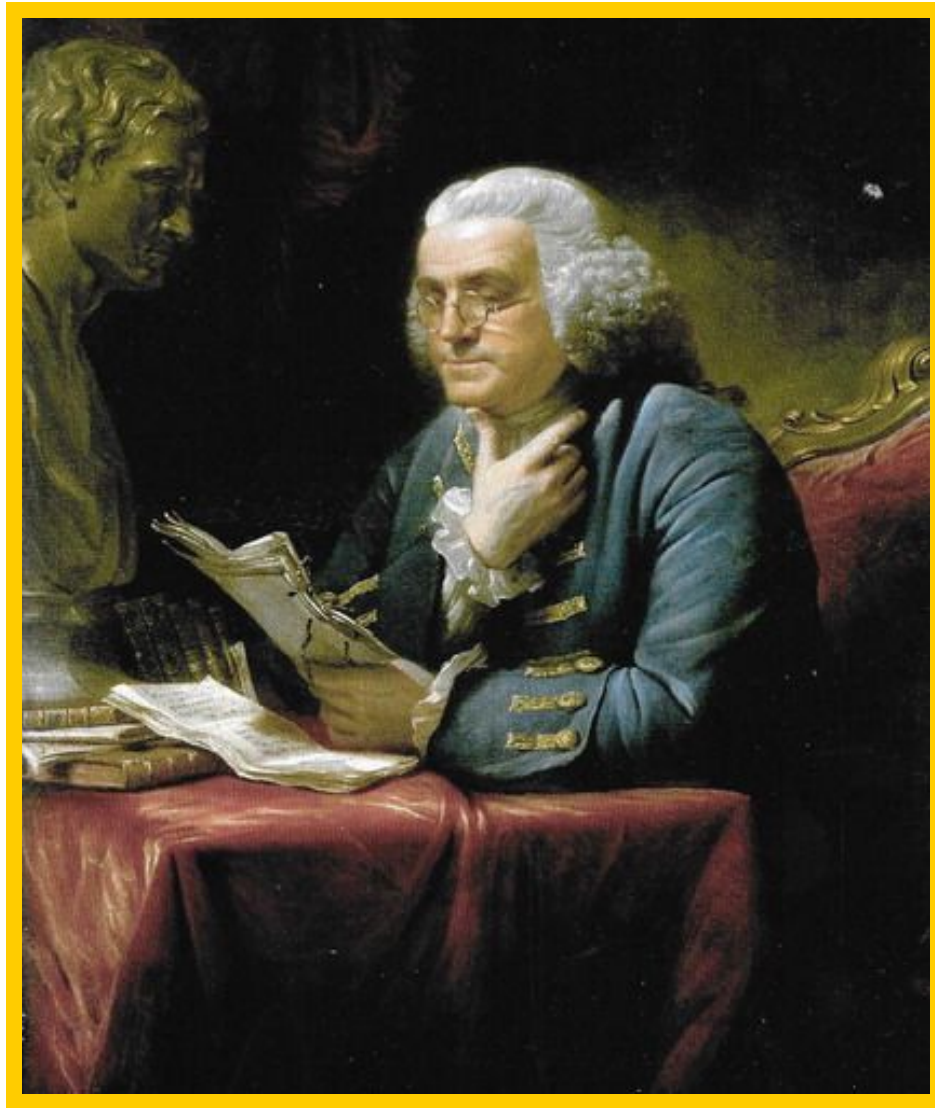


BENJAMIN FRANKLIN SCIENTIST AND INVENTOR

by Brian Roberts, CIBSE Heritage Group



*Benjamin Franklin, 1706-1790
With bust of Sir Isaac Newton FRS on his desk*

Franklin was one of the Founding Fathers of the United States and has been described as “a renowned polymath, leading author, printer, political theorist, politician, freemason, postmaster, scientist, inventor, civic activist, statesman and diplomat.”

This paper looks only at Franklin’s experiments discoveries and activities with electricity, lightning, his heating stove and smokey chimneys, and fire-fighting.

BENJAMIN FRANKLIN

Franklin the Scientist was a major figure in *American Enlightenment* and the history of physics. He is remembered for his discoveries and theories relating to electricity and smokey chimneys. As an inventor, he is known for the lighting rod, the Franklin heating stove and bifocal spectacles. He was involved in the establishment of Philadelphia's Fire Department.

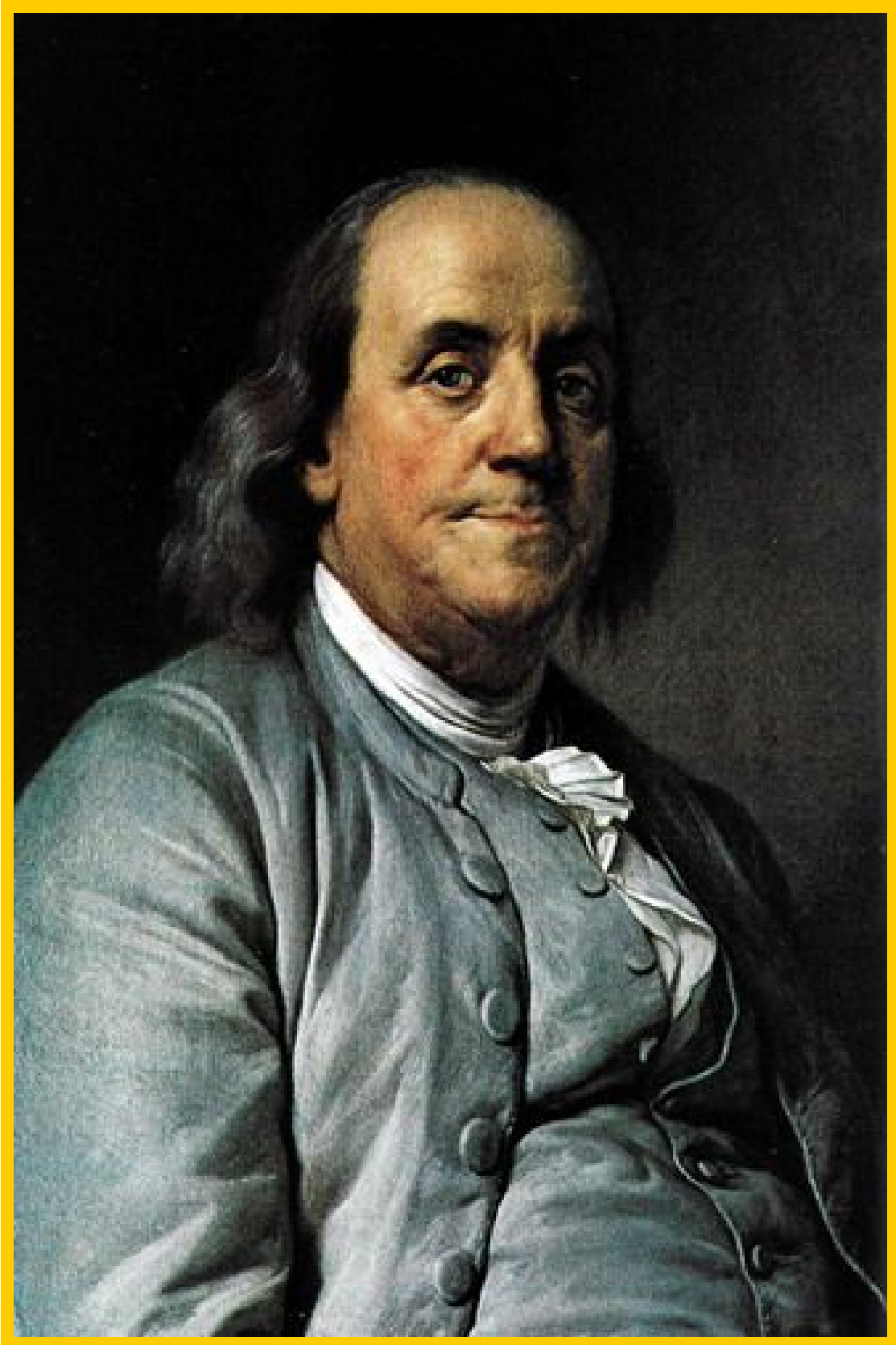
Born in Boston in 1706, Benjamin was one of seventeen children. His father was a tallow chandler. At the age of 12, he entered into an apprenticeship as a printer, his master being his overbearing 21-year-old brother, James. It was at the press that Benjamin discovered the joys of journalism and throughout his life he wrote a variety of pamphlets, and wrote to and edited newspapers, often anonymously. By 1728 he was settled in Philadelphia as owner of the *Pennsylvania Gazette*, going on to publish *Poor Richard's Gazette* (from 1732-57).

In September 1730, Franklin entered a common-law marriage with his long-time friend Deborah Read, whose first husband had disappeared without benefit of divorce. That same year Franklin found himself father of William, an illegitimate son. Benjamin and Deborah raised the boy with their own daughter, Sally.

From the 1750s, Franklin's political interests dominated his activities. He was a member of the Pennsylvania Assembly (1754-64) and Deputy Postmaster for the American Colonies. He visited England in a diplomatic role (1757-62) and found fame in social and scientific circles. He revisited in 1766, but returned to America to play a leading role in the fight for independence and helped in 1776 to draw up the Declaration of Independence. Later as Ambassador to France, in 1783, he was one of the signatories of the Treaty of Versailles, by which independence was finally secured. Franklin died in 1790.



