

# GEORGE WESTINGHOUSE ENGINEER & ENTREPRENEUR

by Brian Roberts, CIBSE Heritage Group

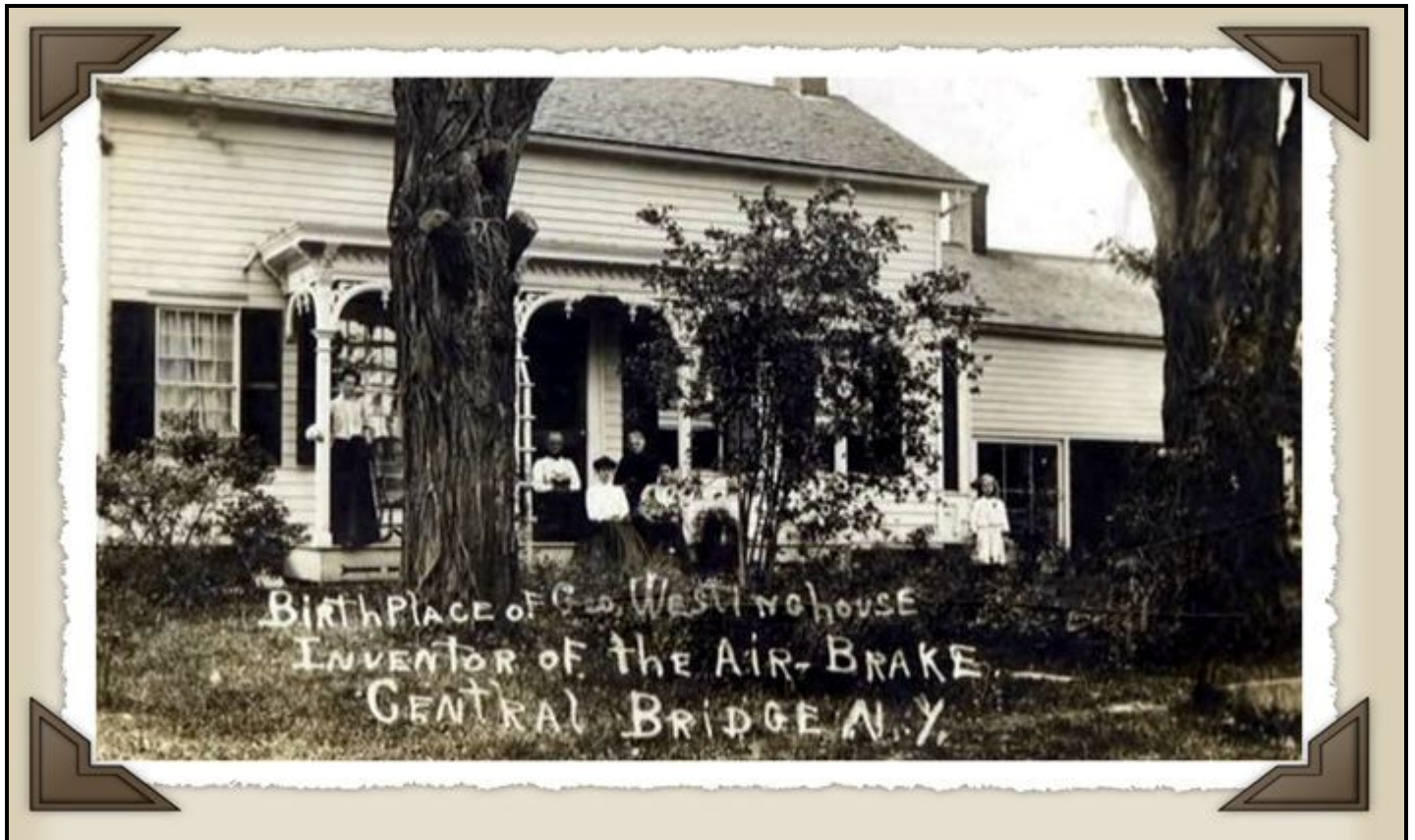


*George Westinghouse, 1846-1914*

George Westinghouse was born on the 6<sup>th</sup> October, 1846, in Central Bridge, New York, the son of George Westinghouse Sr. and Emiline (Vedder). He was eighth out of ten children. His father was the owner of a machine shop and this probably the reason why son George was talented with machinery and in business



