

FRANK J SPRAGUE and the ELECTRIC ELEVATOR

by Brian Roberts, CIBSE Heritage Group



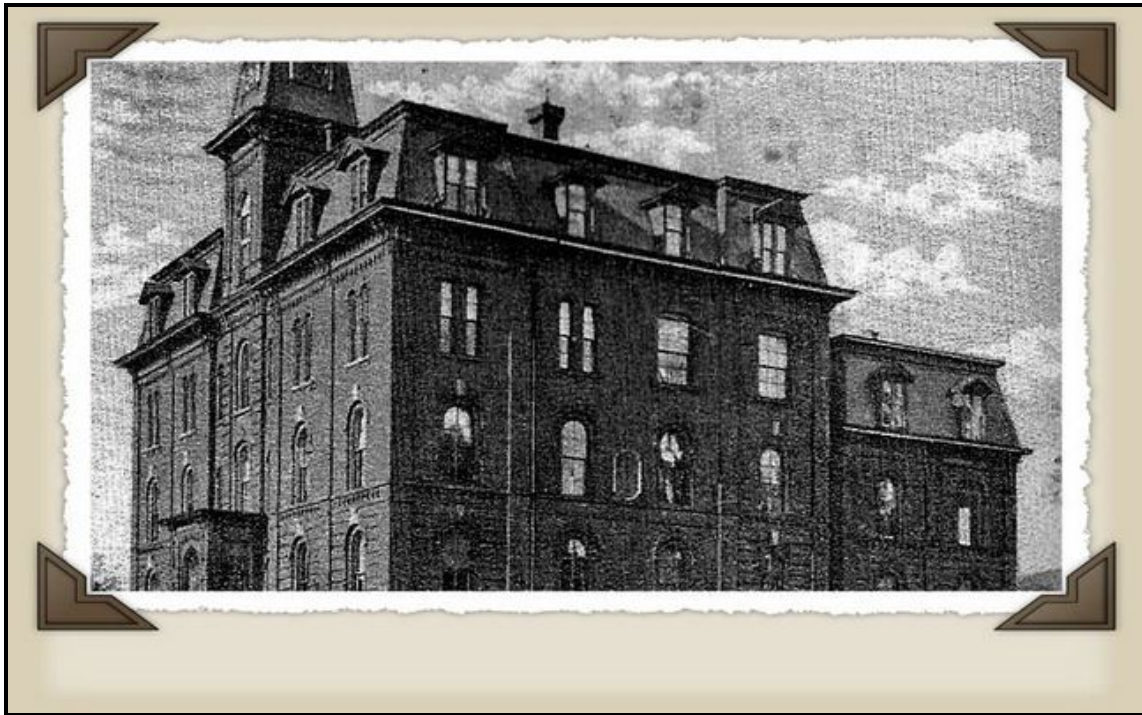
Frank Julian Sprague, 1857-1934

Frank Sprague was born on 25th July, 1857 in Milford, Connecticut to David Cummings Sprague and Francis Julia King Sprague. He attended Drury High School in North Adams, Massachusetts where he excelled in mathematics. In 1874, he won an appointment to the United States Naval Academy in Annapolis, Maryland, graduating in 1878.

He was an American naval officer and inventor who contributed to the development of the electric motor, electric elevators and electric railways. His innovations helped transform the urban space of 20th century cities, enabling them to grow larger (better transportation) and to provide a greater concentration of business in commercial districts (through use of electric elevators in skyscrapers).

For these achievements, Sprague became known as the *Father of Electric Traction*.

SPRAGUE PHOTO ALBUM



Drury High School



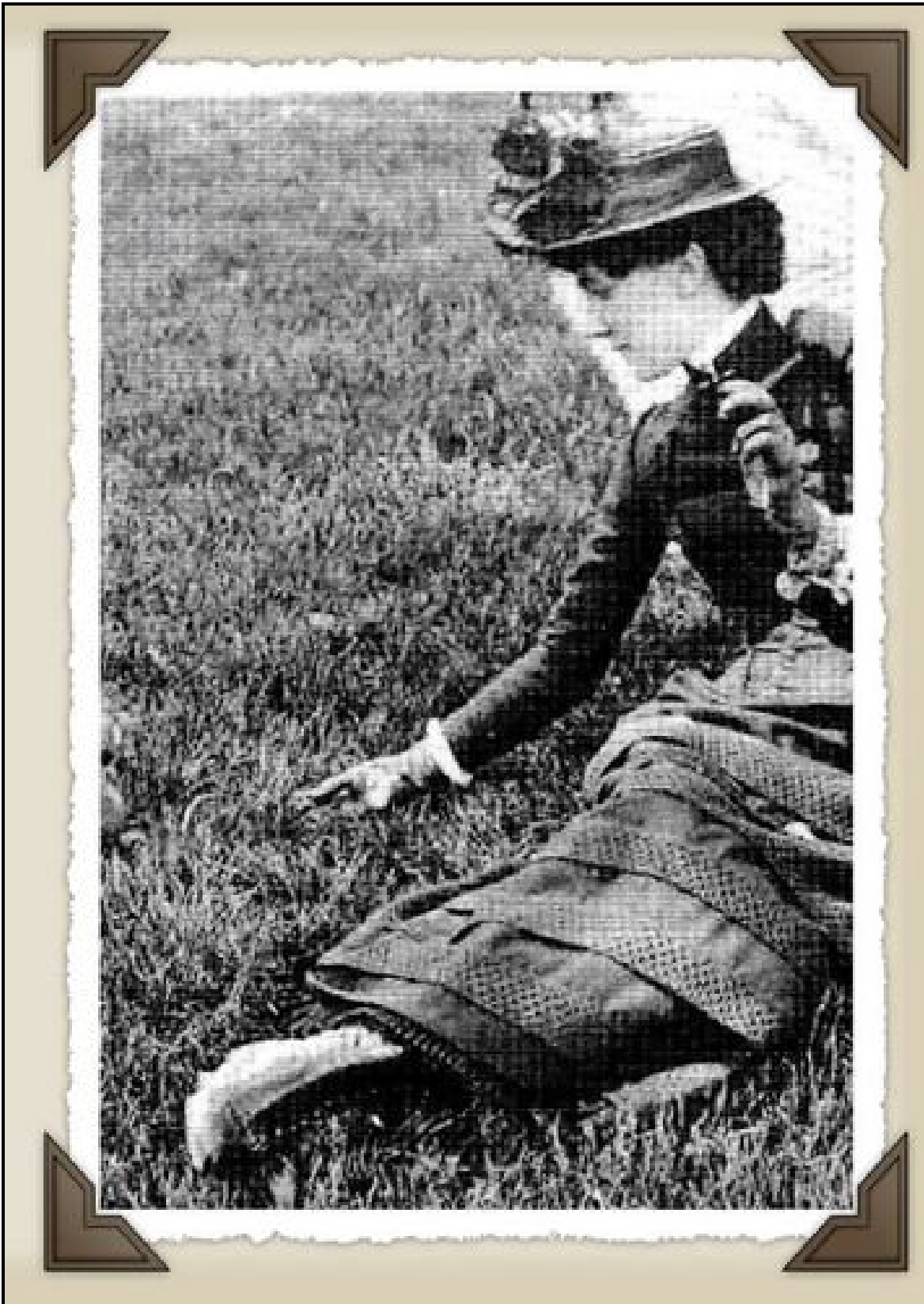
The Naval Academy Class of 1878 with Frank Sprague (2nd row, left)

SPRAGUE PHOTO ALBUM



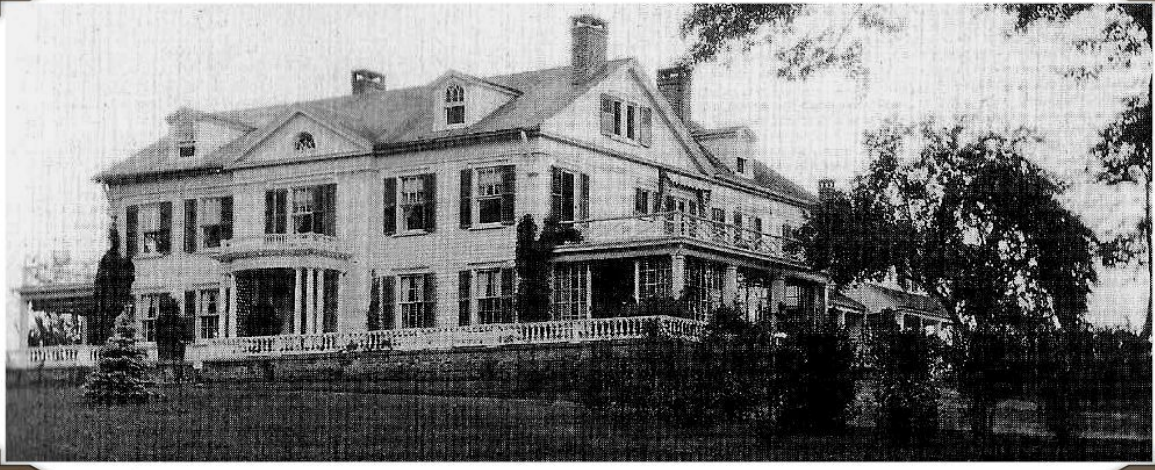
Midshipman Frank Sprague during his Naval Academy years

SPRAGUE PHOTO ALBUM



*On 21st April, 1885, Frank Sprague married Mary Keating in New Orleans
but they divorced in 1895*

SPRAGUE PHOTO ALBUM

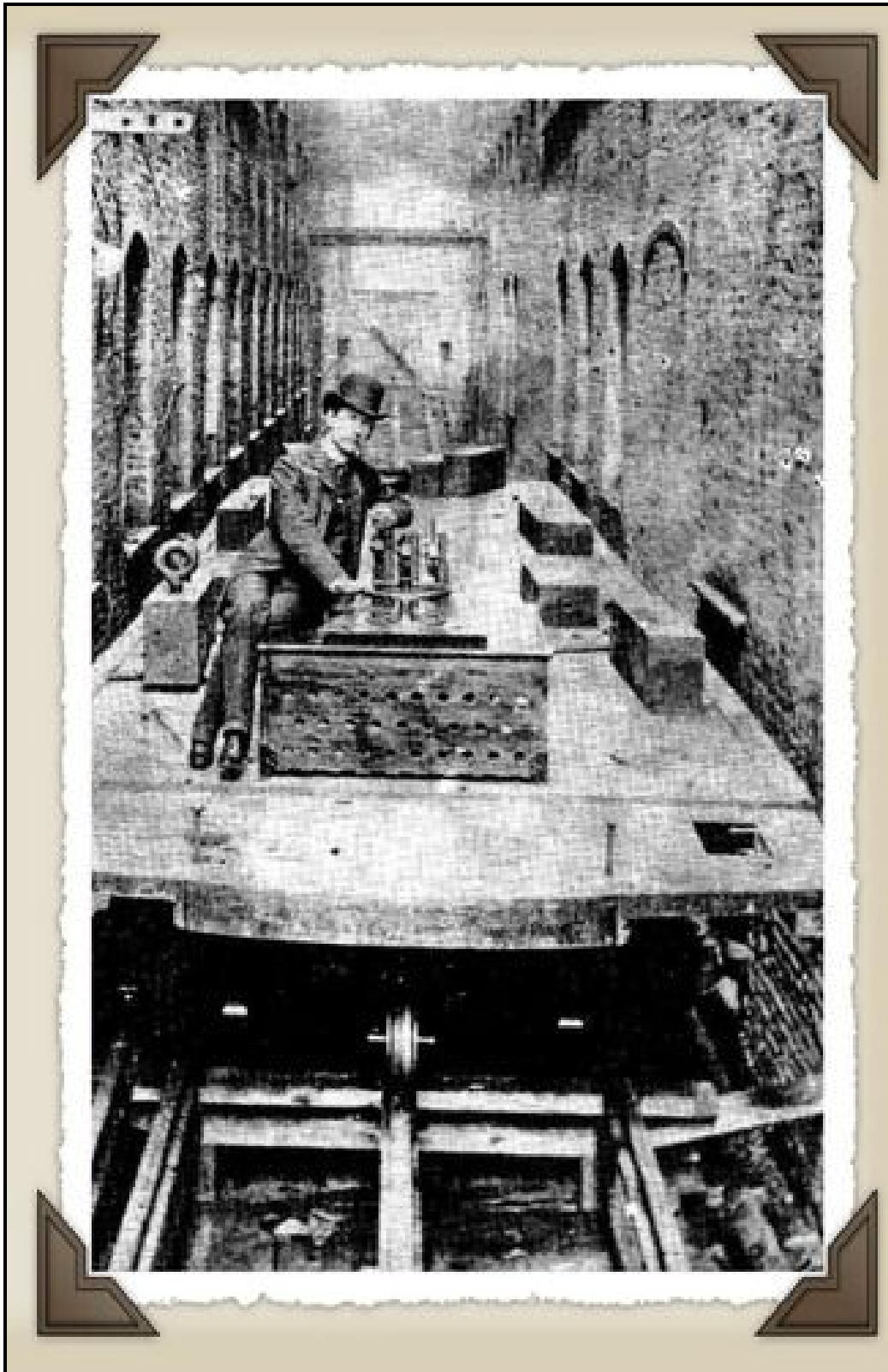


*The Maples, the summer home of Frank and Harriet Sprague, his 2nd wife,
in Sharon, Connecticut*



