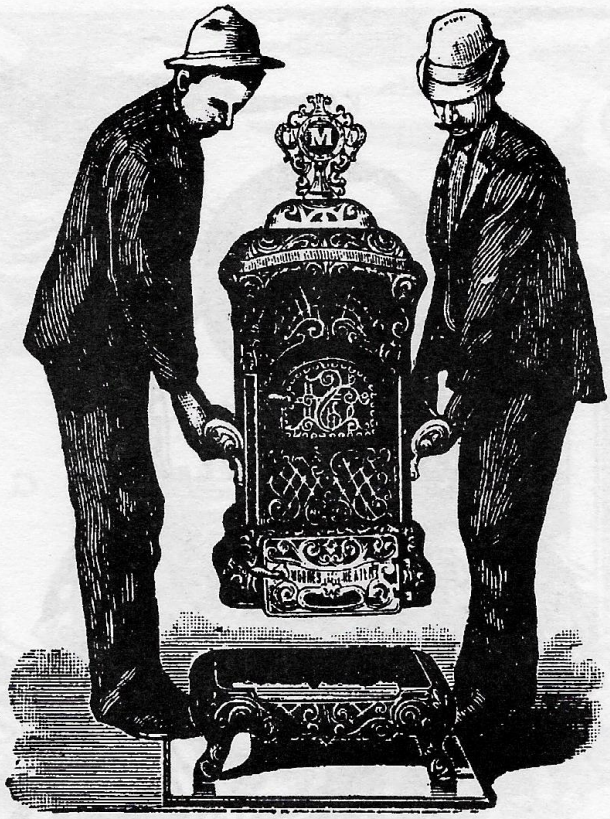
The Comfort Makers

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.*

The Comfort Makers

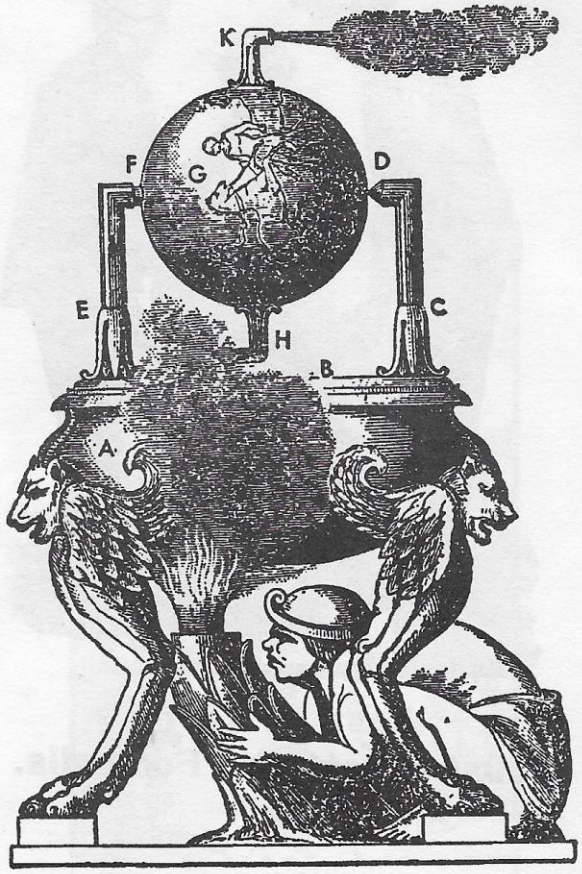


Easy to Carry,
Just Invert the Footrails.

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 contains information on 270 pioneers who have contributed to our knowledge of heating, ventilating, refrigeration, and air conditioning over two millennia. The story is told in a series of mini-biographies with over 100 portraits and some 40 contemporary illustrations and advertisements.

These pioneers were engineers, architects, and scientists. Some were manufacturers of heating, ventilating, and cooling equipment or were controls specialists. Others were designers or installers. The biographies include many people famous in the HVAC&R field; others are virtually unknown. A number are world-famous for notable achievements in science or other areas and are included because of a particular contribution, often largely unrecognized, to the development of comfort engineering. These include doctors, writers, civil engineers, mathematicians, soldiers, horticulturists, a U.S. president, a Bavarian count, statesmen, ironmongers, philosophers, an artist, a curate, a cardinal, an abbott, a railway engineer, a meteorologist, and others from many walks of life or fascinating backgrounds.

To these are added the founders, organizers, and early presidents of some of the institutions, societies, and associations that helped establish the comfort industry: the American Society of Heating and Ventilating Engineers (1894), the American Society of Refrigerating Engineers (1904), and the Institution of Heating & Ventilating Engineers in London (1897).

Today, we take for granted comfort at home, at work, and at play. **The Comfort Makers** reminds us of just some of the people and organizations that made this possible.

Table of Contents

THIS EXTRACT FROM THE BOOK INCLUDES THE MINI-BIOGRAPHIES FROM PAGES 55 to 126. MANY OTHERS ARE ON THE CIBSE HERITAGE GROUP WEBSITE.

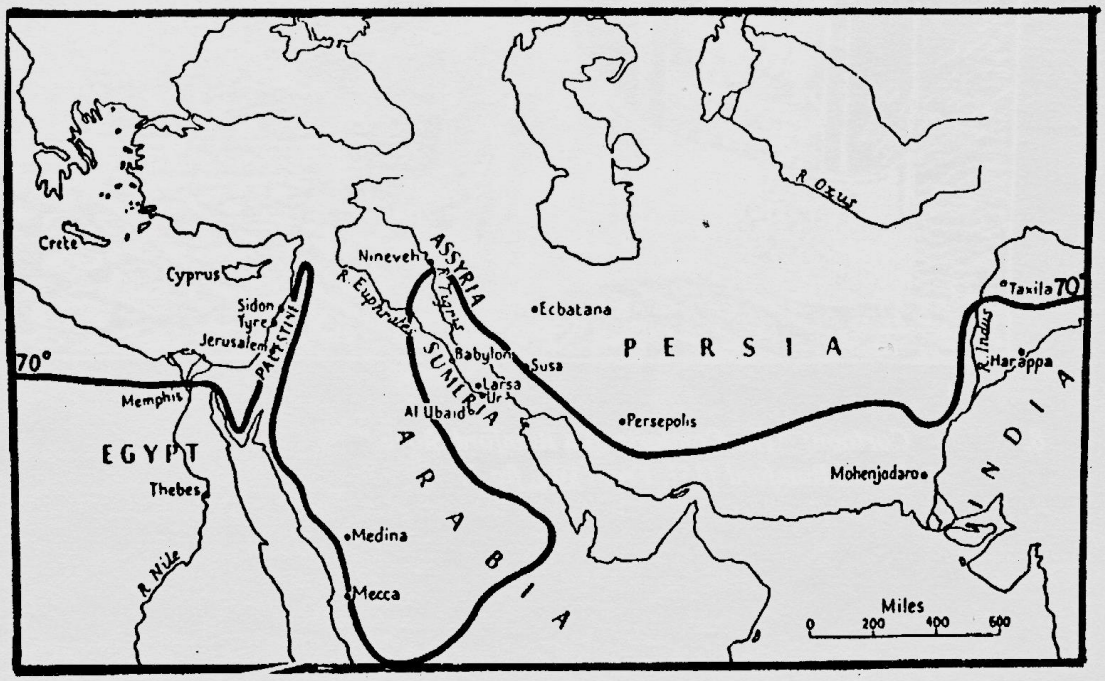
Introduction

As ancient civilizations moved away from the warmer climates, the heating industry was born. This book contains information on 270 comfort makers who have contributed to our knowledge of heating, ventilating, refrigeration, and air conditioning over two millennia.

These pioneers were engineers, architects, and scientists. Some were manufacturers, designers, installers, or control specialists. The biographies include many people famous in the HVAC&R field; others are virtually unknown. A number are world-famous for notable achievements in science or other areas and are included because of a particular contribution, often largely unrecognized, to the development of comfort engineering.

