUS STEINMETZ

Working at GE, Steinmetz was promoted to Head Engineer at the age of 29 and following his work on AC hysteresis, he turned his attention to AC steady state circuit theory. He revolutionised analysis which previously had been carried out using complicated, time consuming calculus-based methods. In 1893, at a meeting of the AIEE (American Institute of Electrical Engineers), he presented his paper, *Complex Quantities and Their Use in Electrical Engineering*; he simplified previous complicated methods to “a simple problem of algebra.”

His books and many AIEE technical papers “taught a whole generation of engineers how to deal with AC phenomena.”

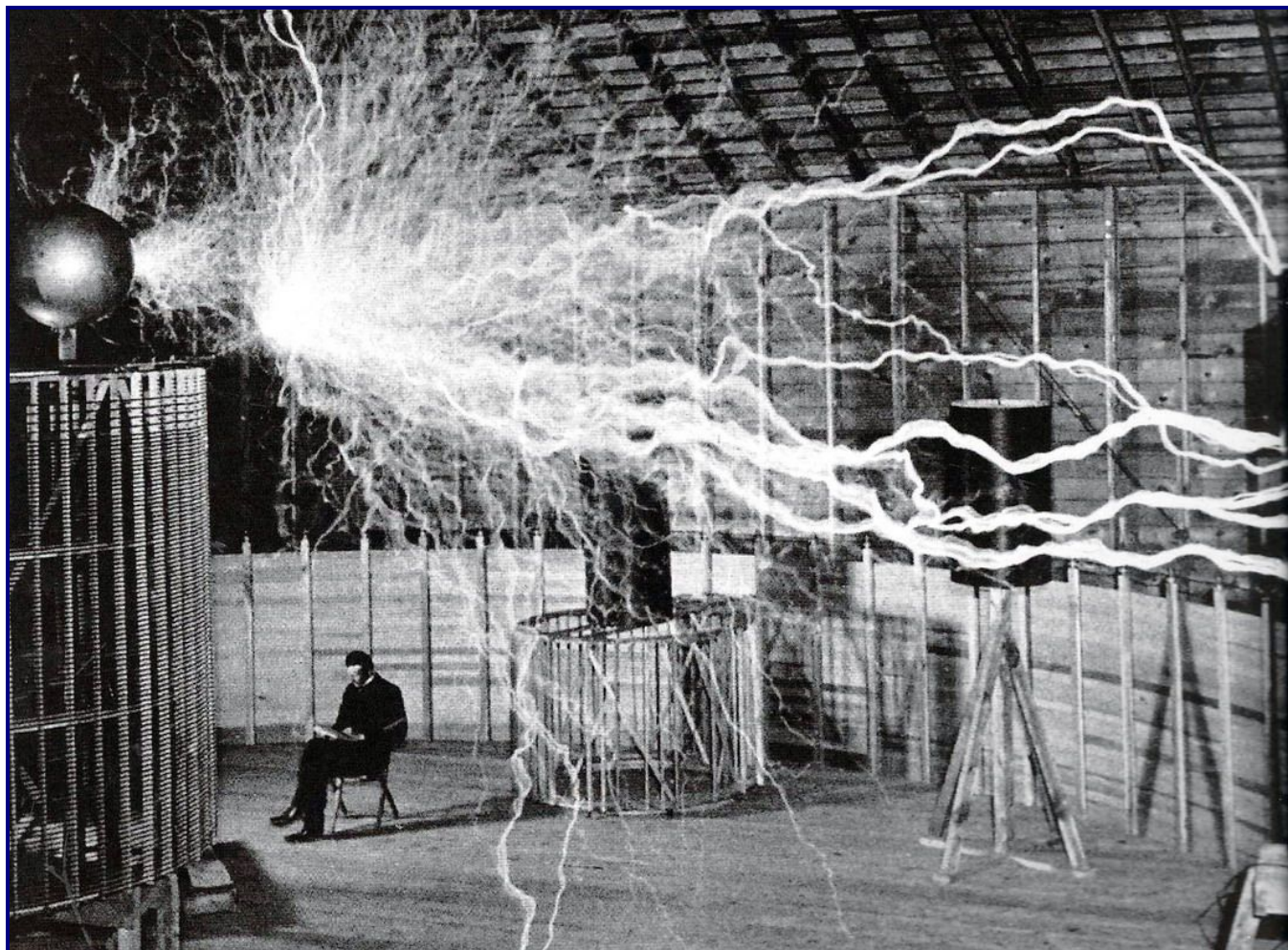


