

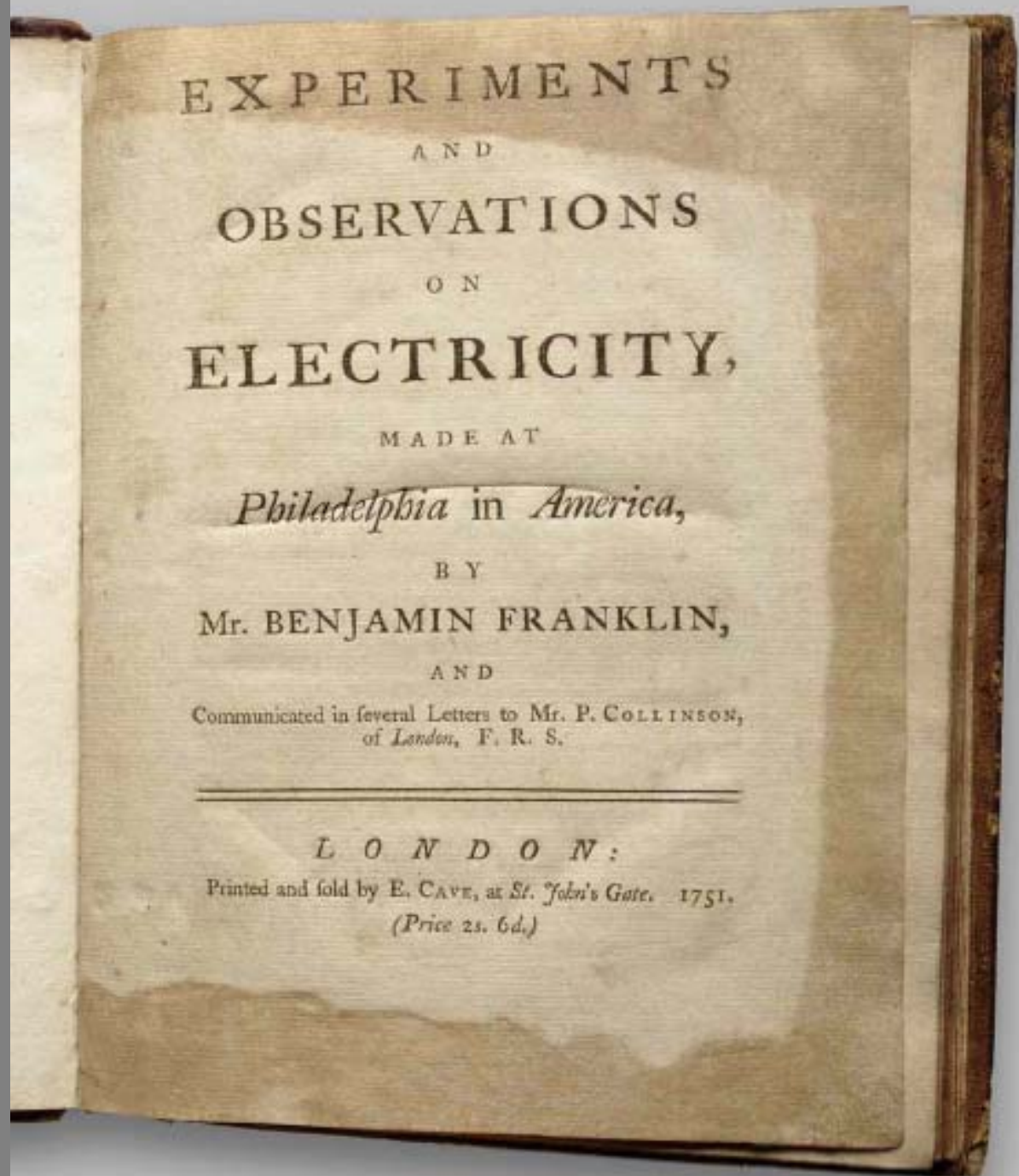
# Benjamin Franklin's Experiments in Atmospheric Electricity

And their influence on the path to  
independence for the 'Colonies'  
from Great Brittan

Between 1747 and 1750 Ben Franklin sent 5 papers to the Royal Society in London.

