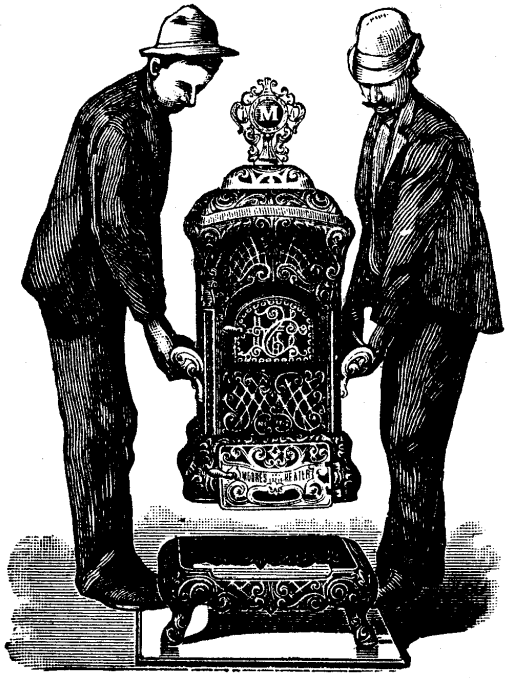
The Comfort Makers

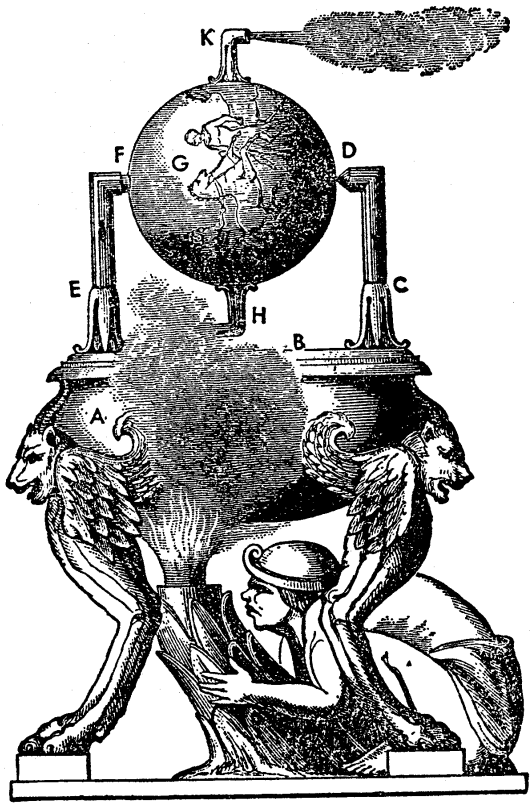


Easy to Carry,
Just Invert the Footrails.

Advertisement: Moore's Air Tight Heater.
Joliet Stove Works, Illinois, USA.
The Metal Worker*, 3 July 1897, p. 9.*

About the Author

Brian Roberts, C.Eng., is a consultant in Surrey, England. He has been chief engineer for two major U.K. design-contractors and technical director of an air-handling unit manufacturer. He has been an ASHRAE member since 1973 and has served on ASHRAE committees and contributed to *ASHRAE Transactions*. Mr. Roberts is also a European Engineer (Eur.Ing.) and a Fellow of CIBSE. In the U.K., he has served on technical committees of CIBSE, the Heating and Ventilating Contractors' Association, the Building Research and Information Association, and the British Standards Institution. He has coauthored a textbook on air conditioning and a history of building services, written some 70 technical and historical papers, lectured extensively, and is the author of the CIBSE Centenary book, *The Quest for Comfort*. He is chairman of the CIBSE Heritage Group, is CIBSE Hon.Librarian, and in 1994 was awarded the CIBSE Silver Medal.



Steam Engine (Aeolipile) by the Greek engineer Hero **[1]**, *c. 50 AD. From* **9.** *p. 64.*

The Comfort Makers

Brian Roberts

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.



Woodcut: Ventilating Machines (Wind Collectors) for Mines, Germany.
De Re Metallica*, Georgius Agricola* **[51]***, 1556. From* **13.** *p. 201.*

ISBN 1-883413-84-2

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Spicers and Peckham, Providence, Rhode Island, USA.