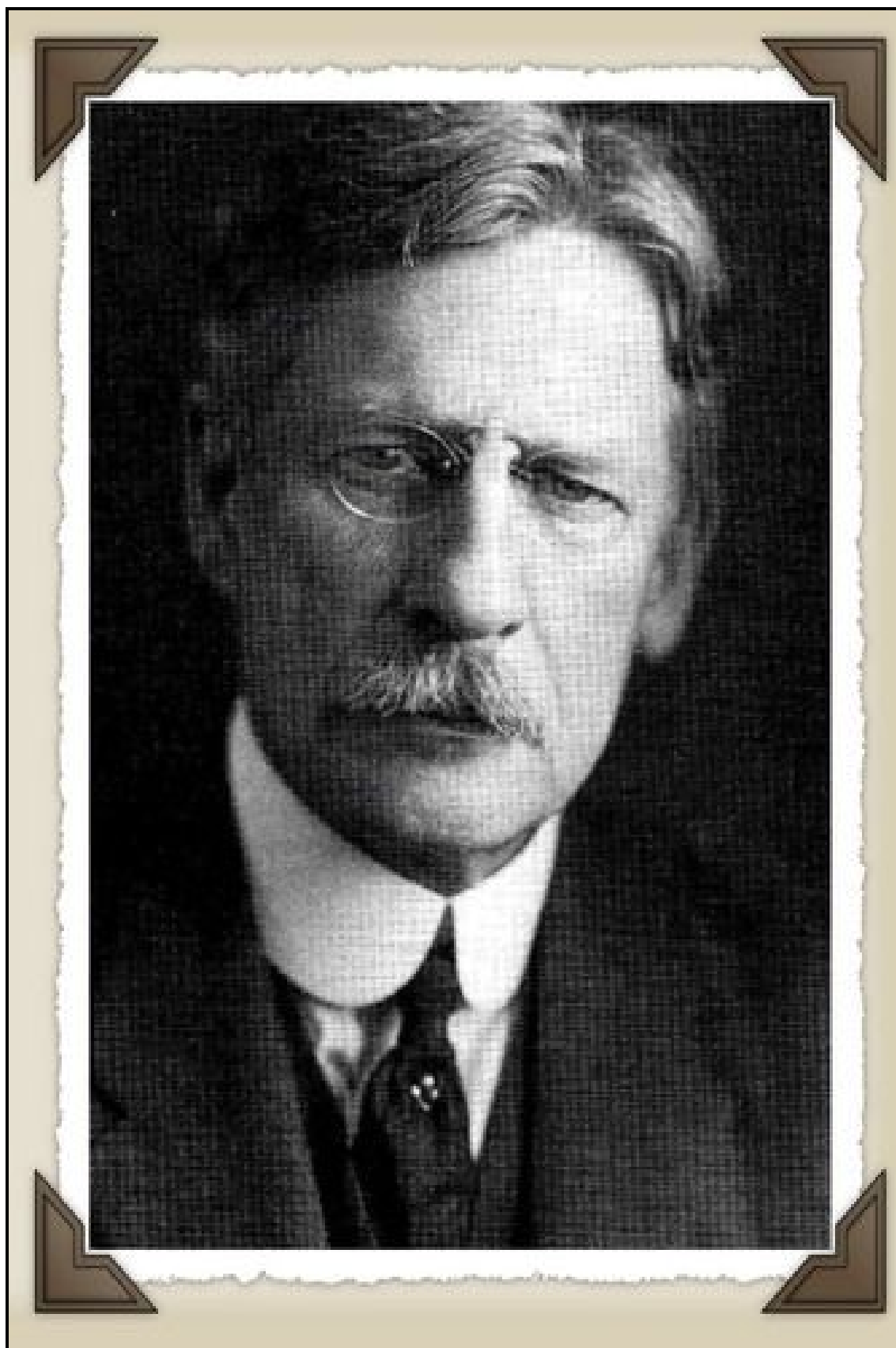
Frank and Harriet with their three children (l-r), Roberts, Frances and Julian

SPRAGUE PHOTO ALBUM



Test railway car set up by Frank Sprague in 1885

SPRAGUE PHOTO ALBUM



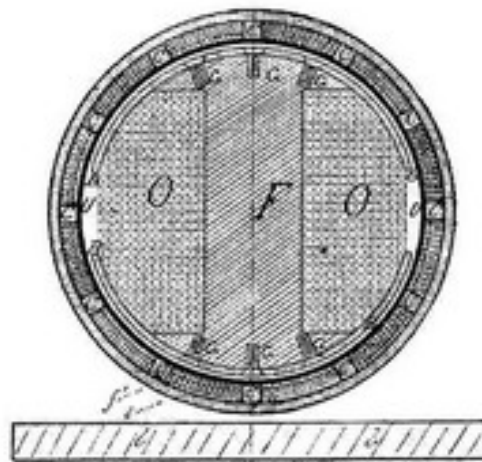
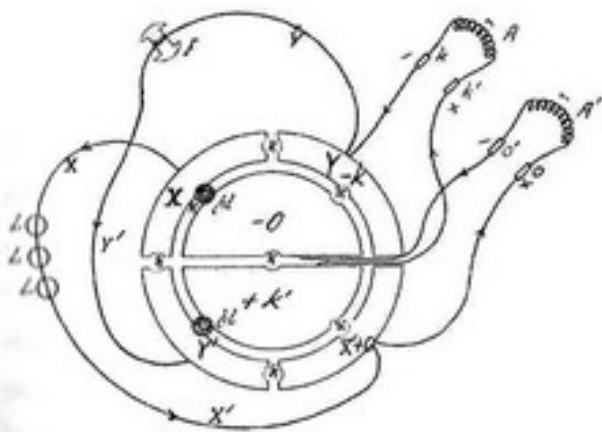
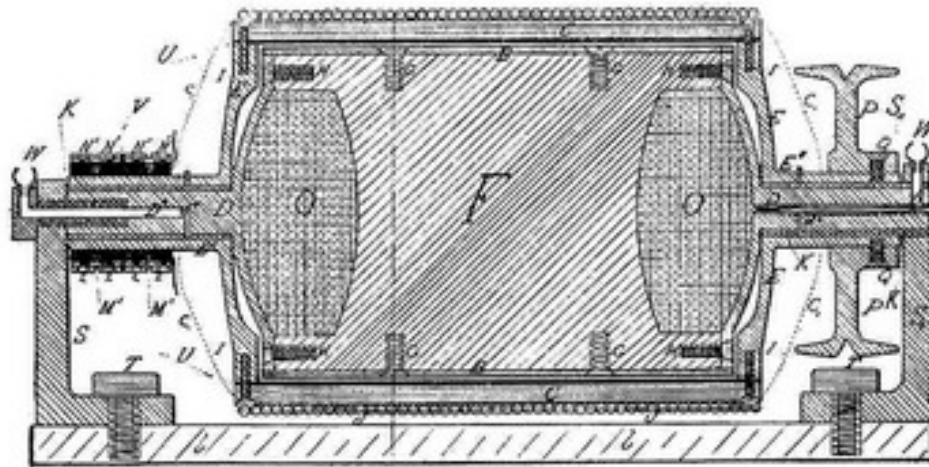
Frank Sprague in about 1921

SPRAGUE PHOTO ALBUM



Frank Sprague's 75th birthday celebration, with Harriet, held at the Engineering Societies Auditorium in New York on 25th July, 1932

SPRAGUE ELECTRICAL ENGINEER



SPRAGUE INVERTED TYPE DYNAMO, SERIES-PARALLEL CONTROL, 1881

Working in Professor Moses G. Farmer electrical machine shop at the Torpedo Station, Sprague developed this notable dynamo electric machine which reversed the electrical field and armature of a dynamo, and featured an arrangement of field and armature circuits that became a basic principal of all series-parallel controllers used on DC railway motors. *Middleton Collection.*

SPRAGUE ELECTRICAL ENGINEER

Fig 1 Elevation

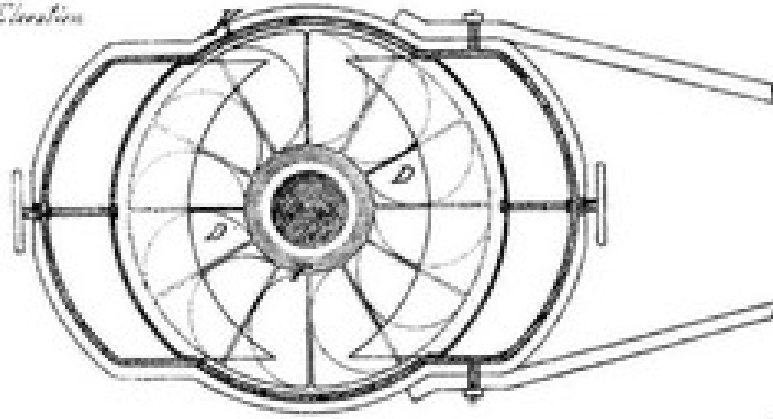


Fig 2 Transverse Section

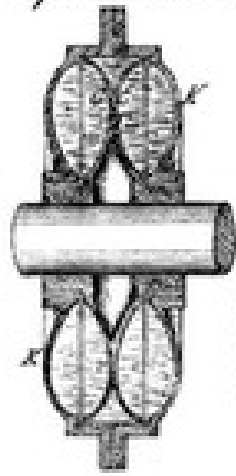


Fig 3



Fig 4



Fig 5



Fig 6



Half bar section.

Fig 7 Half plan.