Franklin discussed the power of 'points' for discharging electrical energy

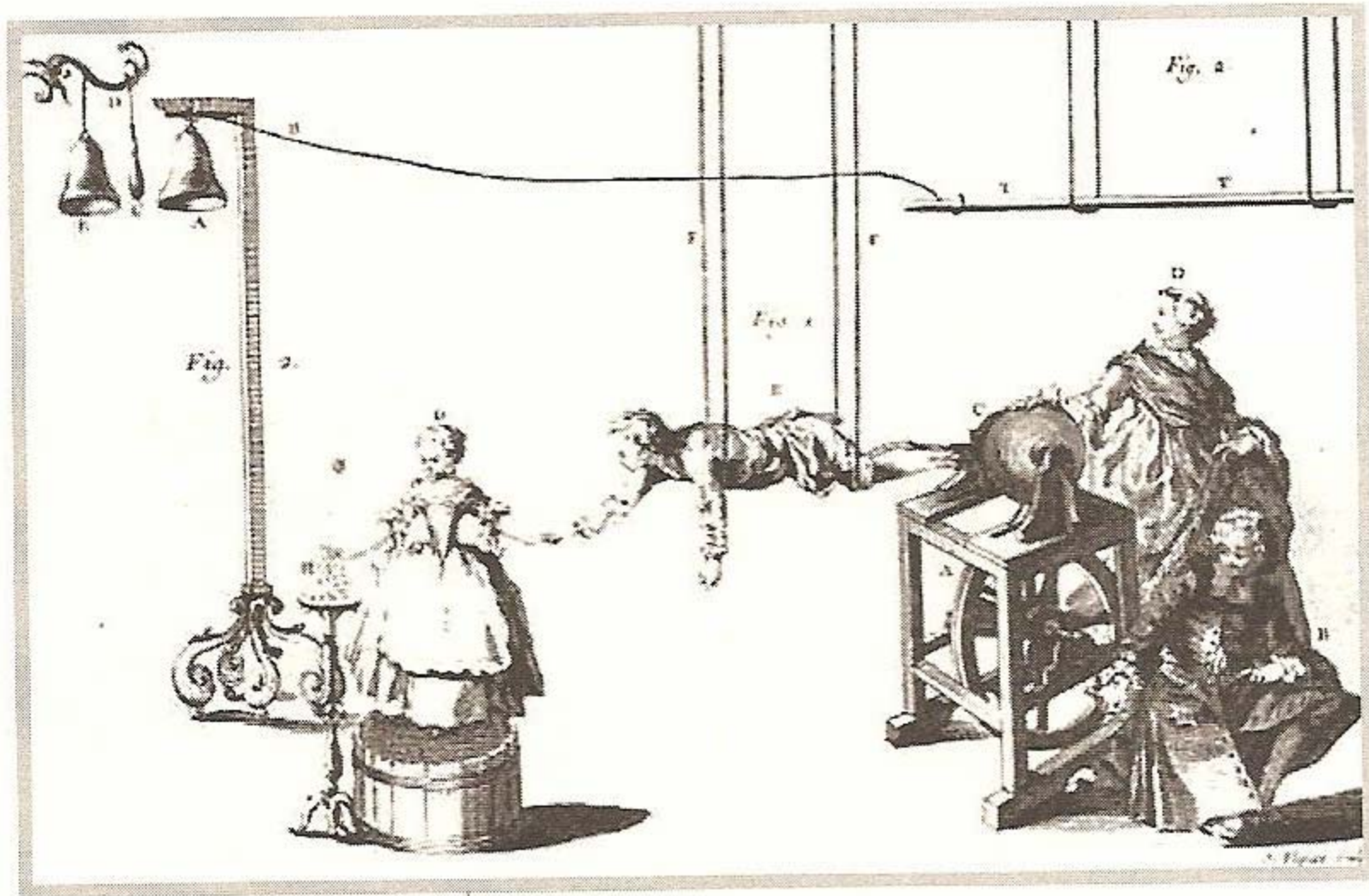
The 5<sup>th</sup> paper provided an idea for how to show that lightning was an electrical phenomenon The Sentry Box Experiment



- Demonstration of Franklin's Sentry Box experiment on May 10, 1752 D'Alibard Day
- On 10 May 1752, as a thunderstorm passed over the village of Marly-la-Ville, a retired French dragoon, acting on instructions from naturalist Thomas-François Dalibard, drew sparks from a tall iron rod that had been carefully insulated from ground (see figure 1). The sparks showed that thunderclouds are electrified and that lightning is an electrical discharge
- Reported 3 days later at Academy of Science in Paris and 2 weeks later at the Royal Society in London

. (Special thanks in this presentation to Dr. Phil Krider – see Physics Today, 2006 )