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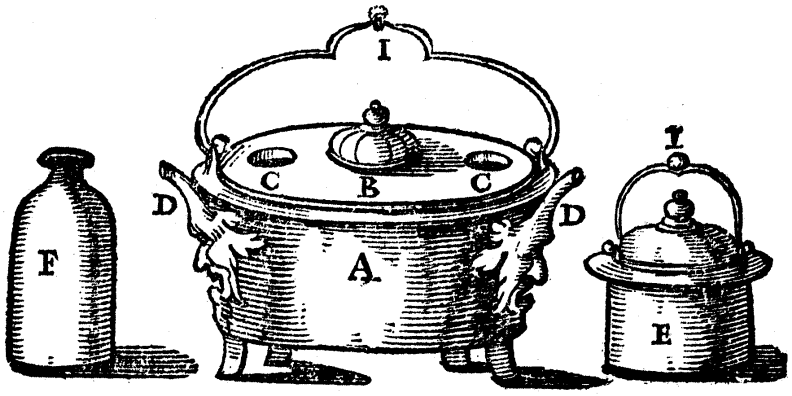
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For my late wife Barbara for her encouragement with my writing and her practical assistance for over forty years.



Cooling Device (Scacchi's Frigidarium), Italy, 1622.
An ingenious apparatus for cooling beverages. From ***20.*** *p. 23.*

For hot, cold, moist and dry, four champions fierce strive here for mastery.

John Milton, *Paradise Lost*, 1666



Advertisement: "The Winchester Heater," Smith & Thayor Co., Boston, Mass. From **99.** *p. 87 (*Engineering Review*, February 1904).*

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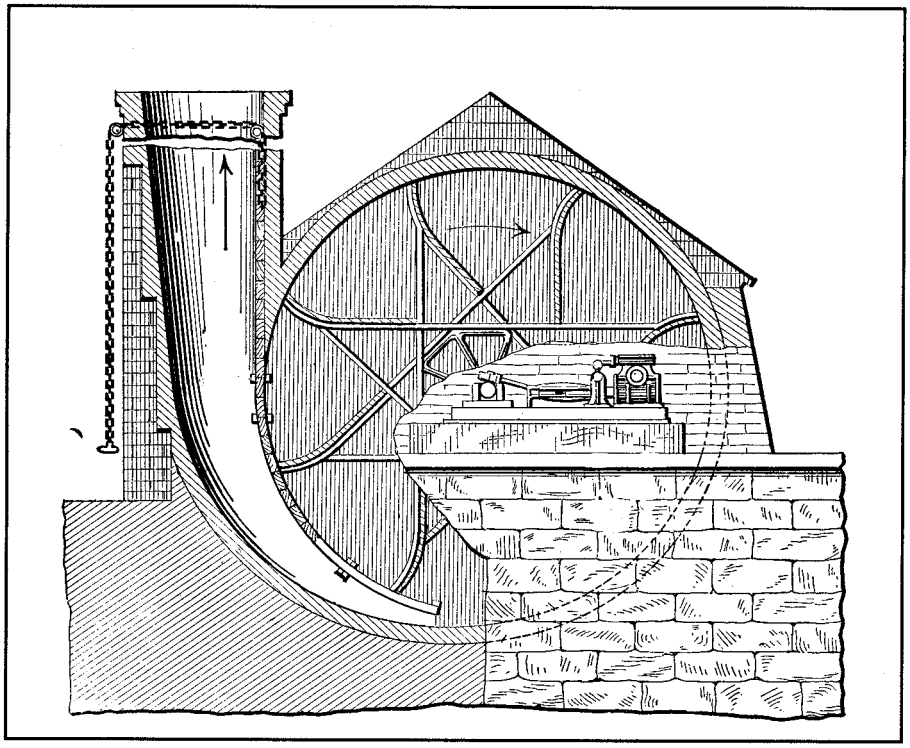
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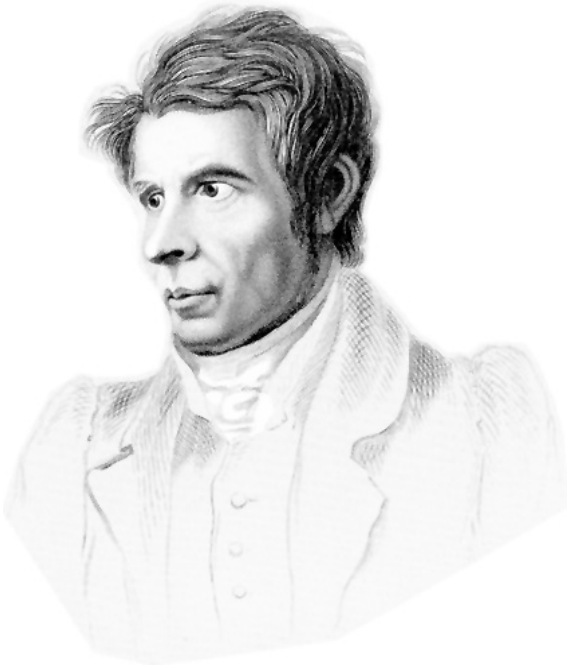


