

# The Ames Power Station

*First High Voltage Alternating Current  
Transmission Anywhere*

By Albert M. Schaffer

# Credits

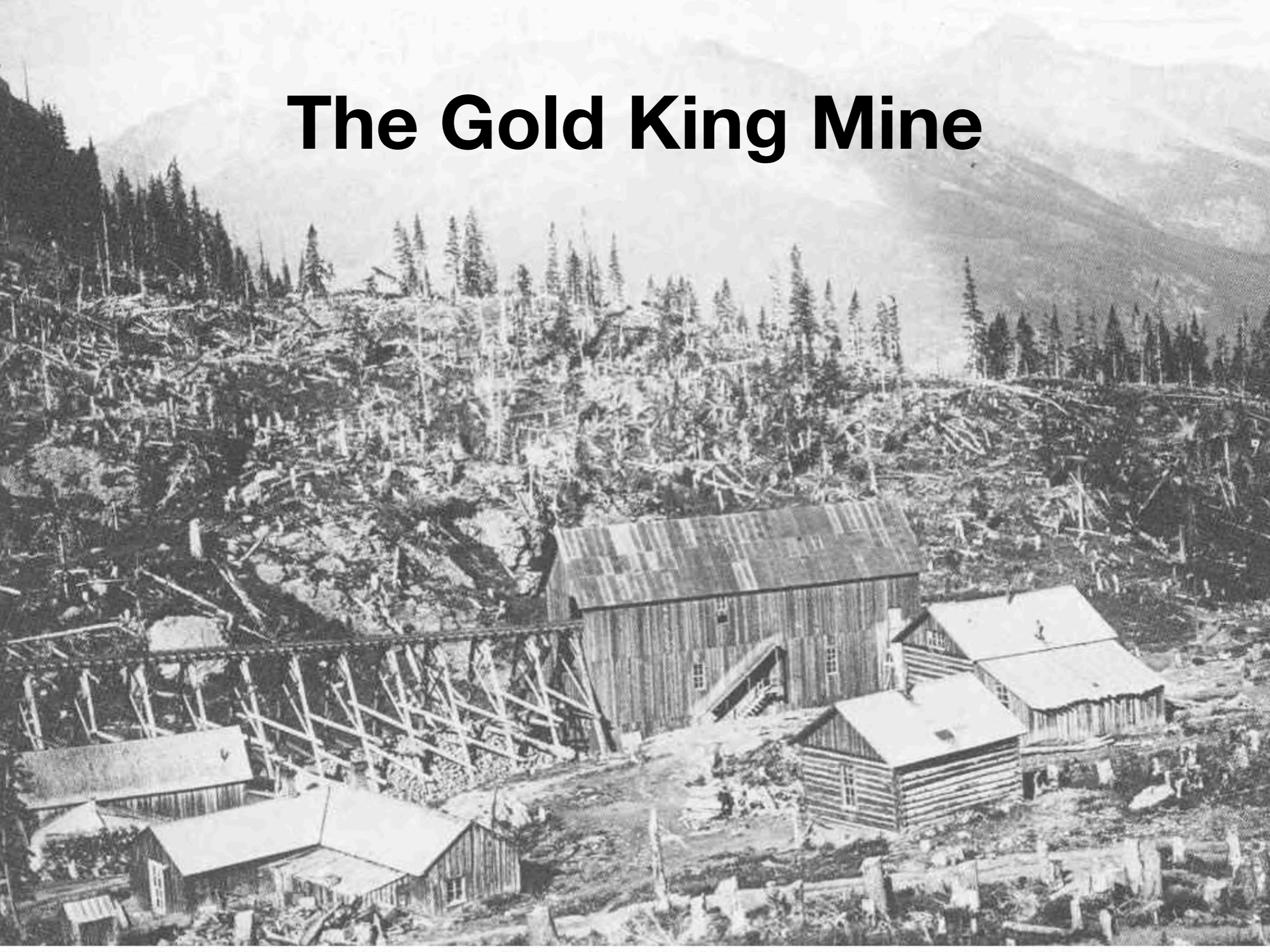
- Charles Wright, IEEE Presentation (1990)
  - I purchased a copy of his slides. Charles sent all of his material to the IEEE before his decease.
- Chris Thompson, Colorado Springs Utilities
  - Chris is responsible for Colorado Springs Hydro plants and is an amazing reference on Hydro History
- Cassier's Magazine ( Jan 1905 Article by Paul Nunn)
  - "Pioneer Work in High-Tension Electric Power Transmission." This article was more than 20 pages in length and was provided to me by Chris Thomson, above. Paul managed Niagara for about 10-years

# Introduction/Context 1888-1890

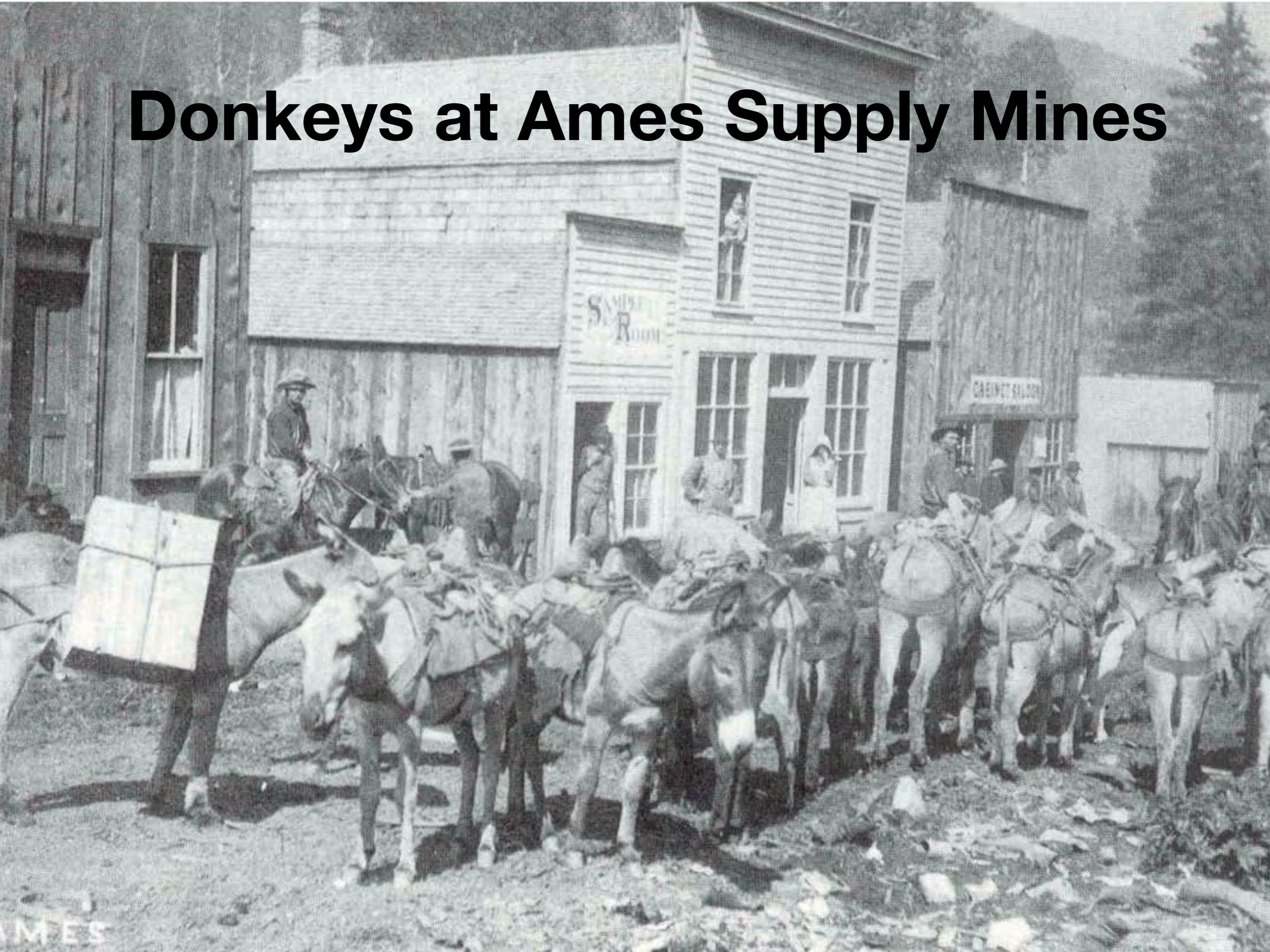
- The “Current War” was raging!
  - Edison/GE (DC) vs. Westinghouse (AC)
- Colorado Gold Rush had special needs
  - Power to run the concentrating mills
  - Transportation of concentrate to the smelter