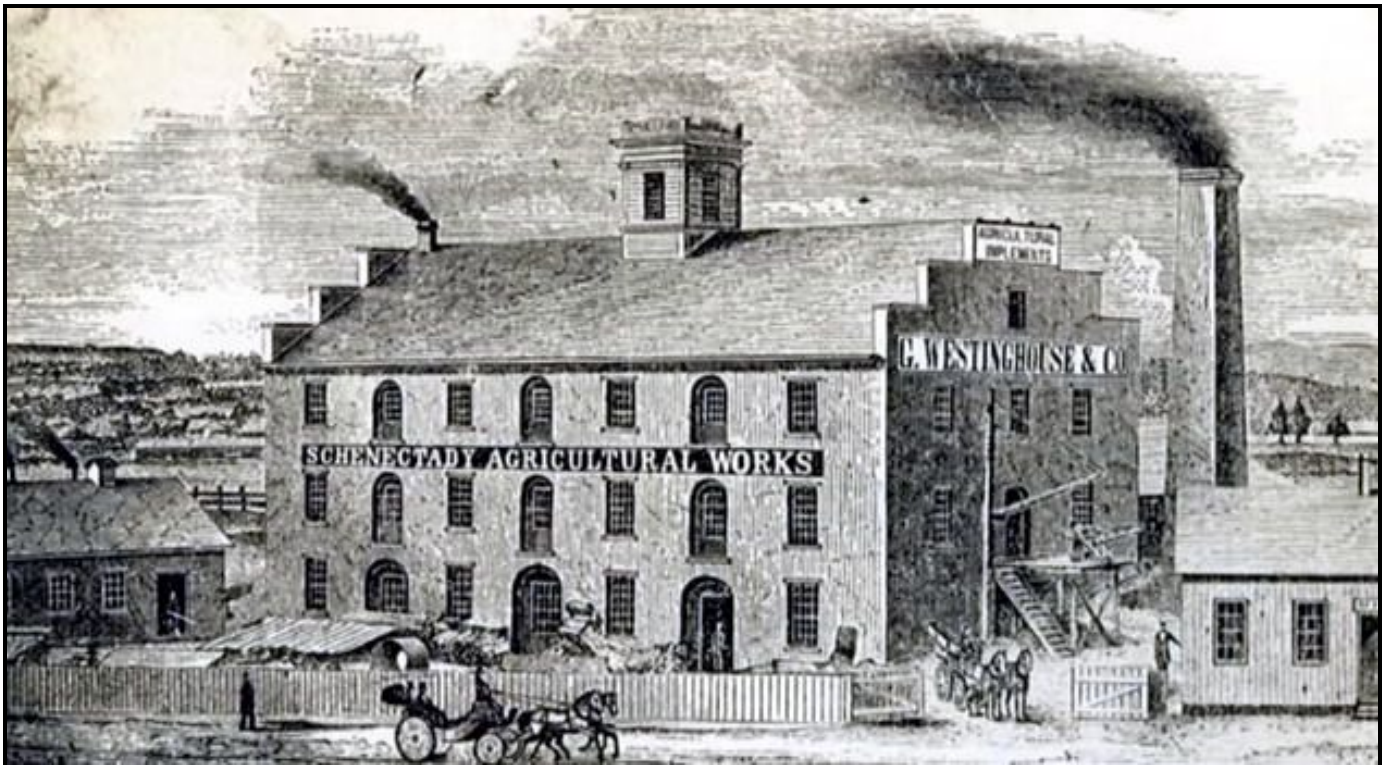
*The young George Westinghouse Junior*



*Central Bridge, New York, birthplace of George Westinghouse*

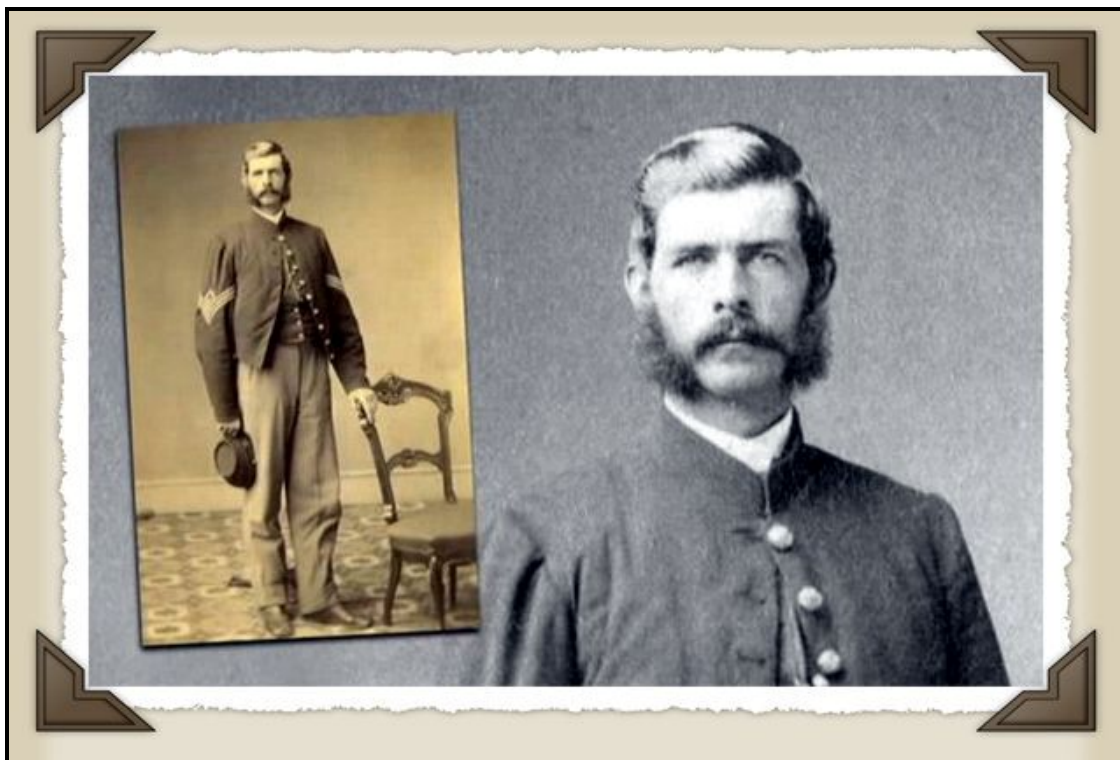
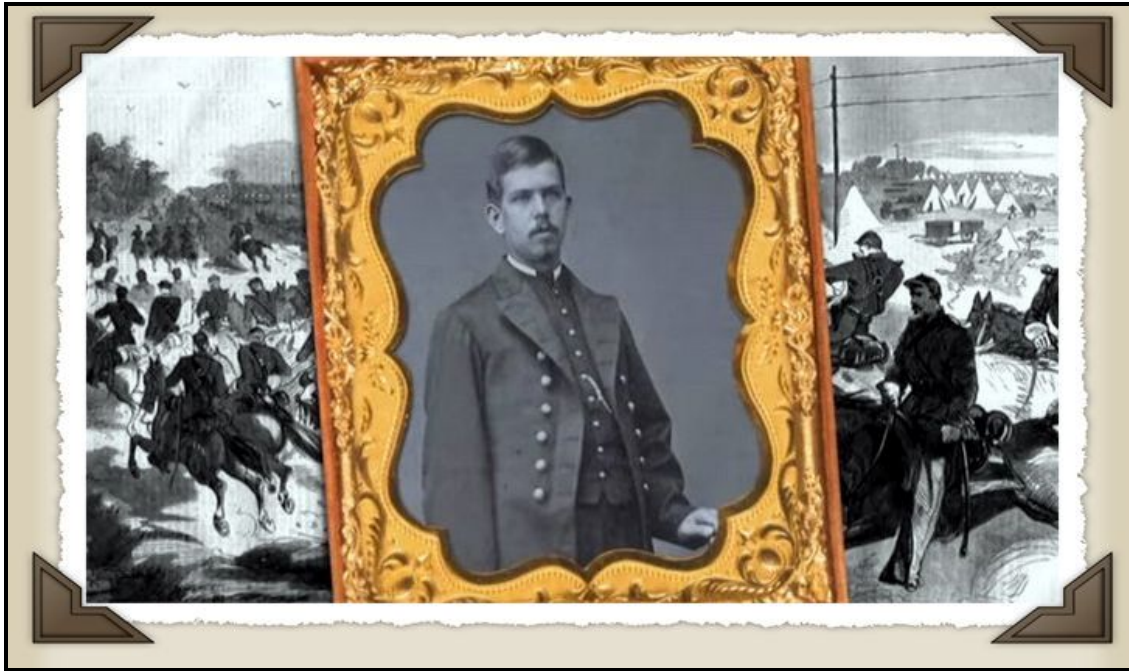


*George Westinghouse Senior and his wife Emiline*

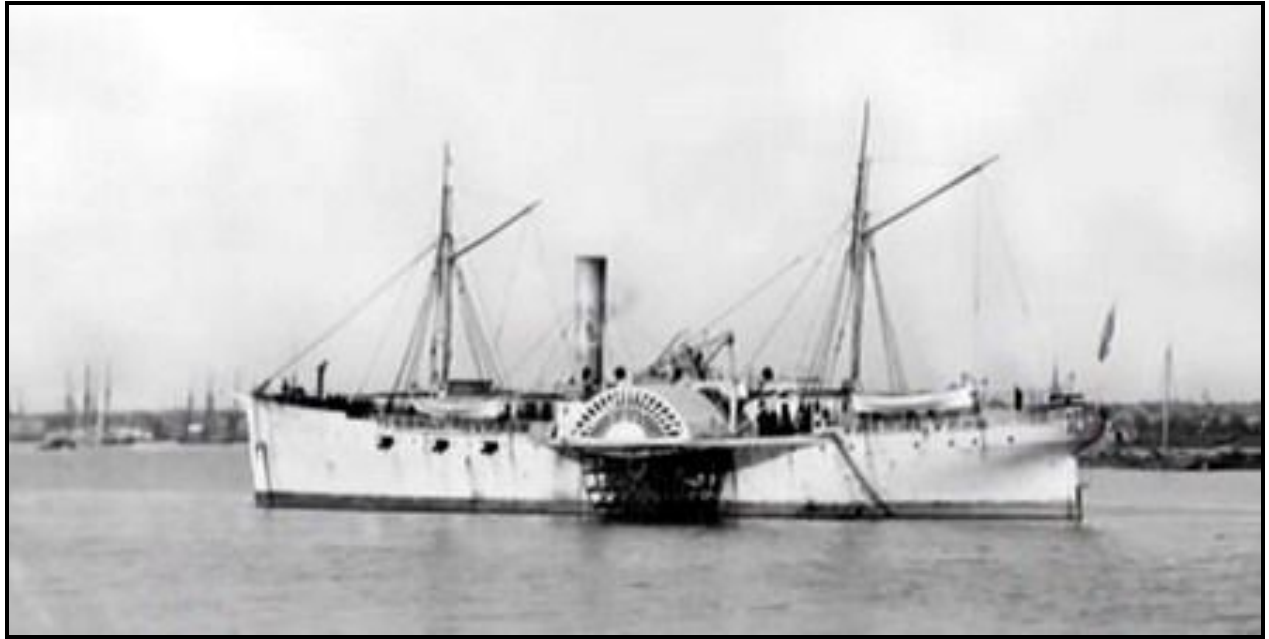


*The Schenectady Agricultural Works of George Westinghouse (Senior)*

He was 15 when the Civil War broke out and he enlisted in the New York National Guard until his parents convinced him to return home. In April 1863, his parents allowed him to re-enlist and he joined Company M of the 16<sup>th</sup> New York Cavalry, earning promotion to Corporal. In December 1864, he resigned and joined the Navy where he served as Acting Third Assistant Engineer on the gunboat *USS Muscoota* until the end of the war.



*George Westinghouse in the military*



*The gunboat USS Muscoota*

In August 1865, Westinghouse returned to his family in Schenectady and enrolled at Union College, but dropping out during his first term. He was still only 19 when he invented a rotary steam engine and devised the *Westinghouse Farm Engine*.

At the age of 21, he invented the first of many devices for the railway industry. This was a piece of equipment (a *car replacer*) to guide derailed railway carriages or waggons back onto the tracks. He followed this with his *reversible frog*, a device used as a railway points switch to guide trains onto one of two tracks.



*In 1867, Westinghouse met and married Marguerite Erskine Walker.*

George and Marguerite were married for 47 years and had one son, George Westinghouse III, who had six children. The couple made their first home in Pittsburgh, later acquiring houses in Lenox, Massachusetts (where they summered) and in Washington D.C.