6. Guibal Fan, c. 1878. From **99.** *p. 104.*

The HEAT MAKERS

Though much has been done by ingenious men in the art of distributing heat for household uses; it must be confessed, that in one or two instances only have they been able to make a permanent impression or bring their contrivances into that general use as to constitute them "machines of society."

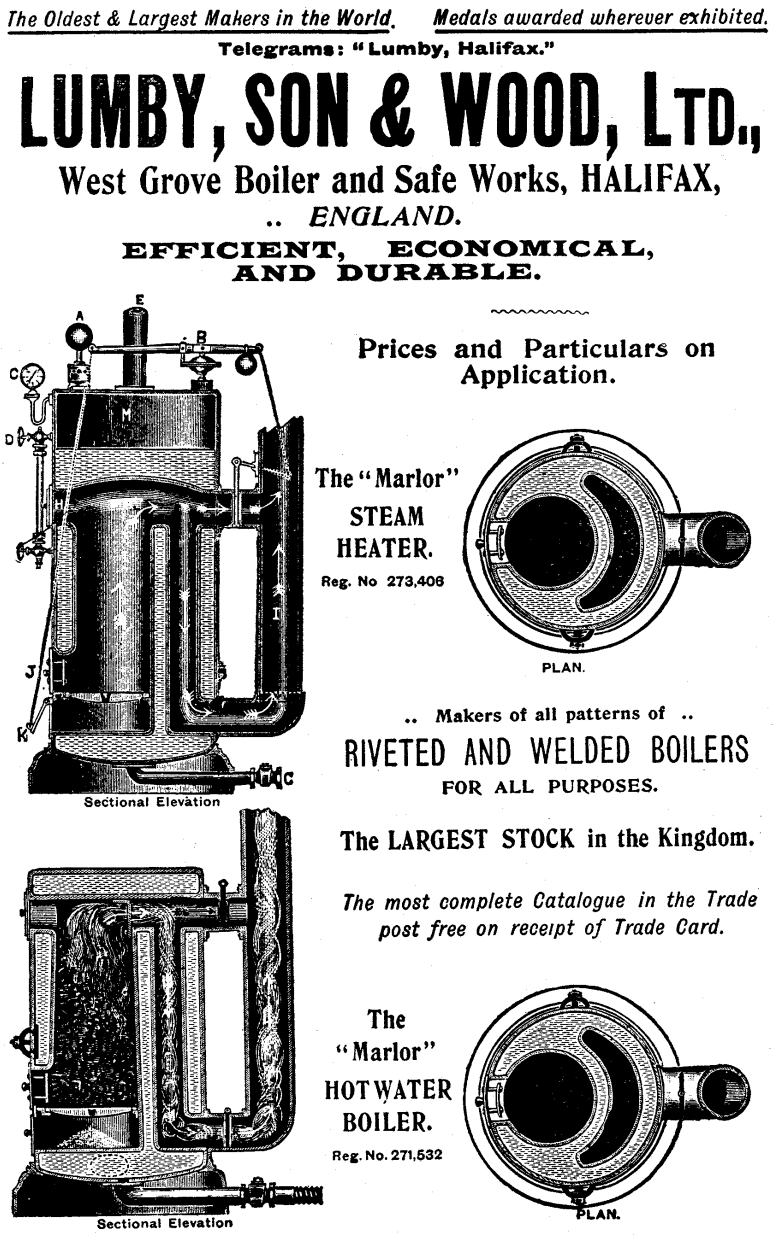
Walter Bernan, Civil Engineer, in his introduction to *On the History and Art of Warming and Ventilating Rooms and Buildings*, Vol. I, 1845.