Steinmetz with a group of bright young engineers, recruited to GE

CHARLES PROTEUS STEINMETZ

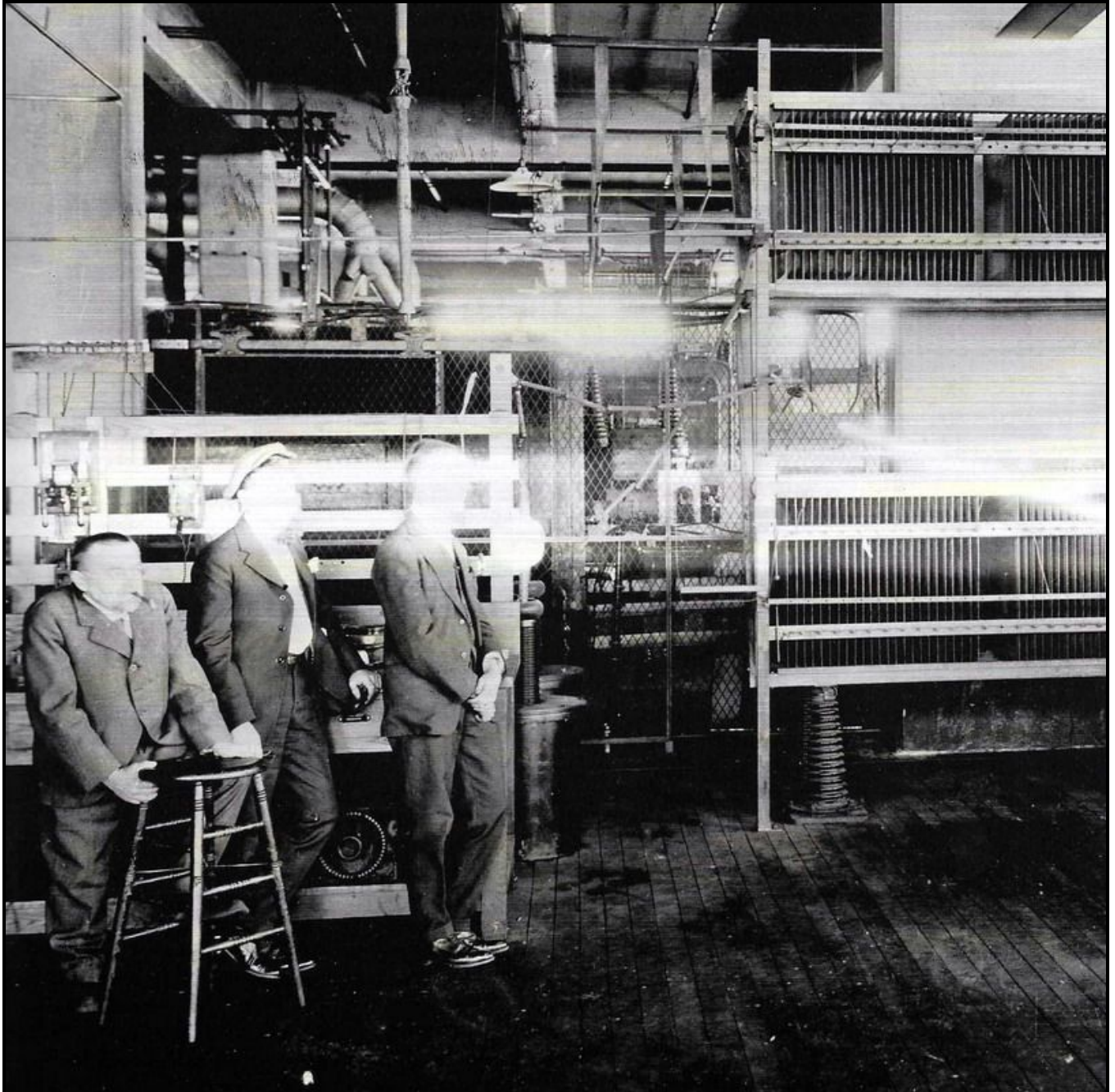
Steinmetz also researched AC transient theory, carrying out a systematic study of lightning phenomena from about 1907 until 1921, resulting in experiments in “man-made lightning” in his laboratory. For his work, Steinmetz was called the *Forger of Thunderbolts*.

Nikola Tesla, a more extrovert character, carried out similar lightning experiments which seem to have started in 1899 and for which he became known as the *Master of Lightning*. Both men used 100,000 volt plus generators and survived in spite of the inherent dangers.