PICTURE GALLERY



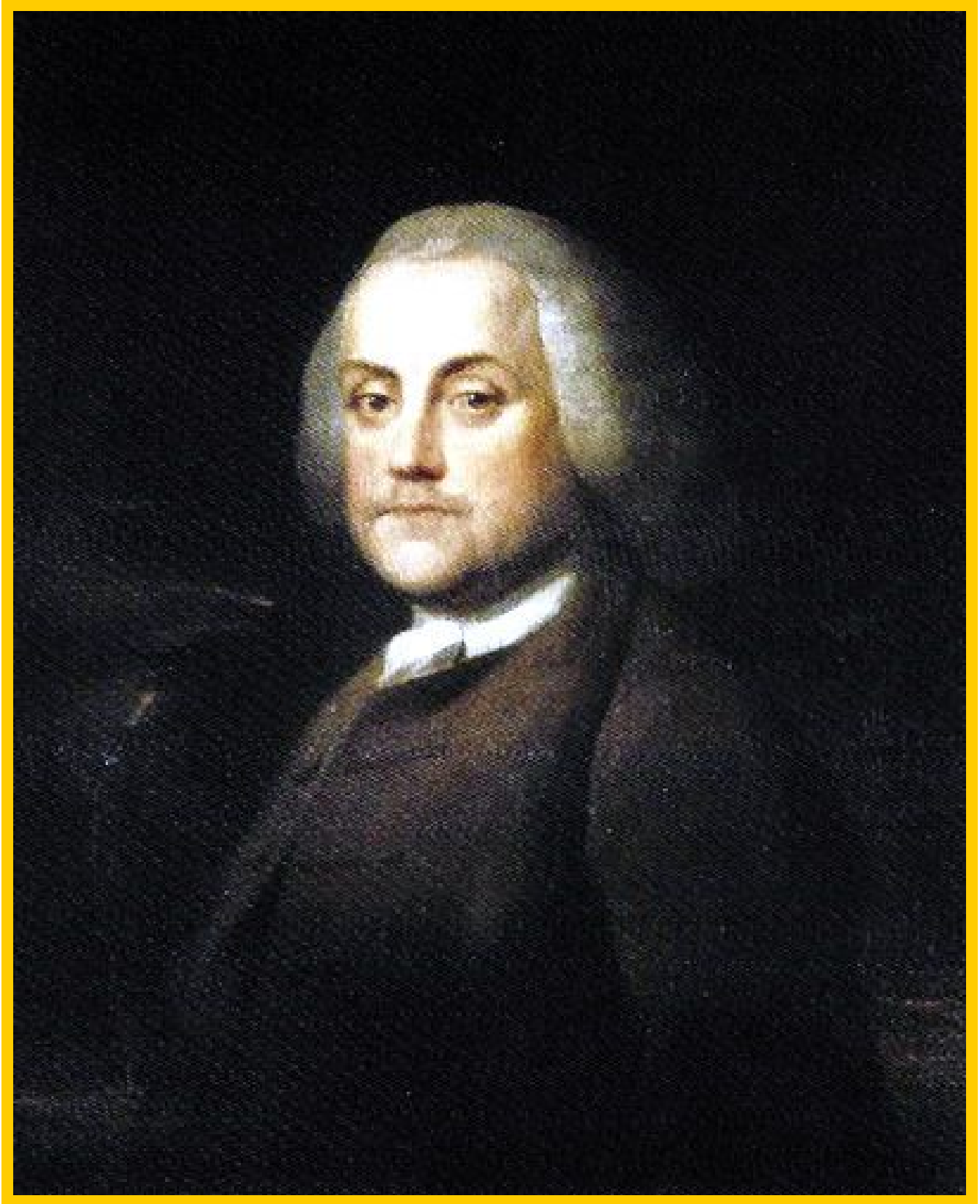
Benjamin Franklin, 6th President of Pennsylvania, 1875-88

PICTURE GALLERY



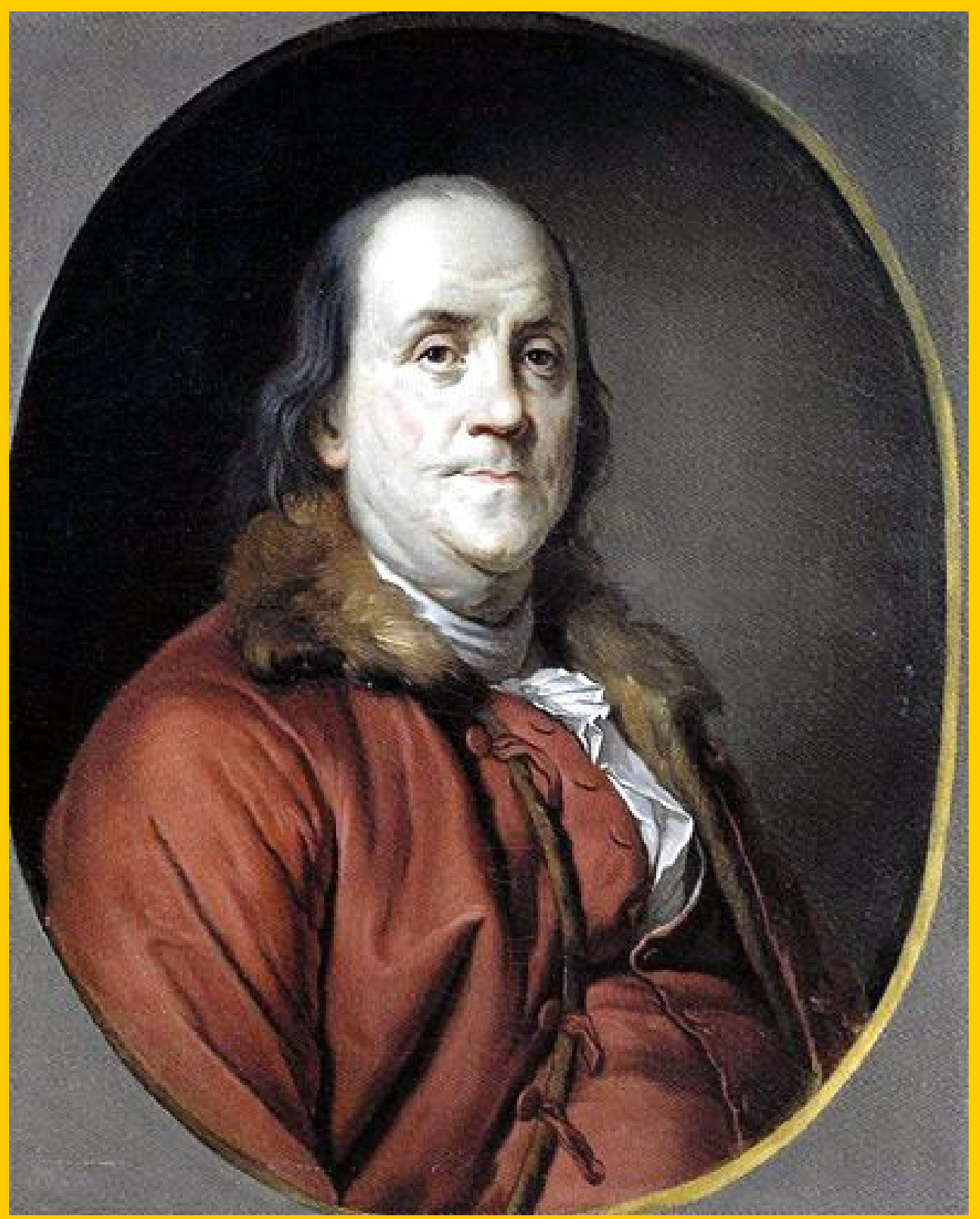
Benjamin Franklin Drawing Electricity from the Sky, c.1816
Philadelphia Museum of Art