The comfort makers are the personal choice of the author. There are many others deserving of recognition, but not overlooked are the founders and early presidents of some of the institutions, societies, and associations who helped to organize the comfort industry.

This book is a companion to the ASHRAE Centennial (1994) publications *Heat & Cold: Mastering the Great Indoors* and *Proclaiming the Truth* and to the CIBSE Centenary (1997), book *The Quest for Comfort.* These have been extensively cross-referenced in the biographical entries as readily accessible sources of additional information and matching illustrations.



7. *The 70°F Isotherm Related to Ancient Civilizations.*
Climate & Man, Neville Billington (President IHVE, 1970),
Building Services *(IHVE Journal), July 1984, p. 53.*

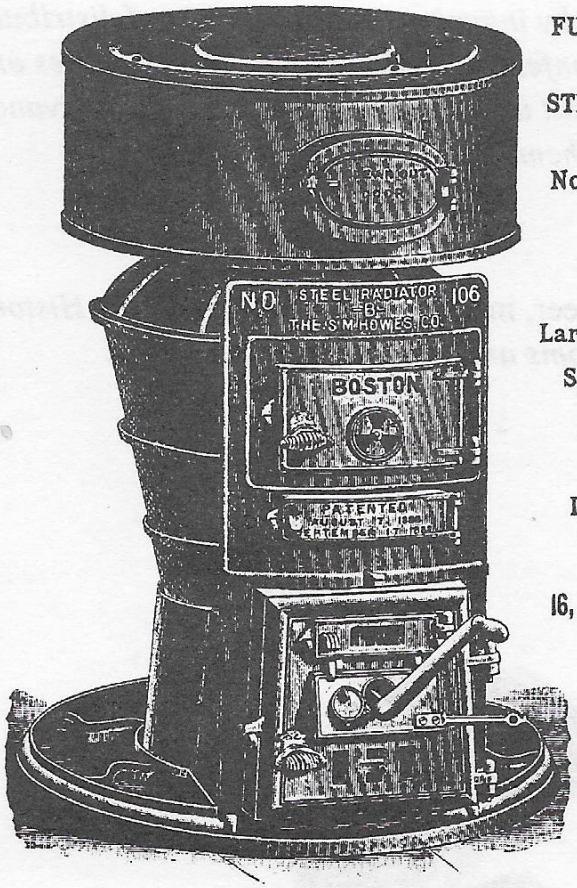
8. *Cartoon: "The Comforts of a Rumford Stove." Count Rumford [15]. From* **105.** *fig.1.*

The S. M. Howes Company

STEEL RADIATOR FURNACE.

POINTS

Extremely Low Price.
First-class Manufacture.
All Practical Selling Features.



FULL CONVERTIBLE FLUE in Top Radiator.

STEEL PLATE driven into Cup Joints.

No possible chance for gas to escape.

Extra Large Combustion Chamber.

Large Doors. Solid Front Shield.

Sectional Fire Pot and Dome.

Castings Extra Smooth and Perfectly Fitted.

Dust Flue, Water Pan, etc.

SIX SIZES:

16, 18, 20, 22, 24 and 26 inch Fire Pots.

IN EVERY WAY JUST WHAT THE TRADE WANTS.

SEND FOR DESCRIPTIVE CATALOGUE AND PRICES.

The S. M. Howes Company,

40, 42, 44 and 46 Union Street,
BOSTON, MASS.

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

The Oldest & Largest Makers in the World. *Medals awarded wherever exhibited.*

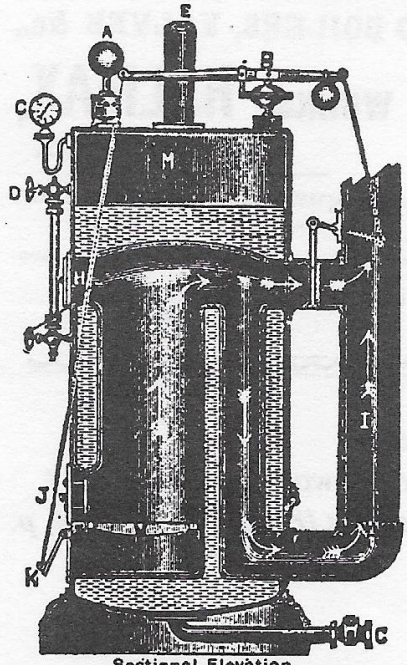
Telegrams: "Lumby, Halifax."

LUMBY, SON & WOOD, LTD.,

West Grove Boiler and Safe Works, HALIFAX,

.. *ENGLAND.*

EFFICIENT, ECONOMICAL, AND DURABLE.

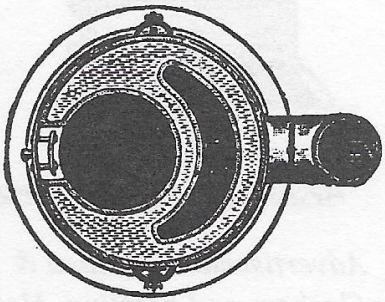


Sectional Elevation

Prices and Particulars on Application.

The "Marlor" STEAM HEATER.

Reg. No 273,406



PLAN.

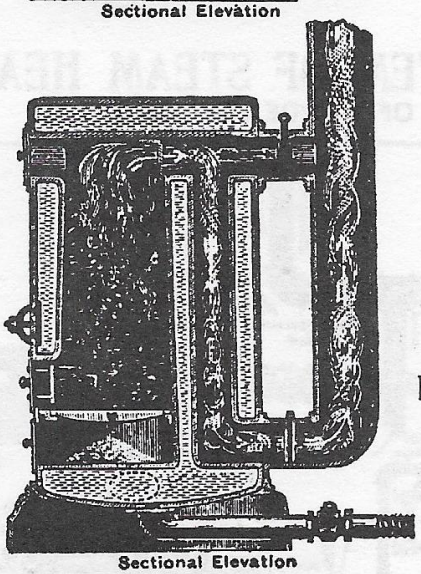
.. Makers of all patterns of ..

RIVETED AND WELDED BOILERS

FOR ALL PURPOSES.

The LARGEST STOCK in the Kingdom.

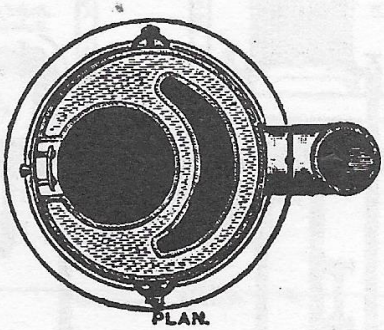
The most complete Catalogue in the Trade post free on receipt of Trade Card.



Sectional Elevation

The "Marlor" HOT WATER BOILER.

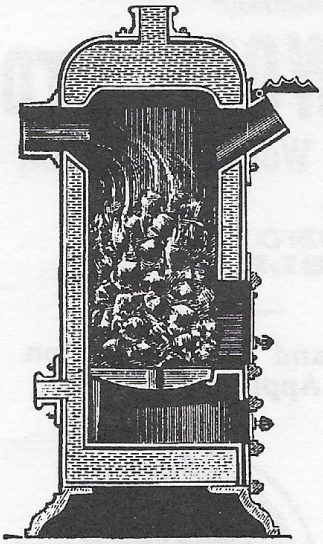
Reg. No. 271,532



PLAN.

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

ESTABLISHED 1854.



Dome Top Boiler
with water-way base.

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.