In 1740s and 1750s Electricity was coming into culture as a curiosity



Parlor tricks from S. Johnson (2008) book about Joseph Priestley

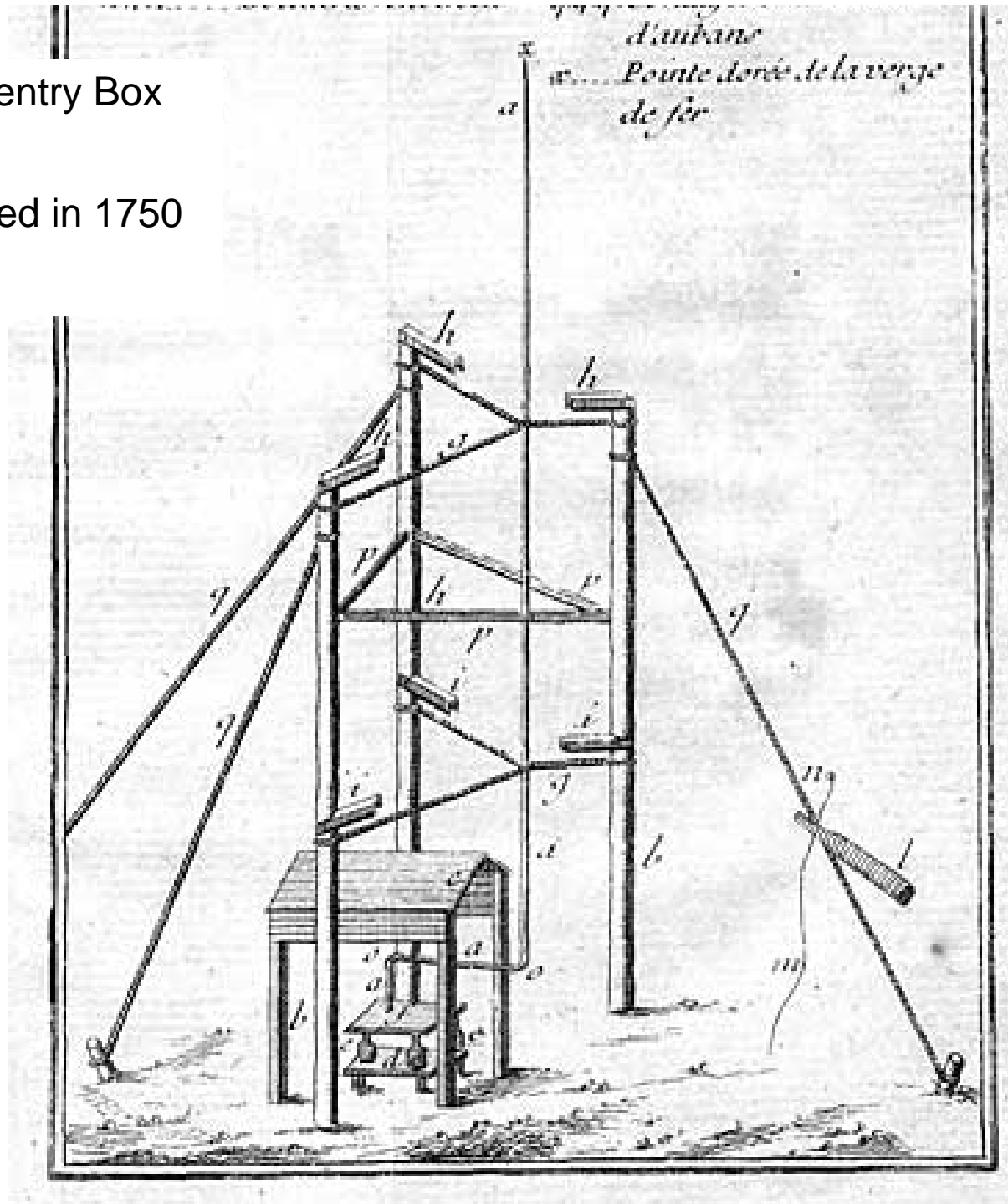
# Franklin's Papers on Electricity

- Points for discharge
- Positive and negative – electrical charge not created or destroyed
- Used Leyden jar (we call capacitor)
- Discussed charging and discharging
- Related discharge to lightning
- Developed a 'battery' (large capacitor bank) for storing lots of charge and rapidly discharging
- practical advice : don't stand under an isolated tree in T-storm "crouching in an open field is less dangerous"

# Franklin's Sentry Box Experiment

First proposed in 1750

In 5<sup>th</sup> paper



From his 5th letter:

- I say, if these Things are so, may not the Knowledge of this Power of Points be of Use to Mankind; in preserving Houses, Churches, Ships, etc. from the Stroke of Lightning; by Directing us to **fix on the highest Parts** of those Edifices **upright Rods** of Iron, made **sharp as a Needle** and gilt to prevent Rusting, and from the Foot of those Rods **a Wire down the outside of the Building into the Ground**; or down round one of the **Shrouds of a Ship** and down her Side, till it reaches the Water? Would not these pointed Rods probably draw the Electrical Fire silently out of a Cloud before it came nigh enough to strike, and thereby secure us from that most sudden and terrible Mischief!

## **Georg Wilhelm Richmann**

He was electrocuted in St. Petersburg "while trying to quantify the response of an insulated rod to a nearby storm."