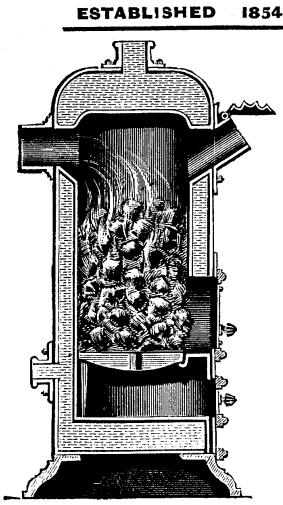
Thomas TREDGOLD [19]



9. Advertisement: Steel Radiator Furnace. The S.M. Howes Co., Boston. The Metal Worker*, 3 July 1897, p. 17.*



10. Advertisement: Steam Heaters and Boilers.
Lumby, Son & Wood, Halifax, founded 1858.
Domestic Engineering, *March 1897, p. 77.*



Dome Top Boiler
with water-way base.

ESTABLISHED 1854.

GRAHAM AND FLEMING

(Successors to S. T. Crook's Exors.)

INVENTORS & MAKERS of

WELDED BOILERS

for Low Pressure Heating,

RIVETTED BOILERS, VALVES &c.,

PREMIER WORKS, **HALIFAX,**
ENGLAND.

Complete Catalogue Free on application

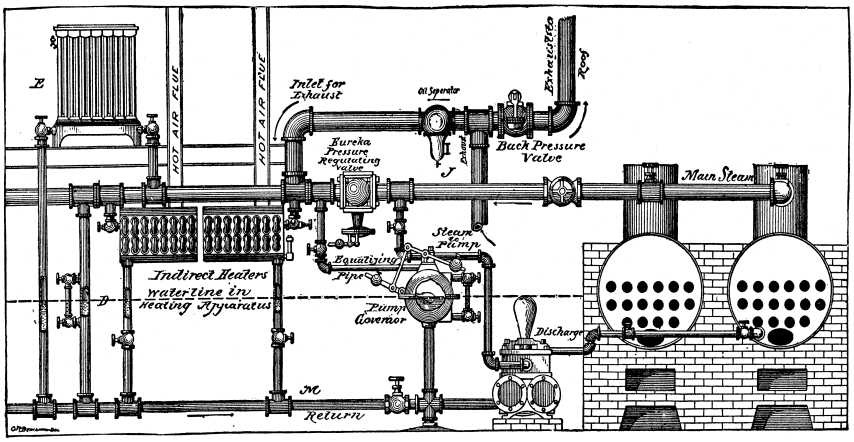
Boilers quoted for and made to customers' own sketches

Telegrams:—' GRAHAM, FLEMING," Halifax.
Telephone No. 39.

11. Advertisement: Welded & Rivetted Boilers.
Graham and Fleming, Halifax. The company was founded in 1854.
Heating & Hot Water, *Walter Jones (President IHVE, 1899), 1894, p. v.*