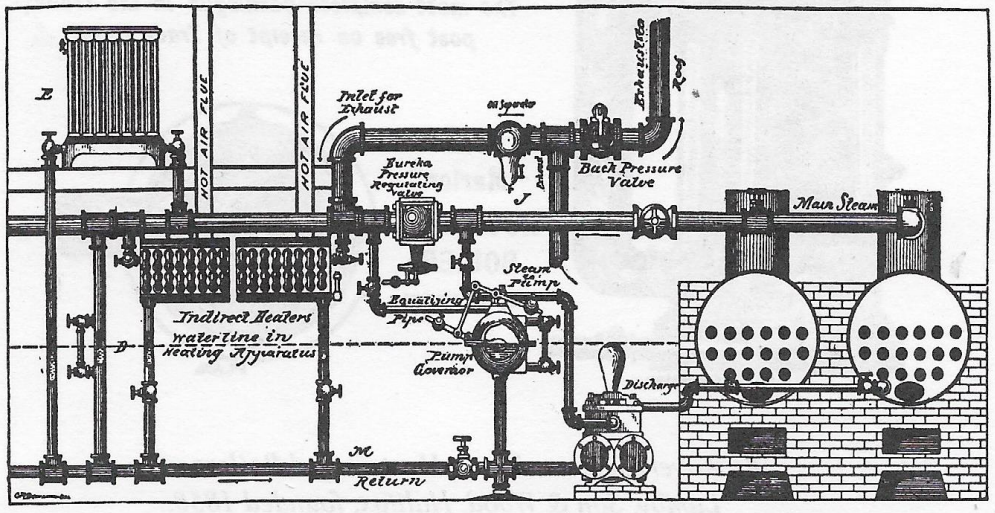
Complete Catalogue Free on application

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.*

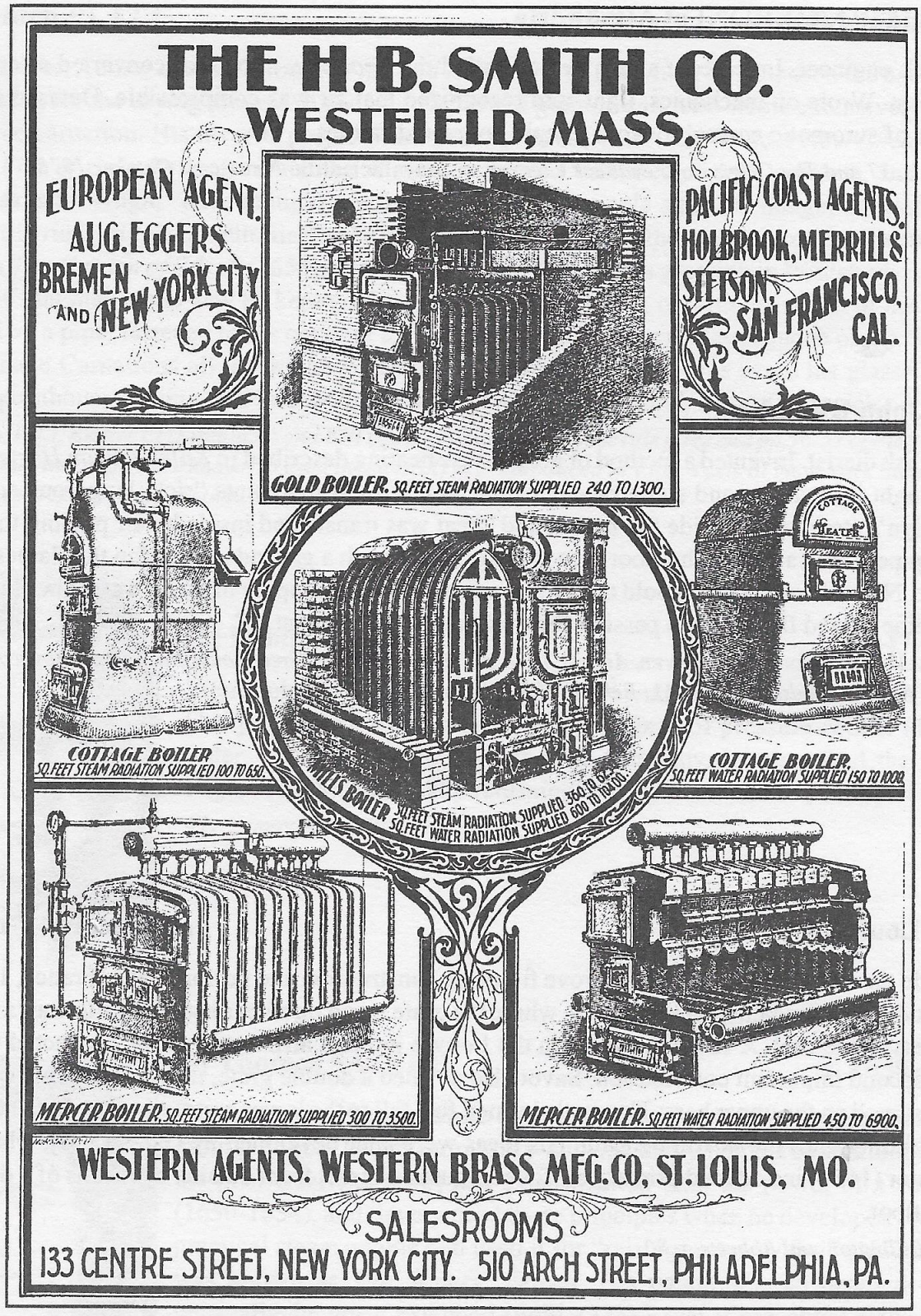
KIELEY'S WATER-SEAL SYSTEM OF STEAM HEATING
AND AUTOMATIC RETURN OF CONDENSATION.



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.

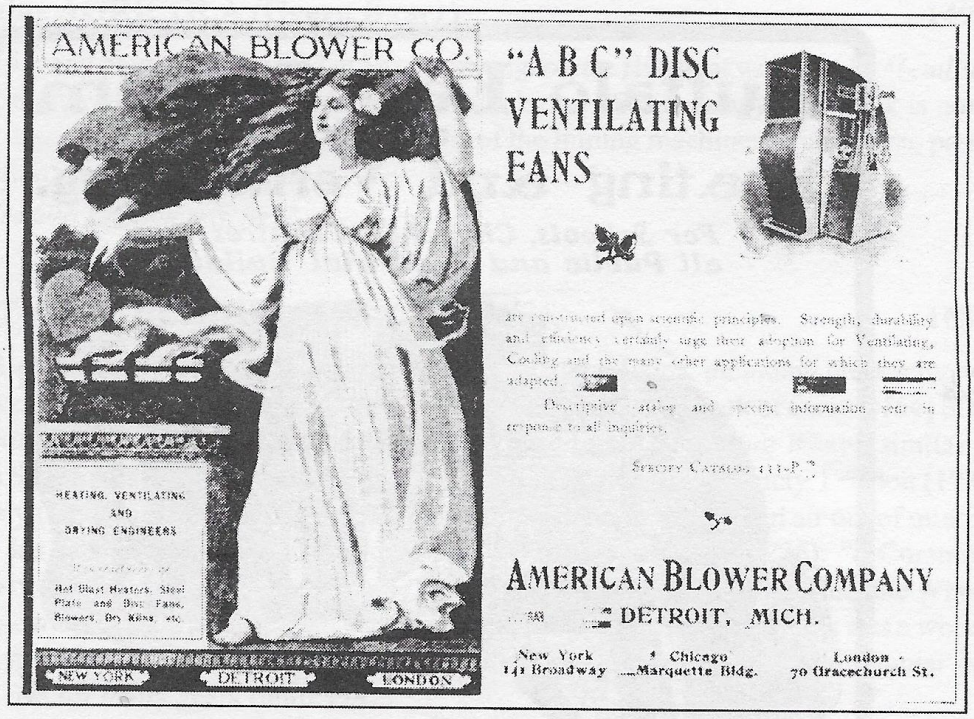
12. *Advertisement: Kieley's System of Steam Heating.*
Kieley & Mueller, New York. Baldwin on Heating, *William J. Baldwin, 1900, p. iv.*