Tesla sitting calmly in his laboratory in Colorado Springs while a million volts of electricity plays above his head in a lightning discharge some twenty-two feet in length

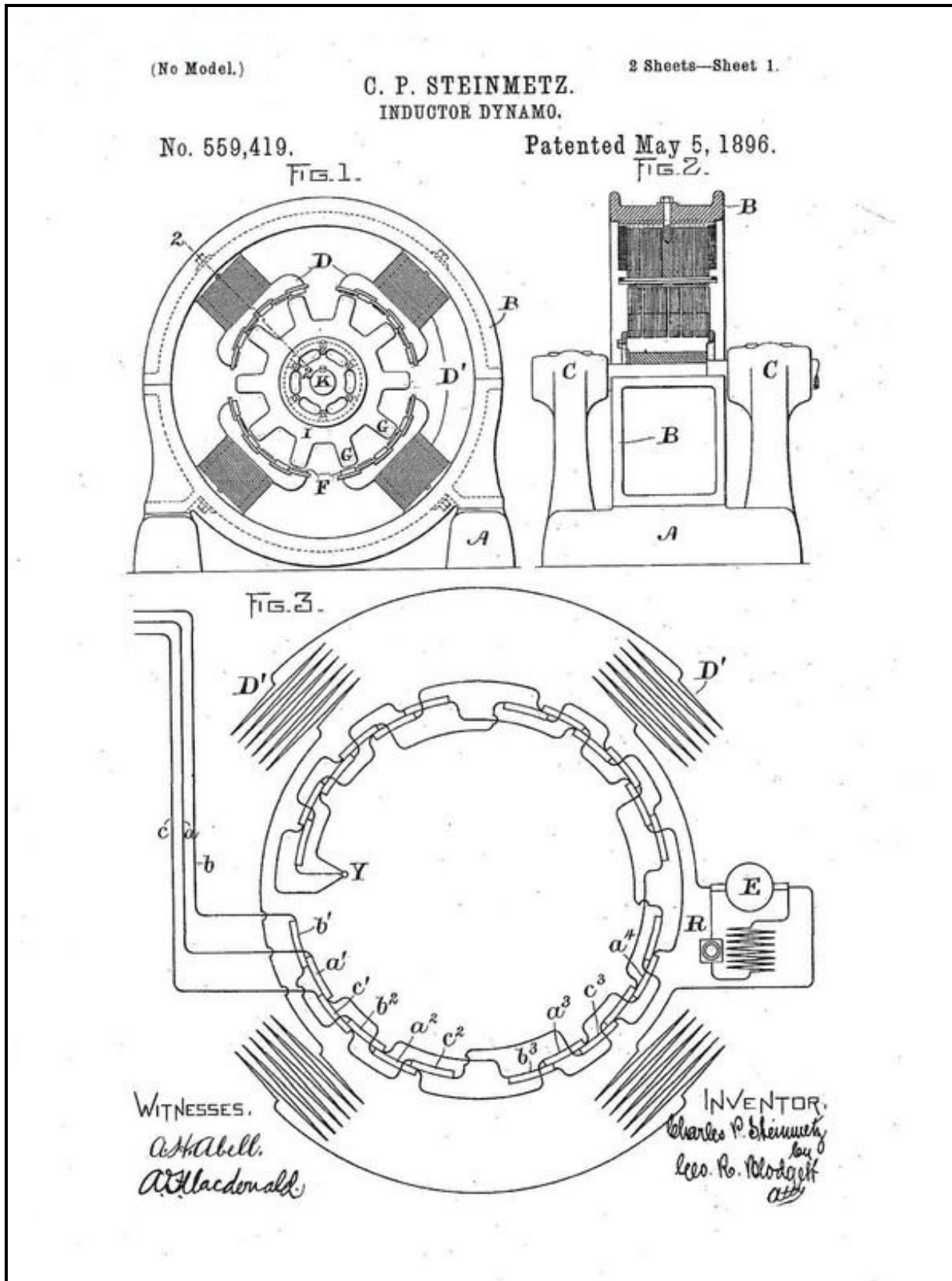
CHARLES PROTEUS STEINMETZ



Steinmetz in his laboratory, with two of his assistants, "surrounded by the incredible electrical machines of the early twentieth century"

APPENDIX I: STEINMETZ PATENTS

Steinmetz secured over 200 patents, many comprising complex electrical circuit diagrams



No. 714,412.

Patented Nov. 25, 1902.

C. P. STEINMETZ.
INDUCTION MOTOR.

(Application filed Mar. 22, 1900.)

(No Model.)