*The Westinghouse home "Solitude" in Pittsburgh*



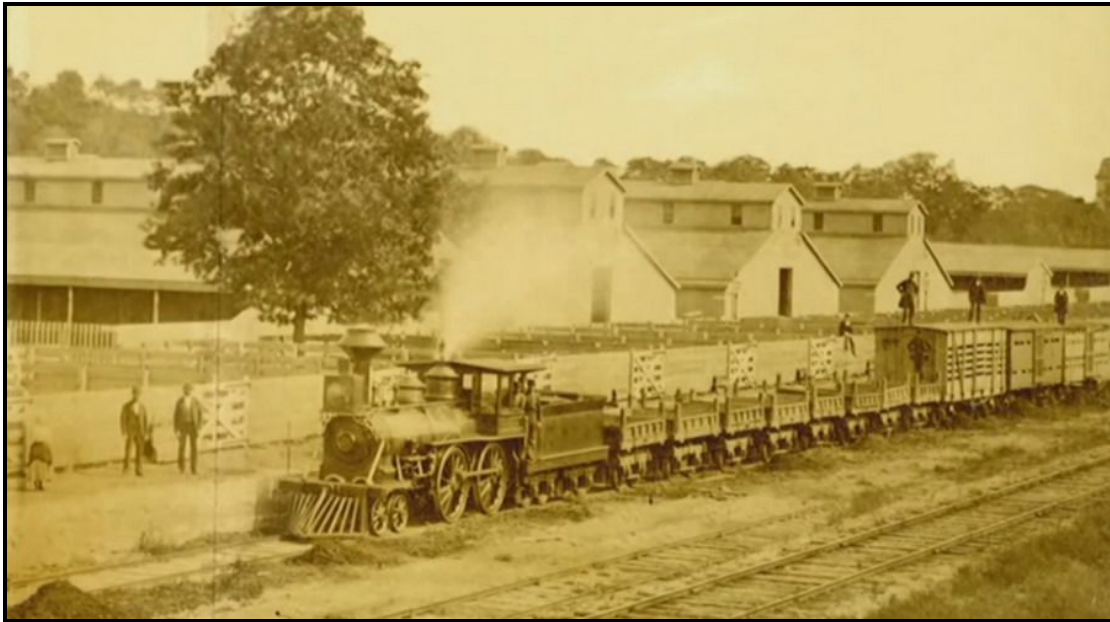
*Mrs Marguerite Westinghouse*



*Employees at an early Westinghouse factory*



*A typical early train crash due to inadequate brakes*



*Brakeman stood on top of the railway carriages and freight waggons*

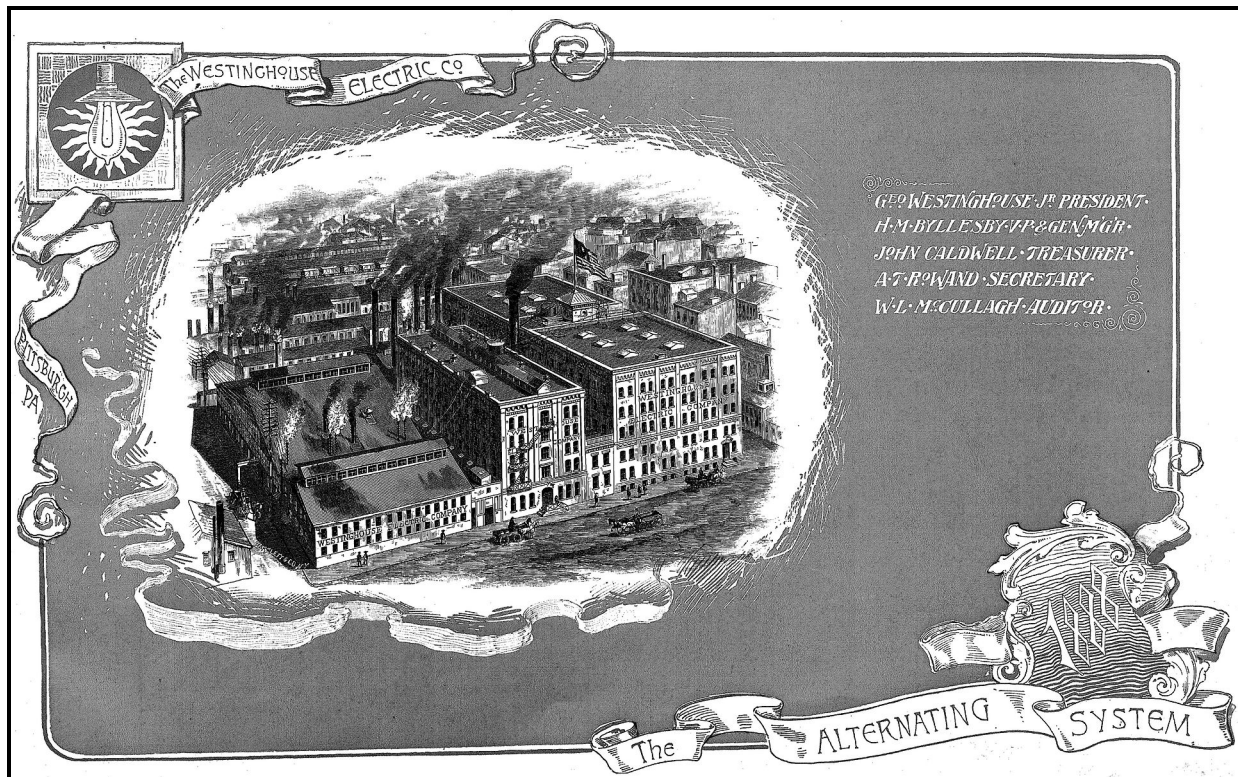
Before Westinghouse invented the rail safety brake (and made his fortune), trains were stopped by brakemen standing on top of the carriages or freight waggons and braking each individually. It was a dangerous and badly paid job and many men lost their lives, their families receiving no compensation. Patented by Westinghouse in 1873 it was, in time, adopted by the railway industry.



After his interests in railway systems, in natural gas distribution and telephone switching, Westinghouse looked into electrical power distribution. In 1884, he began developing his own DC lighting system using the services of William Stanley. However, in 1885, he became aware of European work on AC systems and recognised the advantages of using transformers to *step up* the voltage for long distance power distribution and then *step down* at the consumer. This method overcame the disadvantages of Edison's DC system which could only be distributed about a mile and required multiple generating stations.

In 1885, Westinghouse imported a number of Gaulard-Gibbs transformers and a Siemens AC Generator from Europe. William Stanley developed these transformers into the first practical AC design. Then in 1886, Westinghouse established the "Westinghouse Electric & Manufacturing Company" renaming it, in 1889, as "Westinghouse Electric Corporation." By the end of 1887, the Company had 68 AC power stations compared with Edison's 121 DC stations. This led to a bitter confrontation between the two systems which became known as the *Battle of the Currents*.

Westinghouse had another rival, the Thomson-Houston Electric Company who had also bought out a third AC competitor, the Brush Electric Company. They came to an arrangement with Westinghouse to avoid commercial conflicts. Thomson-Houston paid a royalty to use the Stanley transformer patent while allowing Westinghouse to use their Sawyer-Man incandescent lamp patent.

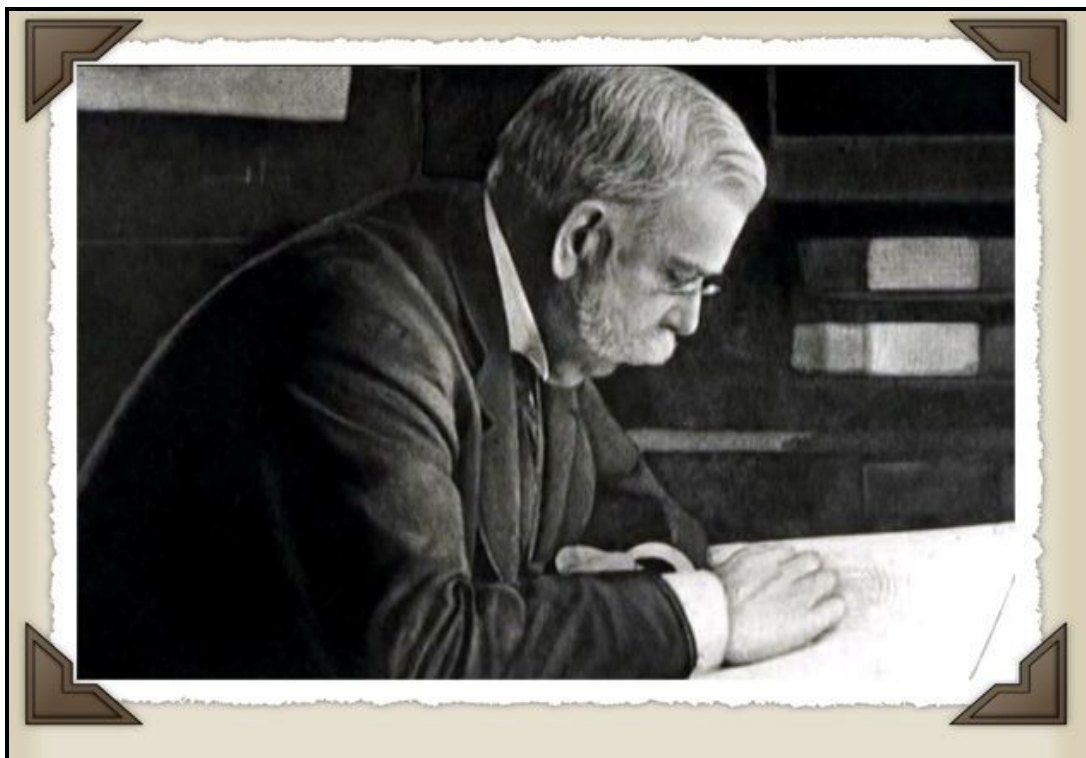


*The Westinghouse Electric Company Factory in Pittsburgh, c. 1889*

The *Battle of the Currents* ended when Edison insisted on developing DC and refused to have anything to do with AC, against the wishes of his financial backers, who by 1892 had taken control of the Edison Machine Works and merged it with Thomson-Houston to form General Electric.