PICTURE GALLERY



Franklin portrait with lightning flash, bottom left

PICTURE GALLERY



Franklin in France

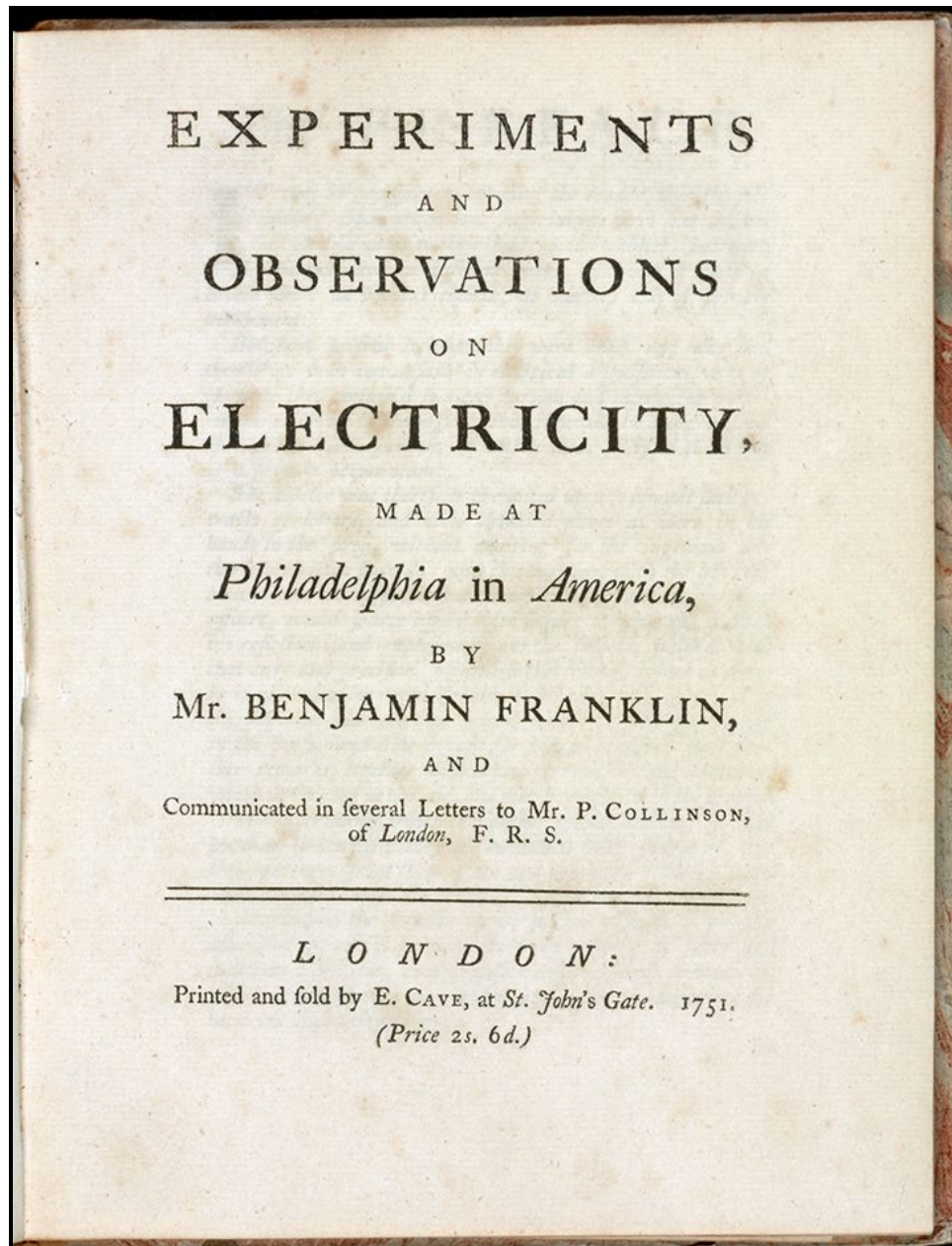
PICTURE GALLERY



Deborah Franklin, Wife of Benjamin

ELECTRICITY

Benjamin Franklin knew that certain objects rubbed together would produce a brief spark of electricity, but to carry out experiments he needed a longer-lasting supply. About 1746, he obtained a rechargeable storage battery known as the Leyden jar. He went on to develop an electrostatic machine capable of continually generating electric sparks for a supply of electricity to be stored in a Leyden jar.



1751

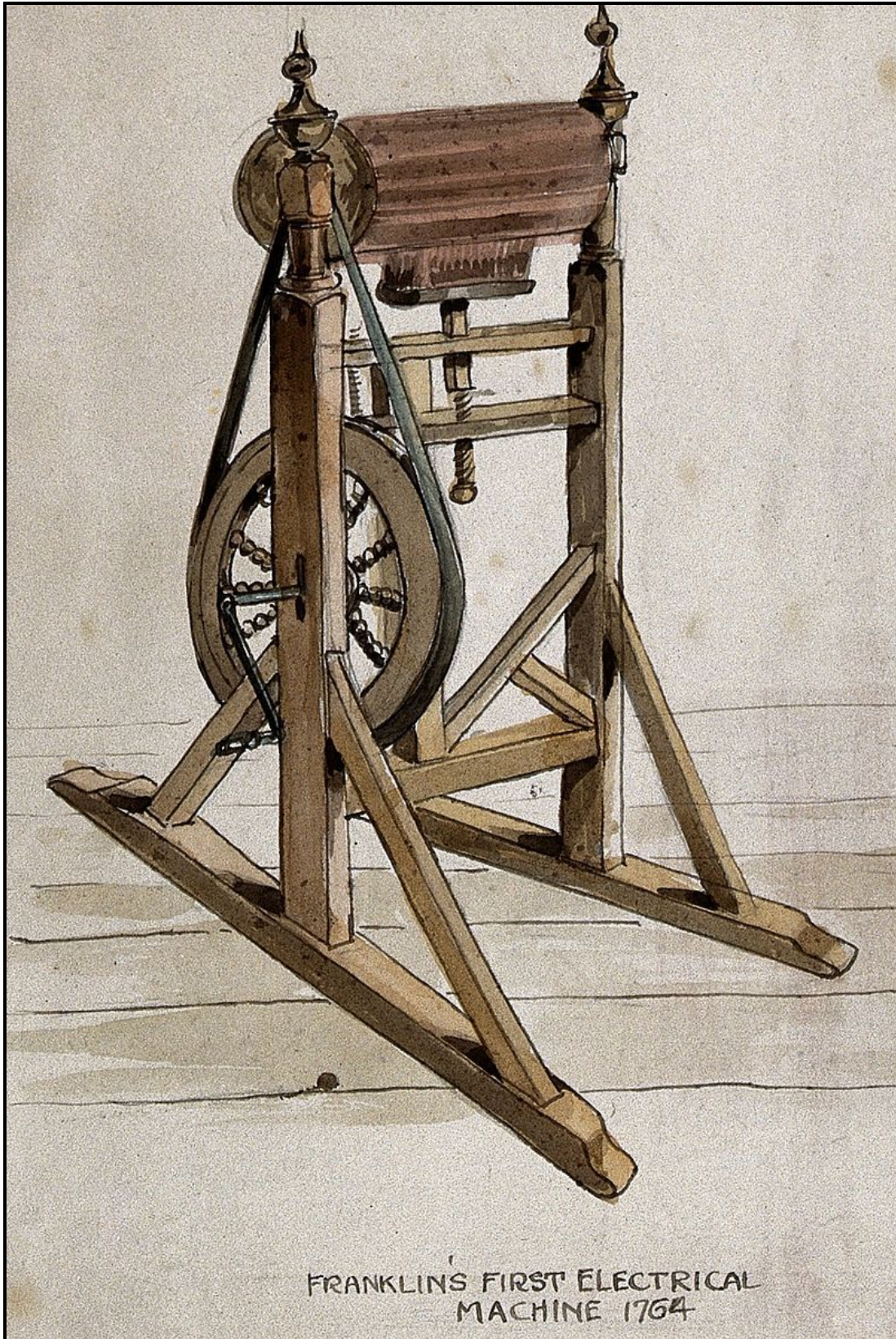
Franklin proved that *positive* and *negative* charges were produced in equal amounts and was the first to use these terms as applied to electricity

ELECTRICITY



Illustration from Franklin's "Experiments and Observations On Electricity," 1769

ELECTRICITY



FRANKLIN'S FIRST ELECTRICAL
MACHINE 1764

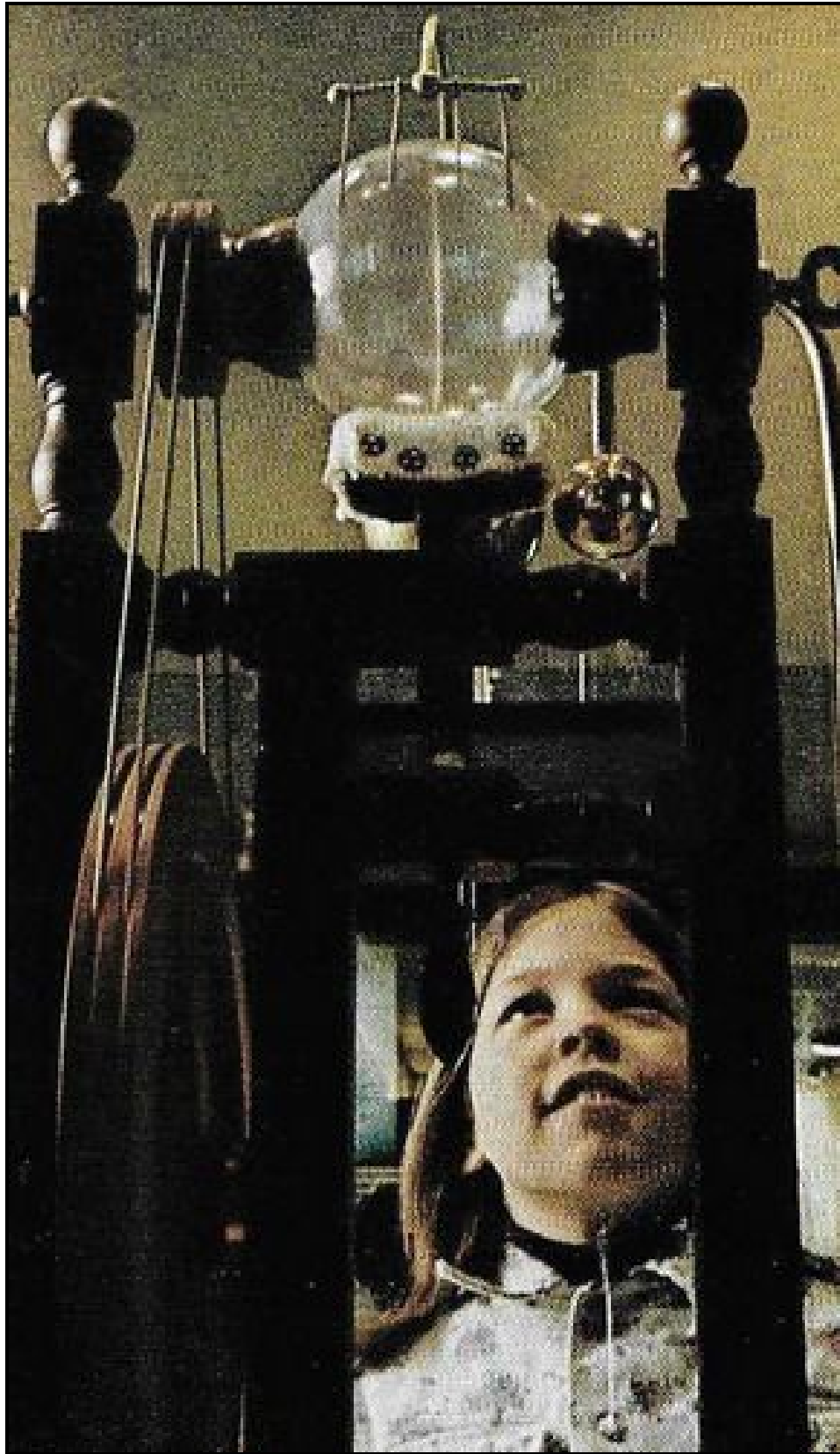
Franklin's first Electrostatic Machine of 1764