2 Sheets—Sheet 1.

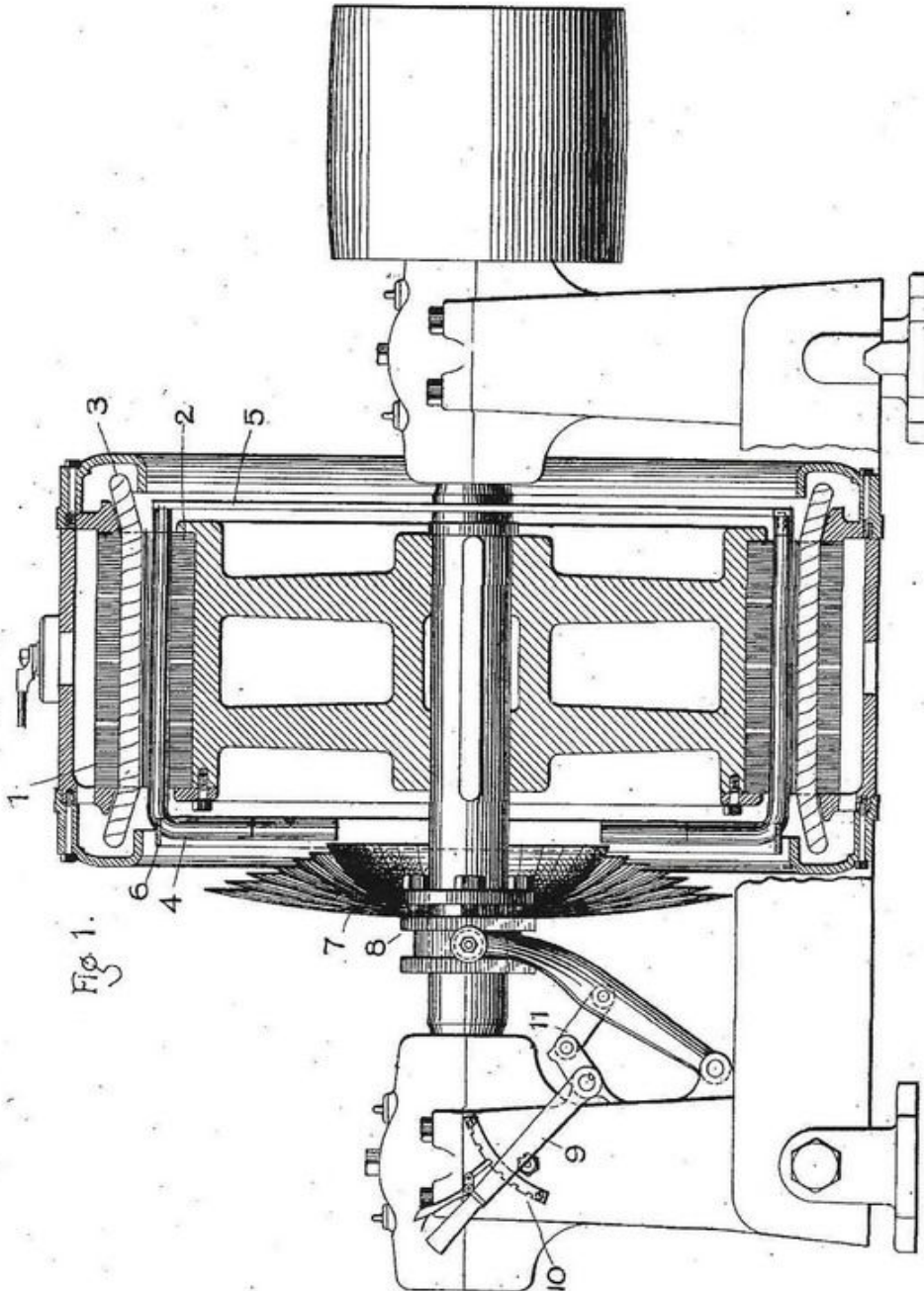


Fig 1.