*Westinghouse and the Tesla Polyphase System*

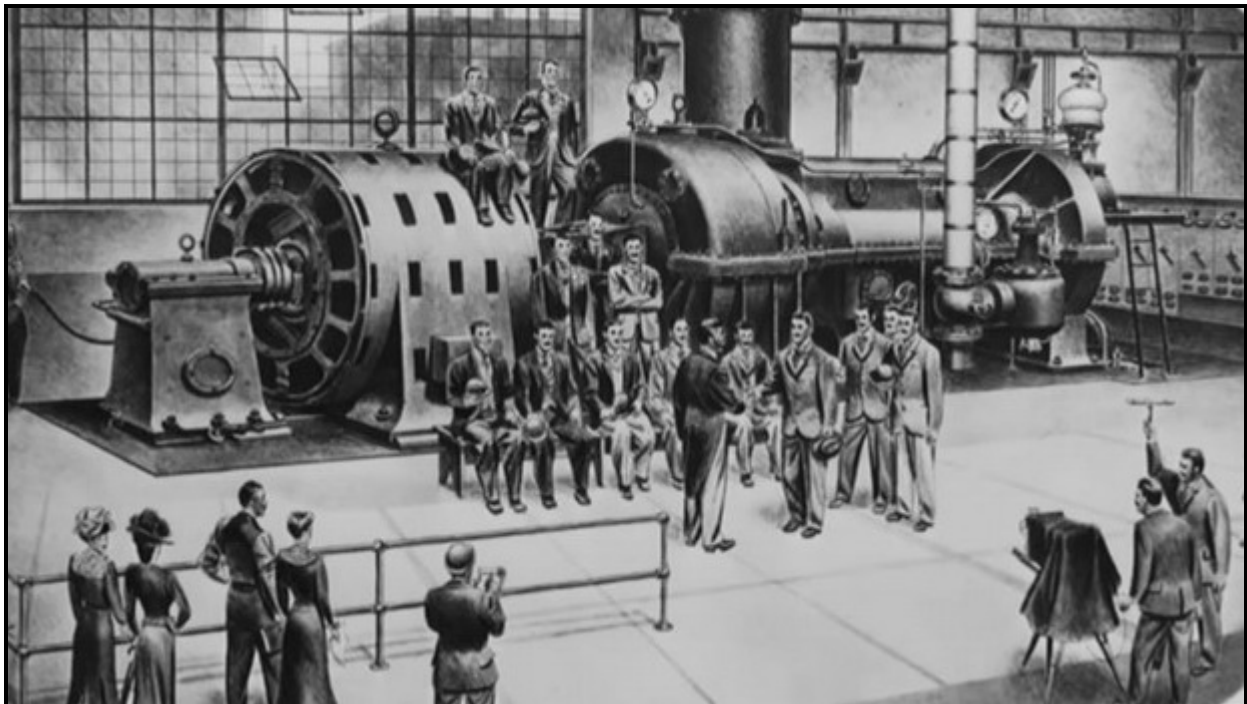


*George Westinghouse at work*

## NIKOLA TESLA & THE AC MOTOR

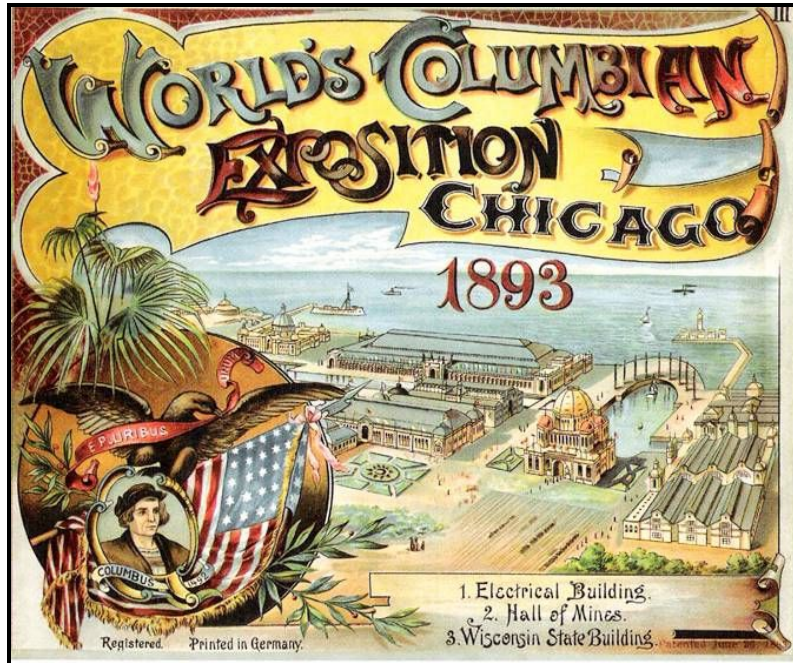
Nikola Tesla (1856-1943) a brilliant electrical engineer, born in Serbia, came to the United States in 1884, initially working for Thomas Edison who refused to accept new ideas relating to the possibilities of AC systems and unable, because of his poor grasp of mathematics, to understand the theory of such systems. Then when Edison failed to pay Tesla a promised bonus for successfully completing a number of tasks (Edison said it was all a joke), Tesla left.

In 1888, Tesla demonstrated a polyphase brushless AC induction motor, the one item that Westinghouse needed to market a completely AC power system. Tesla sold George Westinghouse forty of his patents for \$1,000,000 and having learned more about business, after his bad experiences with Edison, he also negotiated a one dollar per horsepower royalty payment (though he never did collect the latter). Tesla took a job as a consultant with Westinghouse in Pittsburgh but disagreed with William Stanley on how to develop his motor. Stanley wanted to design for a 133 Hz single-phase system which favoured his transformers. Tesla knew that 60 Hz and a two-phase solution produced a better motor design. So Tesla left and went back to New York, leaving Westinghouse to develop larger and larger AC machines.

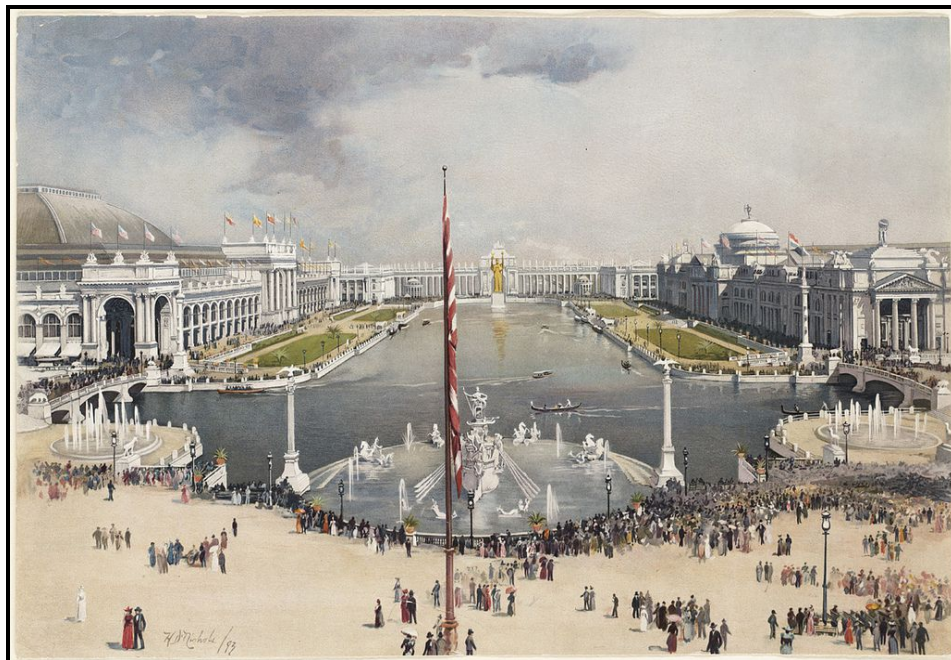


*Building electrical machines at Westinghouse*

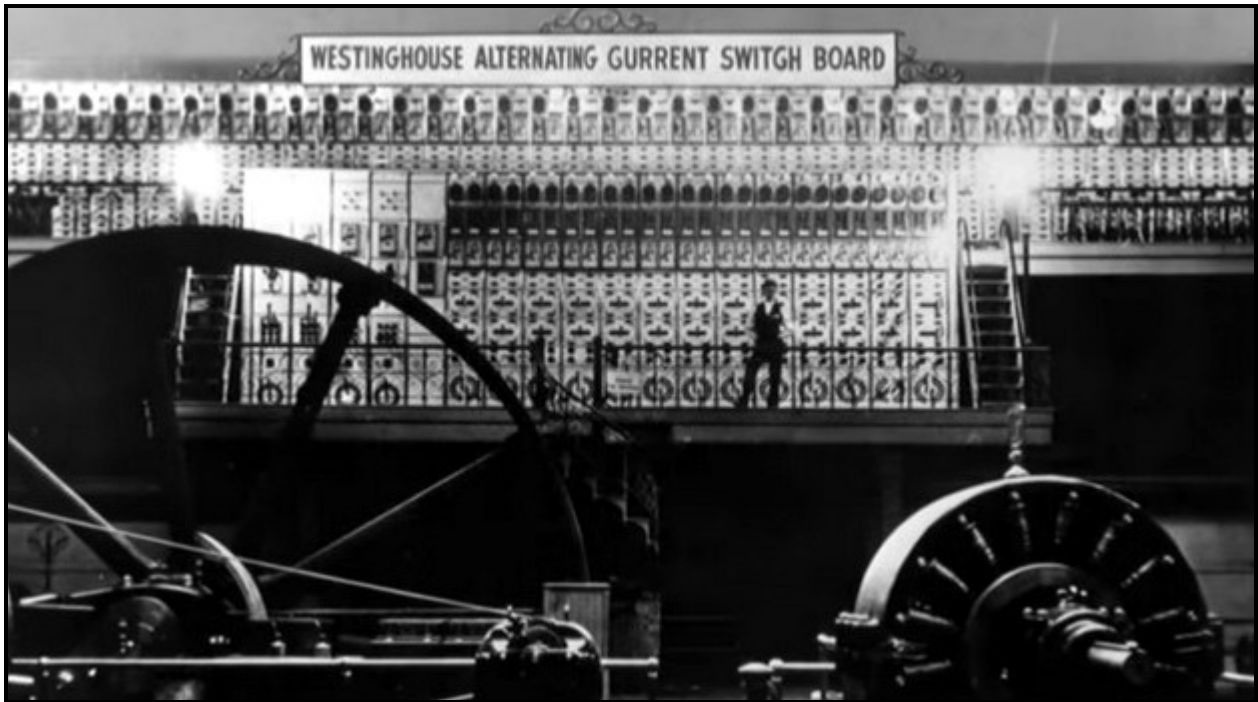
## WORLD'S COLUMBIAN EXPOSITION



In 1893, George Westinghouse won the bid to light the World's Columbian Exposition in Chicago with an offer of one million dollars using AC, half the cost of Edison's DC proposal. Then Edison won a court case, claiming that Westinghouse lamps infringed his patents. Westinghouse quickly developed an alternative lamp and when the Exposition opened "there were 86,620 Westinghouse incandescent lamps, powered by Tesla generators, lighting up the fairground." This success was instrumental in Westinghouse being awarded the contract for a giant two-phase AC generating plant, the Adams Power Pant, at Niagara Falls in 1895.



*The Chicago Exposition*



*The Westinghouse Alternating Current Switchboard at the Chicago Fair*



*A Westinghouse display at the Chicago Fair*

## NIAGARA FALLS POWER STATION



*In 1897, the famous Lord Kelvin (centre) visited George Westinghouse*

Lord Kelvin had previously been head of the Commission to advise on whether the Niagara Power Plant should be DC or AC. He favoured DC until having visited the Columbian Exposition he became convinced of the superiority of AC. Westinghouse was awarded the contract for the Niagara Falls Power Station in 1893



*The opening of the first phase of the Niagara Falls hydroelectric power plant in 1896*



*Niagara Falls Power Station which transmitted AC at 22 kV to Buffalo some 22 miles away and later to New York a distance of over 300 miles*



*The Edward Dean Adams Power Station at Niagara Falls with ten 5000 horsepower Tesla-Westinghouse AC generators*

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"Yas; that's the one I wish."  
"Bress yo' soul, yo' kin take rite holt ob de pump den; I's resigned."