KIELEY'S WATER-SEAL SYSTEM OF STEAM HEATING

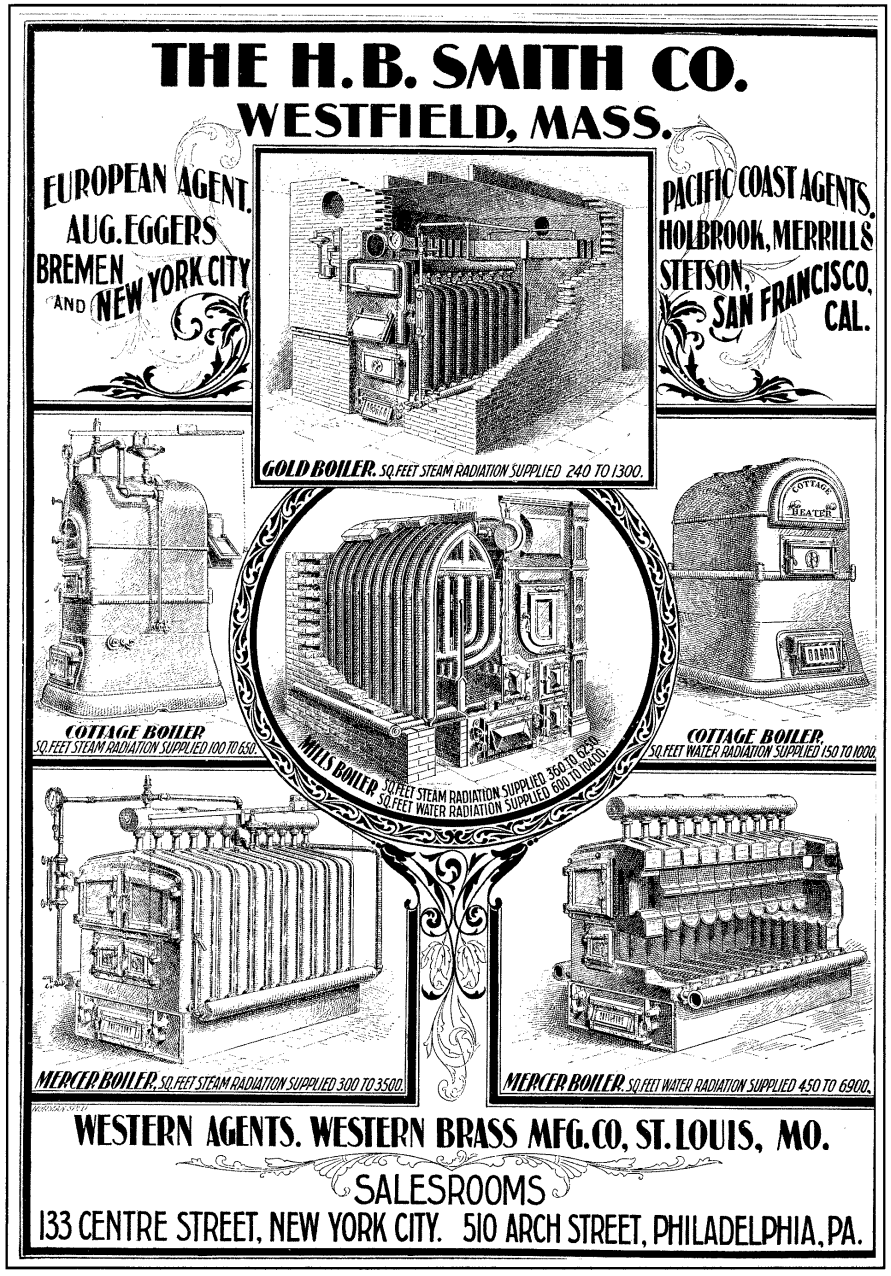
AND AUTOMATIC RETURN OF CONDENSATION.



By the use of this System a large saving of Fuel and a Noiseless Working Apparatus is guaranteed.
The specialties mentioned on opposite page are required to obtain this system.

KIELEY & MUELLER, 7 to 11 West 13th Street, New York.

12. Advertisement: Kieley's System of Steam Heating.
Kieley & Mueller, New York. Baldwin on Heating, *William J. Baldwin, 1900, p. iv.*



13. Advertisement: H.B. Smith Co., Westfield, Mass.
Domestic Engineering*, April 1900, p. 46.*

[1] HERO (HERON) of Alexandria c. 60 AD

Greek engineer. Invented a steam device called the *aeolipile,* a toy that converted steam power to motion. Wrote on mechanics, light, and recognized that air was compressible. Devised simple systems of automatic control to work temple doors and statues.