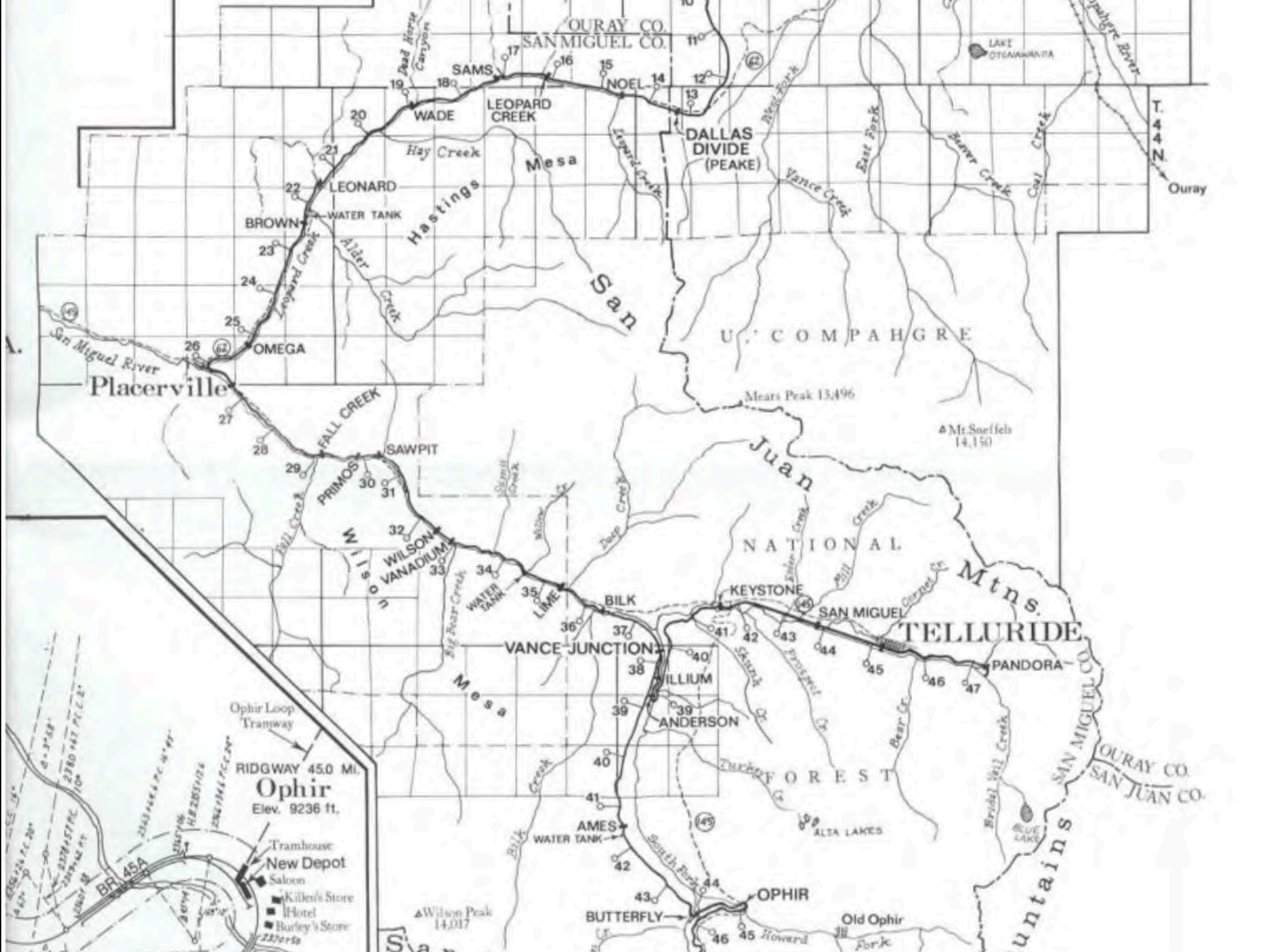
- The advent of the Rio Grande Southern RR to service mine needs. Construction begins in 1890 from both Ridgeway and Durango. RR grade eases delivery of Generator and Motor to remote Ames
- Gold King Mine is spending \$2,500/month (1890 dollars) to haul wood on donkeys to mine and mill at 12,000 ft. to operate steam engines. Mine is near bankruptcy.

# The Gold King Mine



# Donkeys at Ames Supply Mines





# Lucian L. Nunn (L.L.)

- Telluride Banker, Lawyer, Entrepreneur
- A stockholder in the Gold King Mine





# Paul Nunn

- Lucian's Brother, an Engineer & Manager
- Head of Ontario Power @ Niagara Falls