He was apparently the first person in history to die while conducting electrical experiments



To lightning  
rod

ringer

Franklin  
chimes

grounded



*Il a ravi le feu des Cieux \*  
Il fait fleurir les arts en son Climat sauvage.  
L'Amérique le place à la tête des Sages  
La Grèce l'aurait mis au nombre de ses Dieux ?*

# Note about Franklin's Kite

- Franklin did not publish anything about his kite. Rather, he explained the experiment conducted by himself and his son, in which the key lifted by the kite obtained an electrical charge.
- This was described in publications by Joseph Priestley
- The Kite experiment was allegedly flown in June 1752, about a month after D. Alibard's famous demonstration of the Sentry Box. There were no other witnesses.

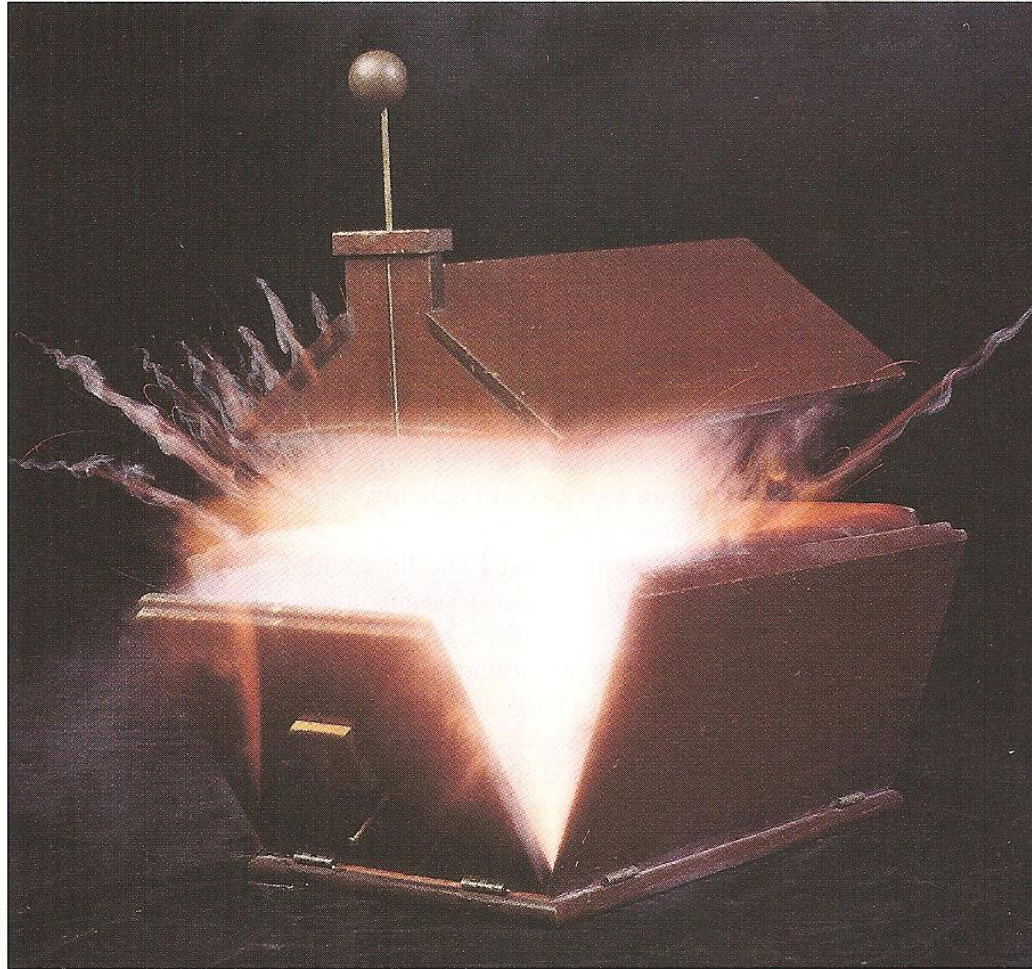
# Lightning Rods

- **First protection system**
- In the 1753 issue of *Poor Richard's Almanac*, Franklin published a method for protecting houses from lightning damage:

“It has pleased God in his Goodness to Mankind, at length to discover to them the Means of securing their Habitations and other Buildings from Mischief by Thunder and Lightning. **The Method is this:** Provide a small Iron Rod (it may be made of the Rod-iron used by the Nailers) but of such a Length, that one End being three or four Feet in the moist Ground, the other may be six or eight Feet above the highest Part of the Building. To the upper End of the Rod fasten about a Foot of Brass Wire, the Size of a common Knitting-needle, sharpened to a fine Point;”

# Lots of practical advice

- Wet is good: when we are under a thunderstorm we tend to get wet clothing, thus providing a conducting path outside our body. “a wet Rat can not be kill’d by the exploding electrical Bottle, when a dry Rat may”
- AND Religious Attacks:  
e.g. In 1756, when an earthquake struck Boston, a place where many lightning rods had been erected, ministers blamed Franklin in his Audacity in stealing lightning from the Almighty.