ELECTRICITY



Model of Franklin's Electrostatic Machine

ELECTRICITY



Inspecting the model of Franklin's Machine

ELECTRICITY



“Electrical battery” of Leyden jars (probably English), 1760-1769

Glass, metal, and wood

American Philosophical Society, Philadelphia

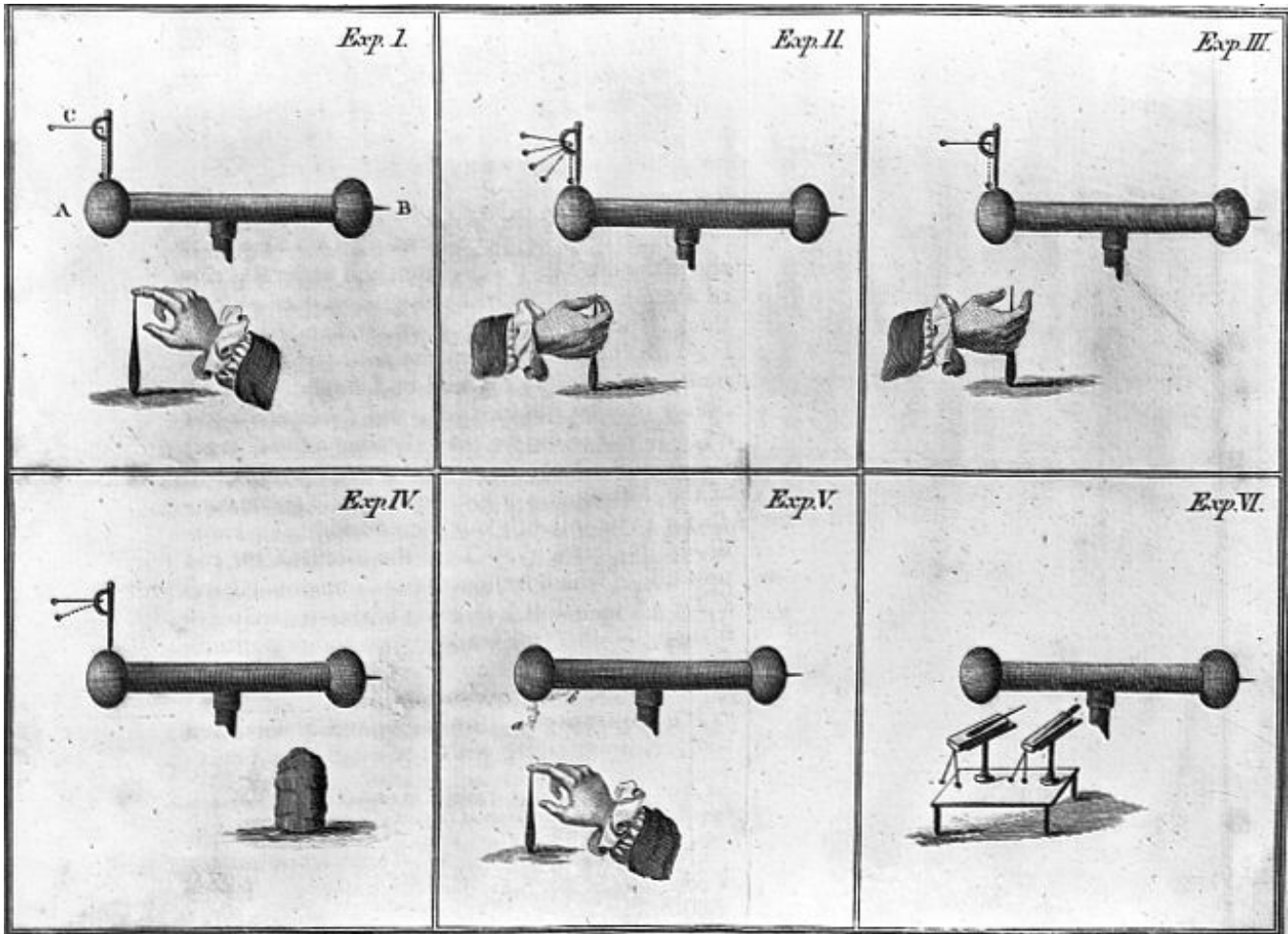
Originally owned by Benjamin Franklin; descended in the family of Francis Hopkinson, one of the executors of Franklin's will

Franklin grouped a number of jars into what he described as a “battery” (a military term). By multiplying the number of holding vessels, a stronger charge could be stored and more power would be available on discharge.

Battery of Leyden jars

LIGHTNING

Franklin's electrical experiments led to his invention of the lightning rod and he noted that conductors with a sharp point rather than a smooth or rounded point would discharge silently and at a far greater distance.

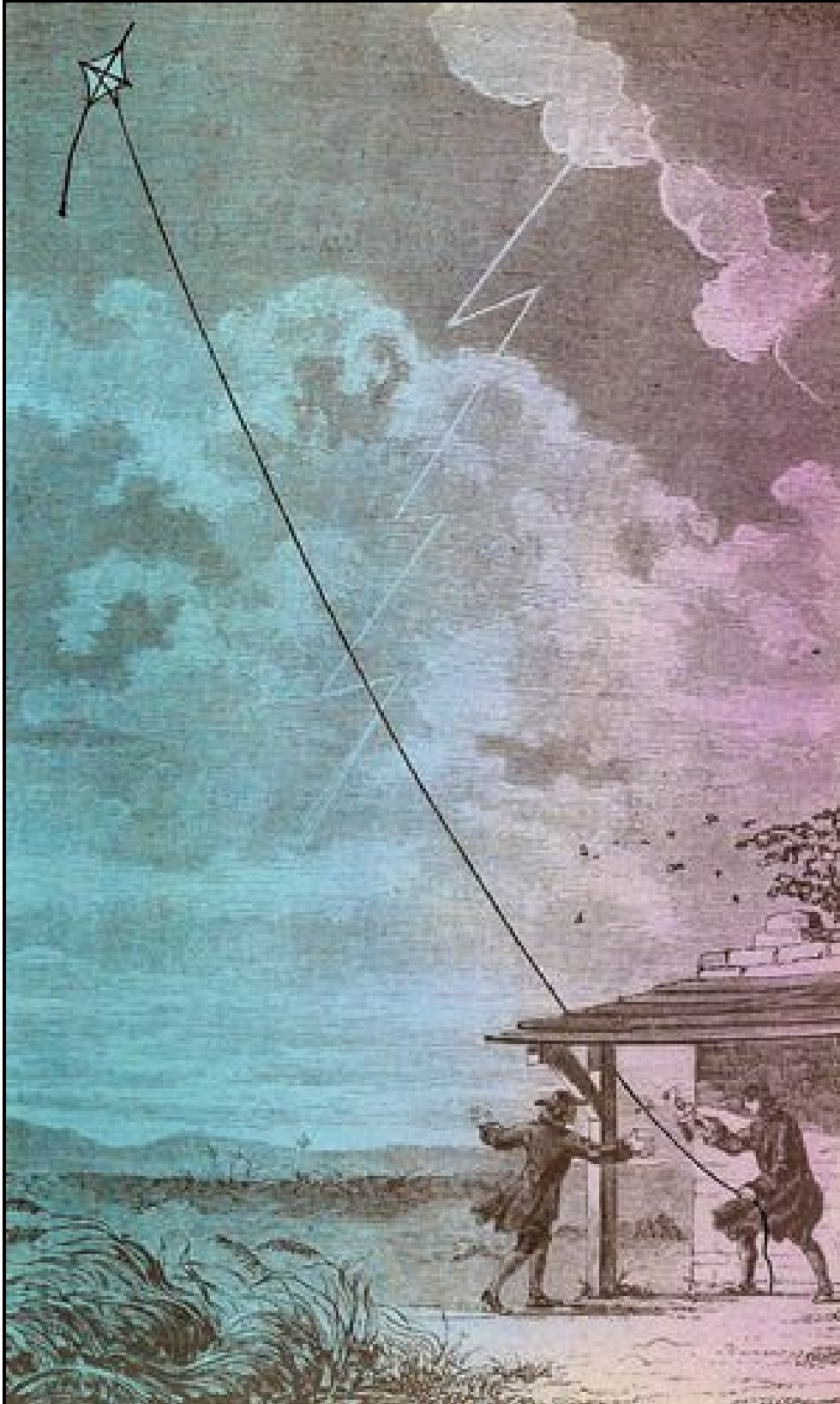


Examples of Franklin's experiments with lightning rod terminations

He realised that buildings could be protected from lightning by attaching “upright Rods of Iron, made sharp as a Needle and gilt to prevent Rusting, and from the Foot of these Rods a Wire down the outside of the Building into the Ground;.....Would not these pointed Rods probably draw the Electrical Fire out of a Cloud before it came nigh enough to strike, and thereby secure us from the most sudden and terrible Mischief!”