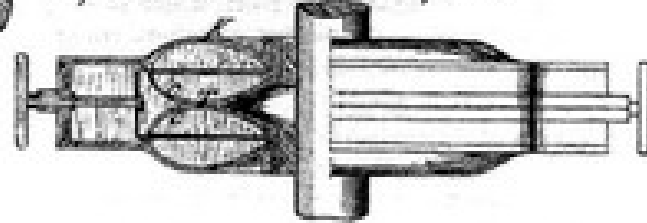
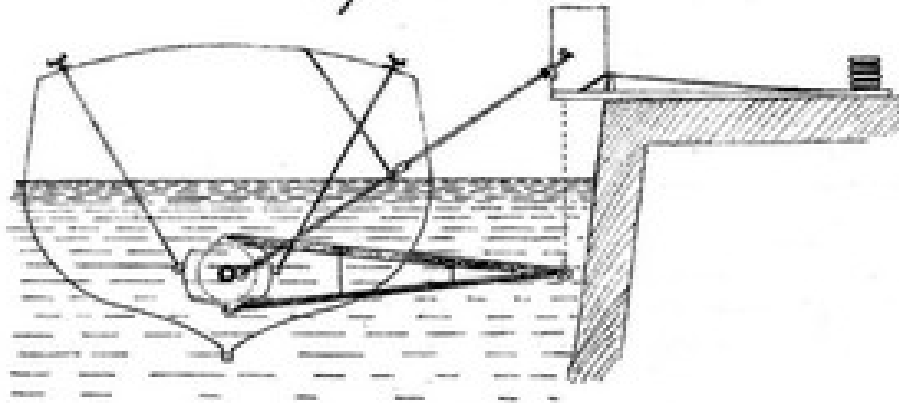
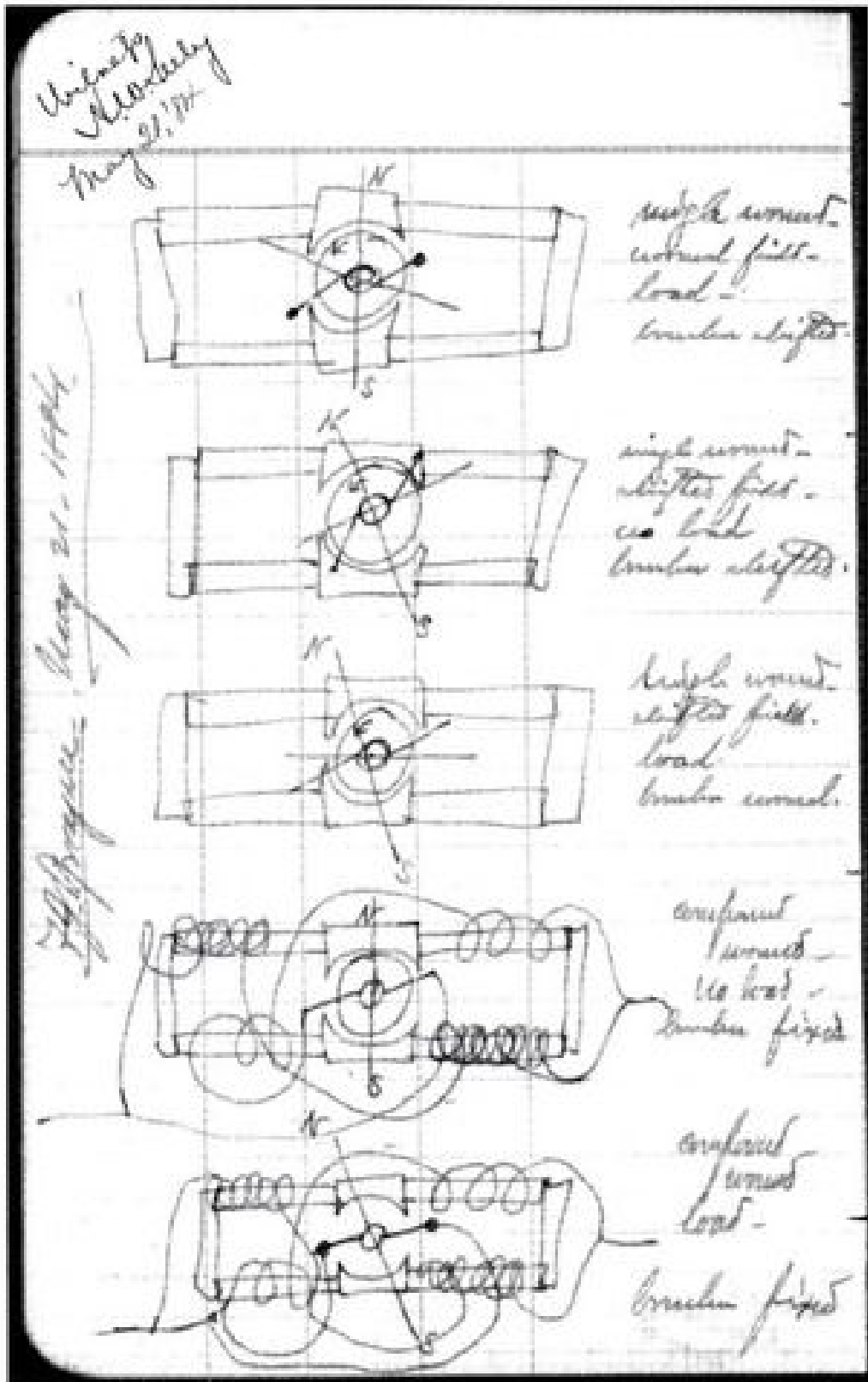


Fig 8



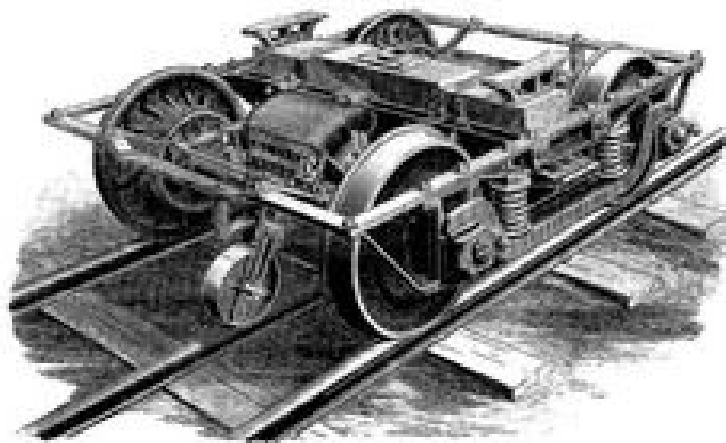
Water dynamometer developed for the testing of Otto and Clark engines. Drawing from Frank Sprague's report on the Crystal Palace Electrical Exhibition. Library of Congress.

SPRAGUE ELECTRICAL ENGINEER

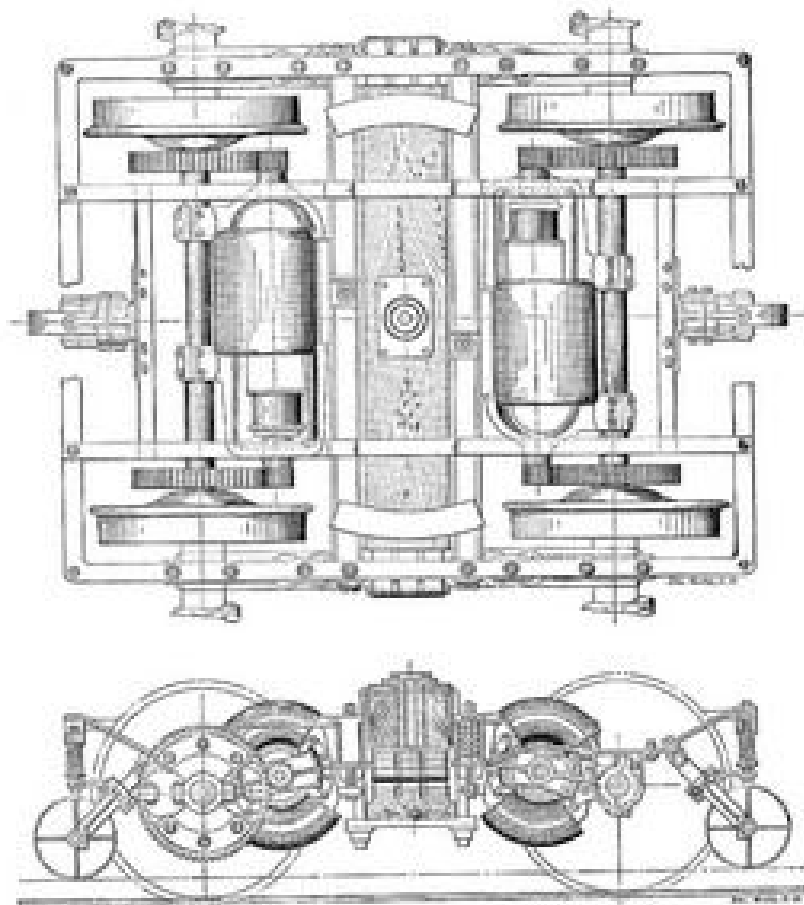


Sprague sketch of 1884, working out the circuiting for an electric motor

SPRAGUE ELECTRICAL ENGINEER

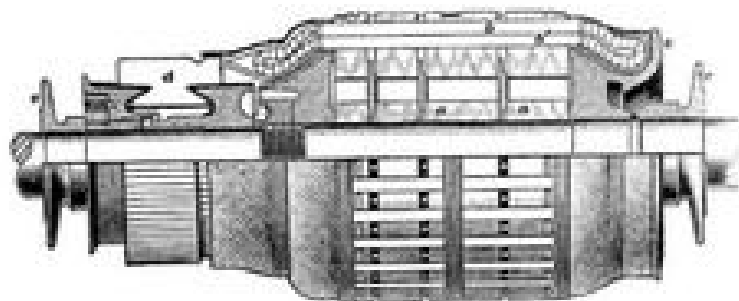
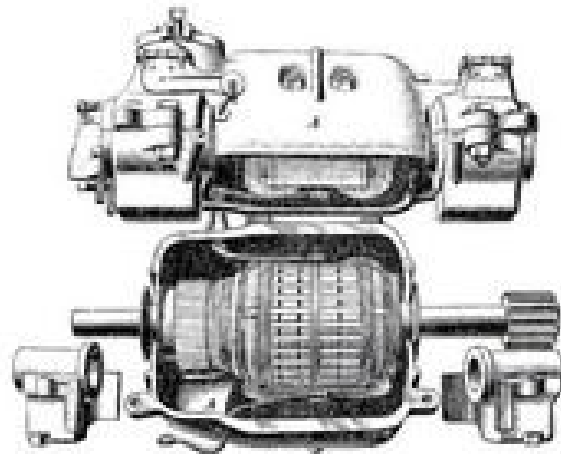
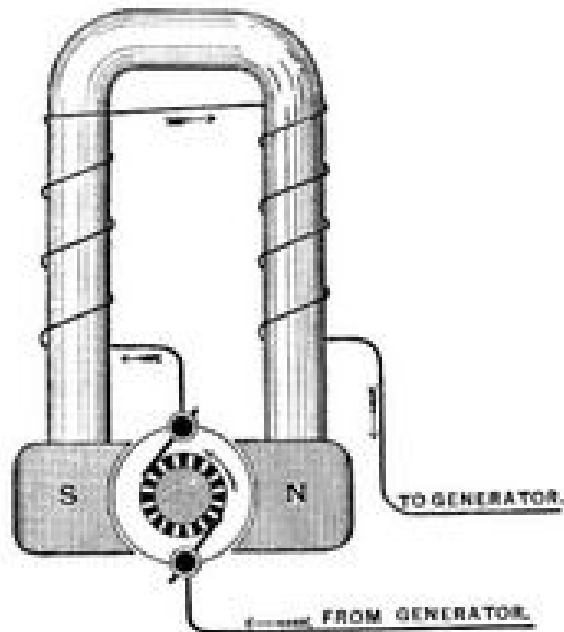


Three views of the Sprague car truck developed in 1881-1886 demonstrated the most important innovation by Sprague, which provided an effective link between traction motors and the wheels. This was the "wheelbarrow" or "nose-suspended" design for the traction motors. *The Electrical World.*



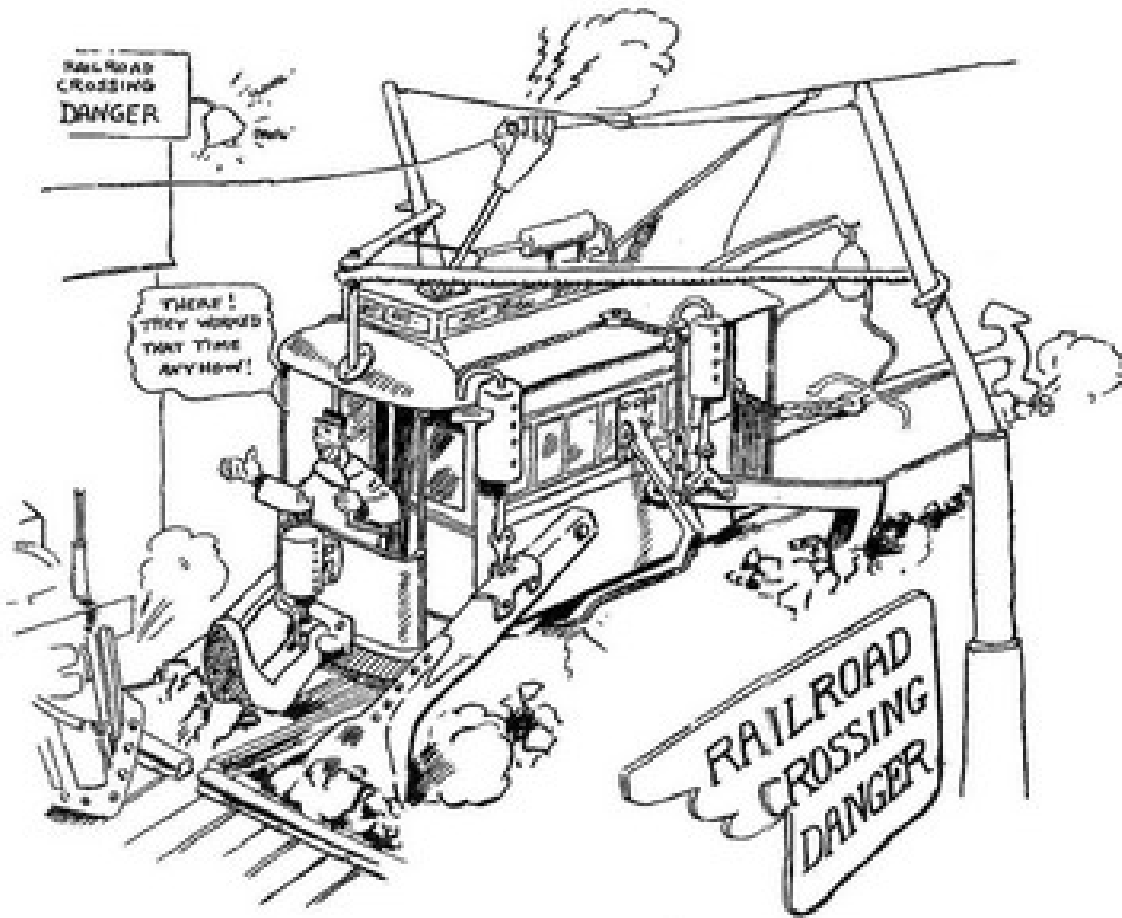
SPRAGUE ELECTRICAL ENGINEER

These drawings depict a typical series-wound direct current electric motor. Principal components include the rotating electromagnet armature, made up of an iron core on which are wound coils of copper wire; the commutator, which is mounted at the end of the armature shaft, and which transmits the current through the circuits of the armature; the brushes, which are usually carbon brushes that connect the armature with the field-magnet coils and external circuit through the commutator; and the field-magnets, which are stationary electromagnets surrounding the armature. These are usually bipolar motors, fitted with insulated copper wire wound in a manner to produce opposite polarity in the opposite pole-pieces. The first figure shows a very schematic arrangement of a series-wound electric motor, with electric power passing from the generator through the brushes to the commutator, through the rotating armature, and back through the brushes to the field magnets. The second shows a drawing of a 17-horsepower General Electric 32 motor, with the armature inside the motor housing, which contains the field-magnets. The third is a cutaway drawing of the G. E. 32 motor armature. *Middleton Collection.*