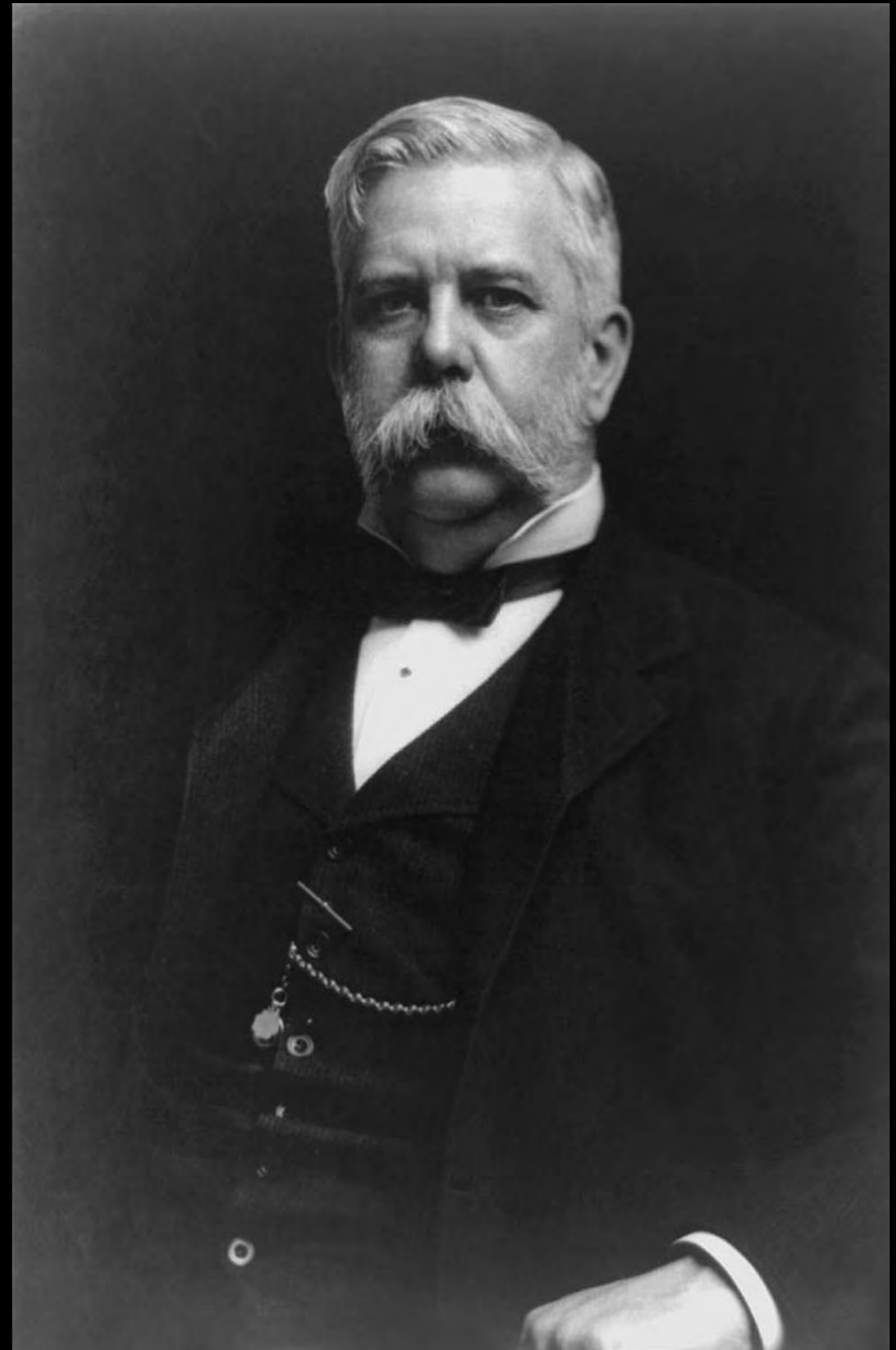


# George Westinghouse

Pioneer in AC Power

Licensed Nikola Tesla  
AC Patents

Tesla was his employee



# Power Options Explored By L.L.

- 2.6 Miles from Ames to Gold King Mine
  - Cable Drive
  - Compressed Air
  - DC Electricity (Copper Costs High)
  - AC Electricity (High Voltage)

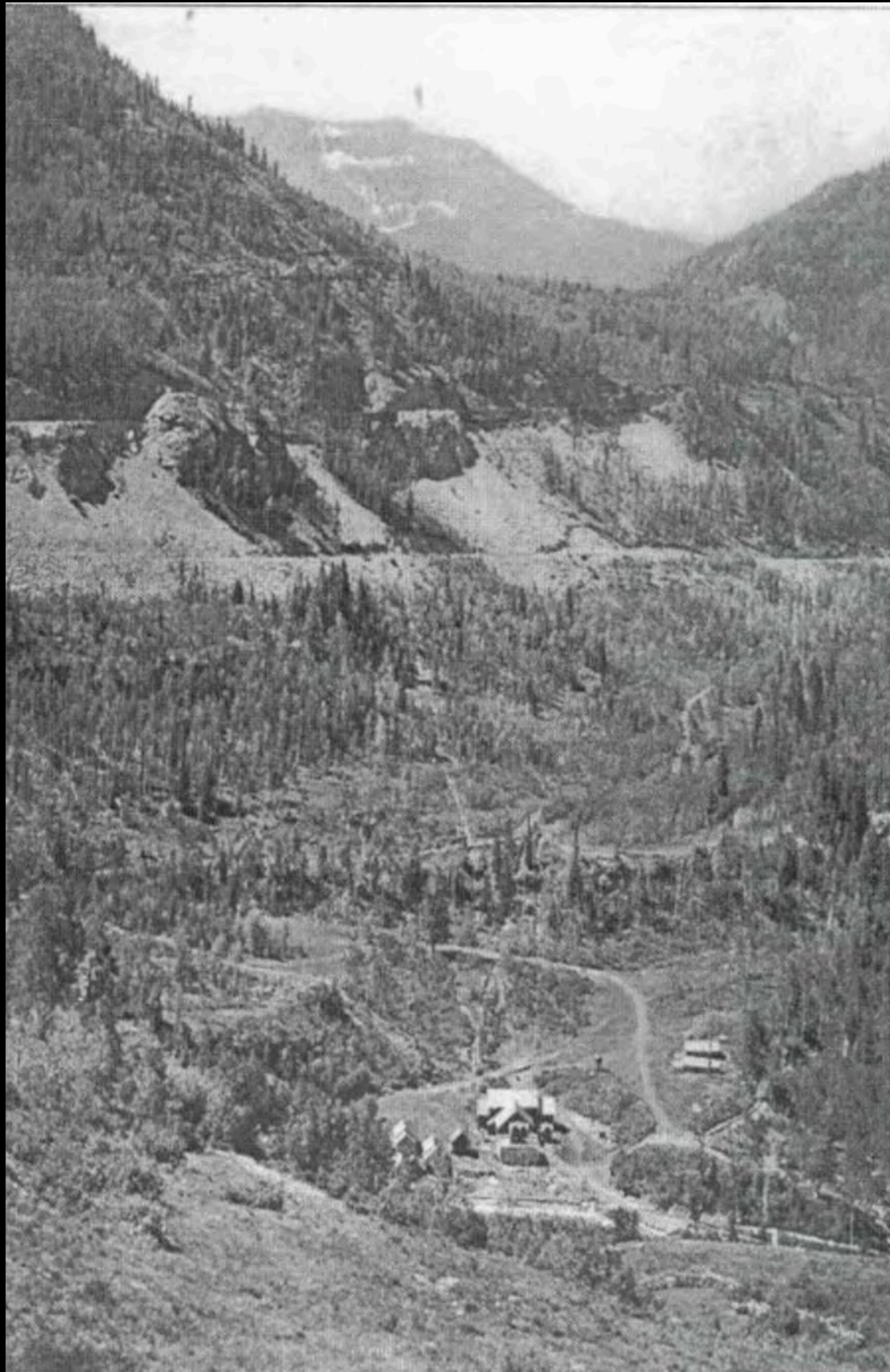
# Striking a Deal

- Paul Nunn, an engineer, felt that AC would work
- He contacted Westinghouse and proposed that AC would be a convincing solution to the Gold King's power problem
- Westinghouse desperately needed such a test case but there were cost unknowns
- Lucian travelled to Pittsburgh and dumped \$50,000 in gold on the table. Done deal!