JIM HARRISON

This “thunder house,” akin to models Franklin made to demonstrate the virtues of his lightning rod, is a replica of an instrument purchased by Harvard in 1789 from the Reverend John Prince of Salem. A three-dimensional mahogany model of a house (10 by 6 by 8 inches), built with removable roof and collapsible walls hinged to the base, it is equipped with a lightning rod that runs up the gable and ends in a detachable brass ball above the chimney. A wooden block can be inserted to break the circuit. Within the house is a cup containing gunpowder. When the circuit is complete, an electrical charge goes through the lightning rod, with no effect on the house. When the circuit is broken, the spark ignites the gunpowder with convincing—and entertaining—effects.

Professor I. Bernard Cohen had the replica made 45 years ago and often used it in his lectures; he recalls consulting his colleague, chemist George Kistiakowsky, about the gunpowder charge.

From  
“Harvard  
Magazine”,  
1995

# And intense theological argument

- summer of 1753, Dr. John Lining, a physician verified Franklin's kite experiment in Charleston, South Carolina. When he tried to install a rod on his house, the local populace objected. They thought that the rod was presumptuous—that it would interfere with the will of God
- 1753 issue of *Poor Richard's Almanack*:
  - “It has pleased God in his Goodness to Mankind, at length to discover to them the Means of securing their Habitations and other Buildings from Mischief by Thunder and Lightning”

# Became Dr. Franklin

- In 1753, both [Harvard](#) and [Yale](#) awarded him [honorary degrees](#).
- In the next 10-15 years, Europe and America sprouted **lightning rods** everywhere: Franklin became a great hero
- In February 1759, the [University of St Andrews](#) awarded him an Honorary Doctor of Laws degree
- In 1762, [Oxford University](#) awarded Franklin an honorary doctorate for his scientific accomplishments and from then on he went by "Doctor Franklin."

# Developments in the 1760s

- French&Indian War (7-years War) (lost by France)
  - 1754 to 1763 (War between Great Britain and France in N. America)
- Lightning Rods embraced by much of Europe and N. America
- Franklin more famous than Isaac Newton or Leibnitz  
“...Franklin's fame was universal. His name was familiar to government and people, to kings, courtiers, nobility, clergy, and philosophers, as well as plebeians, to such a degree that there was scarcely a peasant or a citizen, a valet de chambre, coachman or footman, a lady's chambermaid or a scullion in a kitchen,...”

# Declaration of Independence



John Trumbull depicts the Committee of Five presenting their work to the Congress  
(Wikipedia)

# Ambassador to France: 1776–1785

- Treaty of Alliance (1778) negotiated for the Continental Congress by Franklin
- One of his great successes included securing a critical military alliance in 1778 and negotiating the [Treaty of Paris \(1783\)](#) ending the Revolutionary War