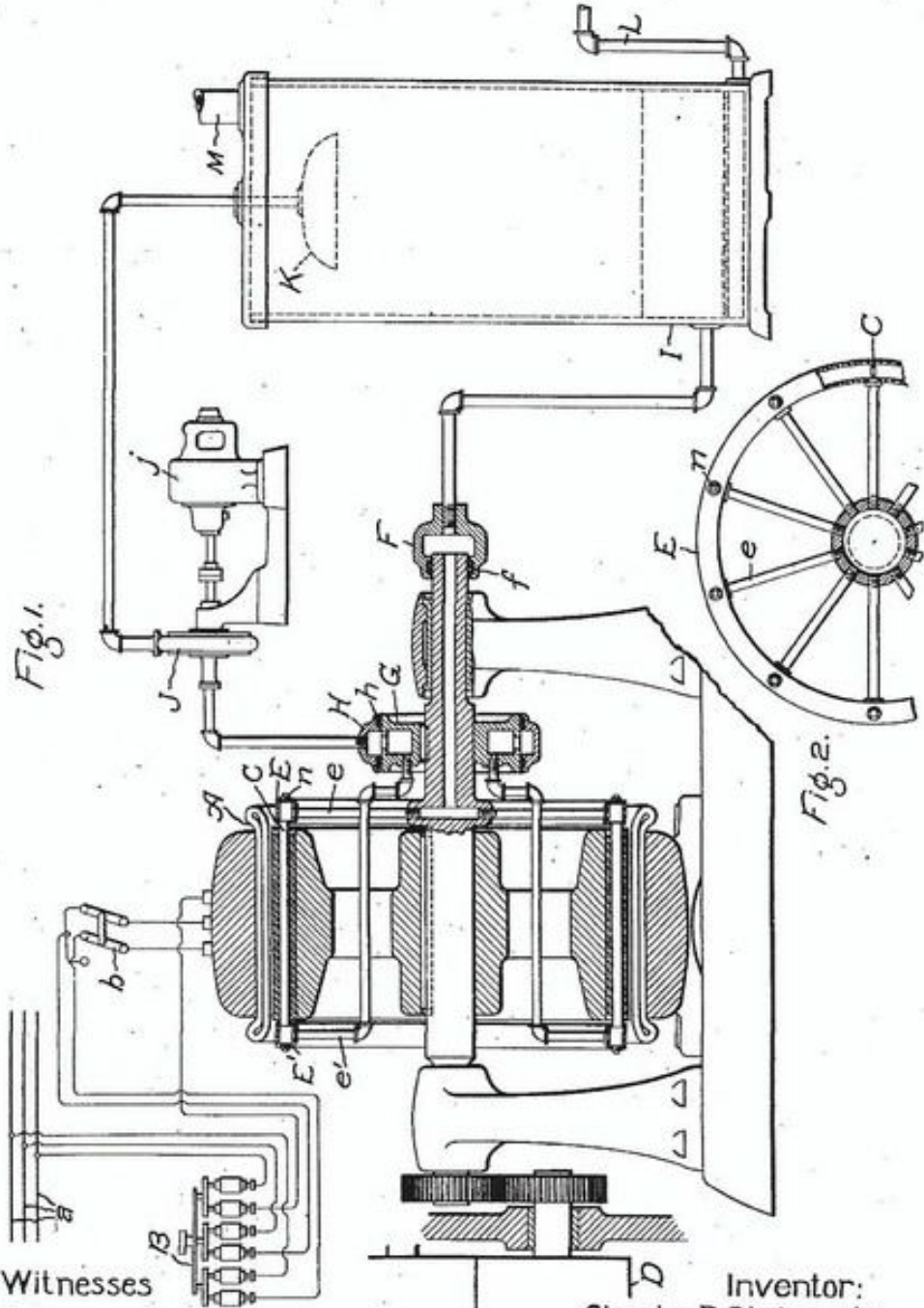
Witnesses
Fred G. Waring
Benjamin A. Hill

Inventor
Charles P. Steinmetz.
by *Albert G. Davis*
Atty.

No. 865,617.

PATENTED SEPT. 10, 1907.

G. P. STEINMETZ.
INDUCTION MOTOR.
APPLICATION FILED AUG. 7, 1905.



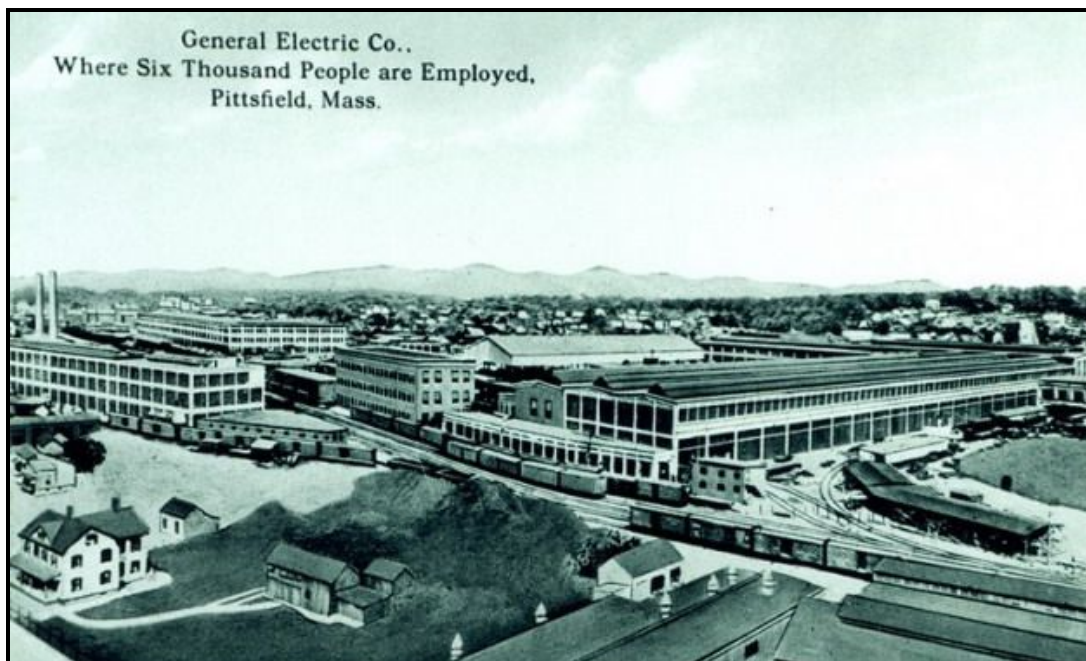
Witnesses
Marcus L. Byng
Benjamin B. Hull

Inventor:
Charles P. Steinmetz
By *Albert S. Davis*
Attv.