125. *p. 37 and The Origins of Feedback Control, O. Mayr,* Scientific American*, October 1976.*

[2] John EVELYN 1620-1706

English diarist. Invented a method of greenhouse heating described in *Kalendarium Hortense* (1664). Thought iron stoves and subterranean caliducts often left the plants "sick, langorous and tainted." Evelyn's stove was outside the house, and "heat was transferred inside by air passing through very hot pipes; cold air from the floor area was drawn through a ground pipe to fan the flames of the furnace. Natural convection would therefore ensure a continual supply of fresh, warm air. This ingenious scheme solved the author's passion for fresh air as well as heat...."

Glass Houses*, Woods and Warren, Aurum, 1988, pp.30-31. Evelyn's Greenhouse Furnace is shown on p.* **62.** *Roberts, fig.17, and described in* **11.** *Bernan, Vol.1, Essay VIII.*

[3] Louis SAVOT active early 17th century

Made the first real attempts to improve fireplace construction and performance (France, 1600-1650). Introduced a fundamental innovation where the grate stood on a hearthstone to allow air a more ready access to the fuel. A fireplace of his in the Louvre in Paris also made use of convected warm air—his second important contribution. Savot also devised a double grate, in which the fuel was partially consumed on the upper bars. The partly burned fuel fell to the lower grate, where it was finally burned, ash falling onto the hearth beneath. His ideas were later developed by Gauger [54], while Sir John Winter (1658) introduced primary air for combustion direct from outside by means of a duct beneath the floor.

98. *Billington and Roberts, p.80.*

[4] Sir Hugh PLATT active 1600-1650

English lawyer. Author of *Jewel House of Art and Nature* (1594) in which he proposed the use of hot water heating for the drying process in the manufacture of gunpowder. Also wrote extensively about fireplace construction. His favorite project was "to sweeten sea coal." He wrote *A New Cheape and Delicate Fire of Cole Balles* in which he advocated various mixtures of coal, sawdust, and earth. "Many," says Sir Hugh, "have thought my fire to consist of sea cole and cow dunge, but rash pens do soone run riot, yet I do not utterlie dislike this mixture." Proposed the use of steam for greenhouse heating in *The Garden of Eden** (1653): "To have Roses or Carnations growing in Winter, place them in a roome that may some way be kept warme, either with a dry fire, or with the steam of hot water conveyed by a pipe, fastened to the cover of a pot..." and "I have known Master Jacob of the Glasse-house to have Carnations all the winter by the benefit of a roome that was neere his glasse house fire...." Greenhouse heating was later attempted (1788) by T. Wakefield, Esq. of Norwich.

11. *Bernan, Vol.I, Essays VI (Fireplace) and VIII (Coal).* Facsimiles of the title page and pp.50-51 of Platt's book (of which only two copies are known to exist in the USA) are reproduced in* Fifty Years of New York Steam Service*, New York Steam Corporation, 1932, p.11.*



[5] Denis PAPIN 1647-1712

French physicist. Went to England (1675) and worked as assistant to Boyle [142]. Developed the steam *digester,* a form of pressure cooker (1679). Later, working first in Italy, then in Germany, he pioneered the steam engine (1698), eventually returning to England to die in poverty.

47. *Asimov, entry 205. Portrait* **124.** *p. 23.*



[6] Thomas SAVERY c. 1650-1715

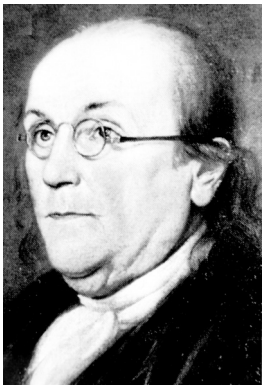
English engineer and prolific inventor. With England badly deforested, the mining of coal became a priority but was badly hampered by flooding of the pits. Guericke [140] had experimented with the power of a vacuum (1650-1654), and Savery used these principles when he developed the first practical steam engine and used it for "raising water by fire" (1698). This was known as *The Miners' Friend.* His patent was so detailed—and, unusually, he got it extended (until 1733)—that it prevented Newcomen [7] securing a patent for his steam engine. (Earlier, 1663, the Marquis of Worcester in his book *A Century of Inventions* described a spherical boiler used for raising water to a height of 12 m.) Savery's boiler "was in the shape of a cauldron with a flat top and could generate steam at 170 kPa. It was constructed of hammered copper, the flat top being of lead."