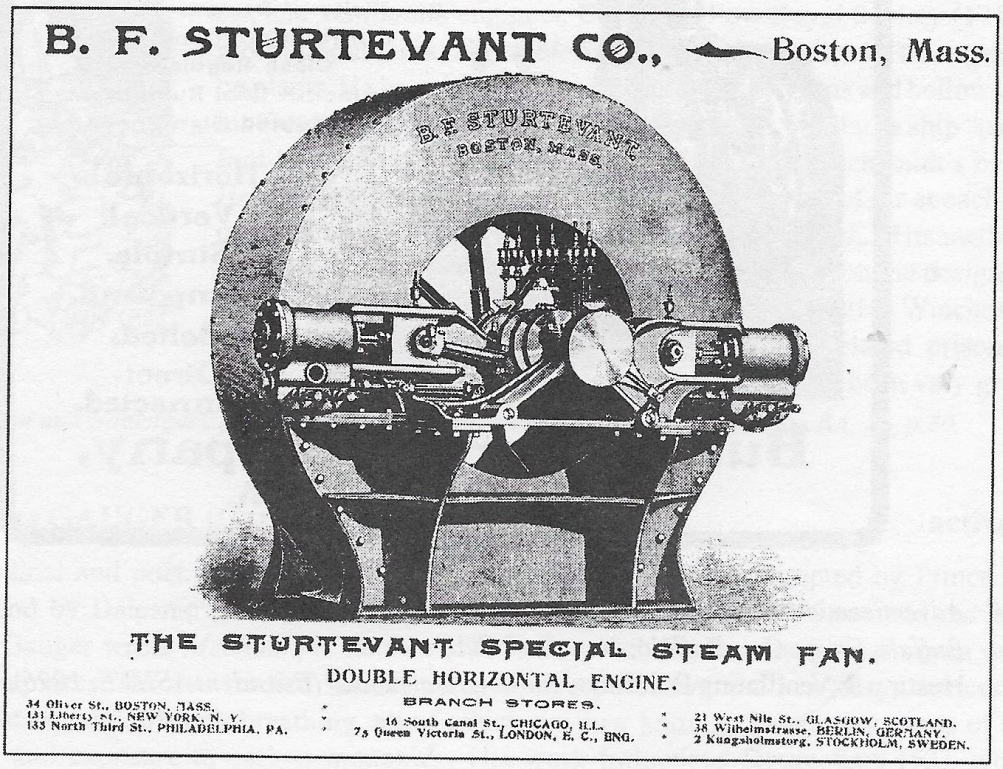
13. Advertisement: H.B. Smith Co., Westfield, Mass.
Domestic Engineering, *April 1900, p. 46.*

A—Drum. B—Box-shaped casing. C—Blow-hole. D—Second hole.
E—Conduit. F—Axle. G—Lever of axle. H—Rods.

14. Woodcut: Manufacture of Fans for Mine Ventilation, Germany, 1556. De Re Metallica. *Georgius Agricola, 1556. From* **13.** *p. 204.*



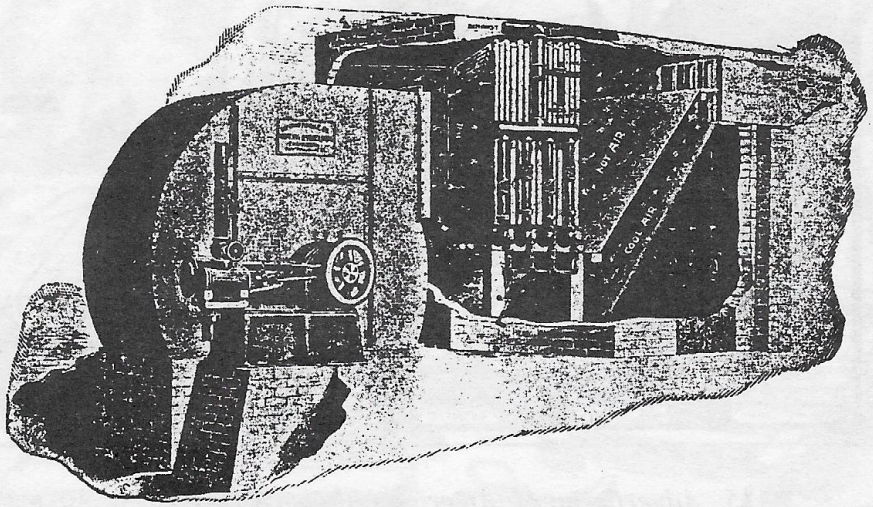
15. Advertisement: American Blower Co., Detroit, Mich.
Engineering Review, *Vol. 12, November 1902.*

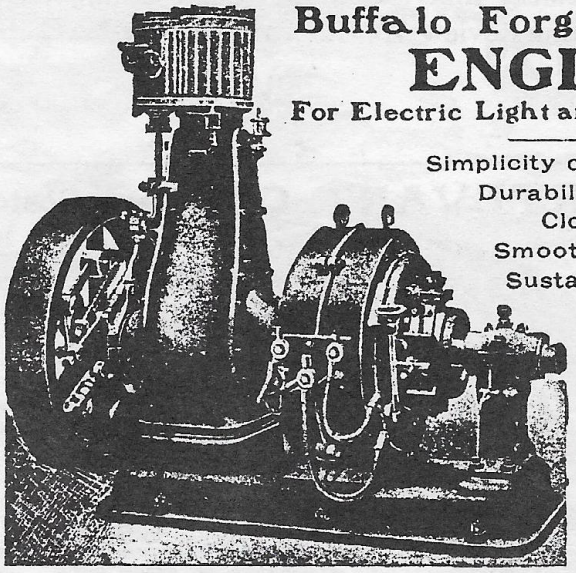


16. Advertisement: B.F. Sturtevant Co., Boston, Mass.
Heating and Ventilation, *June 1895, p. xvii.*

Buffalo Fan System
OF
Heating and Ventilating.

For Schools, Churches, Theatres, and all Public and Industrial Buildings.





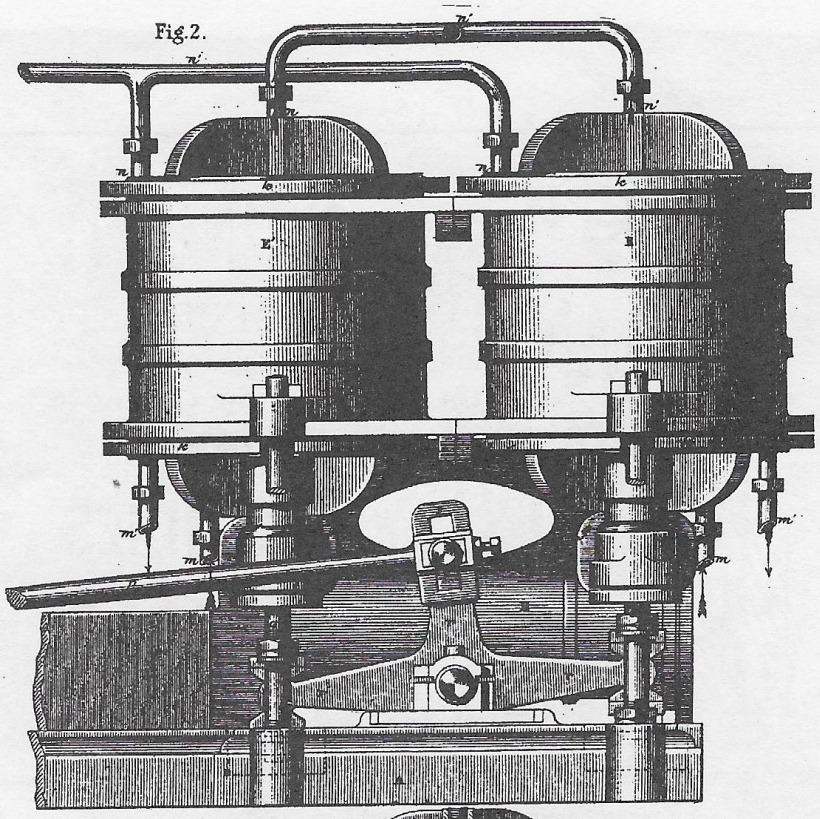
Buffalo Forge Company
ENGINES
For Electric Light and Power Service.