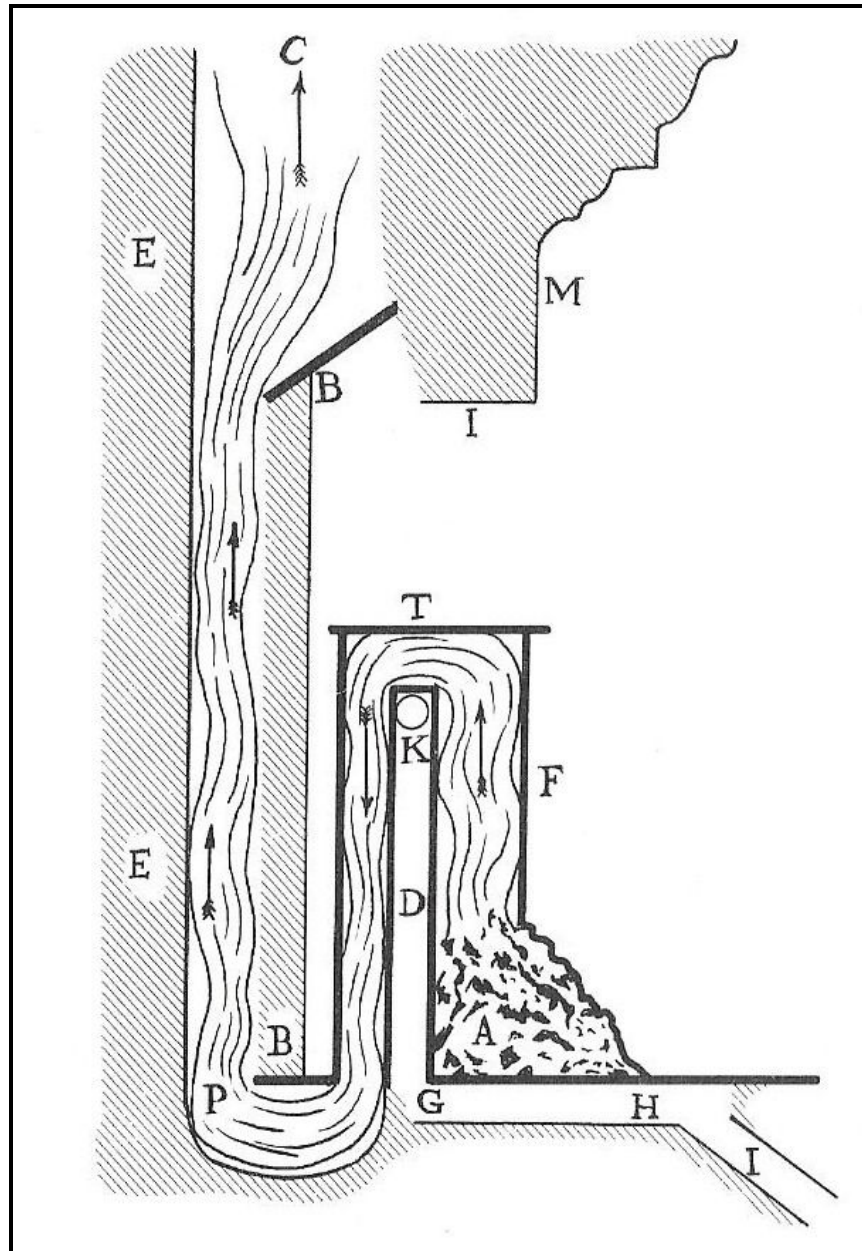
After a series of experiments on Franklin's own house, lightning rods were installed on the Academy of Philadelphia and the Pennsylvania State House in 1752 (later Independence Hall), and his system came to be universally adopted.

LIGHTNING



Drawing of Franklin's famous experiment using a kite to draw electrical fire from the clouds

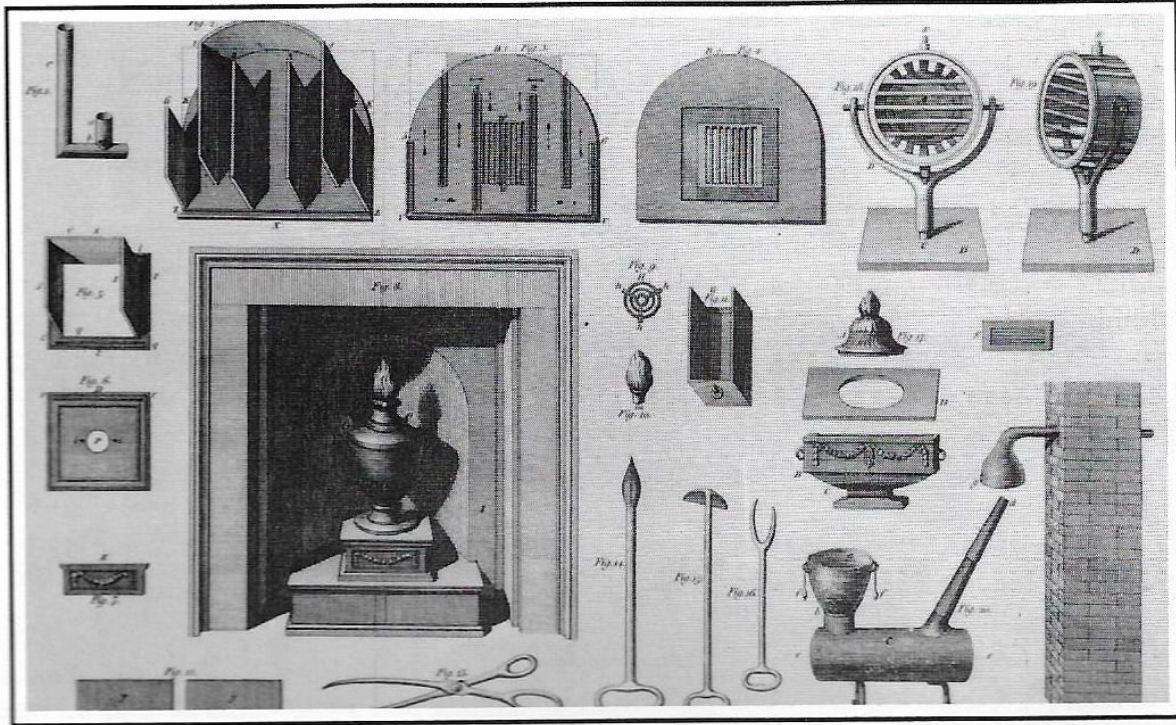
FRANKLIN FIREPLACE



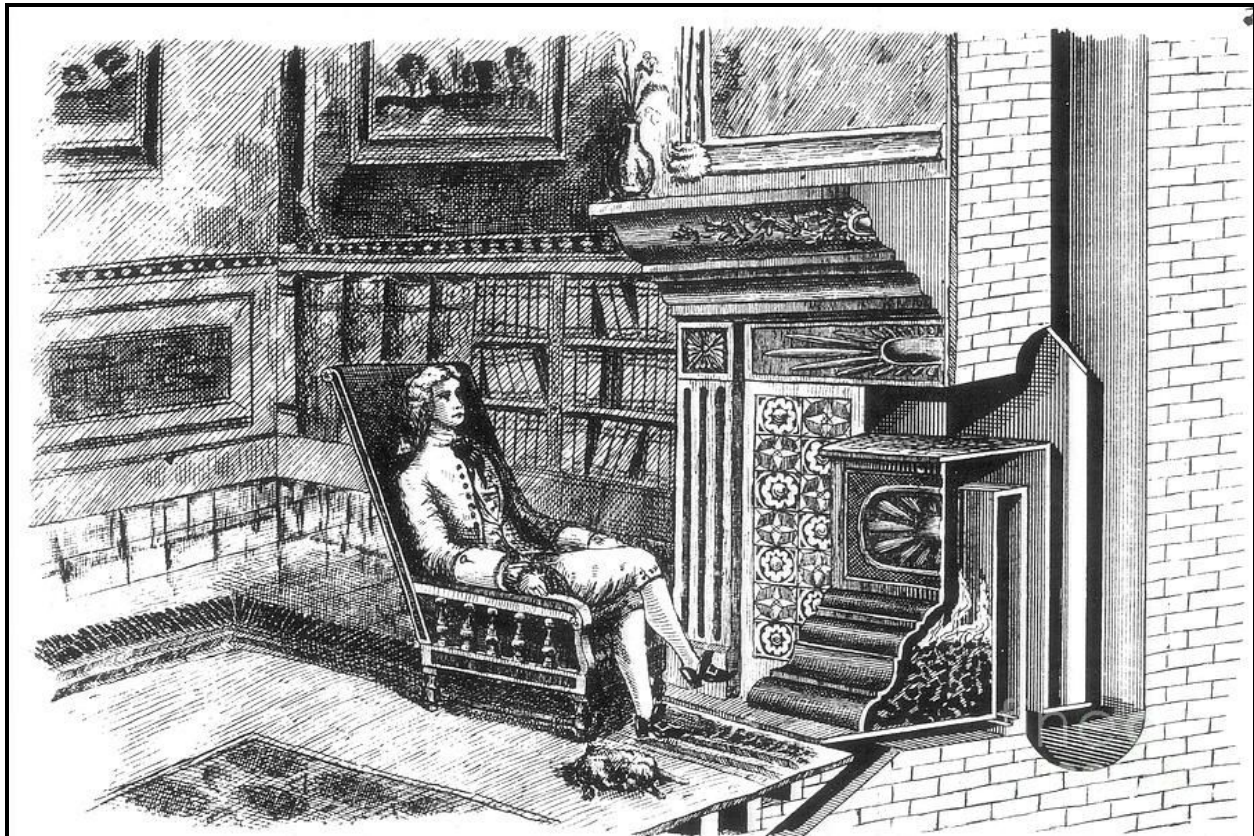
Pennsylvania fireplace

Between 1740 and 1750, Benjamin Franklin turned his attention to the problems of the open fire. In 1749, he published a description of his Pennsylvania fireplace. Designed for burning wood, it was a closable stove, set in an ordinary fireplace recess. Fresh air was admitted both to supply air for combustion at the front of the hearth, and for room warming by means of an air-heating box in the stove. The flue gases were made to pass upward and downwards over the air-box on their way to the chimney. A register plate at the front of the fire was used to control the rate of burning and to close the fire at night.