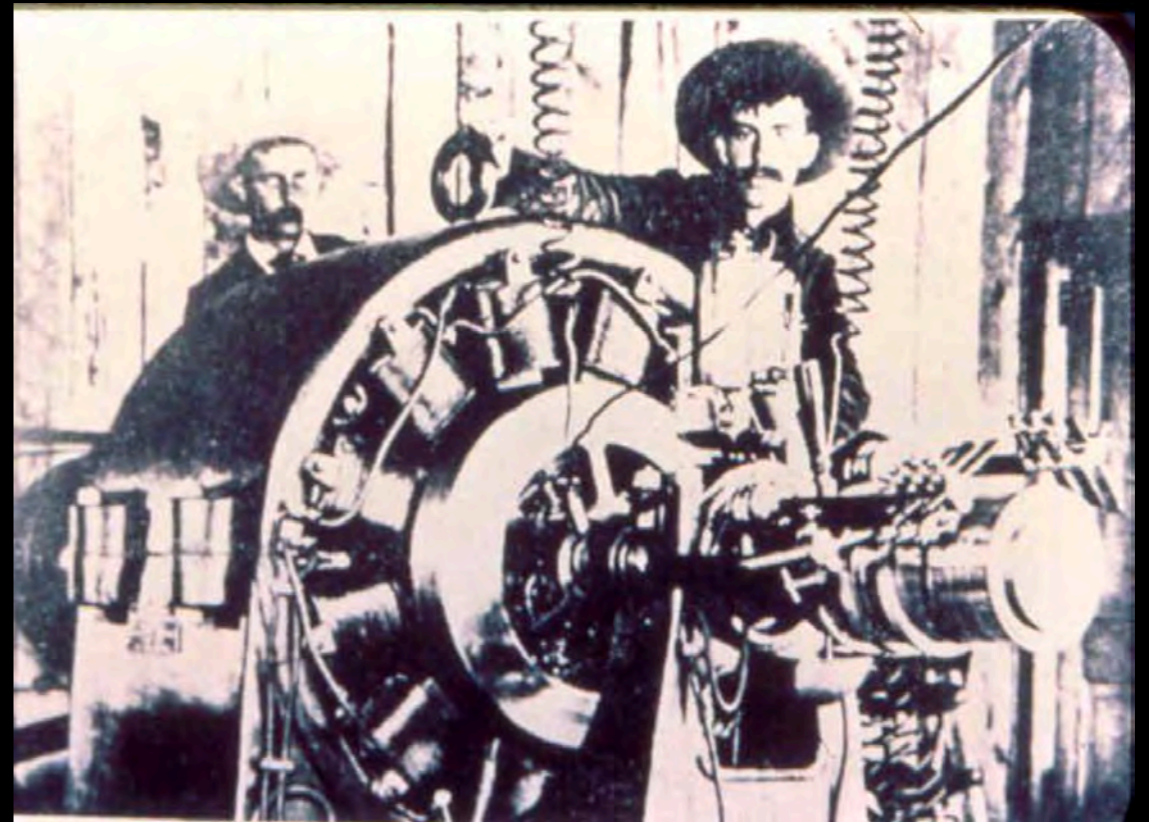
# Ames Power Plant

- Water from San Miguel River, Trout Lake
- Drives a 6 ft Pelton Waterwheel under 320 foot head of water
- Generator is 100 hp, single phase, 3KV, 133 Hz. No Xmfr. Motor runs at 3KV
- No. 3 wire runs 2.6 miles to Gold King Mine
- Power delivered June 19, 1891
- Ran for 30 days with no problems!