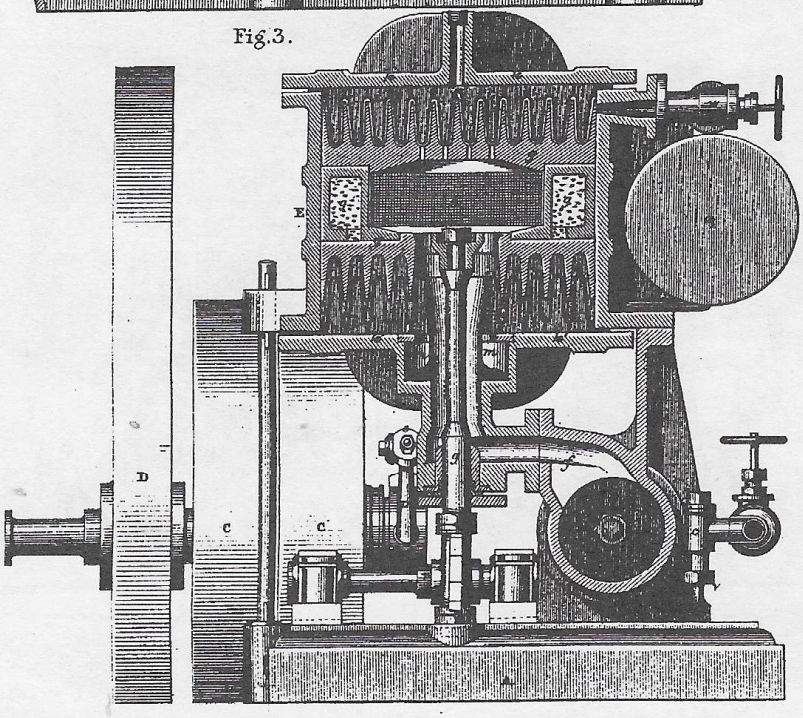
Simplicity of Design.
Durability of Construction.
Close Regulation.
Smooth Cool Running at
Sustained High Speed.

Horizontal,
Vertical,
Simple,
Compound,
Belted,
Direct-Connected.

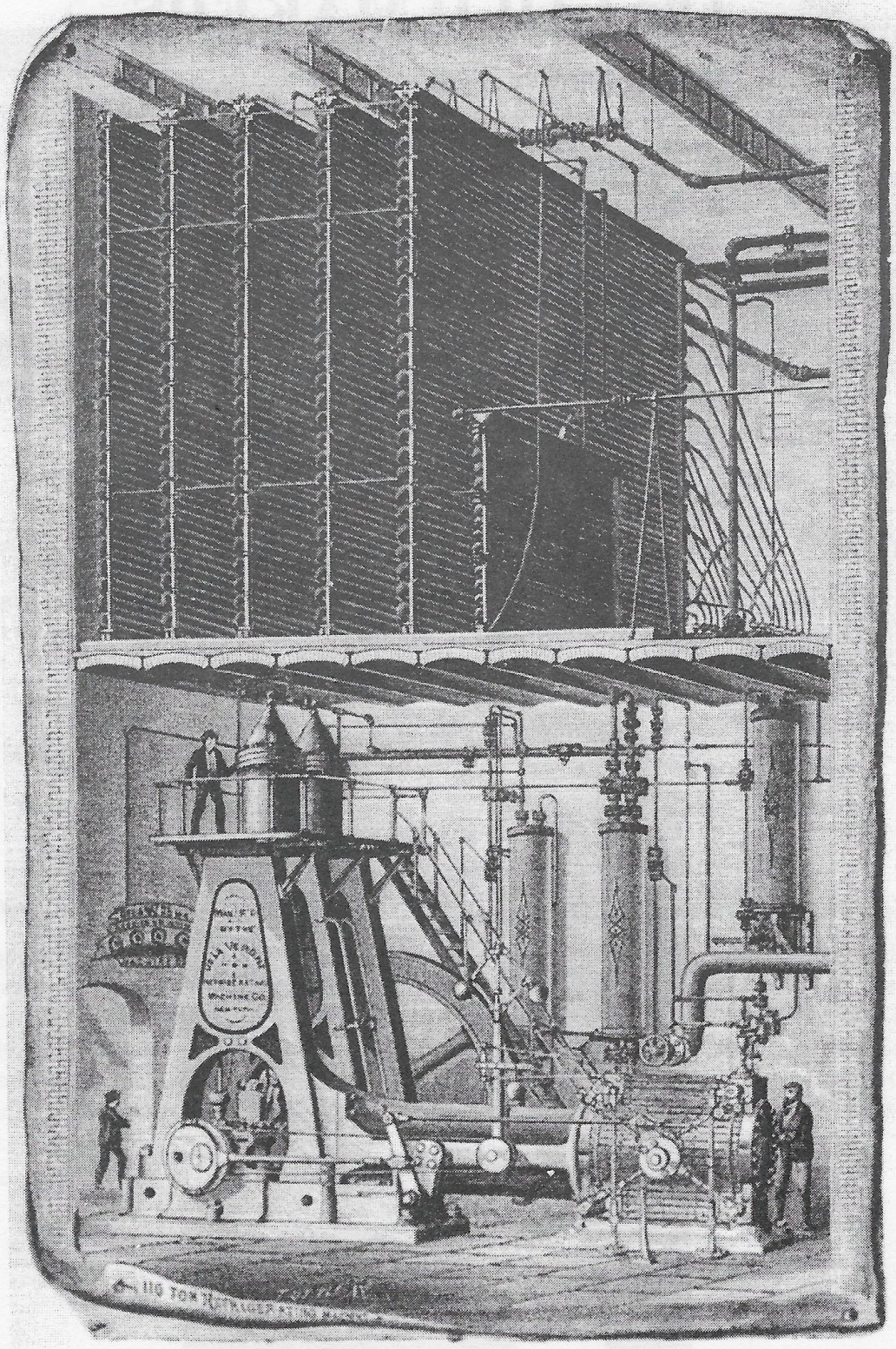
Buffalo Forge Company,
BUFFALO, N. Y., U. S. A.

17. *Advertisement: Buffalo Fan Systems and Engines.*
Buffalo Forge Co., Buffalo, New York State.
Heating & Ventilating Buildings, *Rolla C. Carpenter (President ASHVE, 1896), 1910, p. 3.*