FRANKLIN'S GRATE AND STOVE

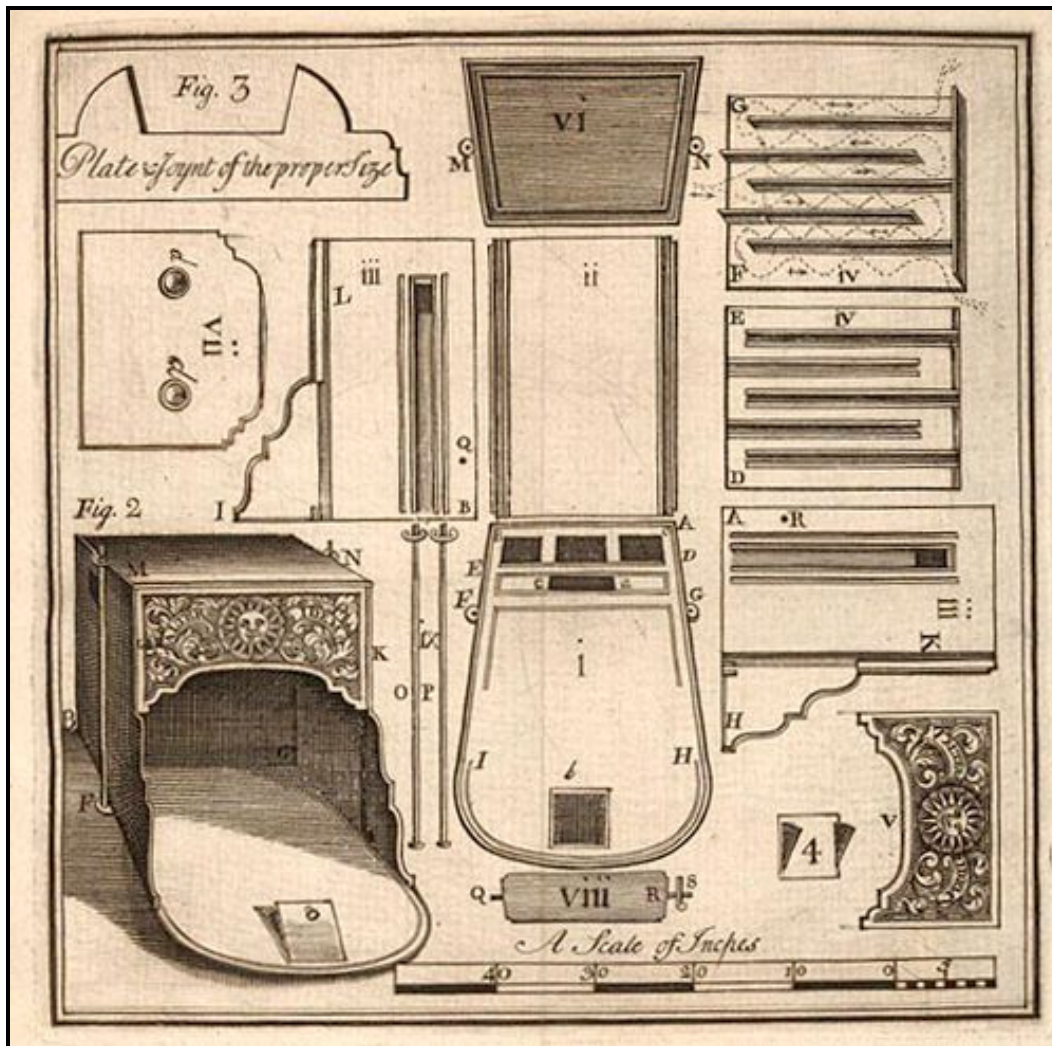


Franklin's "Fancy Grates" from *Observations on Smokey Chimneys*, 1793



Franklin's stove

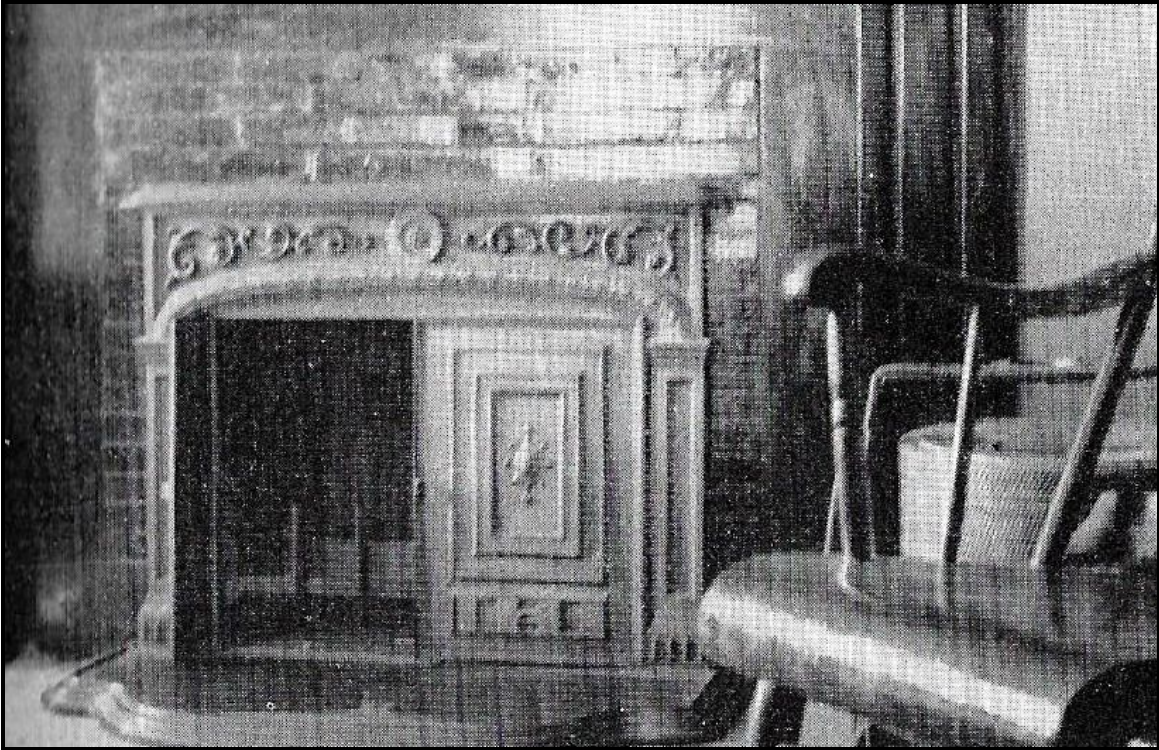
FRANKLIN STOVE



Components of the Franklin stove, developed in 1741

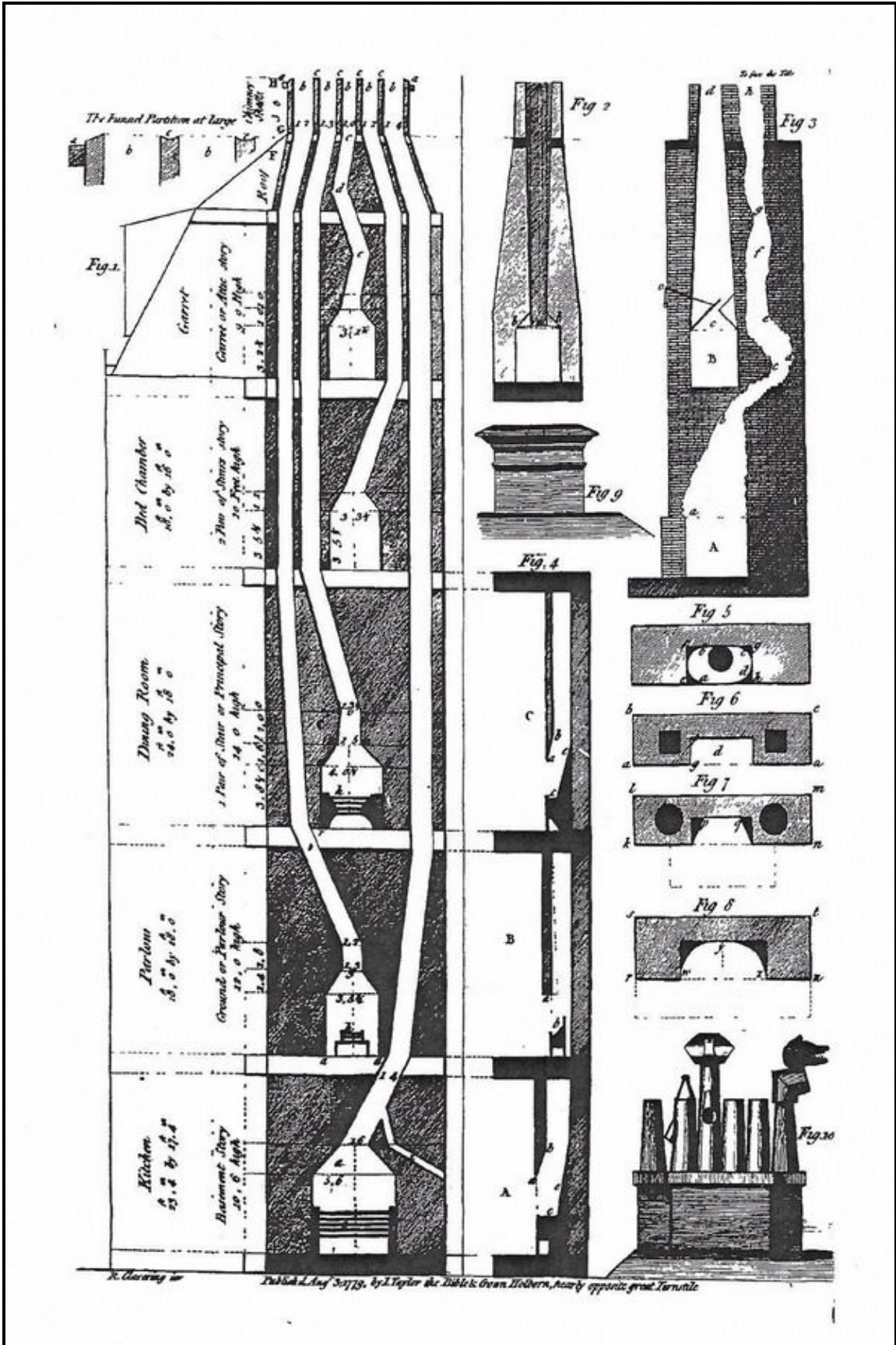
Early fireplaces were designed in France by Louis Savot (1759-1640) and by Nicolas Gauger (c.1680-1730). Franklin's stove appears to be an alternative name or development of his famous Pennsylvania Fireplace. In his stove, "a hollow baffle was positioned inside and near the rear of the stove. The baffle was a wide but thin cast-iron box, which was open to the room's air at its bottom and at two holes on its sides, near its top. Air entered the bottom of the box and was heated both by the fire and by the flames flowing over the front and back of the box. The warmed air then rose inside the baffle and exited through the holes in the baffle's sides. Franklin's baffle thus performed at least two functions.....it lengthened the path that the fire's flames had to follow before reaching the chimney, allowing more heat to be extracted from the fumes..." The stove sold poorly (it produced a poor draught) until later improved by one, David Rittenhouse, the credit remaining with Franklin.

FRANKLIN STOVE



Examples of early Franklin stoves

CHIMNEYS



Multiple flues (from Franklin, 1793)

CHIMNEYS

Benjamin Franklin published his *Observations on Smokey Chimneys* in 1793, proposing rules for the proportioning of fireplaces, as well as the design of various fireplace types. In determining the source of the problem of smokey chimneys, Franklin pointed out nine reasons for the cause of smoke:

Want of air

Openings being too large

Too short a funnel (flue)