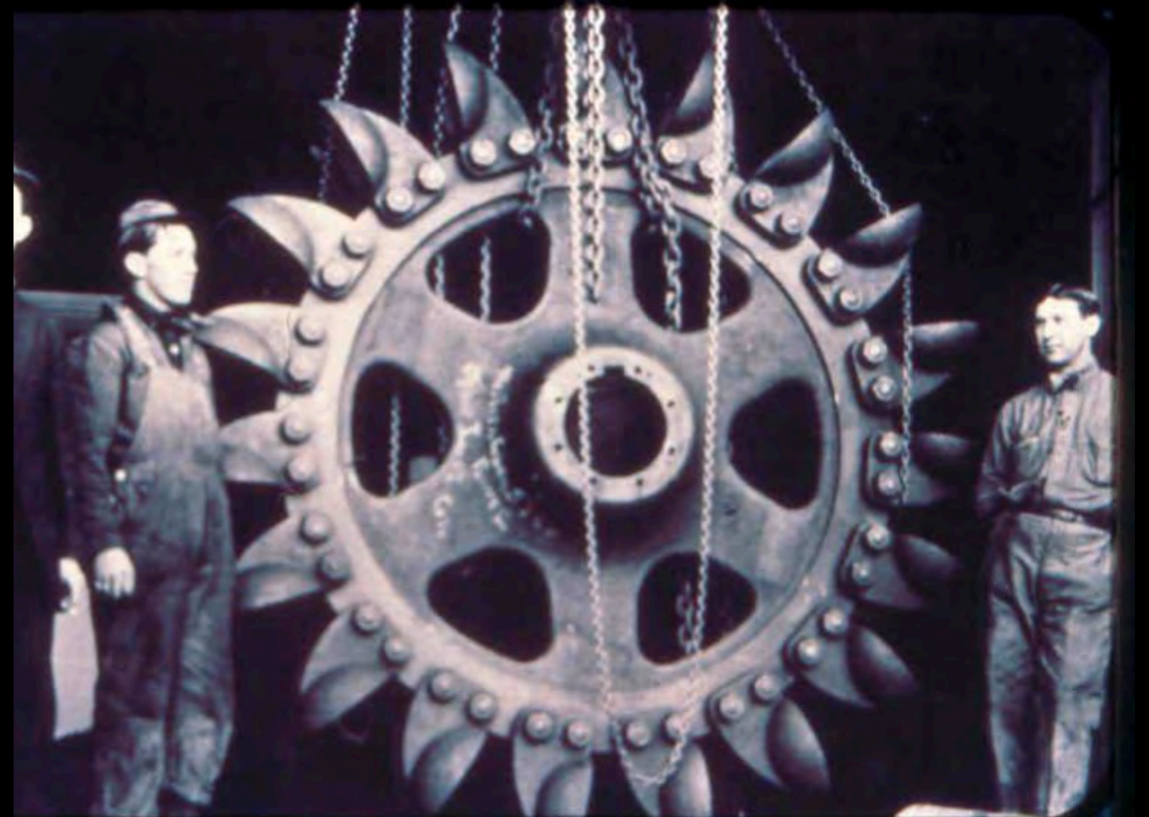




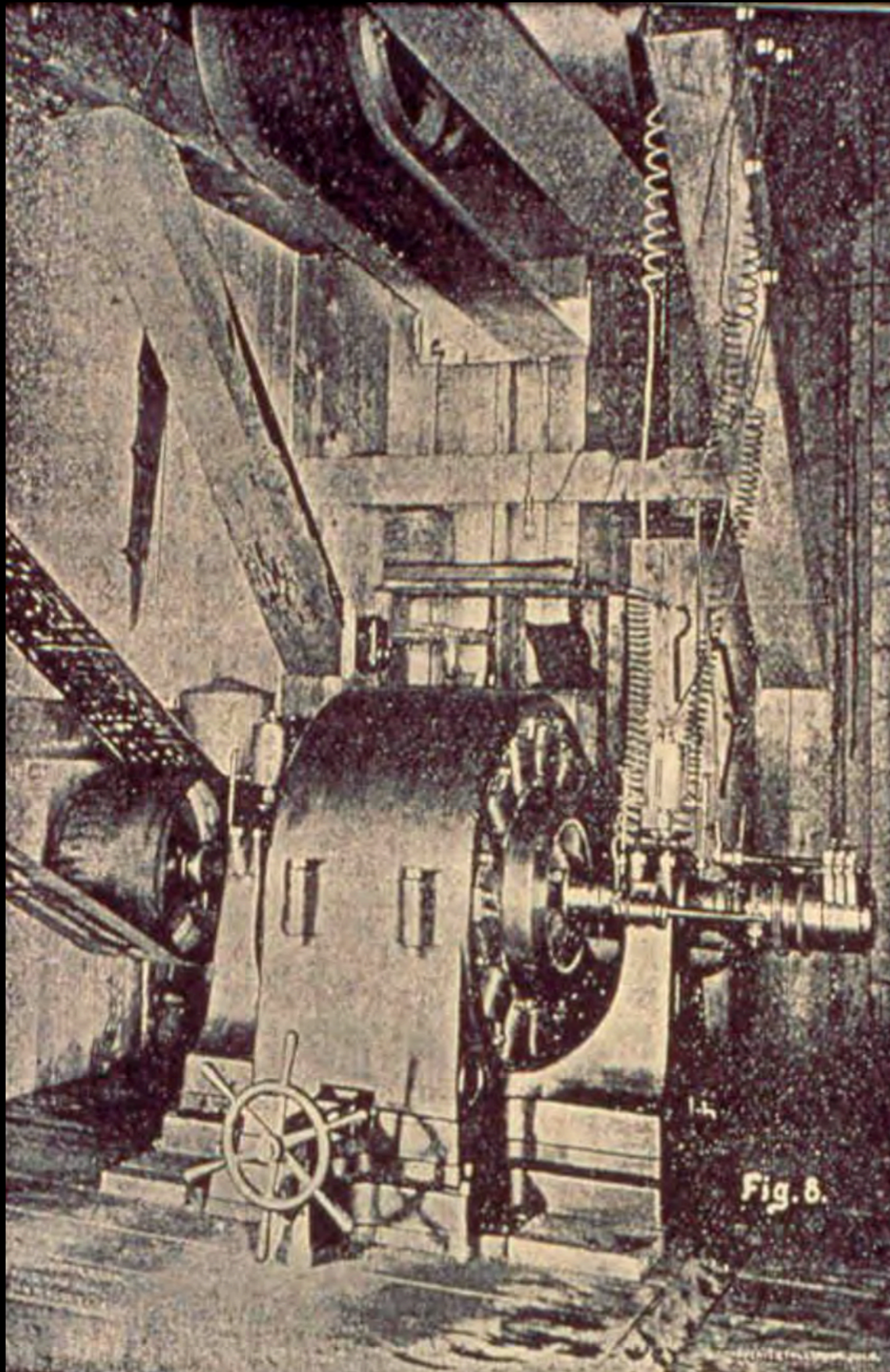
**Ames (new), Water Flume, RR**



**Original Ames 3KV Generator**



**Pelton Water Wheel**



**Motor & Belts in Gold King Mill**



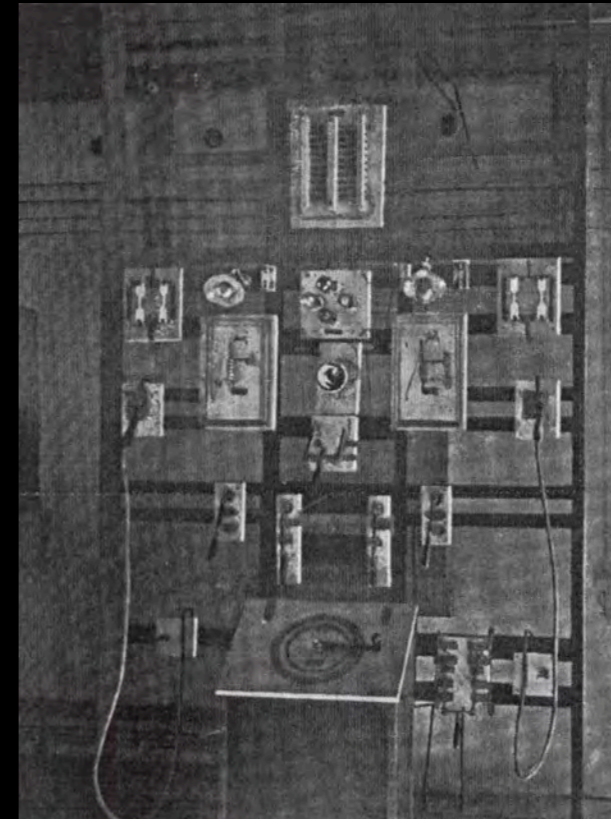
**Gold King Concentrating Mill**



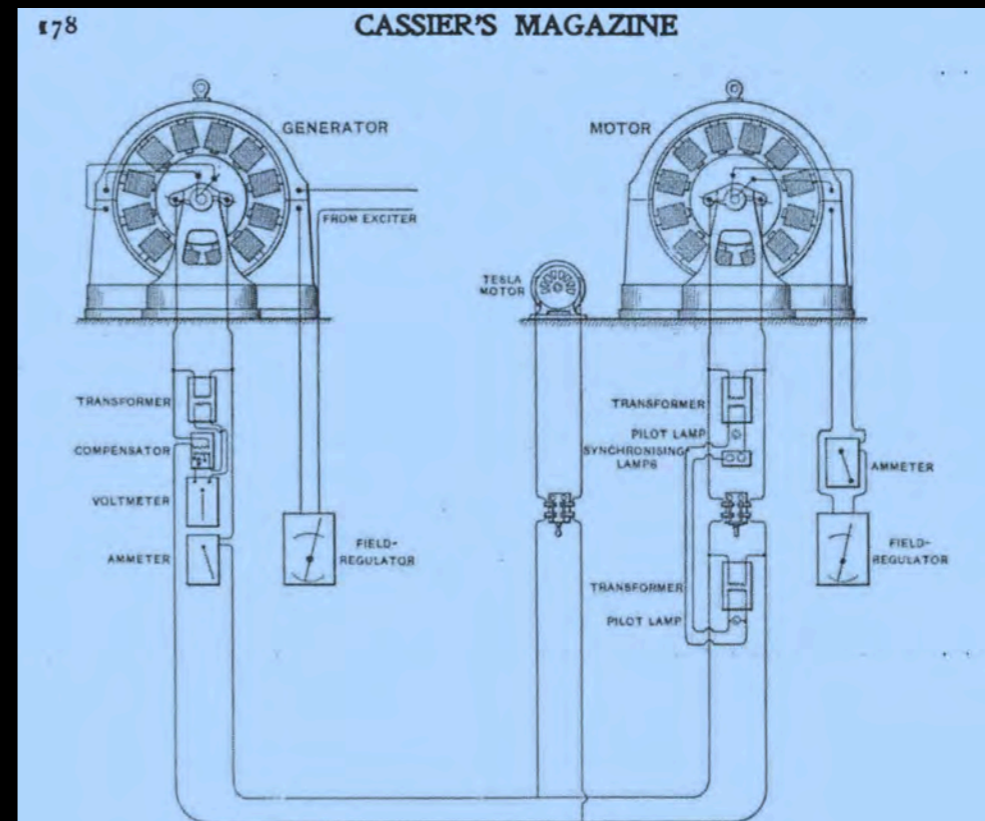
**Gold King Stamp Mill**



**Transmission Line**



**Motor Switchboard**



**Synchronous Motor System**

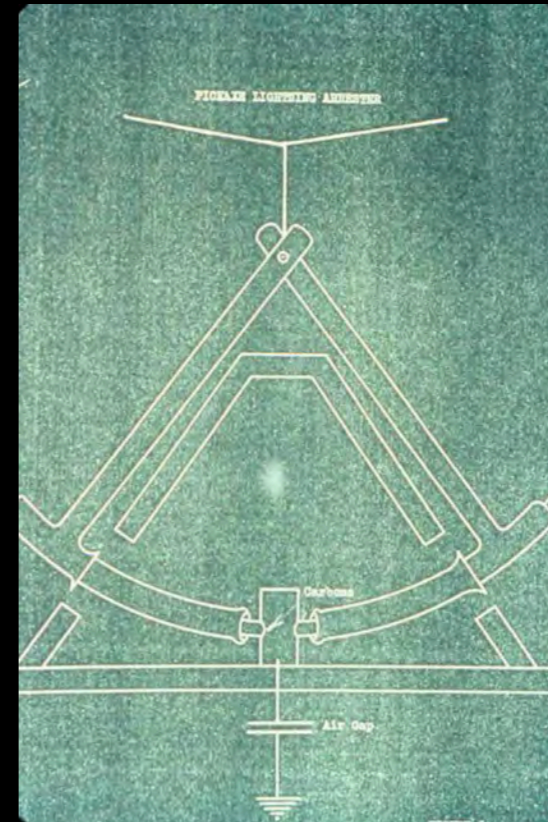


# Problems with Being First

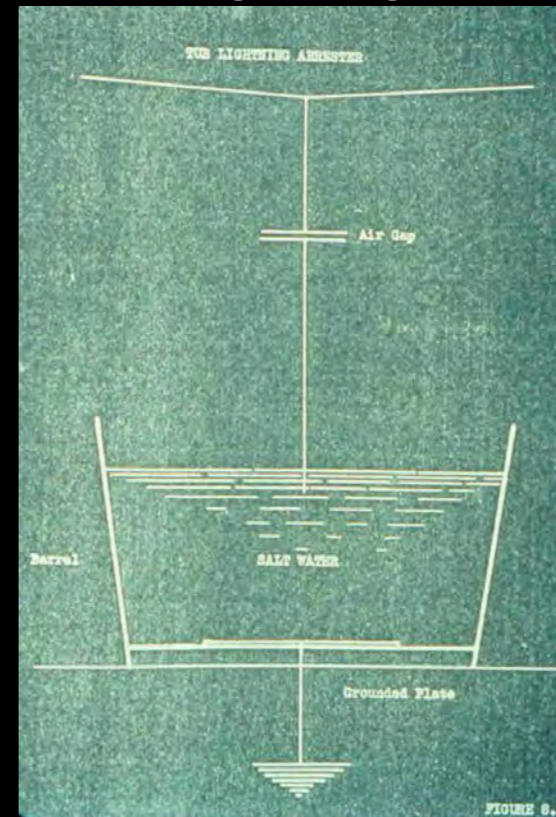
- Lightning, The No. 1 Problem
- Repairing Burned Out Windings
- Perfecting Lightning Arrestors
- Perfecting Gang Switches, Insulators
- Turning Loads ON and OFF
- Little Understanding of Power Factor
- Primitive Instruments
- Lack of Trained Operators (20 needed, typically)