APPENDIX II: GENERAL ELECTRIC COMPANY PITTSFIELD TRANSFORMER WORKS



The GE transformer plant in Pittsfield, Mass, about 1900; the power station with 2-phase 2.3 kW belt-driven generators driven by reciprocating steam engines

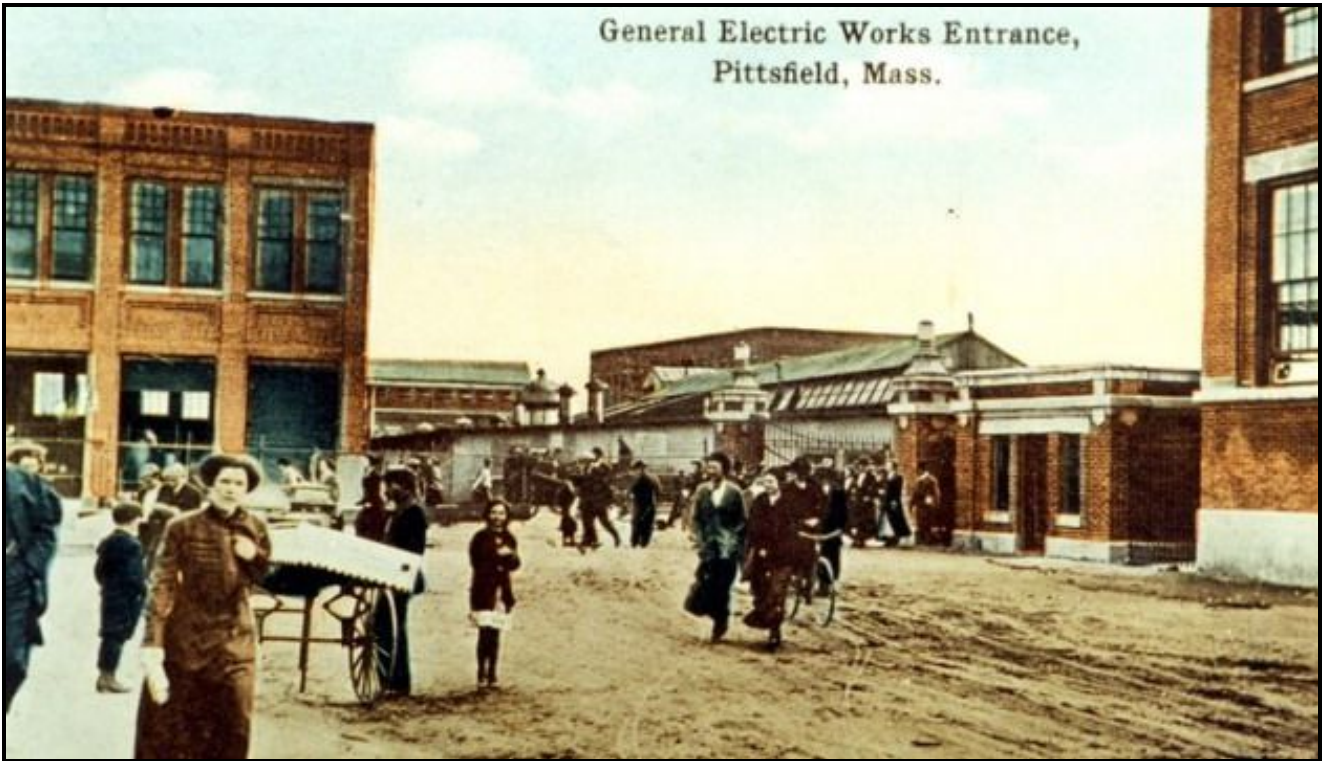


About 1912



Building No. 2 in 1910

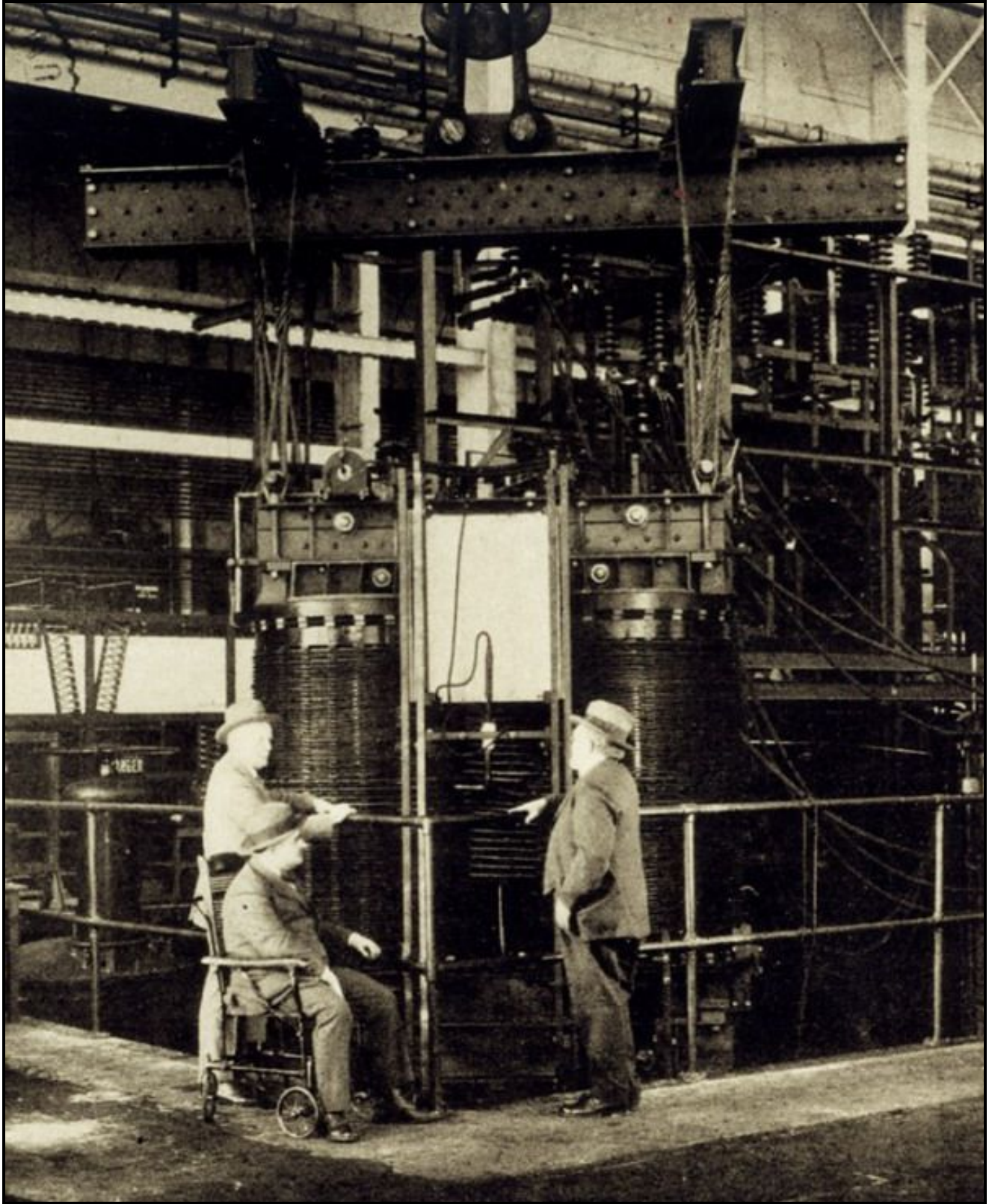
General Electric Works Entrance,
Pittsfield, Mass.



Leaving the Stanley Works at 6 P. M. PITTSFIELD, Mass.



The Pittsfield Works in 1913



A 100 ton water-cooled transformer: 28,886 kVA, 1 phase, 60 Hz, in 1926



The Telephone Switchboard in 1919



The Works Library in 1922



The GE Building, 570 Lexington Avenue, New York, opened in 1931

BIBLIOGRAPHY

----- *Charles Proteus Steinmetz, U.S. Patents Record Office*

1979 *Seizing the Moment (Age of the Inventor-Entrepreneur)*, EPRI Journal, Electric Power Research Institute, Palo Alto, California, March

1992 *Steinmetz: Engineer and Socialist*, Prof. Ronald E Kline, John Hopkins Studies in the History of Technology *

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)

----- *Charles Proteus Steinmetz, Wikipedia*

(*HHF*) after photograph caption indicates from *Hall of History Foundation*, Schenectady, N.Y.