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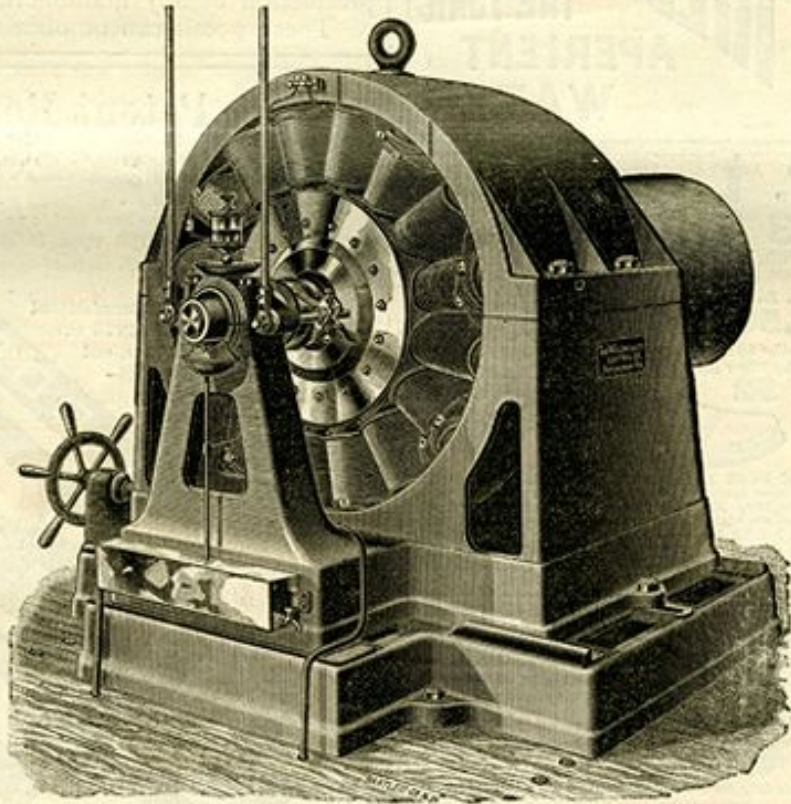
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WILBUR'S



# THE ALTERNATING SYSTEM.

**Incandescent Electric Lighting from Central Stations made Universal, Economical, and Profitable, irrespective of distance.**

## The Westinghouse Electric Co.,

PITTSBURGH, PA.

Eastern Office, 17 CORTLANDT STREET, NEW YORK.

**WILBUR'S**

**DEAFNESS**

Its causes, and a new and successful CURE at your own

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*Mrs Marguerite Westinghouse*



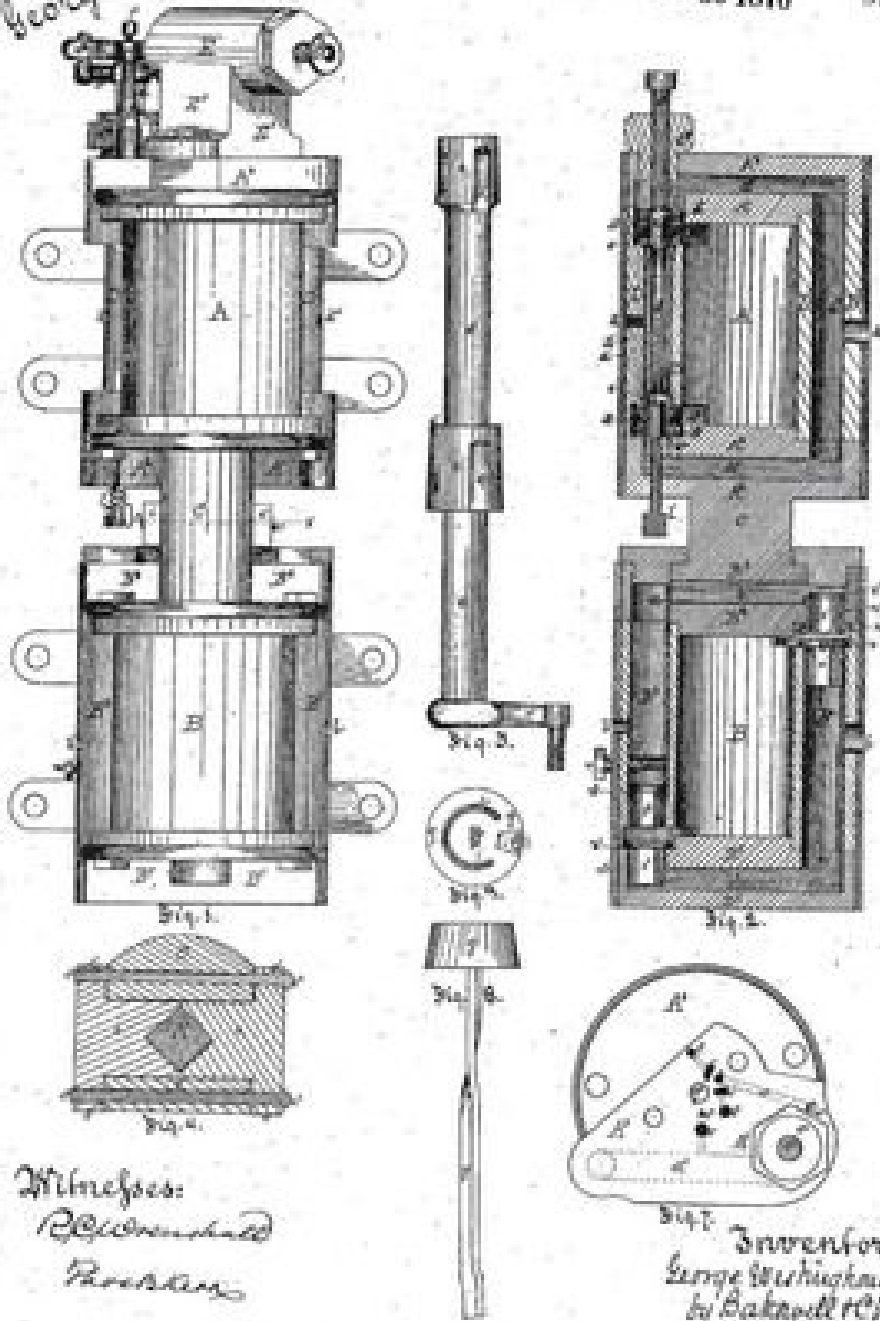
*Mr and Mrs George Westinghouse*

APPENDIX I: WESTINGHOUSE U.S.PATENTS

106899

Sheet 1

George Westinghouse Jr.: Improv in Steam Engine & Pump  
Patented Aug 30 1870



Witnesses:  
R. C. ...  
R. ...

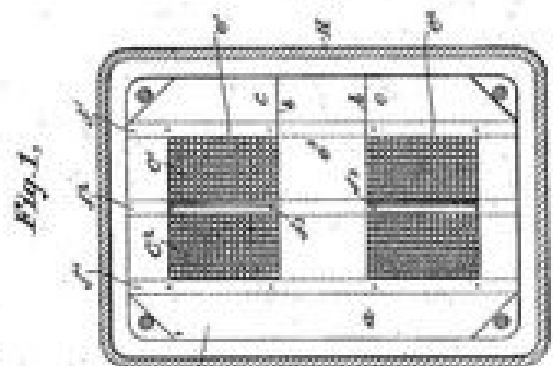
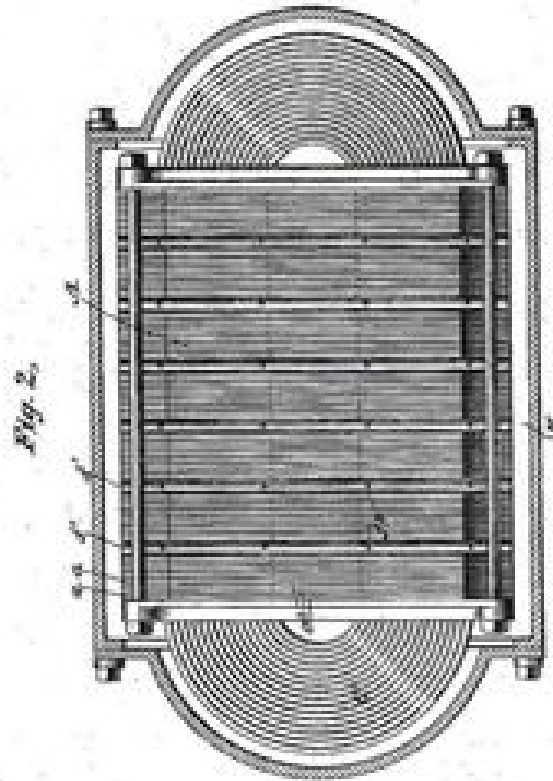
Inventor:  
George Westinghouse Jr.  
by Bakewell & Christy  
his Attys.

(No Model.)

G. WESTINGHOUSE, Jr.  
ELECTRICAL CONVERTER.

No. 366,362.

Patented July 12, 1887.



Witnesses

*Geo. W. Brewster*  
*Samuel C. Ashby*

Inventor

By his Attorney

*George Westinghouse Jr.*  
*Robert C. Spencer*

(No Model.)