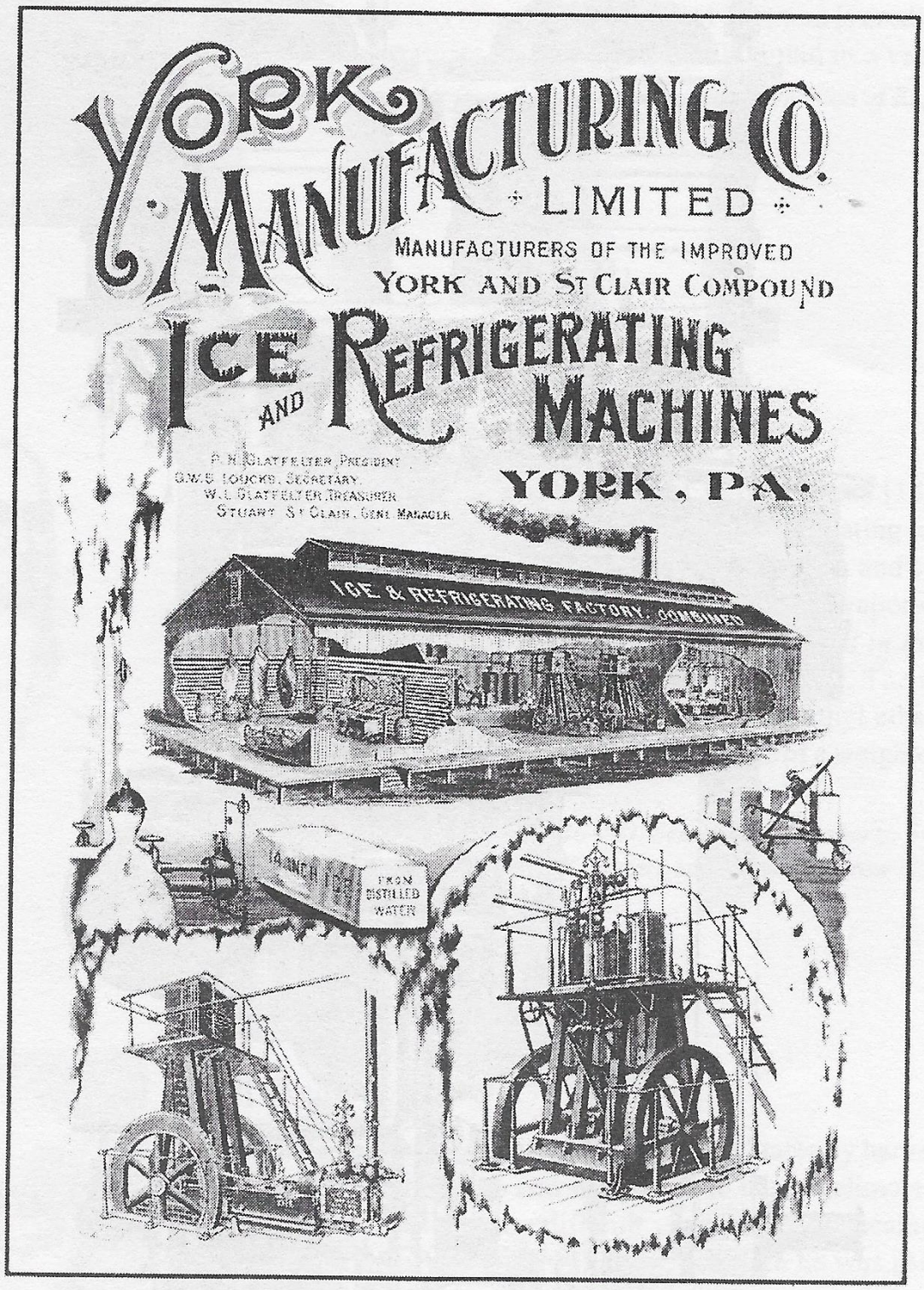




18. *Bookplate: Refrigerating Apparatus.*
Figs. 2 and 3 from a drawing of unknown origin found in a second-hand bookshop. The apparatus has similarities with the Lightfoot cold-air machine of 1886.
(B.M. Roberts Collection)



19. *Catalog Drawing: A 110-ton Capacity Steam-Driven Ammonia Refrigerating Machine with an "Atmospheric" Water-Cooled Condenser.* Mechanical Refrigeration, Processes and Apparatus of the De La Vergne Refrigerating Machine Co., *New York, 2nd edition, 1887.*



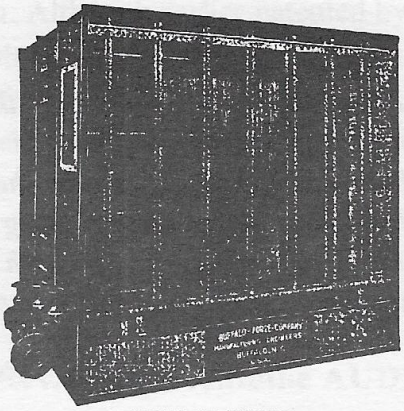
20. *Advertisement: Ice Refrigerating Machines.*
York Manufacturing Co., York, Penn.
Ice and Refrigeration, *October 1891, inside back cover.*

Buffalo Air Washer

AND HUMIDIFIER

Humidifies and cools to any desired degree. It also **dehumidifies,** by condensation, air containing too much moisture.

Scientifically adapted to perfect Humidity conditions of Textile Mills.



BUFFALO AIR WASHER

Automatic control.

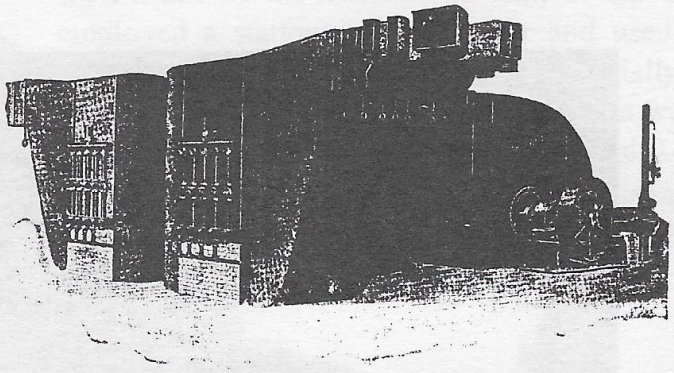
Adapted to occupy any space.

Simple. Nothing to get out of order. Exceptionally compact and requires minimum attention.

ADJUNCT TO

Buffalo Fan System of Heating and Ventilating

1. Apparatus and engineering features originated by us.
2. Individual steam connections to each coil.
3. Coil base that gives hot heater pipes always — no cold ones.



4. Uniform wheel proportions thruout all fan sizes.
5. Proportion method of duct calculation.
6. Tempering coils in air supply.
7. Self-contained Fan Engines with iron sub-base.

BUFFALO FAN SYSTEM APPARATUS

Blow through type with thermostatic control. Single duct system. Air Washer and Humidifier on inlet side of fan.

SEND FOR CATALOG NUMBER 97

Buffalo Forge Company
Buffalo, N.Y.

BRANCHES IN ALL THE LARGER CITIES

Heating and Ventilating Engineers

THE CANADIAN BUFFALO FORGE CO., MONTREAL, QUEBEC

21. Advertisement: Buffalo Air Washer. Buffalo Forge Company, Buffalo, N.Y. The spray-type air washer was developed by Willis Carrier as part of his system for dew-point control of humidity. Engineering Reveiw, June 1906, p. xii.

The Weather Vein

ADVENTURES OF

The Mechanical Weather Man

THE MACARONI CASE

The Messrs. Flour and Water
are in an awful mood
The macaroni that they make
comes back marked "Checked, No good."

They take it to their Foreman,
"What makes the stuff so bad?"
He says "If you'll just come with me,
to show you I'll be glad."

They write the other people
and ask them please to tell
What makes their goods so wonderful
and how they dry so well.

The answer came back quickly
its wording you can see
The partners read it hurriedly
and nodded happily.

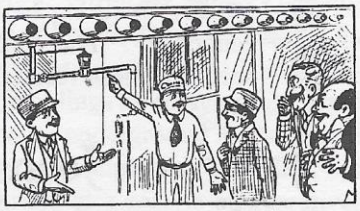
They quickly 'phoned to Carrier
to come and tell them how
To make their plant a modern one
as fast as things allow.

"Our dryroom, sirs, is hopeless,
the goods *will* check and sour.
In spite of all that I can do
we're losing every hour."

"We either sweat too slowly,
which sours the stuff, just so,
Or else we dry so rapidly
we check it 'fore we know."

The partners then examine,
some goods the dealers say
Is just the kind they're looking for,
the best in every way.

And with his usual promptness
comes "Mech", his face asmile,
"We'll have Ejector dryers here
within a little while."

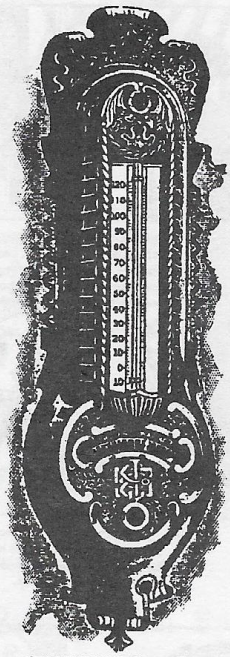


"Mech" kept his word and shortly
their dryers were complete,
With automatic instruments
to regulate the heat.