Chimneys overpowering one another

Downdraughts due to higher buildings or hills

Positive pressure built up by the house

Improper door location

**Descending smoke due to warm air outside
and cool inside air**

Strong winds that blow smoke down the chimney

Franklin also described the design of multiple flues in a single chimney, which allowed for the heating of multi-storey buildings and apartments.

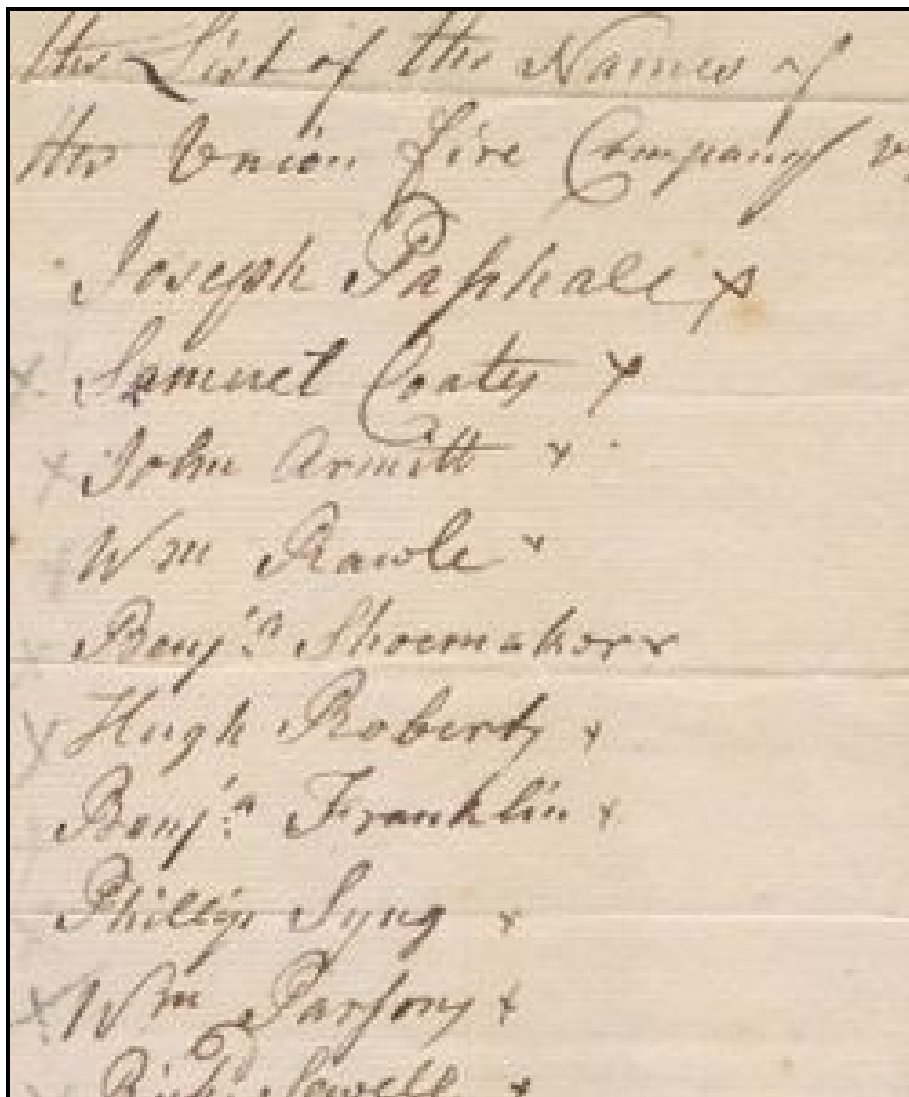
Franklin's recommendations were later expanded in the writings of Benjamin Thompson, Count Rumford (1753-1814), in his rules for fireplace design as described in his 1796 pamphlet on *Chimney Fireplaces* and later in his *Essays* of 1798.

FIRE FIGHTING

Following a major fire in Philadelphia in 1730, Franklin pointed out that if the city had had some decent firefighting equipment and people who knew what they were doing, the fire could easily have been contained before it spread. He wrote *Hints on the Subject of Fires*:

In the first Place, as *an Ounce of Prevention is worth a Pound of Cure*, I would advise 'em to take Care how they suffer living Brands-ends, or Coals in a full Shovel, to be carried out of one Room into another, or up or down Stairs, unless in a Warmingpan shut: for Scraps of Fire may fall into Chinks, and make no Appearance till Midnight; when your Stairs being in Flames, you may be forced (as I once was) to leap out of your Windows, and hazard your Necks to avoid being over-roasted

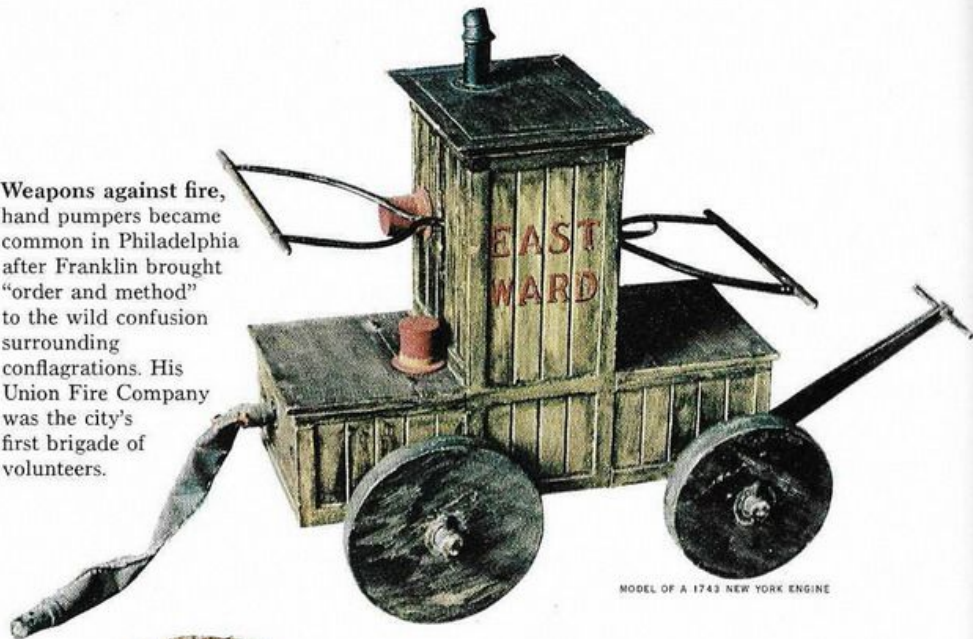
In 1736, Franklin and four friends founded the Union Fire Company, with 26 members of this first brigade. Each member agreed to bring six leather buckets (to carry water) and two stout linen bags (to rescue endangered property) to every fire upon first being alerted to the emergency.