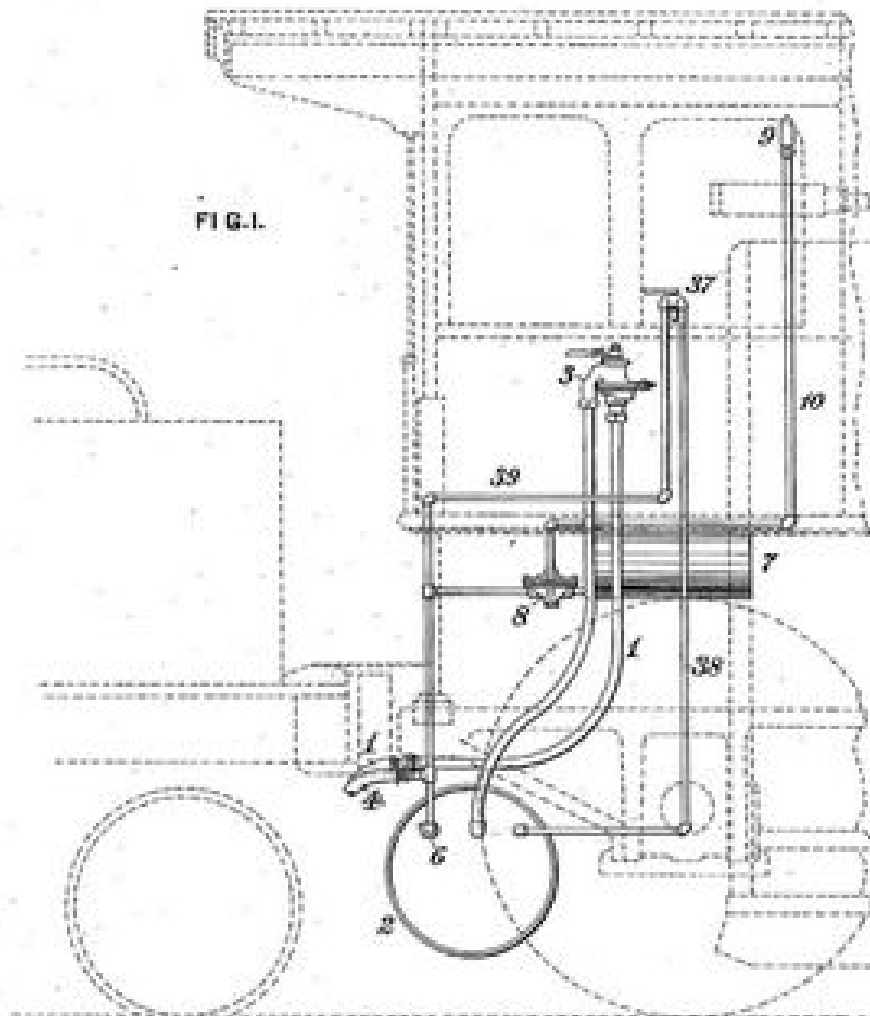
5 Sheets—Sheet 1.

G. WESTINGHOUSE, Jr.

FLUID PRESSURE AUTOMATIC BRAKE MECHANISM.

No. 425,059.

Patented Apr. 8, 1890.



WITNESSES:

*R. H. [Signature]*  
*J. C. [Signature]*

INVENTOR,

*G. Westinghouse Jr.*  
*by J. [Signature]*  
ATTY.

(No Model.)

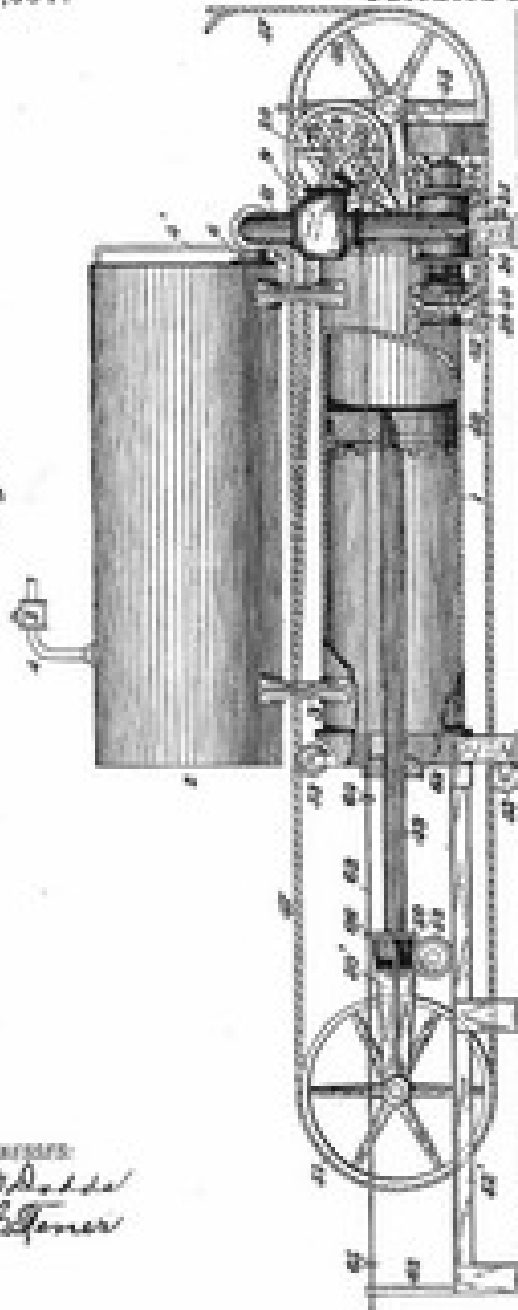
3 Sheets—Sheet 1.

G. WESTINGHOUSE, Jr.  
ELEVATOR.

No. 595,007.

Patented Dec. 7, 1897.

*Fig. 1.*



WITNESSES:  
*Edwin D. Potter*  
*Robert C. Jones*

INVENTOR  
*George Westinghouse*  
BY  
*A. L. Brown*  
ATTORNEY.



W. E. SAWYER & A. MAN.

ELECTRIC LIGHT.

No. 317,676.

Patented May 12, 1885.

Figure 2.

Figure 3.

Figure 4.

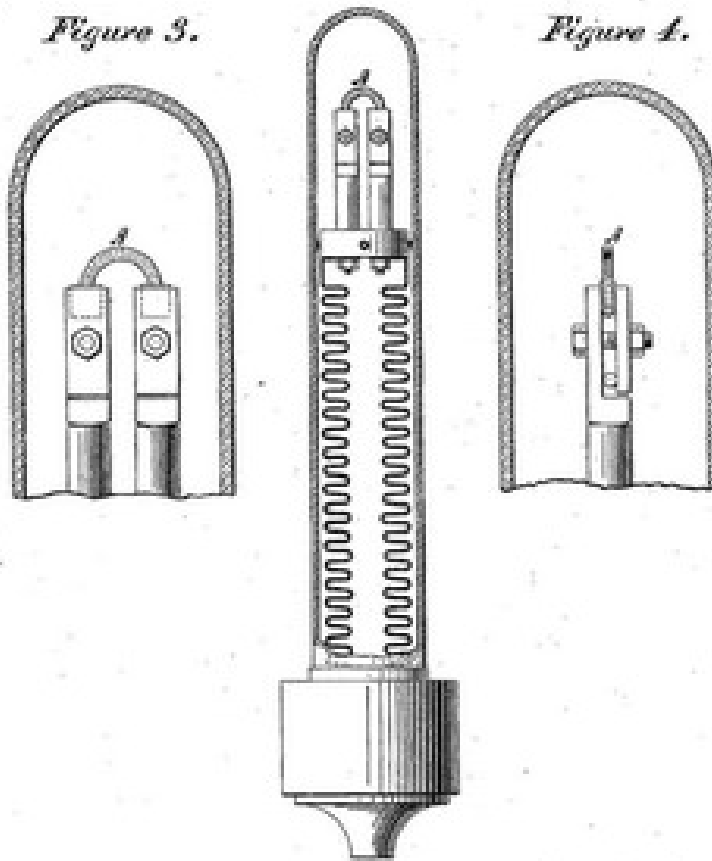


Figure 1.

Witnesses:

*Geo. H. Smith*  
*Jas. G. Cooper*



Inventors:

*W. E. Sawyer*  
*A. Man*  
*W. L. Baldwin*

## APPENDIX II: BENJAMIN G. LAMME



*Benjamin Garver Lamme, 1864-1924*

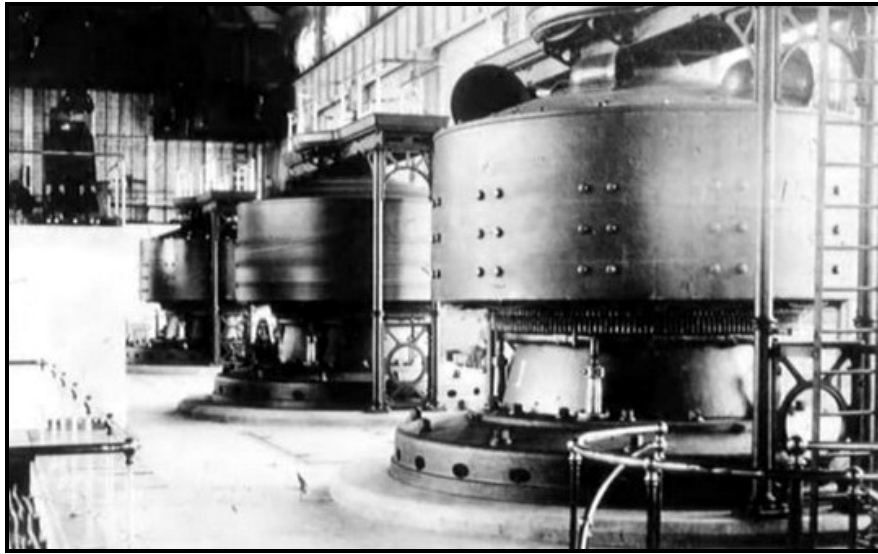
*He spent the whole of his working life with Westinghouse, making significant technical contributions to the success of the Company in the fields of electrical engineering*

Lamme was born on a farm near Springfield, Ohio, on the 12<sup>th</sup> January, 1864 and from an early age experimented with machinery. In 1883, he graduated from the Olive Branch High School near New Carlisle in Ohio and then entered Ohio State University, gaining an engineering degree in 1888.