SPRAGUE ELECTRICAL ENGINEER

Our Compliments for the Season



SPRAGUE

SAFETY CONTROL & SIGNAL CORPORATION

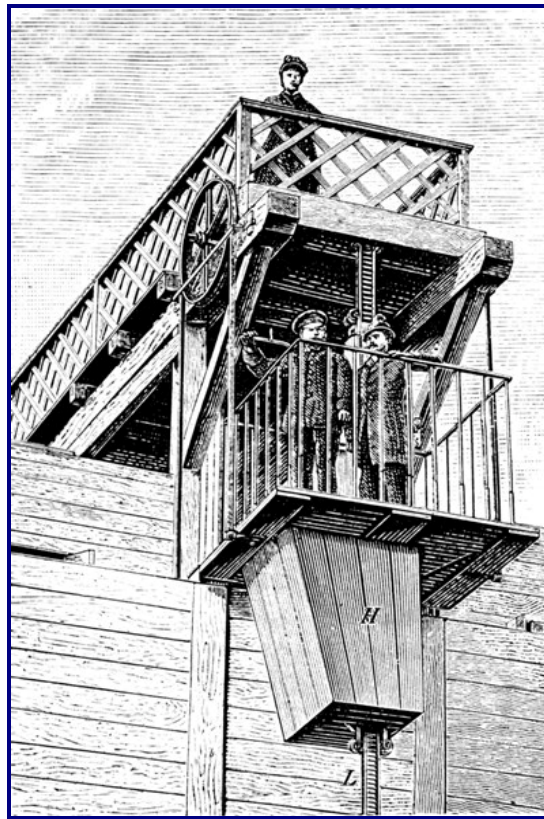
421 Canal St.
New York

310 Michigan Ave.
So. Chicago

Greetings from Sprague Company to railway men 1925

DEVELOPMENT OF THE ELECTRIC ELEVATOR

Elisha Graves Otis demonstrated his safety elevator at the New York Crystal Palace Exhibition of 1854. The first commercial application was in New York's Haughwout Building in 1857. The next passenger elevator installation seems to have been that installed by Otis Tufts (no relation to Elisha) in the Fifth Avenue Hotel, New York, in 1859. These were steam-powered. After Elisha Otis died in 1861, his sons, Charles and Norton, established Otis Brothers and Company in 1867, but the hydraulic elevator appeared in the 1870s and it supplanted the steam elevator in the 1880s. So in 1878, Otis Brothers acquired hydraulic technology from the Hydraulic Elevator Company of Chicago.



Siemens' electric elevator of 1880 (a rack-climbing type)

The first electric elevator was built by Werner von Siemens in Germany in 1880 and later developed by Anton Freissler in Austria-Hungary. Recognising the potential of the electric system, in 1889, Otis Bros began experiments with this new form of power. Using electric motors from Rudolf Eickemeyer (a German immigrant, inventor and manufacturer), Otis sold its first electric elevators in that same year for the Demarest Building in New York City.

Meanwhile in 1890, Frank Sprague, using his expertise in electric traction motors, and having sold his electric railway business to the Edison General Electric Company, turned his attention to the development of the electric passenger elevator

SPRAGUE ELECTRIC ELEVATOR COMPANY

In 1890, Frank Sprague combined forces with the mechanical engineer Charles Pratt, forming the Sprague-Pratt Electric Elevator Company. This became the Sprague Electric Elevator Company in 1892.

Working together, Sprague and Pratt landed their first elevator contract for the small New York Grand Hotel in 1891, going on to equip the new 14-storey new Postal Telegraph-Cable Company on the corner of Broadway. Then in 1896, Sprague was commissioned to provide the elevators for New York City's Park Row Building which at 31 storeys was then the tallest building in the world.

In 1897, Sprague and Pratt won the contract to provide 48 electric elevators for the Central London Railway's new underground railway system. But even as he achieved this success, Frank Sprague decided to leave the elevator business. Between 1892 and 1898 Sprague and Pratt had supplied a total of 584 elevators, but this was small compared with Otis. In New York City alone, between 1884 and 1896, 360 electric elevators were installed, some 200 by Otis while Sprague installed only 19.

It was probably Otis Elevator's aggressive moves to dominate the elevator business and the incorporation of 15 other companies under the Otis umbrella in 1898 (which gave them control of 90 percent of the US market) which persuaded Sprague to sell the Sprague Electric Elevator Company to Otis in 1895.

Frank Sprague went on to devise to devise a multiple unit system of electric railway operation, where each car was provided with electric traction motors, controlled to act together. He obtained contracts for Chicago's elevated railway (the "L") and for his system in Brooklyn, New York and Boston and was involved in the electrification of Grand Central Station and the development of a third rail system.

In the 1920s, Sprague developed a method of safely running two independent elevators, local and express in a single shaft, which he patented and sold to Westinghouse. He continued to work on a variety of ideas until his death in 1934.

*For his many lifetime achievements, Frank Sprague is remembered as
"The Father of Electric Traction."*

SPRAGUE ELECTRIC ELEVATOR COMPANY

SPRAGUE Electric Elevator Company

Postal Telegraph Building, New York City.



THE MULTIPLE SHEAVE SCREW MACHINE

Duplicates Hydraulic Service with less than half the water consumption and coal expenditure. ♣ ♣

IT HAS ANY REQUIRED SIZE
EACH MACHINE IS

LIKE PARTS AND EASY TO REPAIR

IT HAS A SUPERIOR DOWN START
IT OCCUPIES LESS SPACE

IT IS ABSOLUTELY SAFE

THE WORM GEAR DRUM MACHINE

Is for all classes of intermediate service. It is the most perfect machine of its type built. ♣ ♣

THE AUTOMATIC HOUSE ELEVATOR

Is absolutely safe. It requires no operator. ♣ ♣ ♣ ♣ ♣ ♣ ♣ ♣ ♣ ♣

Among typical buildings adopting Sprague Machines are:

Postal Telegraph Building, New York City; Foy's Building, San Francisco; Board of Trade, Chicago; Guaranty Building, Buffalo; Syracuse Building, New York City; Union Trust Building, Detroit; Gordon Building, New York City; Custom House, New York City; Merchants' National Bank, Baltimore; Hotel Wagon,

Philadelphia; J. T. Williams Office Building, New York City; Manhattan Hotel, New York City; Mabley Building, Detroit; Young Men's Christian Association, New York; People's Store, New York; Court House and City Hall, Minneapolis; Boston Daily Globe, Boston; Commercial Cable Com-

pany, New York; Suth Fyfe Building, San Francisco; Academy of Music, San Francisco; Canada Life Insurance Co., Montreal; Star Mutual Life Insurance Co., Worcester; Johns Hopkins University, Baltimore; Edison Electric Illuminating Co., New York; Carrier Bank Building, Los Angeles,

Alvord Building, New York; Signal-Corps Department Store, New York; Hudsonworth Building, New York; The Callender, Manhattan & Frong Company's Department Store, Providence; The residence of Mr. John Jacob Astor; Mr. George Meigs, New York; County Court House, Salt Lake City; and Graham Building, N. Y. City.

Mr. John Jacob Astor's new Hotel, the Largest and Costliest Building erected by private or corporate enterprise, 20 Machines.

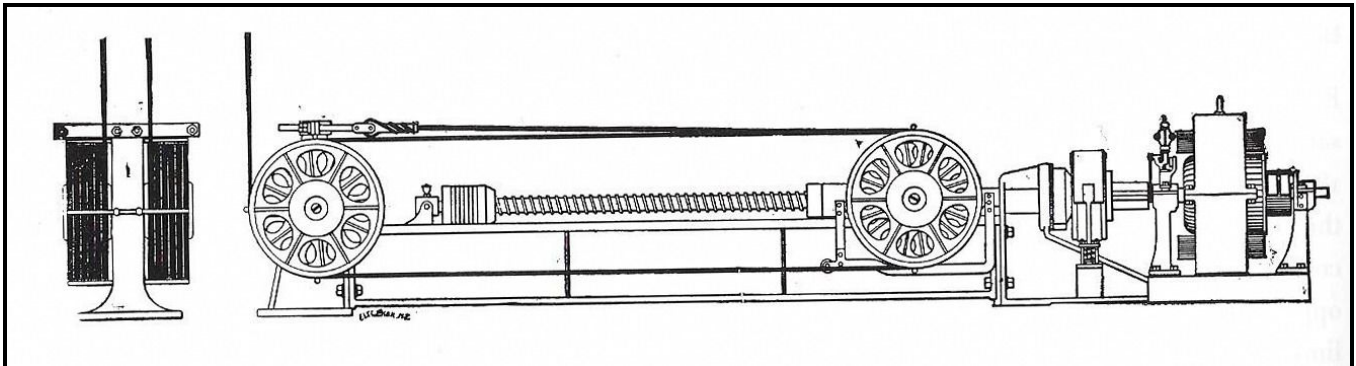
NO ELEVATOR IN THE WORLD EVER MADE SUCH A RECORD!!

SPRAGUE ELECTRIC ELEVATOR COMPANY

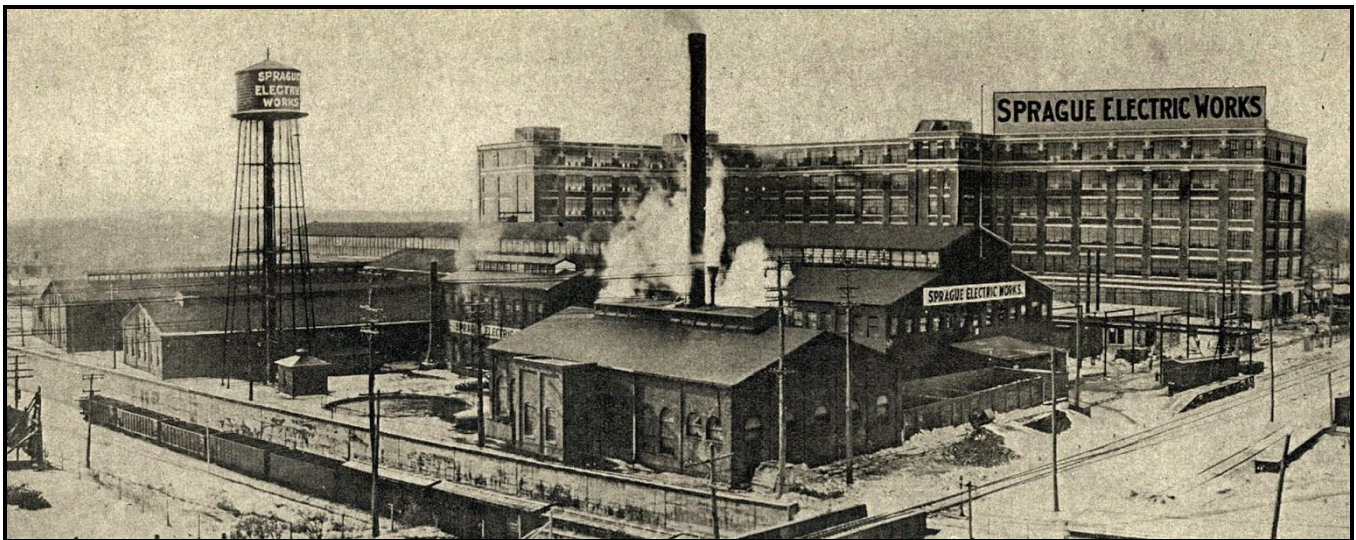


Lord's Court Building, Manhattan, built 1896, equipped with Sprague-Pratt electric elevators