And now when Flour and Water
their finished goods inspect,
They smile at competition for
their goods have no defect.

22. *Cartoon Strip: Adventures of the Mechanical Weather Man: The Macaroni Case.* The Weather Vein, *Vol. 1, No. 10, Carrier Engineering Corp., Newark, N.J., October 1921, pp. 26-29.*

TEMPERATURE REGULATION.



THERMOSTAT.

THE

JOHNSON SYSTEM OF TEMPERATURE REGULATION

has been in public use since 1885 with ever-increasing favor, and is now used ***in all classes*** of buildings where heating is required. This is the original and perfectly developed system and is applicable to every kind of heating device.

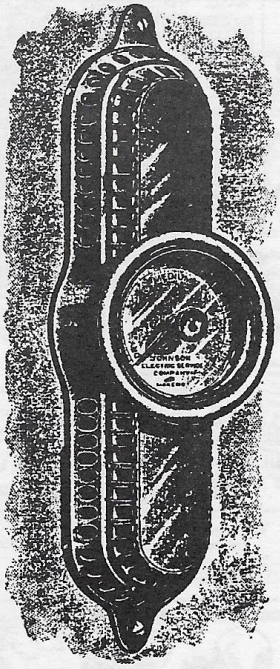
THE

HUMIDOSTAT

controls the humidity of rooms within 2%, thus securing health, comfort, and economy. The only device made securing these results. Address

Johnson Temperature Regulating Company,

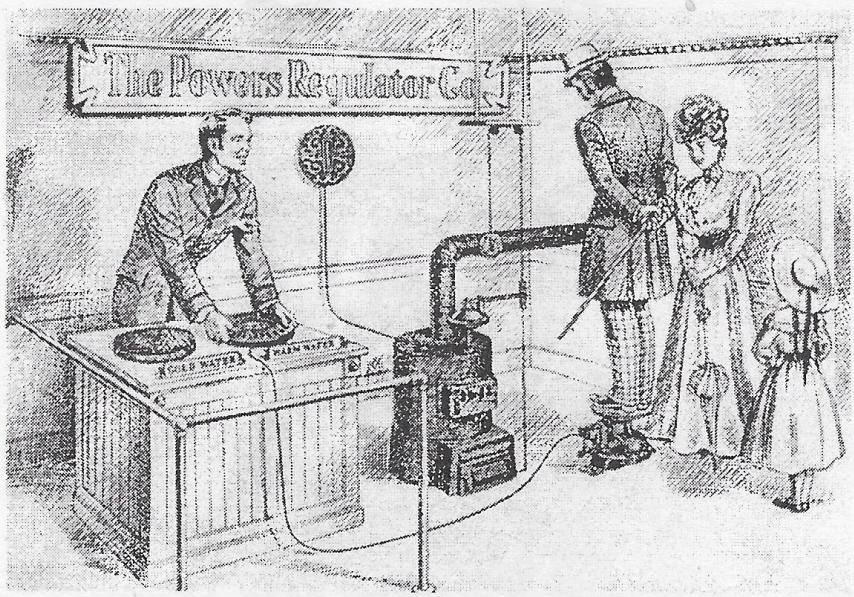
240 FOURTH AVENUE, NEW YORK CITY.



HUMIDOSTAT.

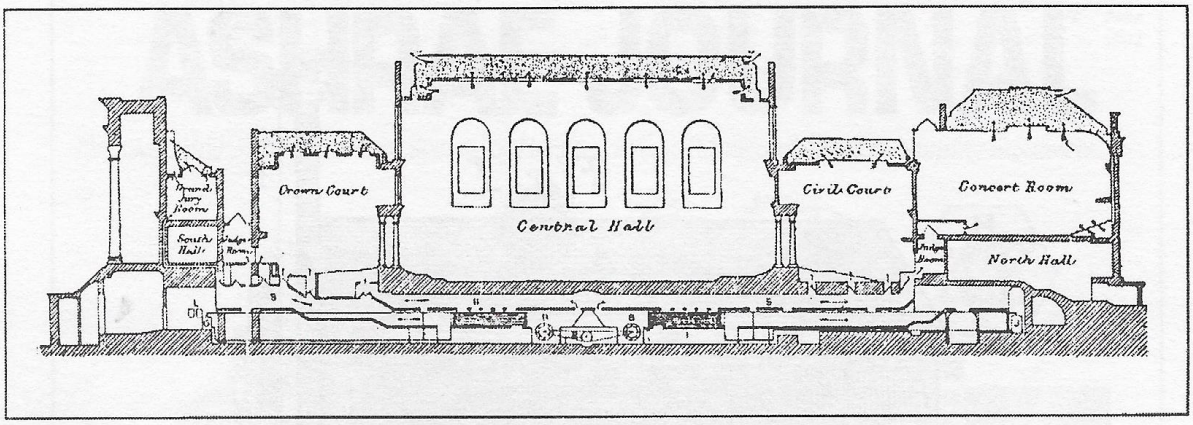
23. *Advertisement: Temperature Regulation and the Humidostat. Johnson Temperature Regulating Co., New York.*
Heating & Ventilating Buildings, *Rolla C. Carpenter (President ASHVE, 1896), 1910, p. 1.*

24. *Advertisment: Electric Heat Regulator Co., New York.* Domestic Engineering, *Vol. 9, June 1985.*

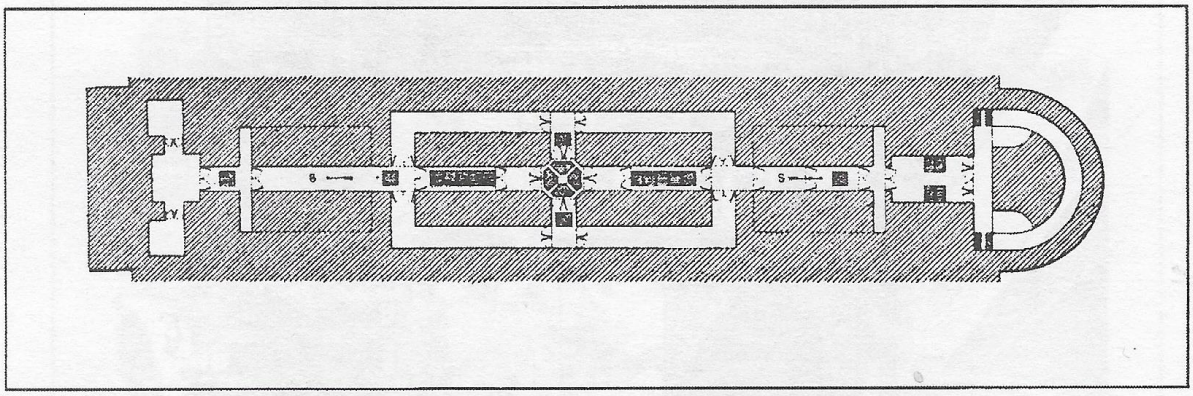


The Powers Regulator Company demonstrates temperature control technology in the 19th Century. (Courtesy of Landis & Gyr Powers.)