In 1889, Westinghouse employed him for his Philadelphia Natural Gas Company in Pittsburgh, but a few months later transferred him to the Westinghouse House Electric Company, where he took over the project of developing a practical version of Nikola Tesla's patented induction motor. Lamme came up with a more efficient design and, over several years, designed a variety of electric motors and generators. He designed the 5000 kW giant hydroelectric generators for the Adams Power Plant at Niagara Falls.

Lamme spent many years; often working at night, developing advanced analysis and computational methods for designing and predicting the performance of electrical machines. In this task, he was aided by his sister Bertha, who also had an engineering degree from Ohio State. (Bertha Lamme was the nation's first woman electrical engineer).





*Westinghouse generators at the Niagara Falls Power Plant*

Benjamin Lamme designed much of the equipment for the Westinghouse exhibit at the Chicago Columbian Exposition of 1893. He became Chief Engineer at Westinghouse in 1903 and held that position for the rest of his life.



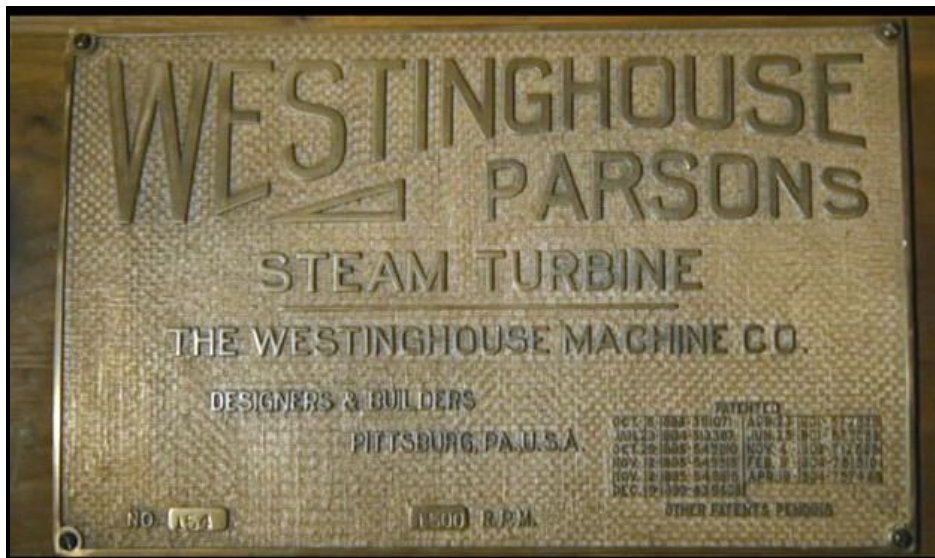
*Westinghouse Exhibit at the Colombian Exposition*

On 16<sup>th</sup> May, 1919, Lamme received the *IEEE Edison Medal* "For Invention and Development of Electrical Machinery." Then on 12<sup>th</sup> January, 1923, Lamme was the first recipient of the *Joseph Sullivan Medal* by Ohio State University.

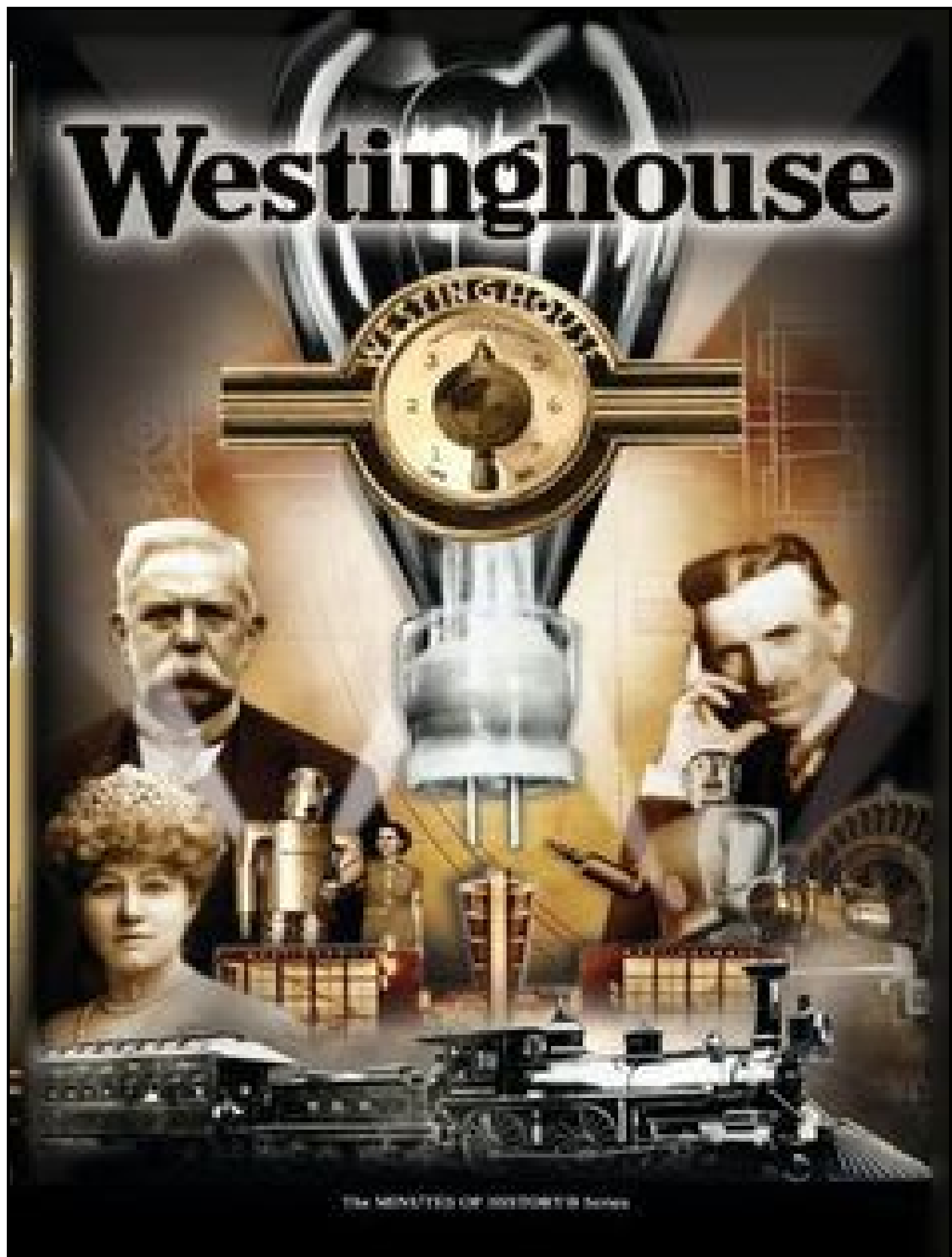
Lamme, who never married, died in Pittsburgh aged 60, on the 8<sup>th</sup> July, 1924. In his will, he established the *Lamme Medal* of the American Institute of Electrical Engineers to recognise members for "meritorious achievement." His will also provided for the American Society for Engineering Education to award a Gold Medal for achievements in technical teaching.

## BIBLIOGRAPHY

- 1979 *Seizing the Moment (Age of the Inventor-Entrepreneur)*, EPRI Journal, Electric Power Research Institute, Palo Alto, California, March
- 1999 *The Man Who Invented the Twentieth Century: Nikola Tesla, Forgotten Genius of Electricity*, Robert Lomas, Dowager Books
- 2001 *Tesla: Master of Lightning*, Margaret Cheney & Robert Uth, MetroBooks, USA
- 2010 *Westinghouse: The Life and Times of an American Icon* [DVD, Region 1, NTSC]
- 2013 *Westinghouse*, Full Feature Documentary by Inecom Entertainment Company, USA [Available on *You Tube*, duration 1 hour 50 minutes]
- 2016 *George Westinghouse: The History of Electricity*, Mary Bells (website)
- *George Westinghouse*, Wikipedia
- *Westinghouse Electric Corporation*, Wikipedia
- *Benjamin G Lamme*, Wikipedia
- G Westinghouse Jr., U.S. Patent Office Records
- B G Lamme, U.S. Patent Office Records