SPRAGUE ELECTRIC ELEVATOR COMPANY

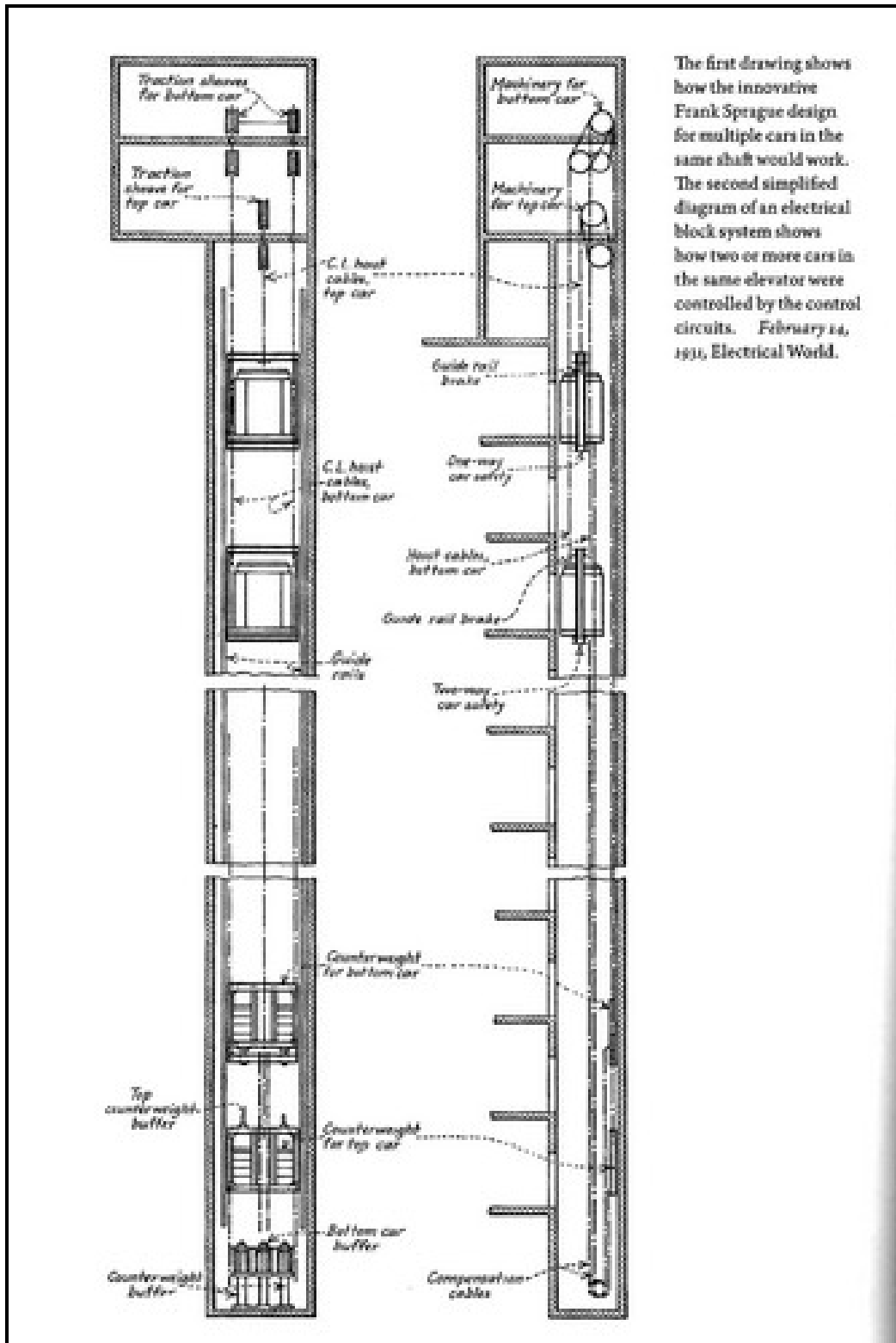


Sprague-Pratt electric elevator equipment as used in Lord's Court Building. This used a Sprague electric motor, set with its armature axis horizontal, and a drive that consisted of an extremely long screw engaged with a travelling nut at the free end. The rotation of the screw moved the nut to draw together or separate two sets of travelling sheaves connected to the elevator car by hoisting cables.



Sprague Electric Works: General view of the Bloomfield Factory in 1918

SPRAGUE ELECTRIC ELEVATOR COMPANY



The first drawing shows how the innovative Frank Sprague design for multiple cars in the same shaft would work. The second simplified diagram of an electrical block system shows how two or more cars in the same elevator were controlled by the control circuits. February 14, 1910, *Electrical World*.

Sprague's design for operating multiple lift cars in the same shaft, 1931

CASE STUDY: PARK ROW BUILDING, NEW YORK



The Park Row Building under construction in 1898

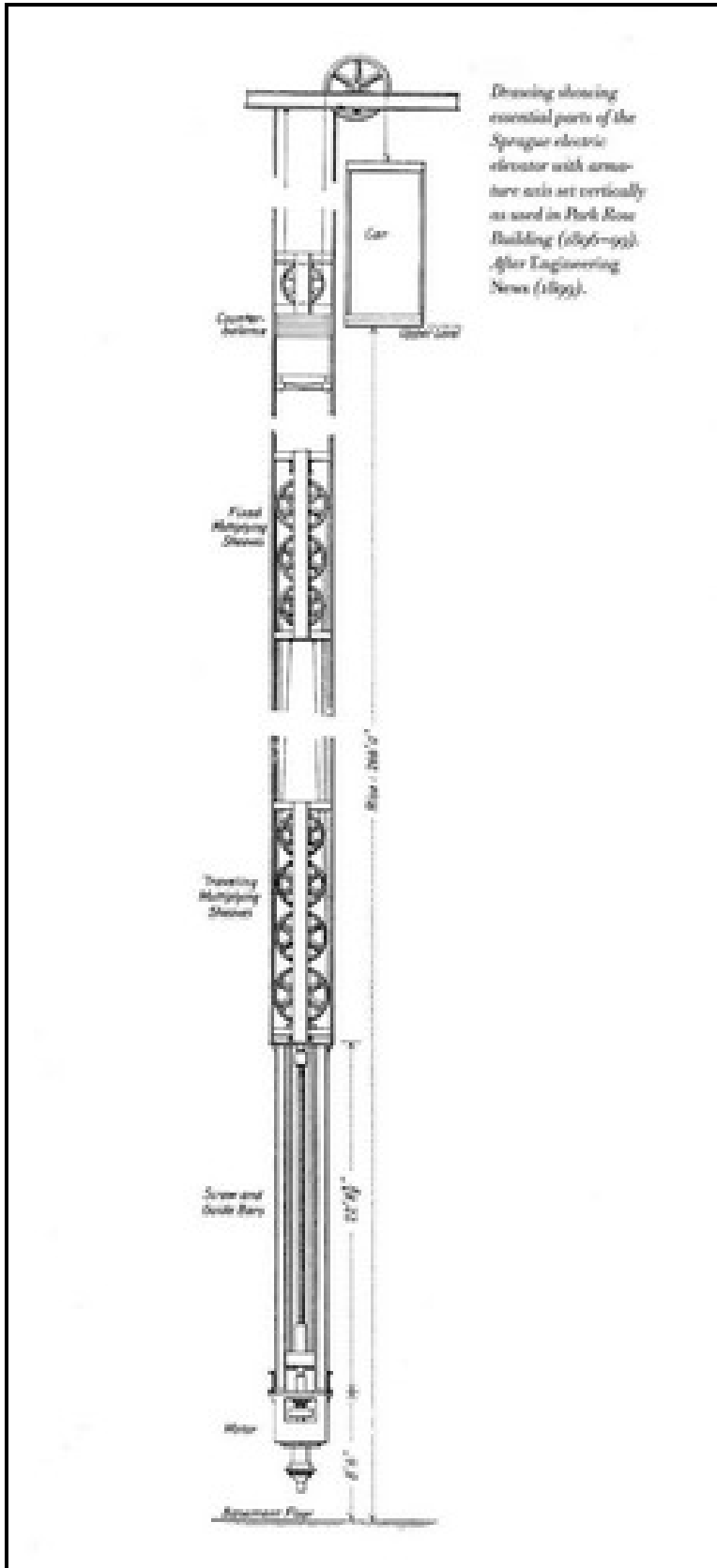
Park Row was one of the first buildings to be called a skyscraper and was completed in 1899 after two years and nine months of construction. The building was designed by R H Robertson, a pioneer in steel skyscraper design and engineered by the firm of Nathaniel Roberts. At 391 feet tall, with 31 storeys, it was the tallest building in the world from 1899 until 1908, when it was surpassed by the Singer Building, also in New York. The building contained 8,000 tons of steel and it accommodated some 4,000 people. Sprague and Pratt provided their new vertical screw system for the ten passenger elevators installed in this building.

PARK ROW BUILDING



Scientific American Magazine, 24th December, 1898

PARK ROW BUILDING



The Sprague-Pratt electric elevator as used in the Park Row Building, 1899

PARK ROW BUILDING



The Park Row skyscraper (centre, left)



Elevator lobby of the Park Row Building

APPENDIX: SPRAGUE ELEVATOR PATENTS

No. 647,239.

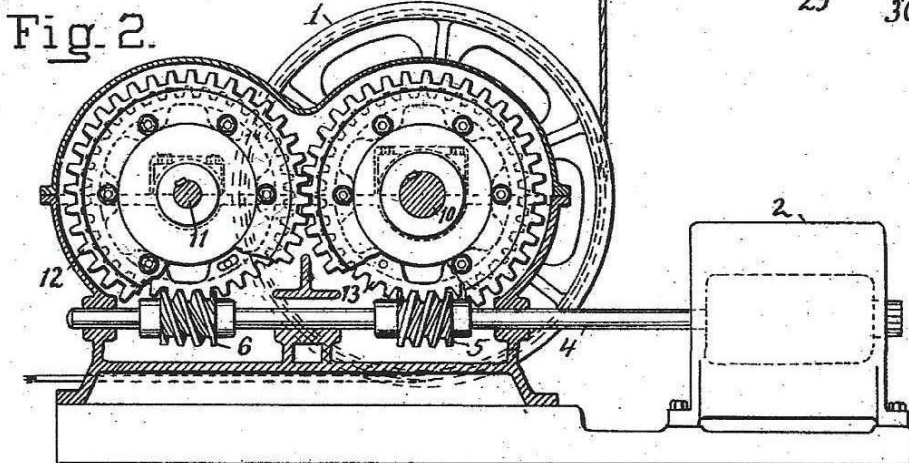
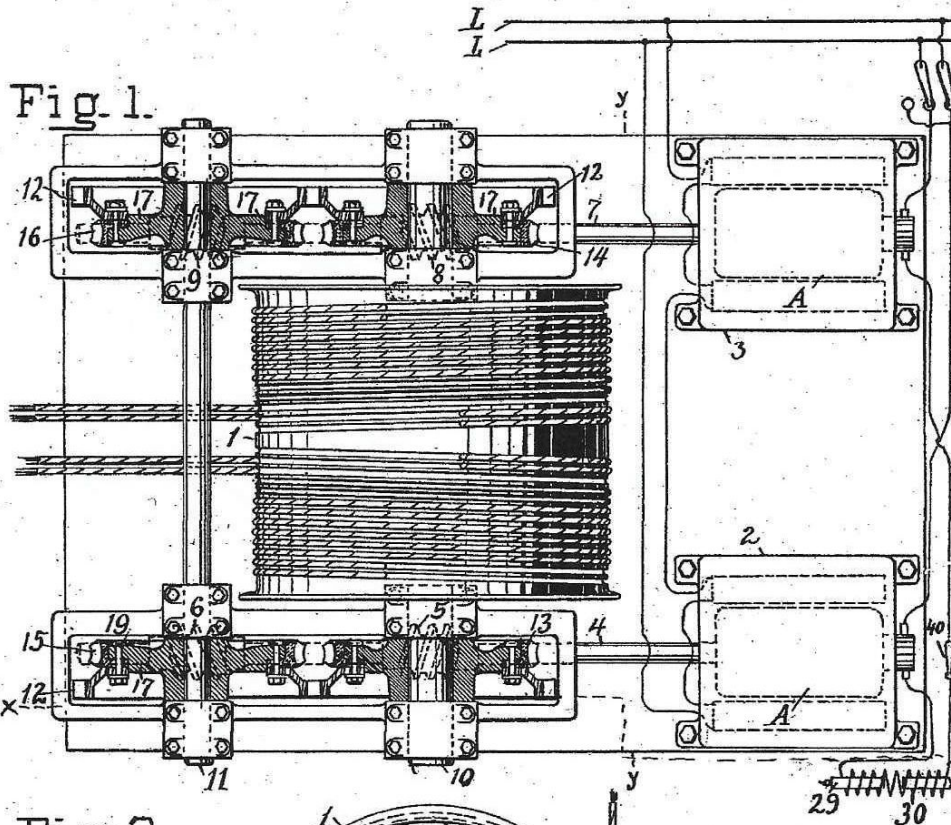
Patented Apr. 10, 1900.