47. *Asimov, entry 206. Portrait* **124.** *p. 138.*

[7] Thomas NEWCOMEN 1663-1729

English blacksmith and gifted amateur engineer. Taking advice from Hooke [119] and Triewald [9], he constructed (1712) with the help of John Calley the first "atmospheric" steam engine, or *fire and air engine.* Owing to the earlier patent of Savery [6], he made little profit from his invention. After Savery's death (1715), he acquired some of these rights and later developed the engine, which came in general use (from 1725) until the superior engine of Watt [13].

47. *Asimov, entry 211.*



[8] Benjamin FRANKLIN 1706-1790

American statesman, printer, and scientist. Started a fire service (1736). Developed bifocal spectacles. Founded American Philosophical Society (1743). Turned his attention to the problems of the open fire. Published a description (1745) of his *Pennsylvanian* fireplace commenting "my common room is made twice as warm as it used to be, with a quarter of the wood formerly consumed there." Heated a row of houses by means of an iron stove-furnace set in a chamber beneath the ground (1748). Best known for his experiments in static electricity, including his famous, but dangerous, flying of a kite in a thunderstorm (1752). This led to the invention of the lightning conductor. He devised a back-to-back revolving grate that could be turned to face either of two rooms (1785). Later wrote *Observations on the Causes and Cures of Smokey Chimneys*, his recommendations being expanded by Rumford [15]. Held many important posts, awarded many honors, and helped draft the American *Declaration of Independence* (1776). At an ASHVE meeting (1927), Thornton Lewis (ASHVE President 1929) declared Franklin "one of the greatest men the world has ever known, and strange to say the same gentleman, Benjamin Franklin, was also a heating and ventilating engineer." By resolution of the Council, Franklin was adopted as the Patron Saint of the ASHVE.

5. ASHRAE Journal. **6.** *Hall.* **94.** *ASHRAE, p. 15. Portrait: a painting by Charles Willson Peale,* **119.** *p. 220.*

[9] Sir Mårten (Martin) TRIEWALD active 1716-1741

Swedish gentleman. Military architect to the King of Sweden. Worked as an assistant to both Desaguliers [52] and Newcomen [7]. Lived for many years in Newcastle-on-Tyne. Said to have attempted the first successful use of hot water for heating a greenhouse (1716), though its original use has also been ascribed to Evelyn [2]. In Triewald's scheme, "The water was boiled outside of the building, and then conducted by a pipe into a chamber under the plants." He also experimented with bellows for ships' ventilation (1741) and "invented a machine to draw foul air from Swedish ships blockading the port of St. Petersburg."

98. *Billington and Roberts, pp.110, 208, and 215.*

[10] Colonel William COOK active 1745

Read paper on steam heating before the Royal Society, published in *Philosophical Transactions* (1745). He improved on the suggestions of Sir Hugh Platt [4] and "gave a diagram of an engine for heating all the rooms in a house from the kitchen fire." This is possibly the earliest reference to the use of steam for heating.

99. *Donaldson and Nagengast, pp.39-40.*

[11] Johann Paul BAUMER active mid-18th century

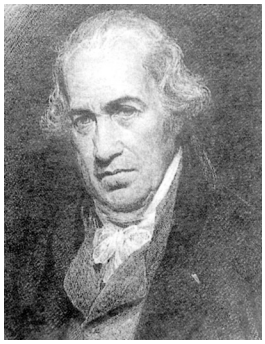
In continental Europe, early simple stoves were of clay bricks (c. 820). Around the 13th century, the *kachelofen* masonry stove was in use in northern Germany. By the 16th century, its use was widespread in Sweden, Russia, Poland, and Hungary while Holland and Germany used metal stoves. Early in the 17th century, Kesslar in Germany introduced the zigzag flueway, making more effective use of the flue gases. Around this period, there was a trend toward the adoption of the massive Swedish tile and brick stove giving continuous, slow combustion. Baumer is credited with the first scientifically constructed, economy tiled stove (1765).