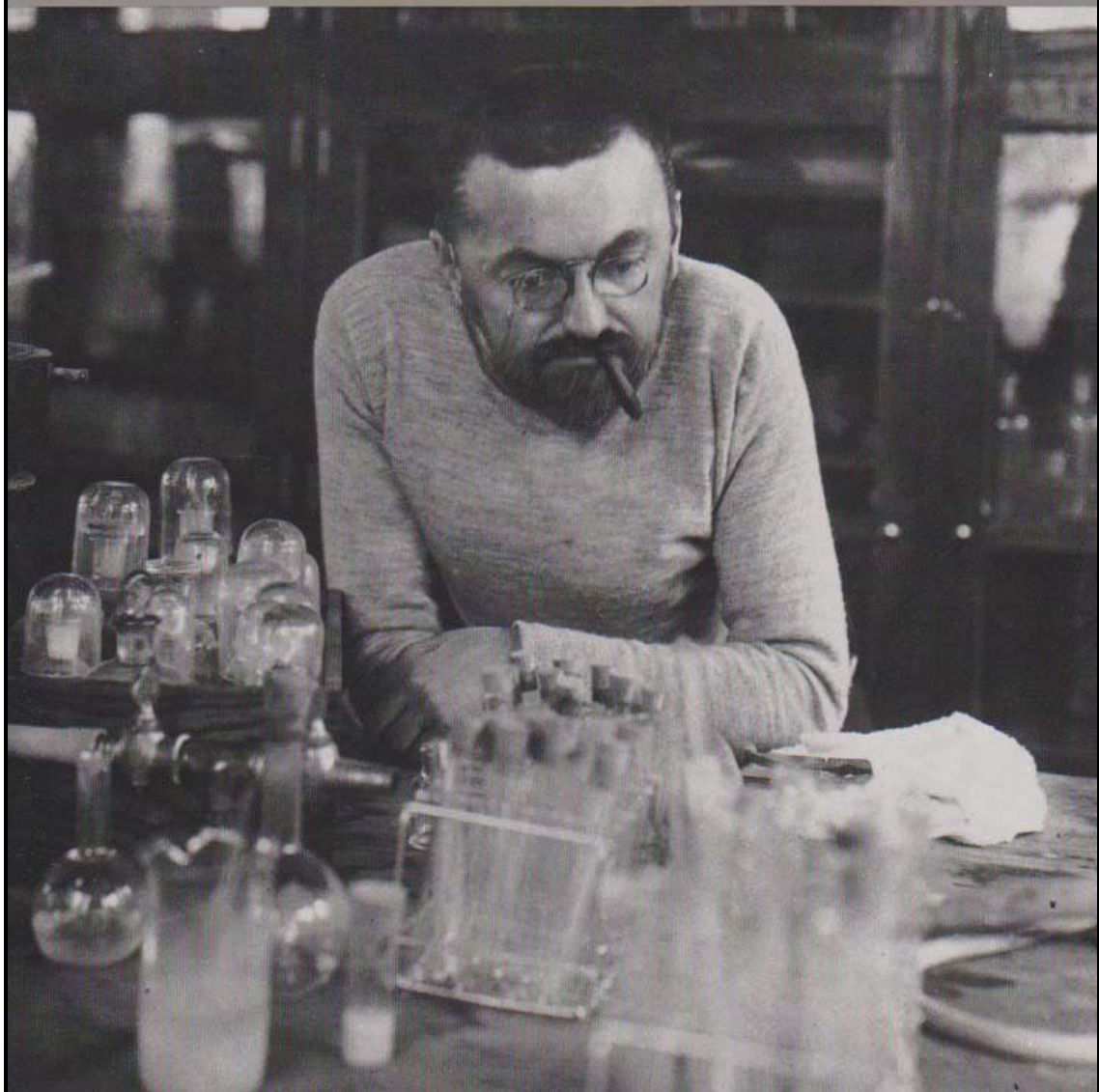
** Steinmetz's Biography is a 400-page book packed with information for researchers who may wish to undertake a more detailed study of his life and technical accomplishments. It includes some 67 pages of Notes with about 1000 references.*

*In addition, Part 2 "The Incorporation of Science and Engineering" goes into depth in connection with Steinmetz's mathematical approach to the theory of alternating current systems based on complex numbers which consist of a **real** part plus an **imaginary** component leading to the remark that he "was allowed by his employers to try to generate electricity from the square root of minus one."*

RONALD R. KLINE

Steinmetz

ENGINEER AND SOCIALIST



1992

EPILOGUE

Steinmetz died on the 26th October, 1923 and is buried in Vale Cemetery, Schenectady, New York. He is remembered for his contributions in three major fields of alternating current systems theory: steady-state analysis, hysteresis and transients.



Professional Achievements

Professor of Electrical Engineering, Union College, 1902 and
Chairman Electrical Engineering Department

Honorary Degrees from Harvard University and Union College

President Board of Education of Schenectady

President Schenectady City Council

President American Institute of Electrical Engineers, 1901-02

First Vice-President International Association of Municipal Engineers

Awards

Certificate of Merit of Franklin Institute, 1908

Elliot Cresson Medal, 1913

Cedergren Medal, 1914

Steinmetz wrote 13 books and 60 articles not all about engineering. One of the highest technical awards given by the Institute of Electrical and Electronics Engineers is the IEEE Charles Proteus Steinmetz Award.



Statues of Charles Proteus Steinmetz and Thomas Alva Edison in Schenectady