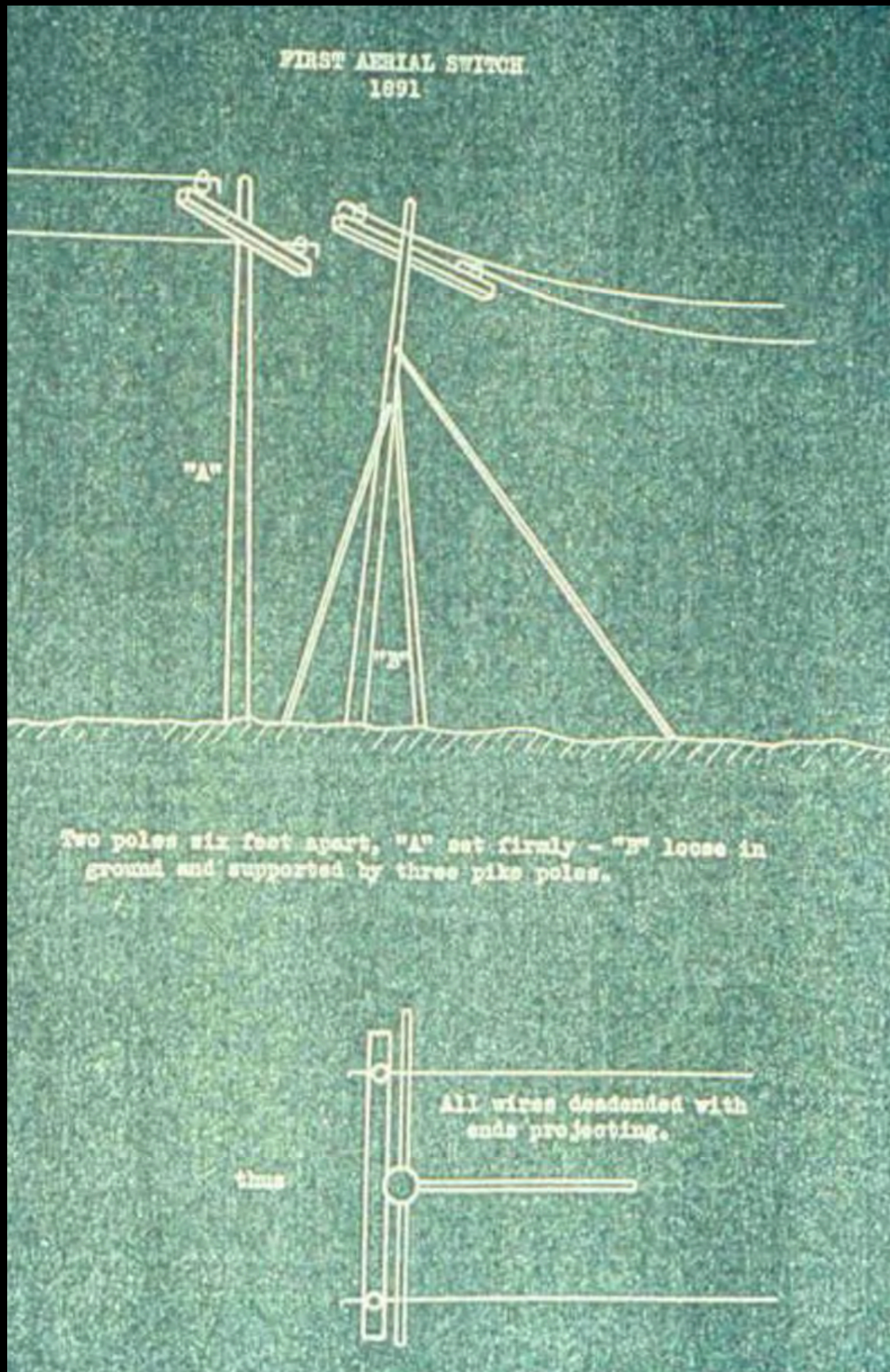
**Pole Top Fires**



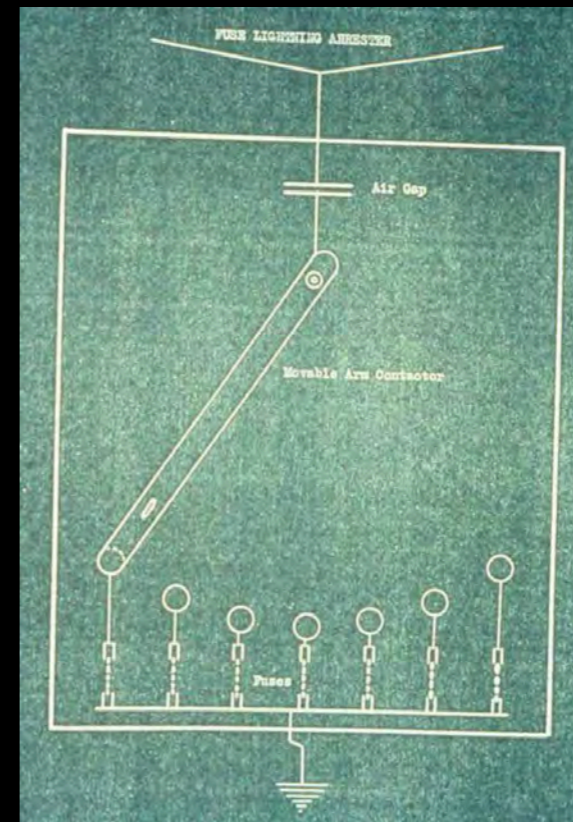
**Pick Ax Lightning Arrestor**



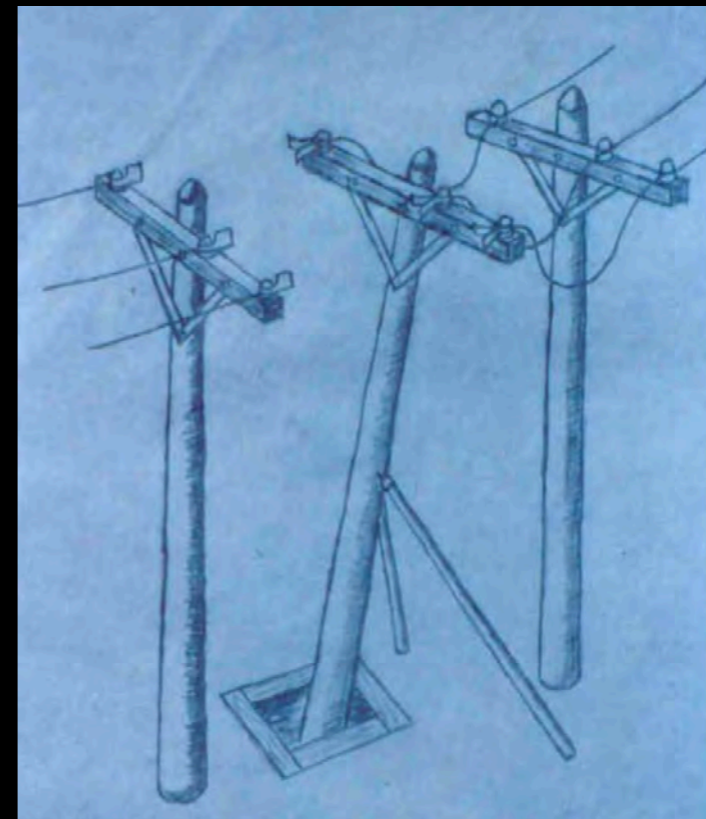
**Water Tub Lightning Arrestor**



**First Line Switch Design, 1891**



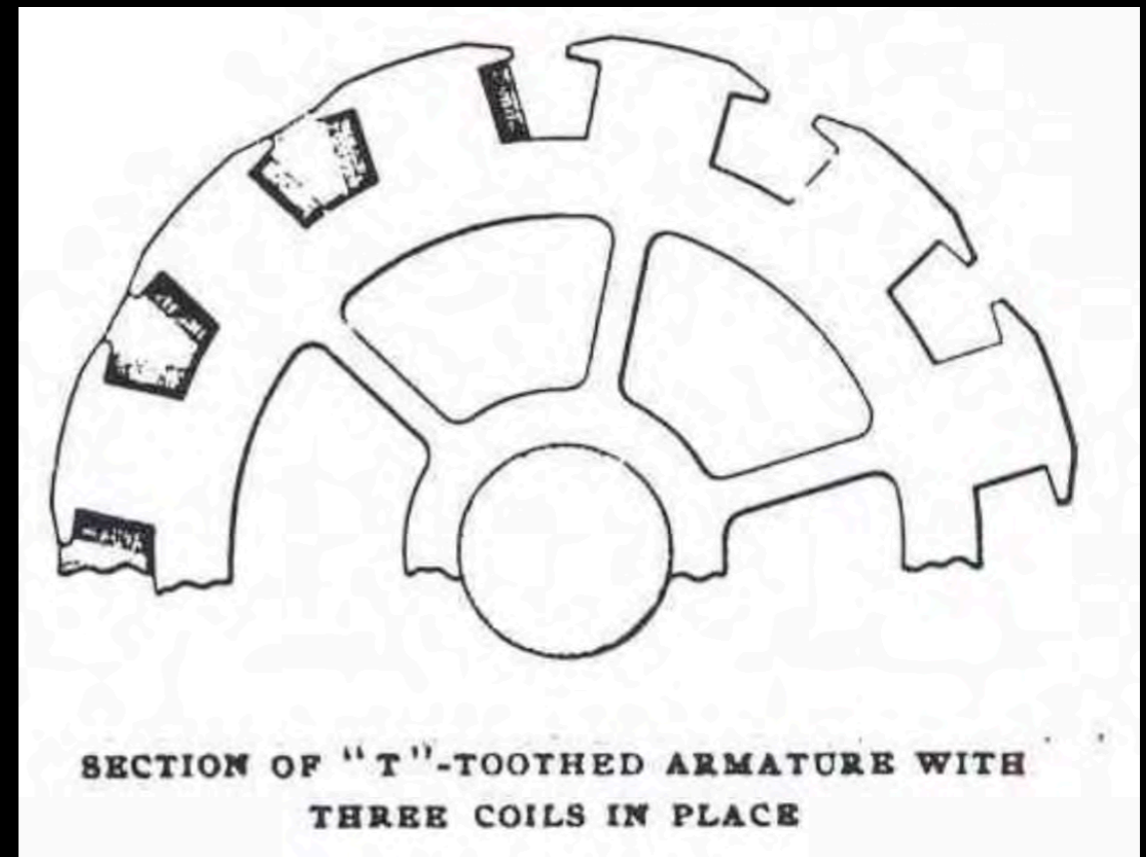
**Fuse Lightning Arrestor**



**Second Design of Gang Switch**

# Repairing Burned Out Windings

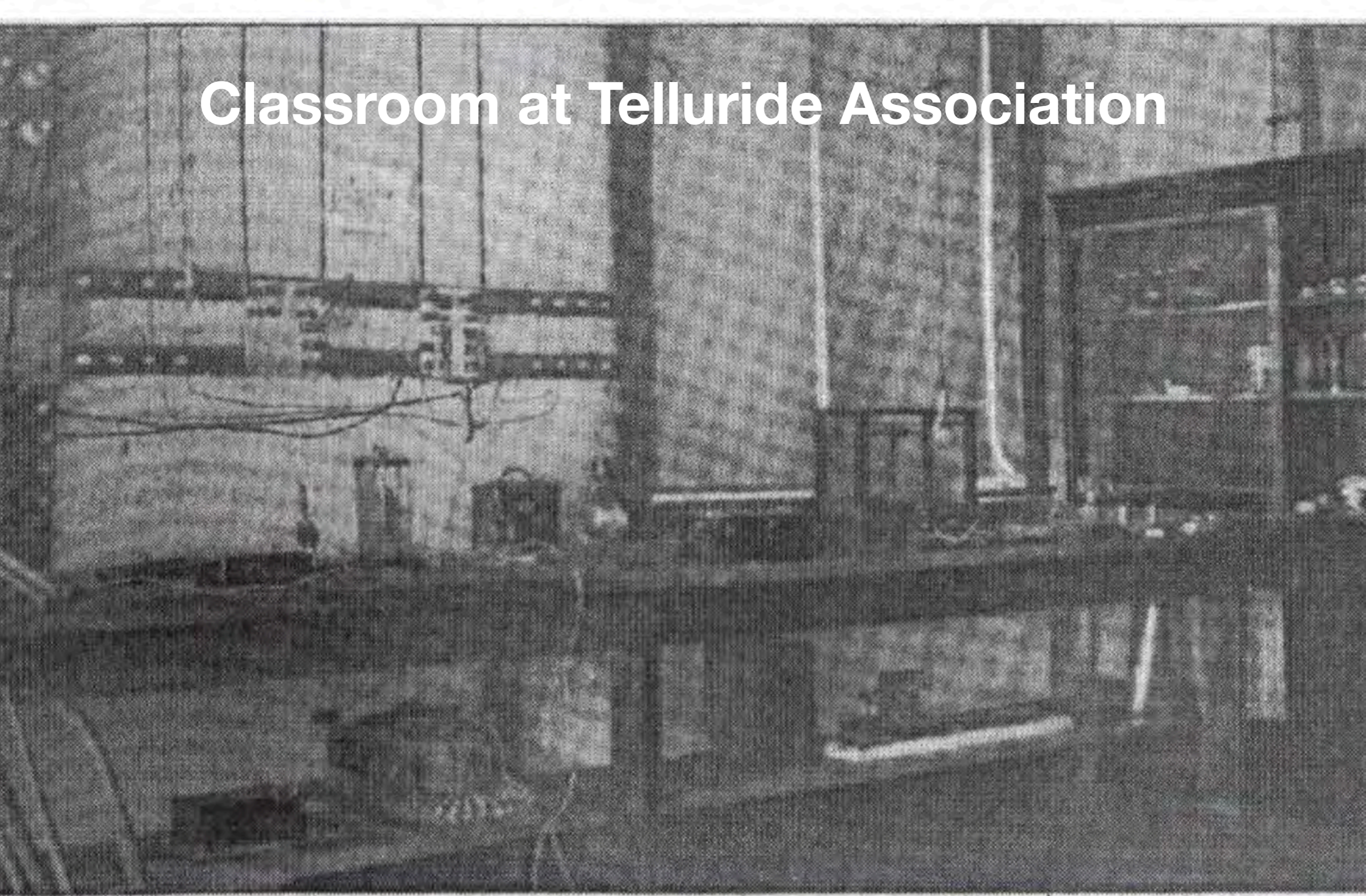
- The Ames armature was “T”-toothed. Coils could be cut out and new coils slipped on and wedged in place in about 2 hours. Clever design!
- Competing DC generators in use at some mines required that the entire armature be replaced after a lightning hit.
- Lightning could strike 4 to 5 times/minute



# The Telluride Association

- The need for education and engineering was obvious. Lucian funded early efforts at the Telluride Association which later became the seed of the EE dept at Cornell University.
- The Ames success story resulted in the powering of many other mines.
- Providing AC power was more profitable than hard rock gold mining, and Lucian spent the next 35-years building and managing numerous hydroelectric enterprises (esp. Provo Utah)