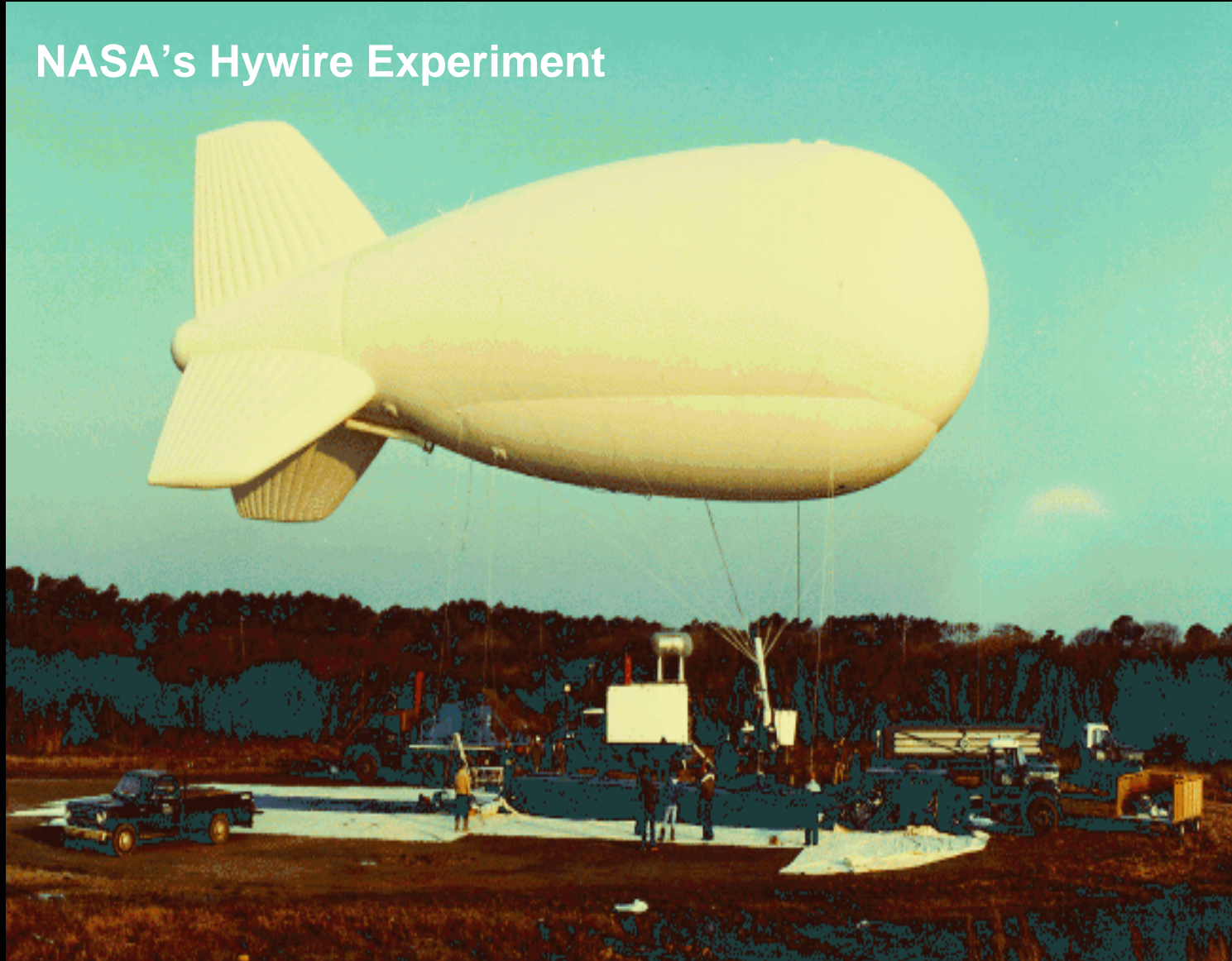


Nara, Japan



# Modern day follow up to Ben Franklin

NASA's Hywire Experiment



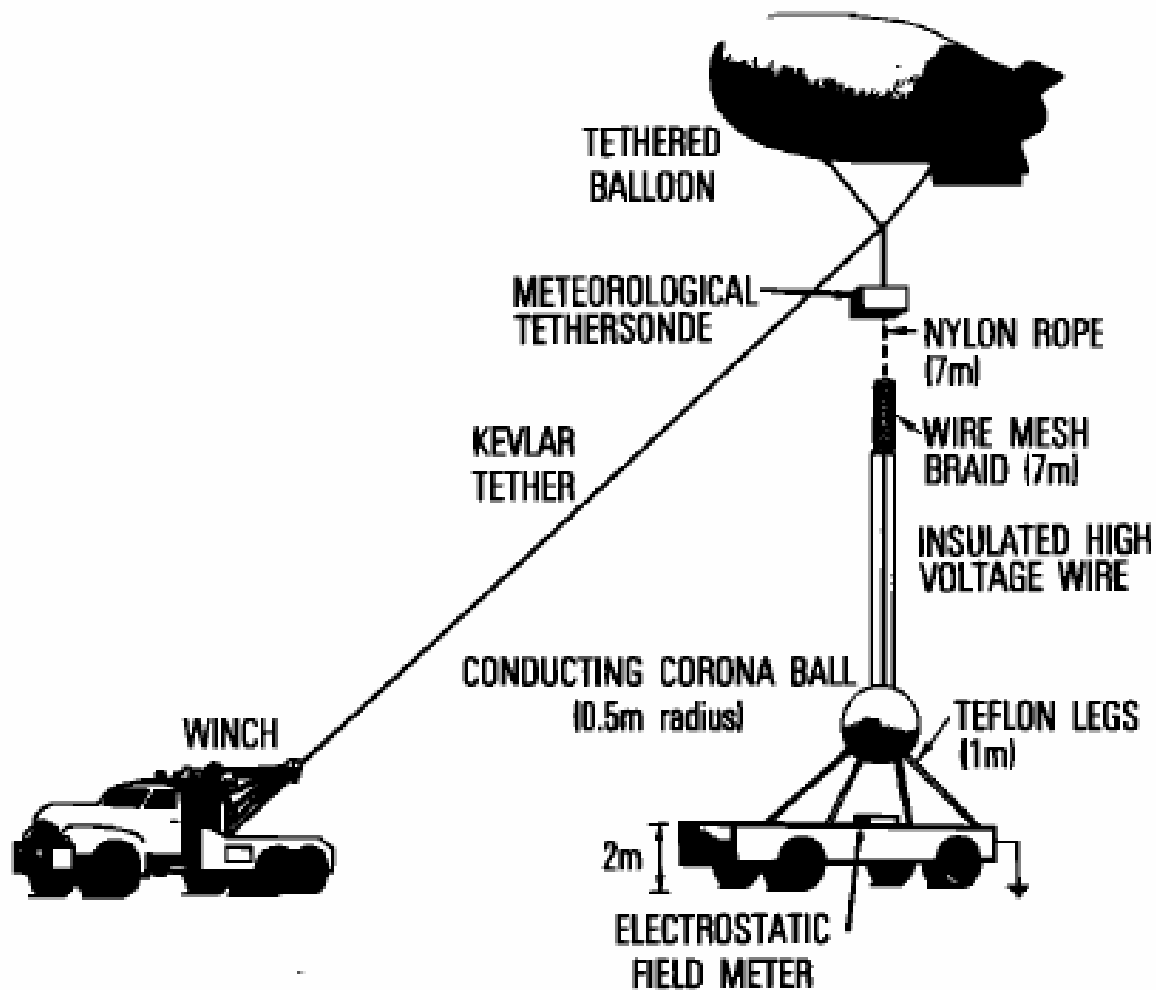


Fig. 1. Schematic of Hy-wire apparatus. The wire mesh, center conductor of insulated wire and corona ball are all one conductor.