F. J. SPRAGUE.
ELEVATOR.

(Application filed July 27, 1898.)

(No Model.)

2 Sheets—Sheet 1.



Witnesses:

Samuel W. Balch
H. J. Whitman

Inventor,

Frank J. Sprague.

by *Thomas Ewing Jr.*
Attorney.

No. 647,241.

Patented Apr. 10, 1900.

F. J. SPRAGUE.
BRAKE FOR HOISTING MECHANISM.

(Application filed Sept. 20, 1899.)

(No Model.)

Fig. 1.

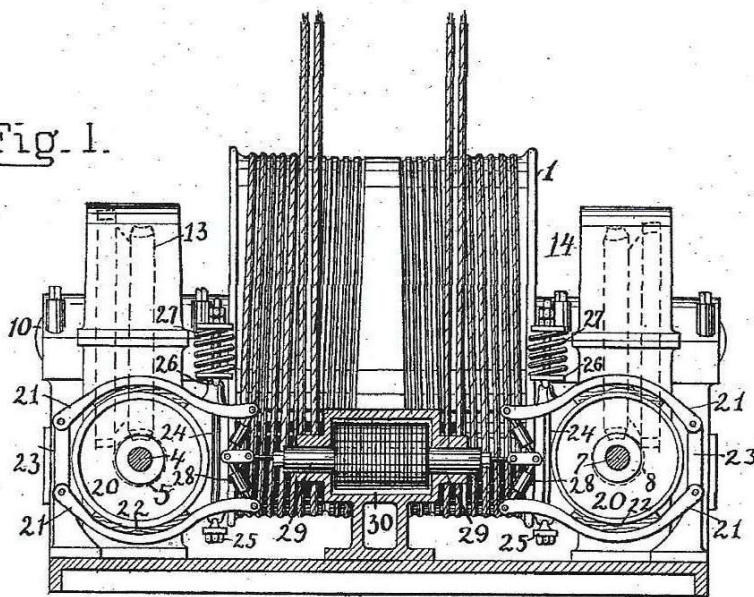
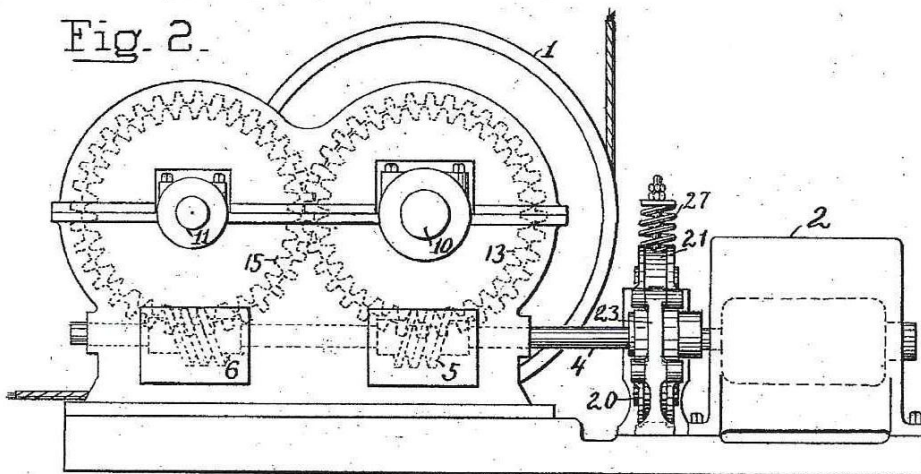


Fig. 2.



Witnesses:
Samuel W. Balch
Hytt. Whitman

Inventor,
Frank J. Sprague
By *Thomas Ewing Jr*
Attorney.

No. 647,242.

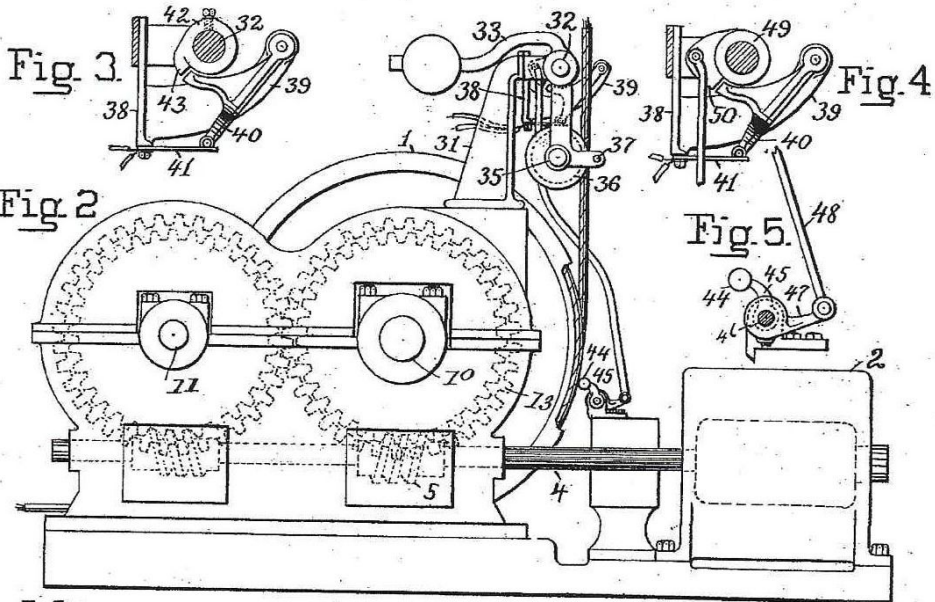
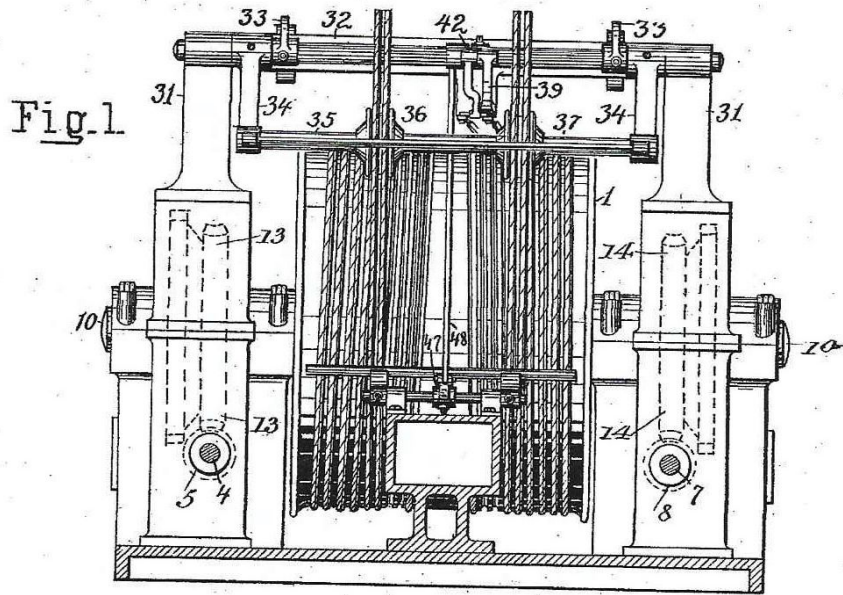
Patented Apr. 10, 1900.

F. J. SPRAGUE.
CABLE WINDING SAFETY DEVICE.

(Application filed Sept. 20, 1899.)

(No Model.)

2 Sheets—Sheet 1.



Witnesses:
Samuel W. Balch
Hy H. Whitman

Inventor,
Frank J. Sprague,
by *Thomas Ewing, Jr.,*
Attorney.

No. 716,953.

Patented Dec. 30, 1902.

F. J. SPRAGUE.
ELECTRIC ELEVATOR.

(Application filed Oct. 29, 1894.)

8 Sheets—Sheet 1.

(No Model.)

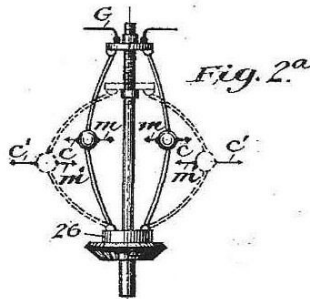
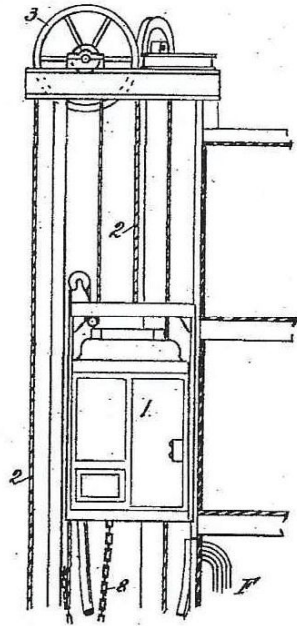
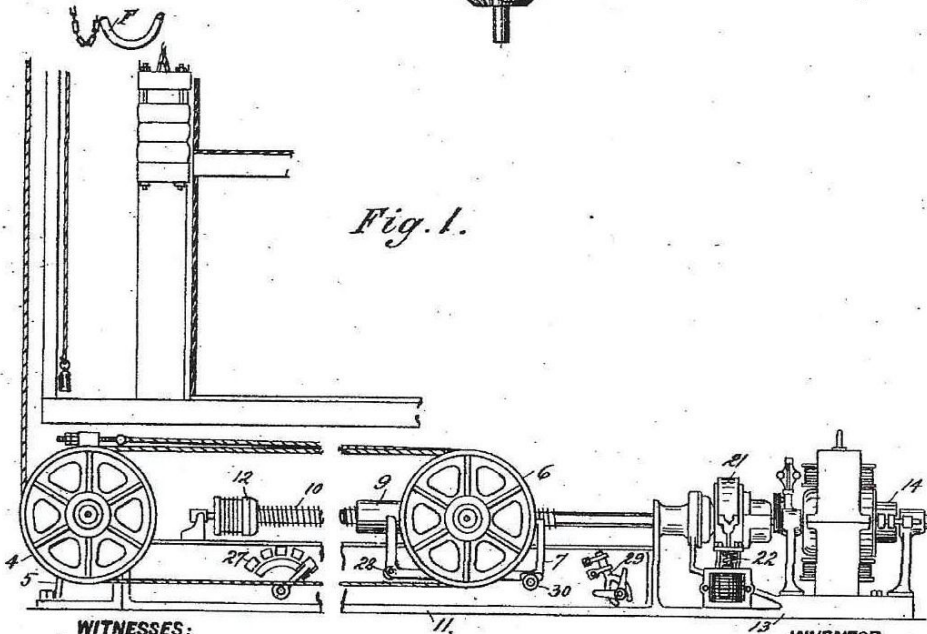


Fig. 1.



WITNESSES:

Samuel W. Balch
H. Rydquist.

INVENTOR

Frank J. Sprague.
BY
Thomas Ewing Jr.,
ATTORNEY

No. 716,953.