# Classroom at Telluride Association



**THE EARLY LABORATORY FOR STUDENTS**

# The Telluride Association, continued

- Experimental pole/insulator combinations were tried, as well as pole spacing
- Voltages were gradually increased and by 1895 lines carrying in excess of 50KV were tried. 10KV was fairly common.
- Transformers were improved (oil filled)
- Redundant transmission lines and multiple generating stations provided improved availability of power to mines and towns

# Ames Plant Improvements

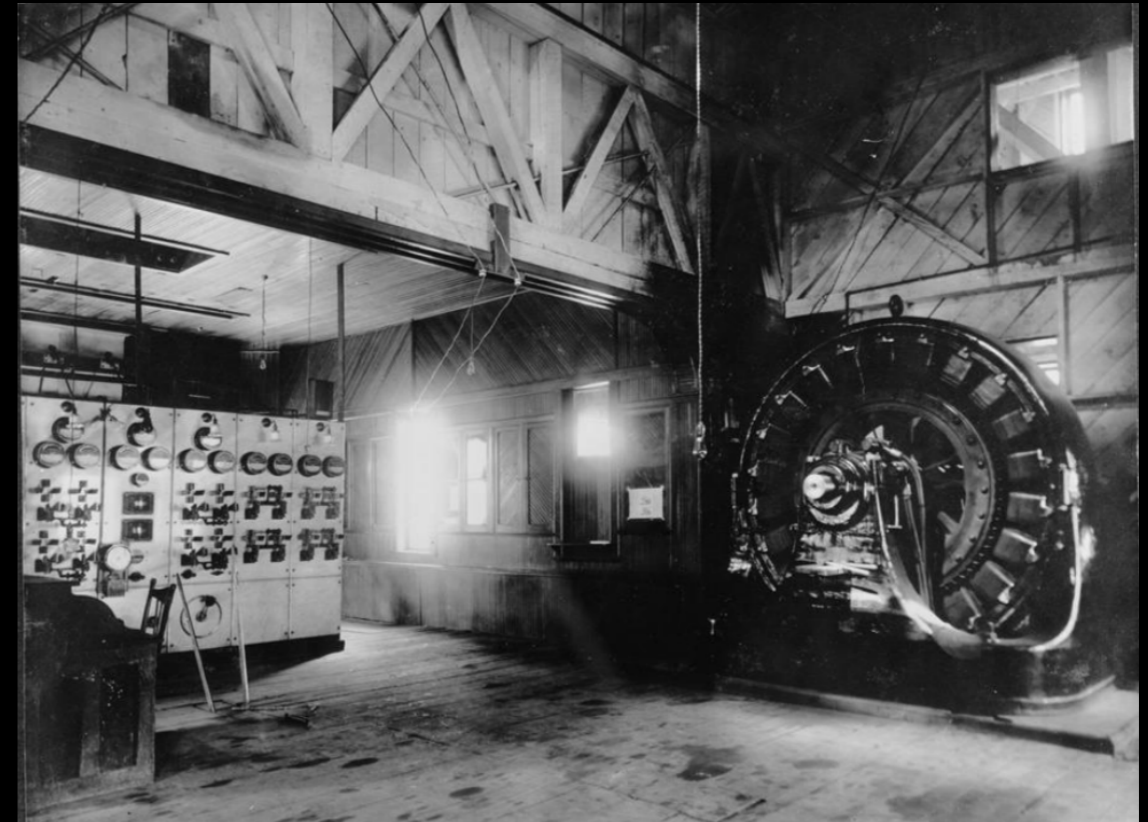
- Additional mine power needs were met with 2nd and 3rd generation facilities
- 2nd Ames plant, built in 1895, used two 600KW, 60-cycle, 500 volt, 2-phase generators connected to water-wheels under 600 and 900 feet head respectively. 10KV lines were used.
- Poor quality transformers would explode, spilling oil in the wood buildings and posing a fire hazard.
- A masonry transformer building solved this.



**Ames Plant, 1895**



**Interior of 1895 Ames Plant**



# Power Plant at Illium, 1900

- A new power plant was built in Illium, 6 miles north of Ames, nearer Telluride
- Featured a single 1200 KW GE revolving field generator, driven by 2 Pelton wheels each under 500 feet head.
- Lines extended to both Ames and other points of distribution providing for duplicate transmission to customers.



**Illium Plant**



**Interior of Illium Plant**

# Provo, Utah Plant

## Uses 40KV

- A plant was built at Provo in 1897 based on experience learned in Colorado
- Provo featured two 750-KW, 60-cycle, 800V, 3-phase GE generators, direct connected at 300 rpm to twin turbines under 125 feet head
- Two complete independent units designed to operate separately or paralleled at both high or low voltage
- Two banks of oil transformers and 2 output circuits

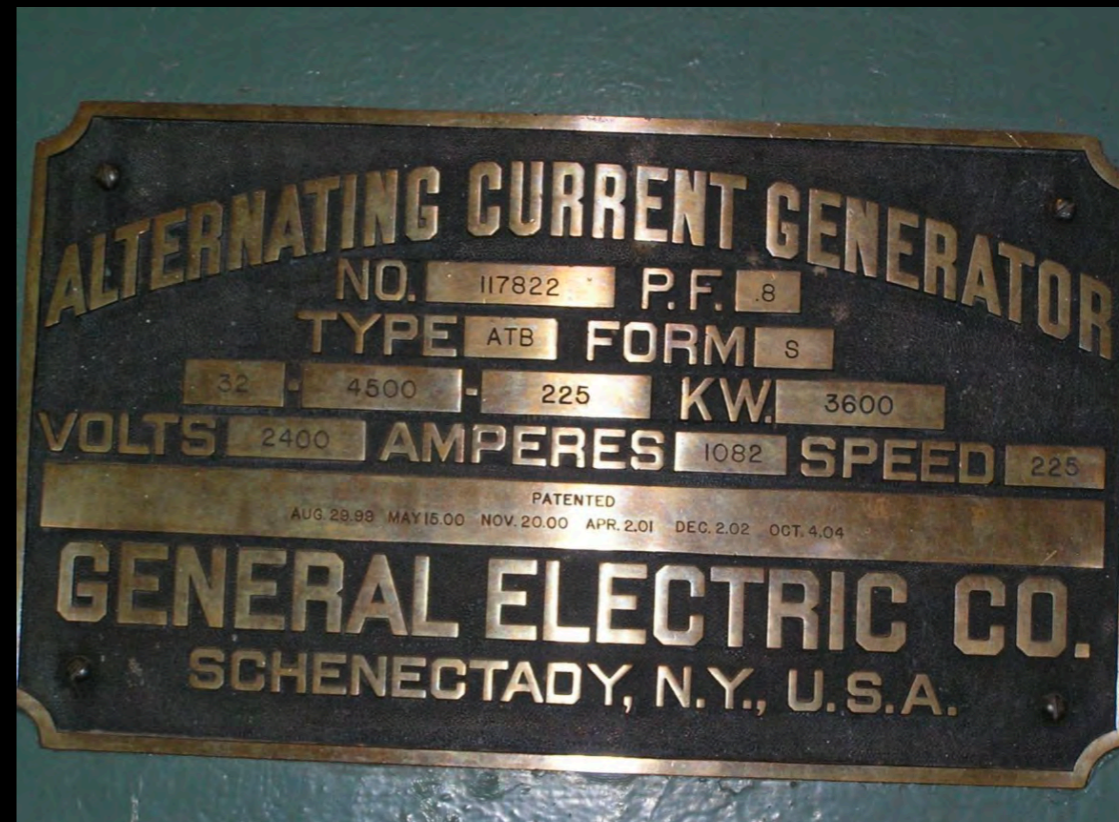
# Present Ames Plant (1905)

- Dual water source:
  - Trout Lake via flume and pipe
  - Howard Fork of San Miguel River
- 3600 KW, 2400 Volt, 1082 Amp, 225 rpm
- Running almost continuously since 1905. (Trout Lake dam burst in 1908)





**Trout Lake, 4 miles by flume**



**GE Name Plate at Ames**



**IEEE Plaque at Ames Station**



**Dual Pelton Wheels, 460 psi**

# Armature of Original Plant