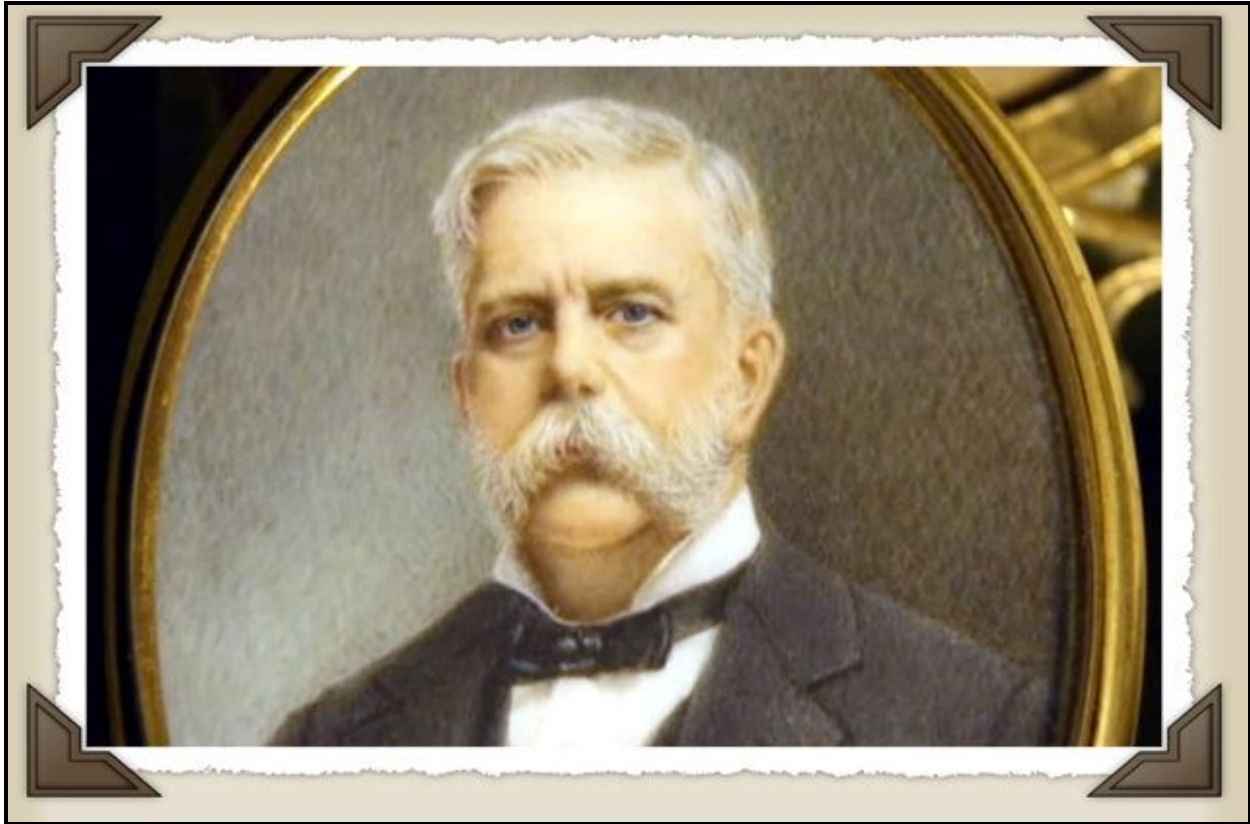


In 1885, Westinghouse bought rights to the Parson's steam turbine and improved the technology.



2010 Westinghouse: The Life and Times of an American Icon [DVD]

## EPILOGUE

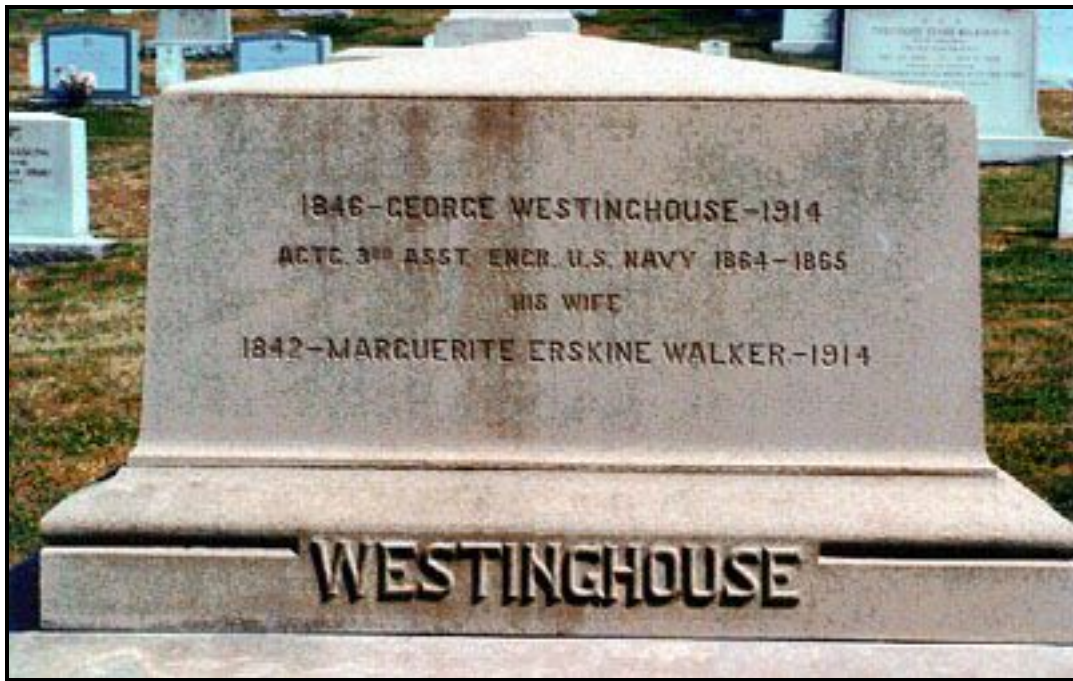


George Westinghouse resigned from the company he founded in 1907 and by 1911 was no longer active in business, due to declining health.

George Westinghouse died on the 12<sup>th</sup> March, 1914, in New York City at the age of 67. He was initially interred in the Woodlawn Cemetery in the Bronx in New York City. As a Civil War veteran he was removed from Woodlawn in December 1915 and buried at the Arlington National Cemetery. His wife Marguerite, who survived him by three months, was also buried initially at Woodlawn, before being reinterred at Arlington.

Westinghouse secured 361 patents, the last four years after his death. This compares with over 1000 patents by Edison, who patented everything designed by one of his employees in the Edison name, whereas Westinghouse allowed patents to be granted in the name of the employee responsible.

In 1918, his former home *Solitude* was razed to the ground and the land donated to the City of Pittsburgh to establish Westinghouse Park. In 1930, the Westinghouse Memorial, funded by his employees, was placed in Pittsburgh's Schenley Park, while in 1932 the Westinghouse Bridge, near the site of his Turtle Creek factory was named in his honour. In 1986, his boyhood home and birthplace in Central Bridge, New York, was added to the National Register of Historic Places.



*Headstone at the Arlington Grave of George Westinghouse and his wife*



*The George Westinghouse Memorial in Schenley Park, Pittsburgh*

**GEORGE WESTINGHOUSE**

**1846 - 1914**

**SCIENTIST                      INDUSTRIALIST**  
**HUMANITARIAN                INVENTOR**

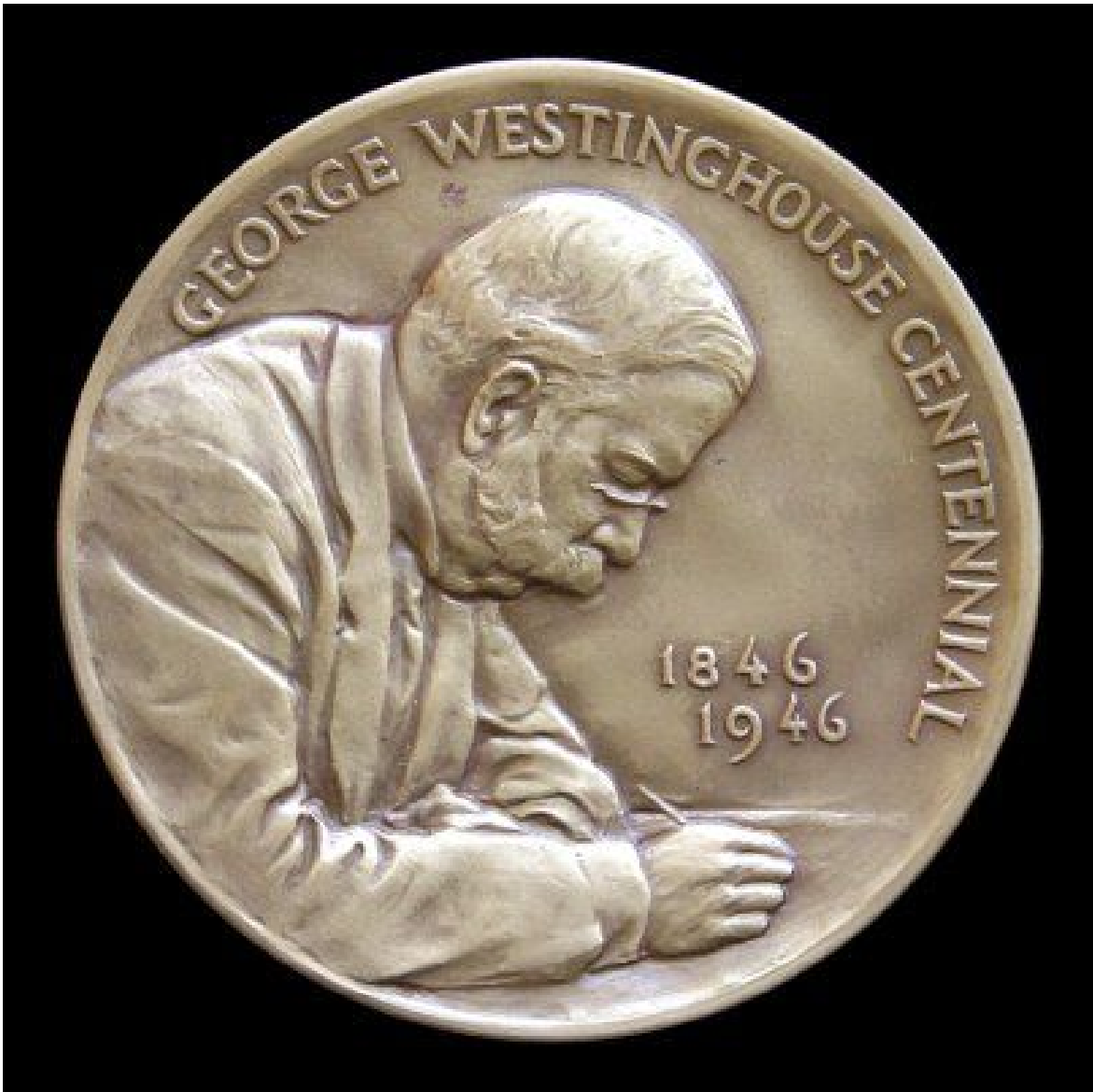
Holder of 361 patents, including the automatic air brake, considered to be one of the great inventions of all time. His contributions to transportation, industry, and his fellow man made him a legend in his own time... Founded the Westinghouse Air Brake Company located in Wilmerding, just a few miles from this spot. This industry continues to serve the world over as a living monument to this great American.

**Wabco - Westinghouse Air Brake Div.**

**Leopold Kaftal - Architect**

**James J. Mirro - Orig. & Pres.**

**Monroeville Historical Society**



*The George Westinghouse Centenary Celebration Medal, 1846-1946*