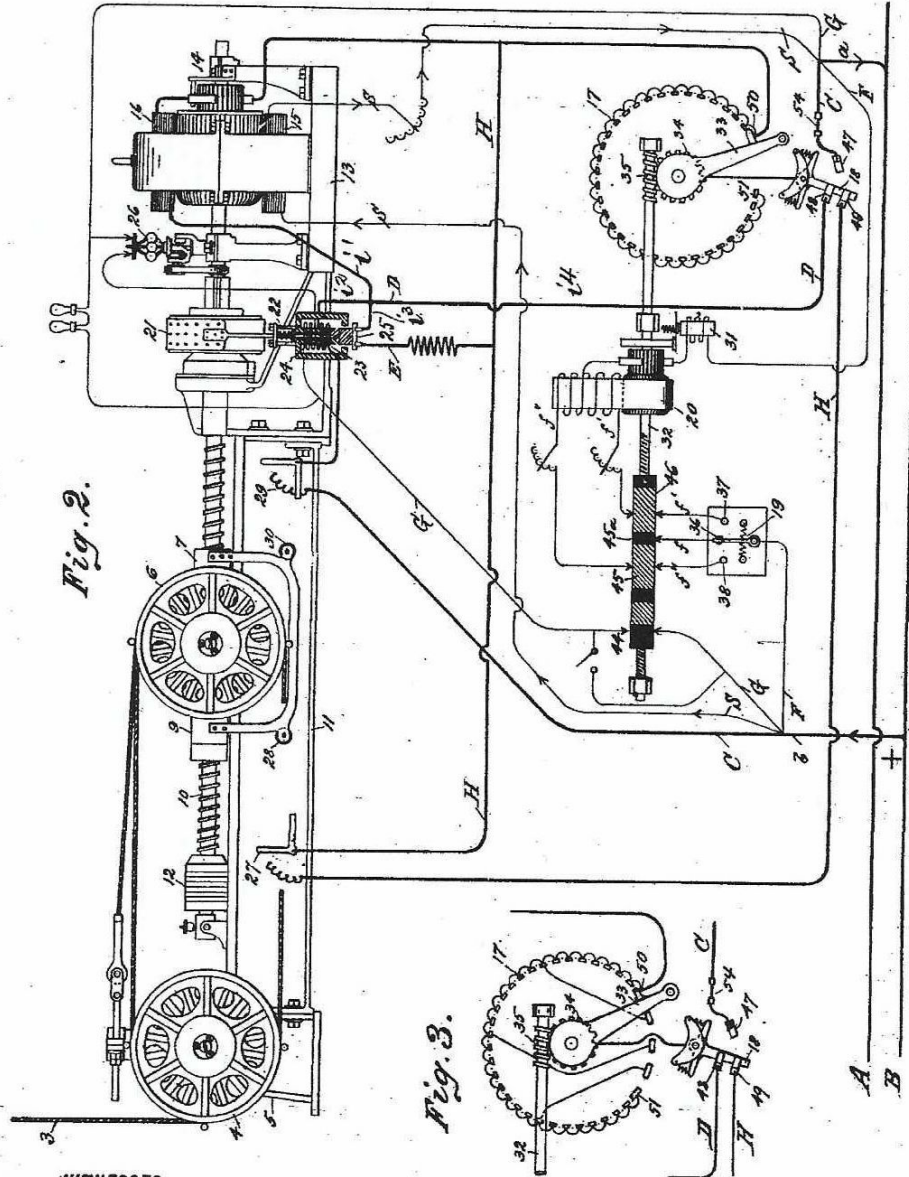
Patented Dec. 30, 1902.

F. J. SPRAGUE.
ELECTRIC ELEVATOR.

(Application filed Oct. 29, 1894.)

(No Model.)

8 Sheets—Sheet 2.



WITNESSES:

H. Pydquist.
Samuel W. Balch

INVENTOR

Frank J. Sprague
BY
Thomas Ewing, Jr.
ATTORNEY

June 10, 1930.

F. J. SPRAGUE

1,763,198

DUAL ELEVATOR SYSTEM AND CONTROL

Filed Dec. 31, 1926

7 Sheets-Sheet 1

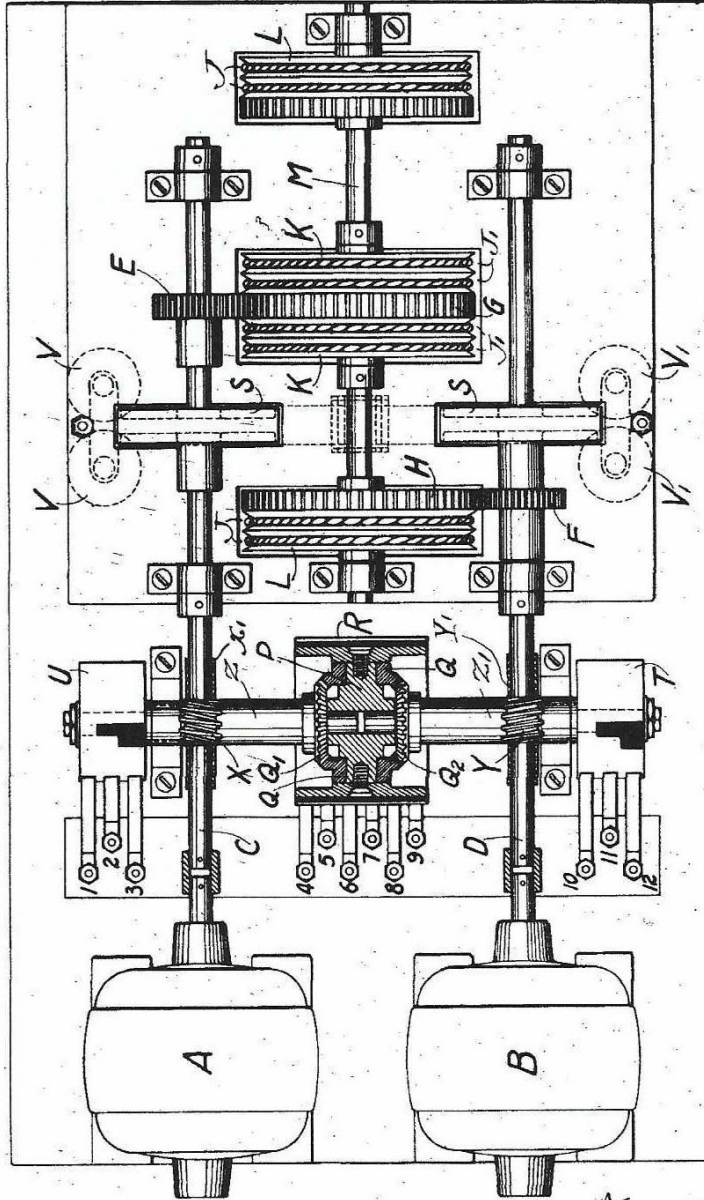


Fig. 1.

F. J. Sprague
INVENTOR.

BY *Dorsey & Cole*
ATTORNEYS.

Aug. 21, 1934.

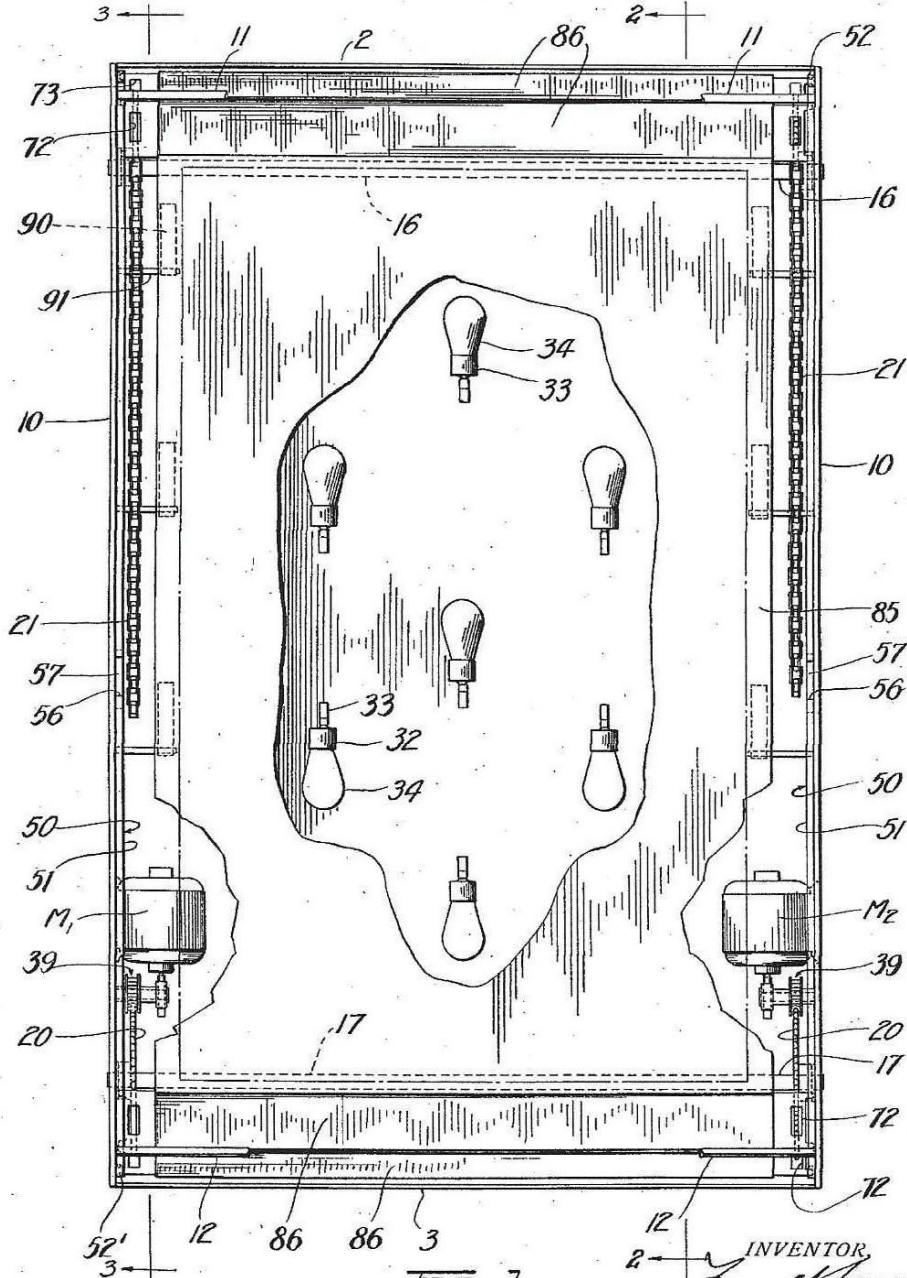
F. J. SPRAGUE

1,971,281

DISPLAY DEVICE

Filed Jan. 30, 1933

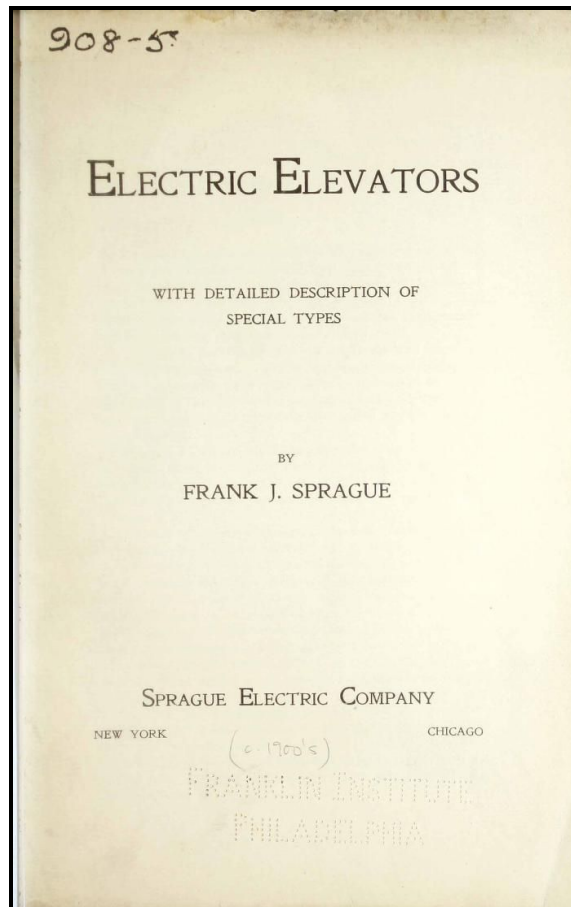
4 Sheets-Sheet 1



INVENTOR
F. J. Sprague
BY
Dorey & Cole
ATTORNEYS.