A 1736 Union Fire Company Member Roster
Franklin's name is 7th on the list

FIRE FIGHTING

Weapons against fire, hand pumbers became common in Philadelphia after Franklin brought "order and method" to the wild confusion surrounding conflagrations. His Union Fire Company was the city's first brigade of volunteers.



MODEL OF A 1743 NEW YORK ENGINE



PHILADELPHIA CONTRIBUTIONSHIP

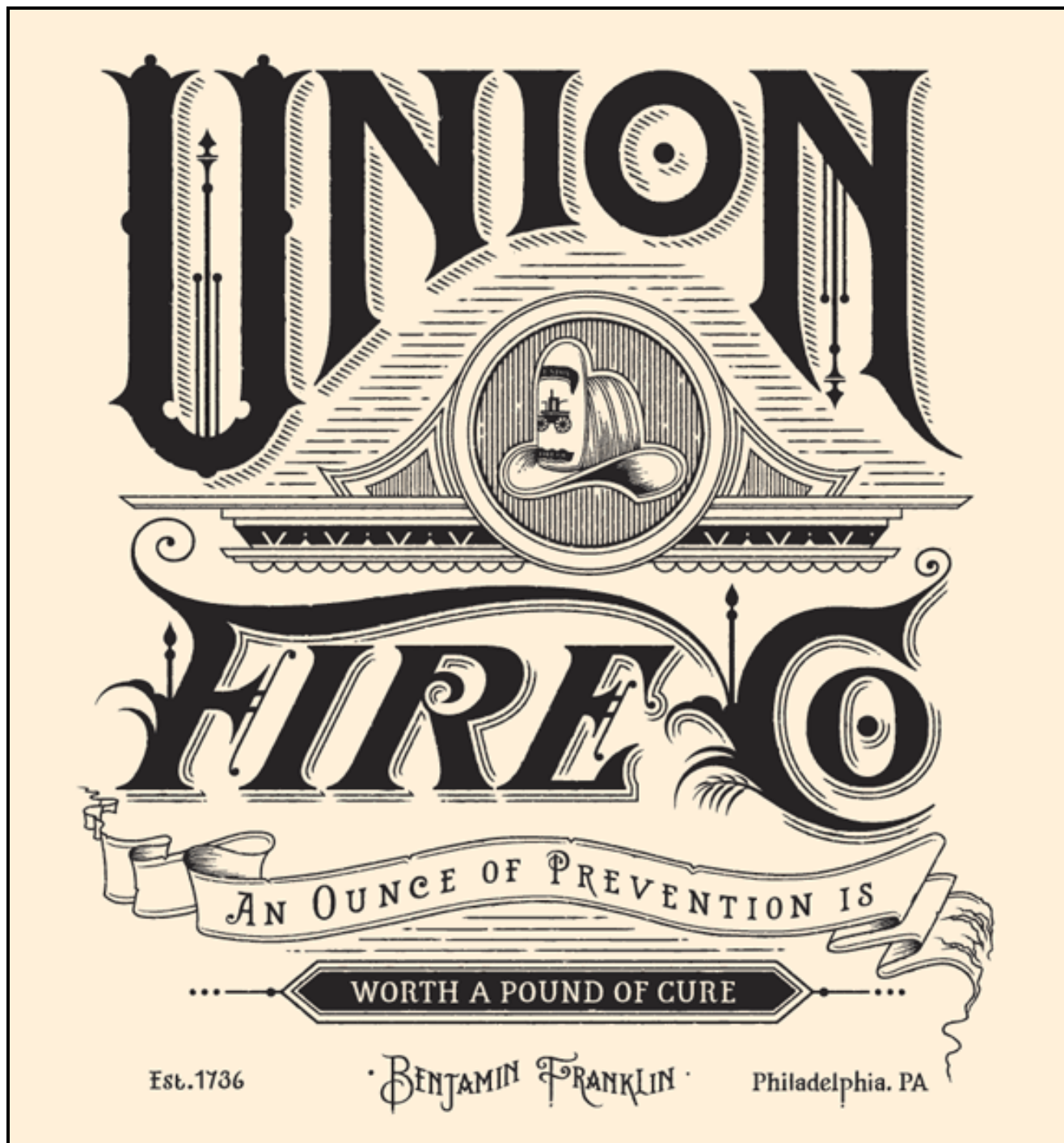
Interlocked hands on this fire mark identified a colonial home insured by the Philadelphia Contributionship, America's oldest fire insurance company. Promoted by Franklin in 1752, it flourishes still.

Owner's name on a leather bucket assured its return when he threw it to passing fire fighters. Franklin's company brought such buckets to monthly meetings, where men practiced techniques; fines from absentees paid for new equipment.



INA CORPORATION MUSEUM, PHILADELPHIA (ABOVE AND TOP)

FIRE FIGHTING



Poster of The Union Fire Company, established in 1736, with Franklin's slogan

FIRE FIGHTING



Franklin and Fire Insurance

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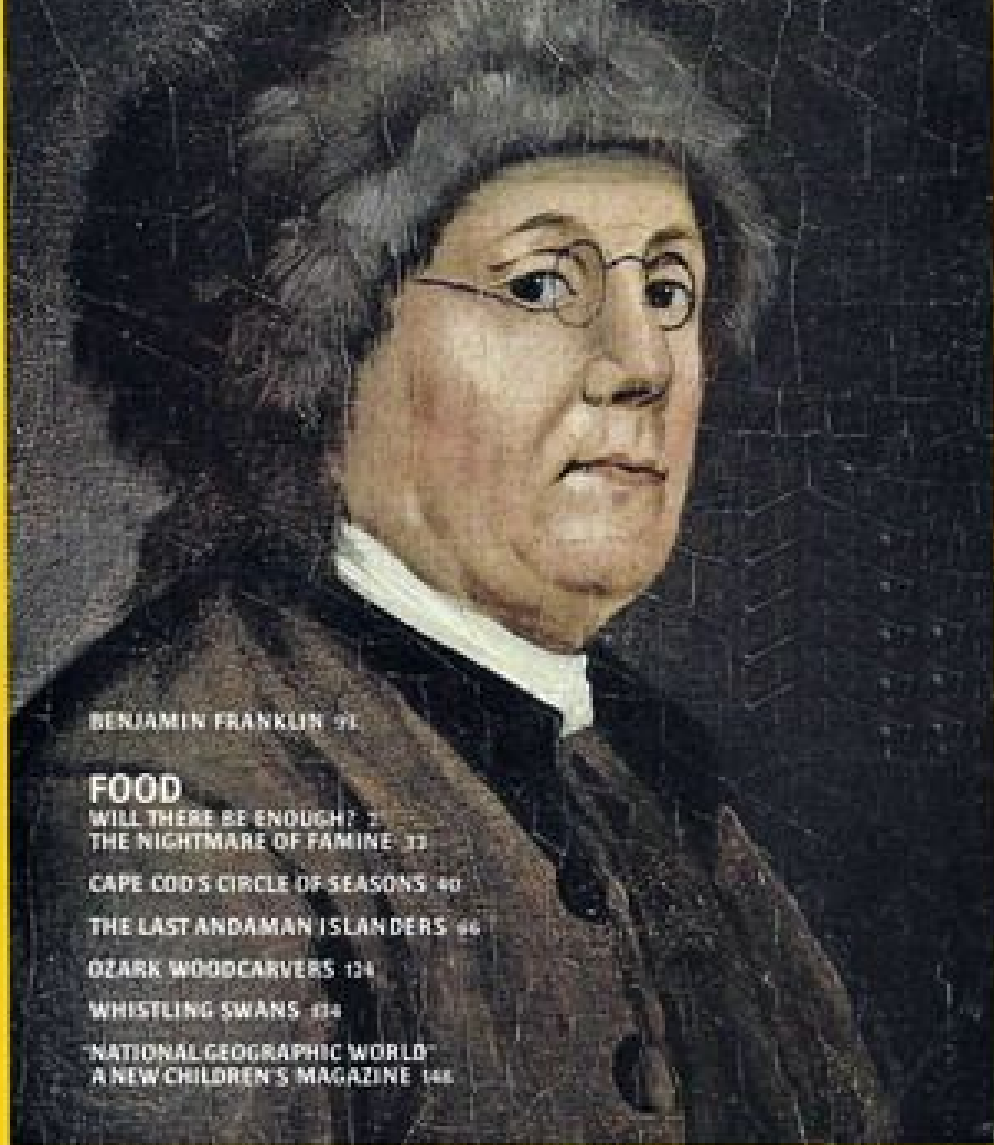
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1975

HEAT & COLD

Mastering the Great Indoors



A Selective History of

HEATING, VENTILATION,
REFRIGERATION & AIR CONDITIONING

BARRY DONALDSON BERNARD NAGENGAST
WITH AN INTRODUCTORY ESSAY BY GERSHON MECKLER

EPILOGUE

Benjamin Franklin died in 1790. His grave is at Christ Church Burial Grove in Philadelphia, where he is buried with his wife.



*Philadelphia grave of Benjamin & Deborah Franklin
It has become the custom to throw pennies onto their gravestone*

Professional Achievements & Awards

Founder Member American Philosophical Society, 1743

Founder Member Philadelphia Academy, 1751

Copley Medal of the Royal Society London, 1753

President Supreme Executive Council of Pennsylvania (1785-88)

Philadelphia Postmaster

Postmaster General North America

Honorary Degree from Yale University

Honorary Degree from Harvard

Honorary Degree from St Andrews, Scotland



Franklin's statue in Boston