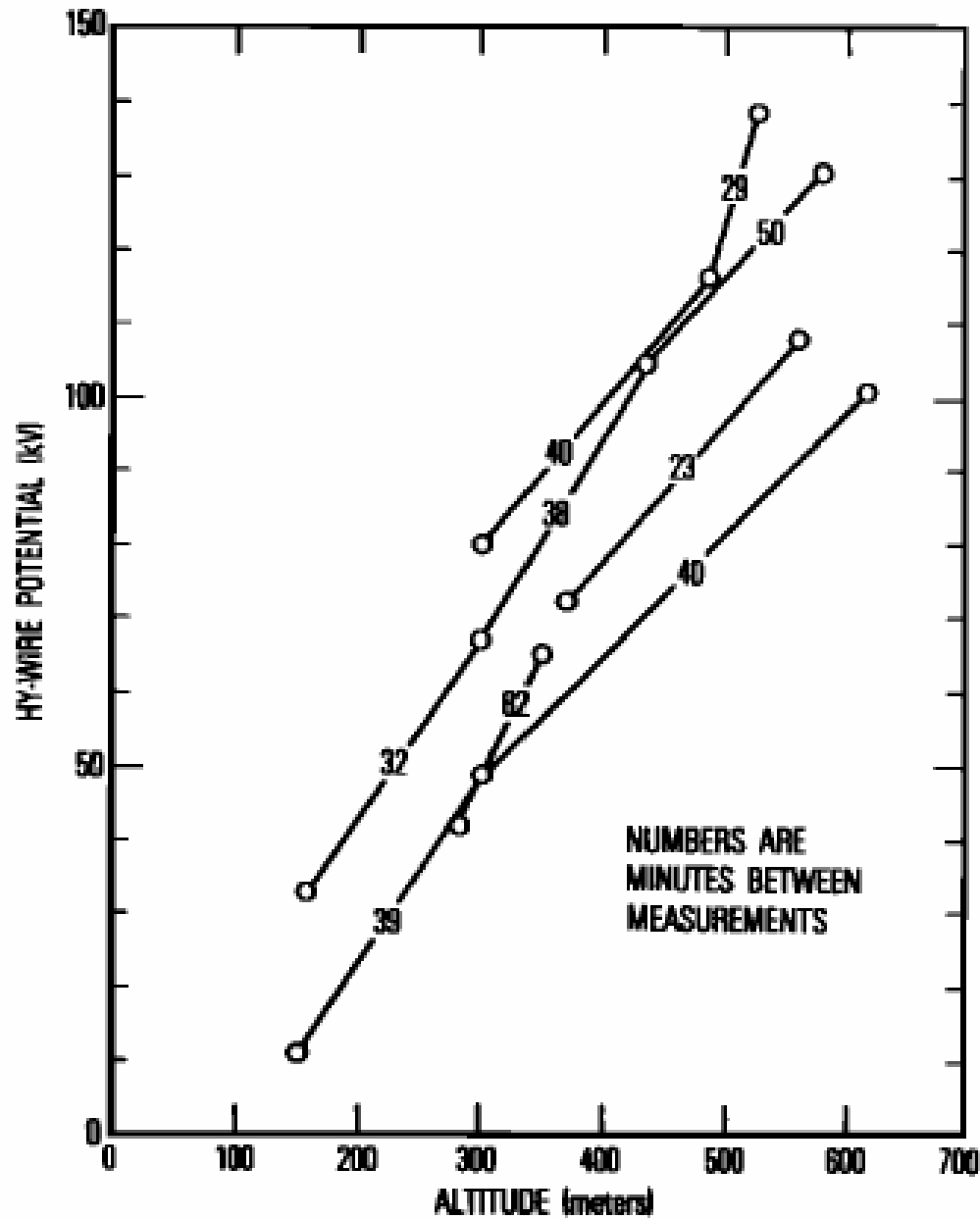
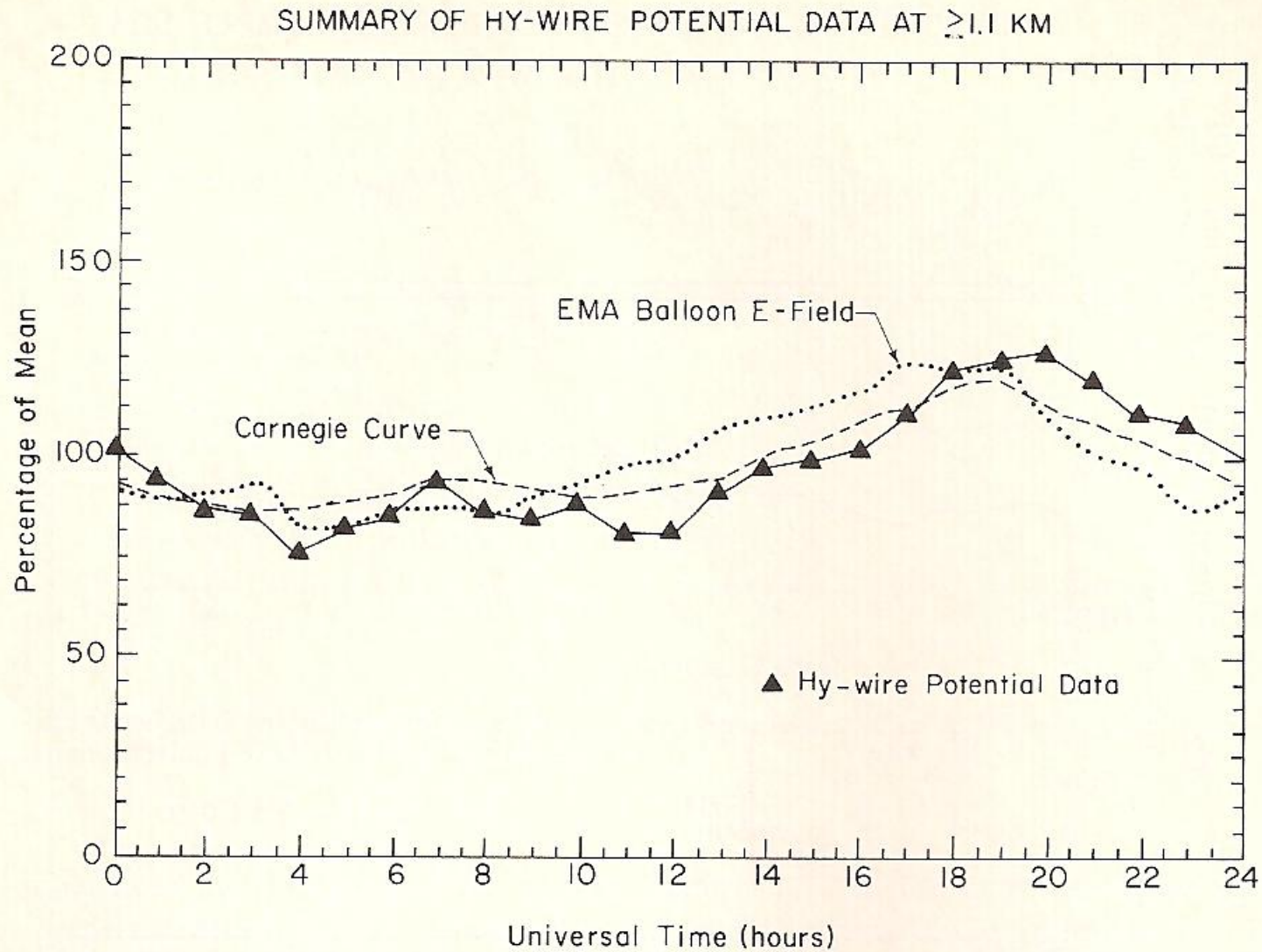


Fig. 3. Hy-wire potential as a function of altitude. Numbers indicate time in minutes between measurements.

# Global Electric Circuit Variations

WOOSLEY AND HOLZWORTH: ELECTRICAL POTENTIAL MEASUREMENTS



7. A summary of all existing Hy-wire potential data taken at  $\geq 1.1$  km. The Carnegie curve and the long-term average of  $E$ -l data taken by simultaneous stratospheric balloons [Holzworth *et al.* 1984] are provided for comparison.