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- 1996 *Rise of the New York Skyscraper, 1865-1913*, Sarah Bradford Landau & Carl W Condit, Yale University Press
- 2001 *Otis: Giving Rise to the Modern City*, Jason Goodwin, United Technologies Corporation
- 2009 *Frank Julian Sprague: Electrical Inventor & Engineer*, William D Middleton & William D Middleton III, Indiana University Press
- *US Patent Office Records*
- *Park Row Building*, Wikipedia
- *Frank J Sprague*, Wikipedia



1900s

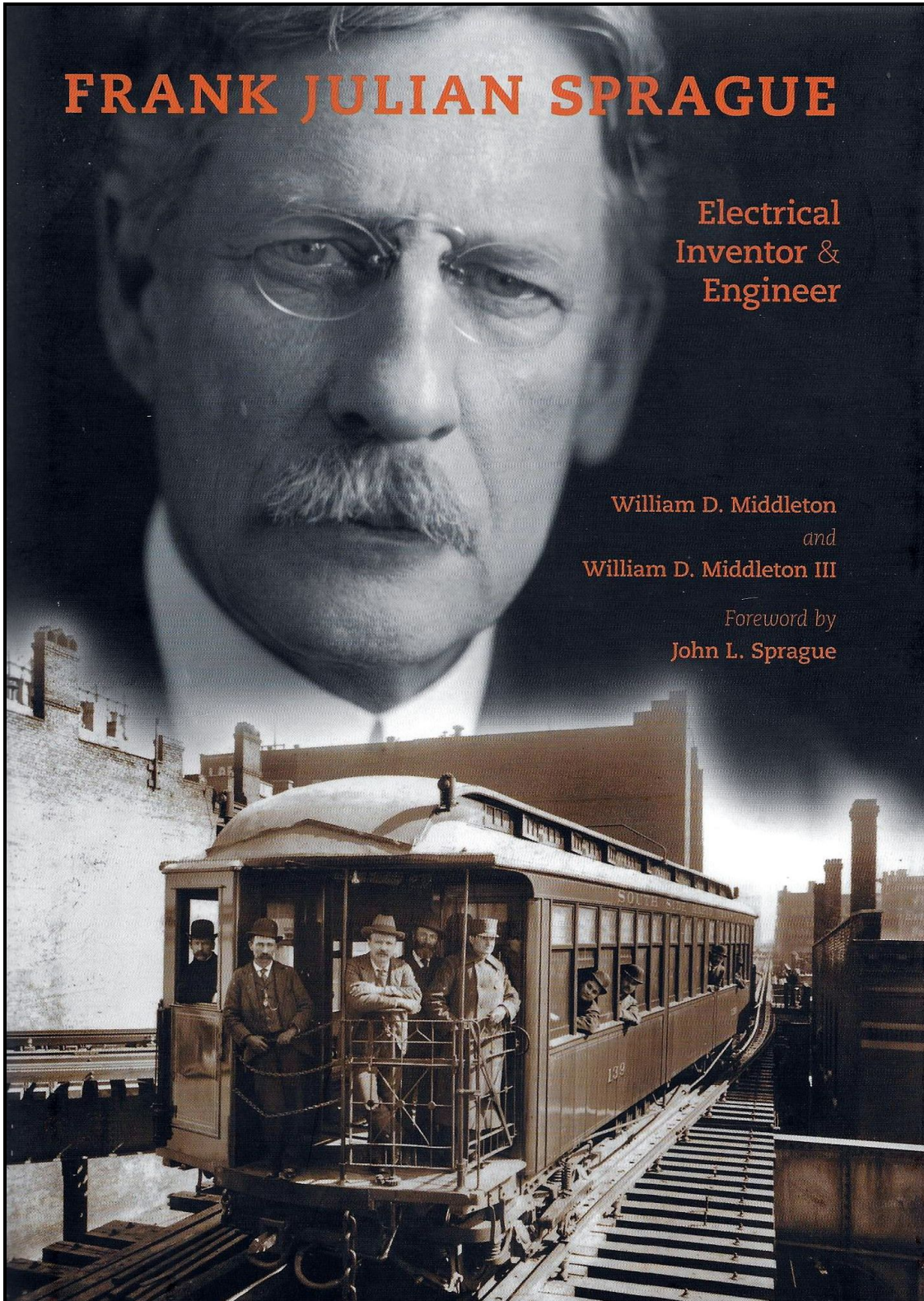
BIBLIOGRAPHY

FRANK JULIAN SPRAGUE

Electrical
Inventor &
Engineer

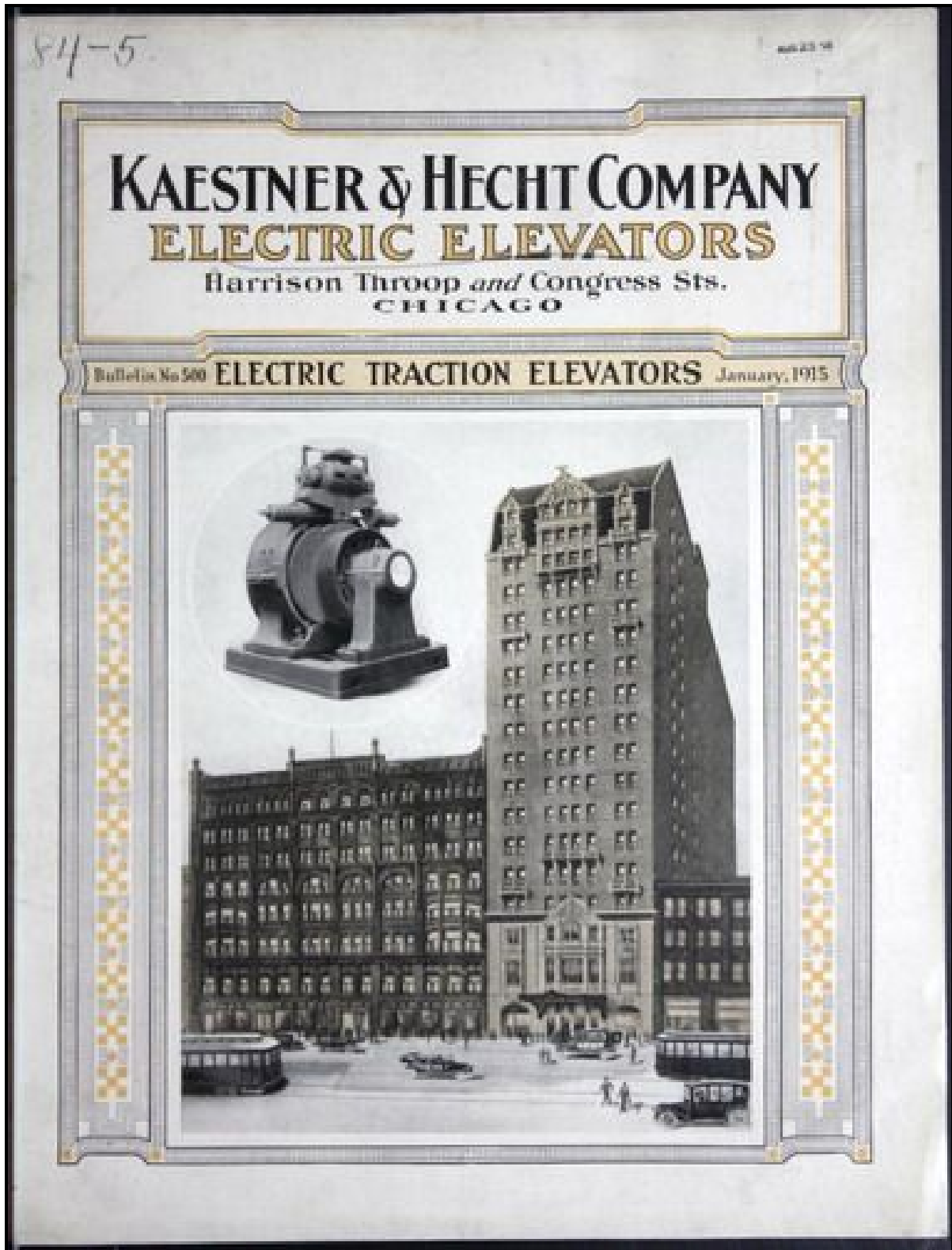
William D. Middleton
and
William D. Middleton III

Foreword by
John L. Sprague



2009

ELEVATOR PUBLICATIONS



ELEVATOR PUBLICATIONS

EDWIN F. MORSE,
President

W. F. SAUTER,
Vice President

C. BEARDS,
Secretary

G. R. BERMAN,
Treasurer

MORSE, WILLIAMS & Co.

BUILDERS OF

Passenger and Freight Elevators

OF EVERY DESCRIPTION.

1105 Frankford Avenue, PHILADELPHIA.

408 Liberty Street, NEW YORK.

82 Church Street, NEW HAVEN.

19 Pearl Street, BOSTON.

414 Spruce Street, SCRANTON.

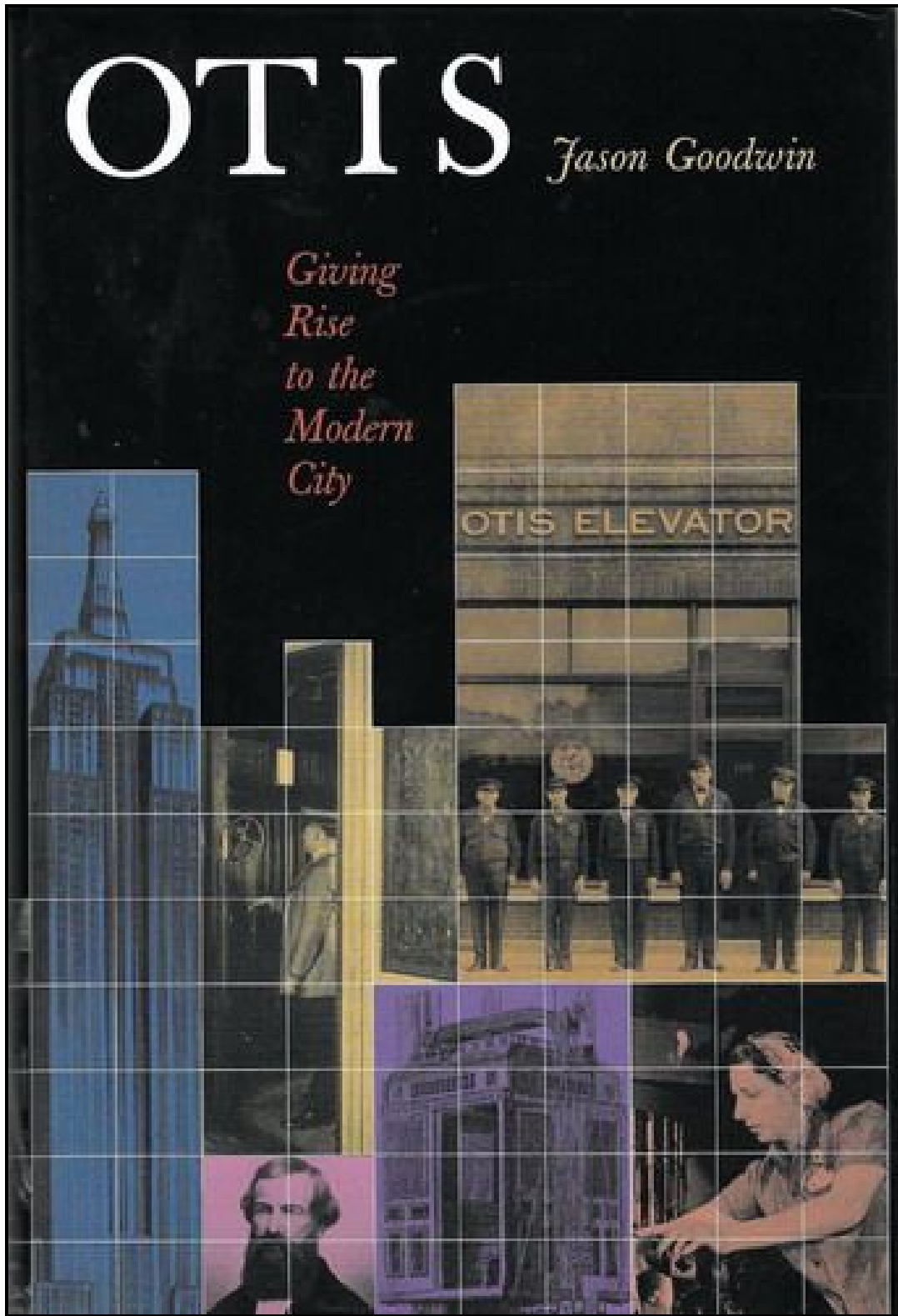
411 Fourth Avenue, PITTSBURGH.

Builders' Exchange, BALTIMORE.

ELEVATOR PUBLICATIONS



About 1900



EPILOGUE



On 25th October, 1934, Frank Sprague died in his New York Home. He was buried at Arlington National Cemetery in Arlington, Virginia. Harriet Sprague survived her husband by 35 years and she was interred beside him after her death in 1969.

Frank Sprague received many Awards and Honours:

Awards

Gold Medal, Paris Exposition, 1889

Elliot Cresson Medal, Franklin Institute, 1904

Grand Prize, Louisiana Purchase Exposition, St Louis, 1904

Edison Medal, American Institute of Electrical Engineers, 1910

The Franklin Medal; The Franklin Institute, 1922

Frank Julian Sprague Bronze Portrait Bust, Interborough Rapid Transit Co, 1934

John Fritz Medal from four National Engineering Societies

Honorary Degrees

Doctor of Engineering (D.Eng), Stevens Institute of Technology, 1921

Doctor of Science (D.Sci), Columbia University, 1922

Doctor of Laws (LL.D), University of Pennsylvania

Distinguished Offices and Memberships

President, American Institute of Electrical Engineers, 1892-93

Member, Board of Visitors, US Naval Academy, 1906

Honorary Membership; The Franklin Institute, 1911

Honorary Membership, American Institute of Electrical Engineers, 1932

President, New York Electrical Society

President, American Institute of Consulting Engineers

President, Inventors' Guild