From **106.** *Usemann.*

[12] Matthew BOULTON 1728-1809

English engineer. Partner of Watt [13] in the construction of steam engines. Employed William Murdock, *Father of Gas Lighting,* at his Soho Works, near Birmingham (1777). Also, George Haden, Sr., father of George Haden [223] was foreman of his copying machine shop. Boulton used steam to heat his bath at Soho House (1789) and was involved with steam heating systems for the libraries of the Marquis of Landsdowne and a Dr. Witherington. Both systems failed due to problems with pipe joints, as did his son's installation for Soane [189]. When Boulton extended Soho House (late 1790s) he therefore opted for a cockle and warm-air system, as pioneered by Strutt [22], the first warming installation in the UK for a large house since the Roman hypocaust systems. (Soho House has recently been restored and is open to the public.)

Early Heating, Ventilating and Air Conditioning in the UK, Paul G. Yunnie, ASHRAE Trans*., 1995. See also* **105.** *Roberts, p. 111.*



[13] James WATT 1736-1819

Scottish engineer. Working at Glasgow University he improved the steam engine (1765) by the addition of a separate condenser and a steam jacket. Obtained the backing of John Roebuck, who sold his interest to Matthew Boulton [12] of Birmingham. Watt successfully developed his engine (1775) and was taken into partnership by Boulton. Watt used steam to heat his writing room (1784). His radiator was a crude tin box, approximately 1 m long × 0.76 m wide × 25 mm deep, but it did not emit sufficient heat because of its bright metallic surface. The firm carried out a number of steam heating installations, including (c. 1800) Lee's Cotton Mill in Manchester (probably the Salford Twist Mill) where "the boiler was placed in the basement and the steam was taken through hollow cast-iron columns which served both as heating surface and as structural members." The firm may have been the first to use cast-iron pipes for heating. The unit of electric power, the *watt*, was named after him.

9. *Hart.* **98.** *Billington and Roberts, Chap. 3. See also* **105.** *Roberts, fig. 18. Portrait from the brochure,* Haden: A Short History of the Company 1816-1991*, inside front cover.*

[14] Joseph BRAMAH 1748-1814

Versatile English inventor. Devised hydraulic press, water closet, and security lock. After his death, his company, J. Bramah & Sons, was responsible (1829) for one of the first large-scale applications of steam heating at the Orangery of the Royal Palace at Windsor. The system described by Tredgold [19] was intended to maintain temperatures in the Orangery at 55ºF and to provide humidity, or *artificial dew*, by a manually operated valve that admitted steam to the space. Soon after (1830), the company installed a hot water heating system in Westminster Hospital.

99. *Donaldson and Nagengast, pp. 75-76.*

[15] Count RUMFORD (Sir Benjamin Thompson) 1753-1814

Born Woburn, Massachusetts. Went to London where, for his experiments with gunpowder, he was elected Fellow Royal Society (FRS). Later, in the service of the Elector of Bavaria, introduced army education, drained marshes, established workshops, and provided relief for the unemployed. Credited with introducing the steam engine of Watt [13] to the continent. Made Count of the Holy Roman Empire (1791). Became interested in heat, then thought of as a fluid, *caloric.* Rumford, while boring cannon at Munich (1798), noticed the blocks of metal grew so hot as the boring tool gouged them out, they had to be cooled constantly with water. He concluded that the mechanical motion of the borer was being converted into heat and that heat was, therefore, a form of motion. Returning to England, he helped establish the Royal Institution (1799) and appointed Davy [153] a lecturer. He refused to patent his many inventions, which included a double boiler, a drip coffeepot, a pressure cooker, and a kitchen range. He also devised his rules for *Chimney Fireplaces* (1796) that "have hardly been bettered to this day." Settled in France (1804), where he made an unsuccessful marriage to the widow of Lavoisier [148] and where he died. Today, the *Rumford Club* of London (founded May 1947) remains a meeting place for engineers.

99. *Donaldson and Nagengast, pp. 28-30. For portrait of Rumford see page xii.*