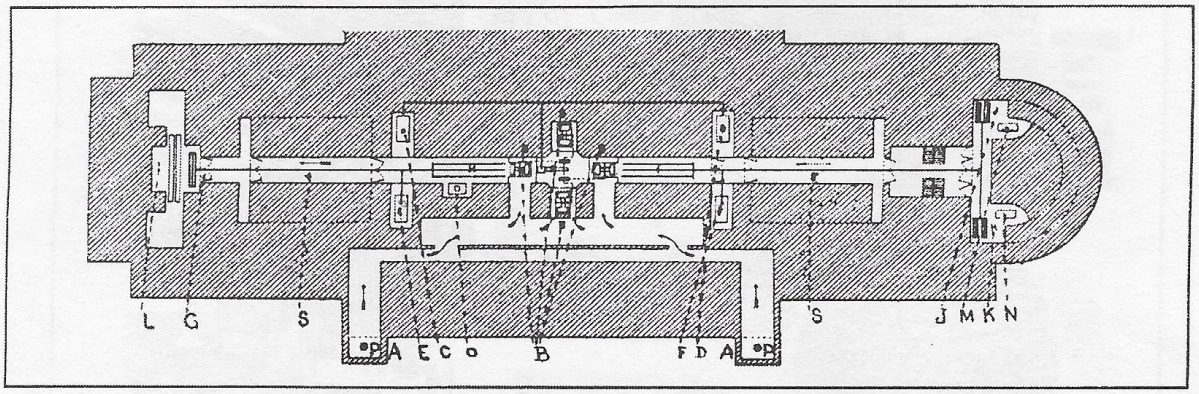
25. *An Early Demonstration of Temperature Controls. The Powers Regulator Co., Chicago. The V in ASHRAE: A Historical Perspective, John E. Janssen,* ASHRAE Journal, *August 1994, p. 130.*



a. Longitudinal section of St. George's Hall.

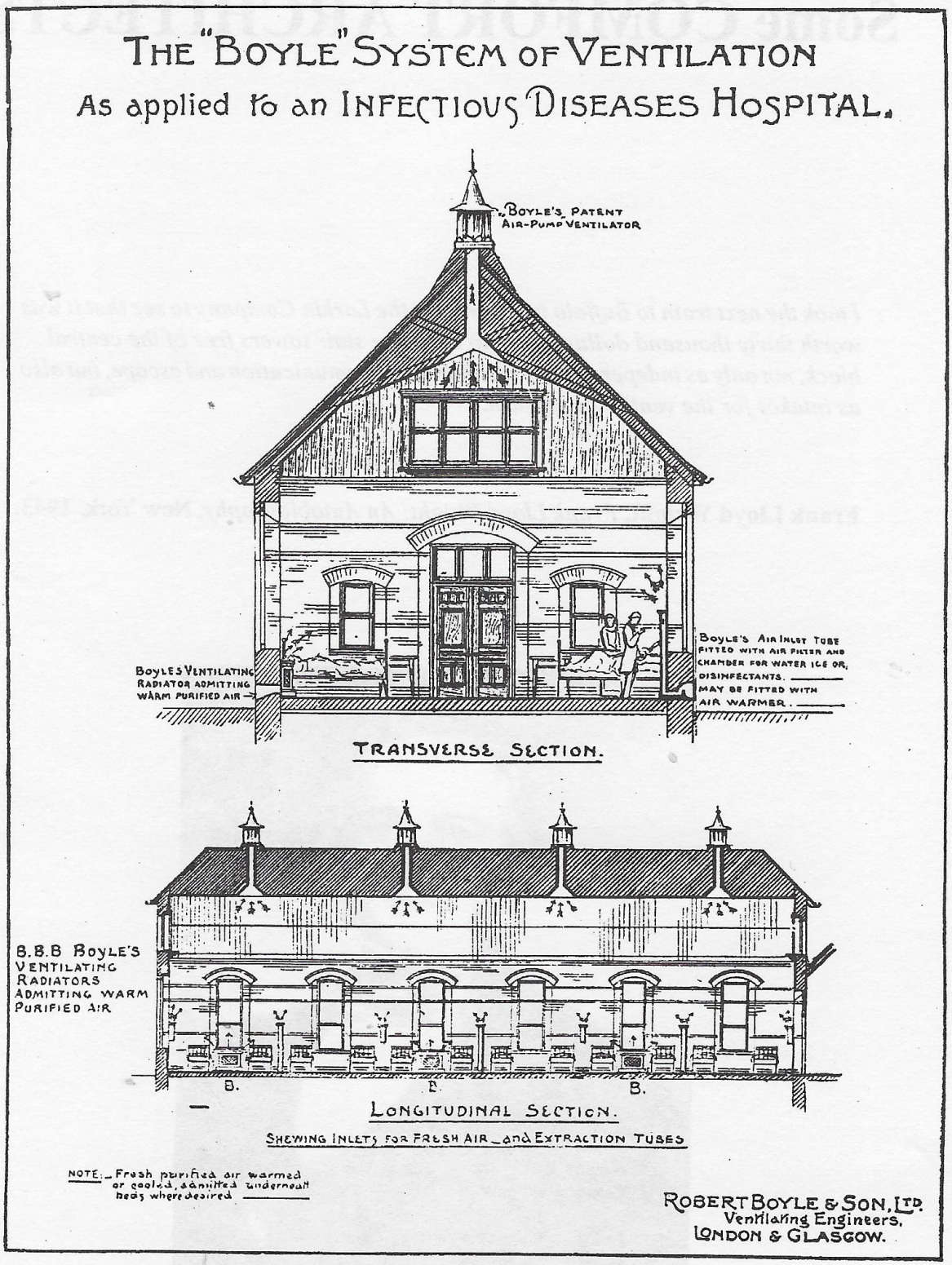


b. Basement plan, St. George's Hall, at level of upper air channels.



c. Basement plan, St. George's Hall, at level of lower ducts.

28. *Section and Plans: St. George's Hall, Liverpool, 1854.*
The Mechanical Ventilation and Warming of St. George's Hall, Liverpool, The Heating and Ventilating Magazine, *October 1907.*



29. Catalogue Illustration: Natural Ventilation by the Boyle System of the South West Fever Hospital in London. An example of collaboration between architect and ventilation engineer. The Boyle System of Ventilation, Robert Boyle & Son, Ltd., High Holborn, London, c. 1900.

Cost for Annual Maintenance of Apparatus
Working all day and night in Winter
Night only in Summer.

		£ s d
Fuel for 200 days and nights Warming and Ventilation for heating apparatus	210 Tons @ 16/	168. 0. 0
Fuel for Steam Engine 24 hours 365 days including service of Baths	84 Tons .	77. 0. 0
Two Stokers at 30/- per week		156. 0. 0
Sundries Repairs Oil and Wipings &c		38. 0. 0
		£ 439. 0. 0

Cost of Warming and Ventilation per bed per annum

The number of beds in the Hospital being 588 will shew taking into consideration the service of the Baths and Ventilation and Warming of the other Rooms, that the cost would be about 11/8 per bed per annum.

Cost of the Apparatus

From the best of my judgment I consider that the cost of the apparatus for carrying out my proposed plan will not exceed the sum of £1928. 0. 0

This Sum would include all personal supervision of the Work during the erection of the Building and supplying all the necessary apparatus, Steam Engine Boiler, Fans, Gearing, Heating apparatus, Cast Iron Air Gratings for Escape and Inlet, Regulating Valves, Indicating Dials &c &c but exclusive of all Brickwork for the formations of Engine Rooms, Air Chambers and Flues and Channels.

General Remarks

This is in a few words the Plan, I should propose for the Ventilation and Warming of the new St Thomas's

/5

30. *Handwritten Report: Costs for Annual Maintenance and Apparatus. Proposals for Ventilation and Warming of St. Thomas's Hospital, Lambeth, London. Submitted by the engineer W.W. Phipson, dated 20 November 1865. The scheme was not adopted. (CIBSE Heritage Group Collection)*

Schemes and Estimates submitted free of charge for installations of Warm Air, Low Pressure Hot Water or Steam Apparatus.

PERFECT EFFICIENCY GUARANTEED.

JOHN GRUNDY,

. . . Heating and Ventilating Engineer,

MANUFACTURER AND PATENTEE OF

"HELIOS" and "SIRIUS" Smoke Consuming Grates for Chimney Pieces.
"HESTIA" slow and Quick Combustion Portable Warming and Ventilating Stoves.
"CALORIFER" and the well-known "GRUNDY" Smoke Consuming Central Fresh Warmed Air Heating Apparatus for Public Buildings and Private Dwellings.

27 MEDALS HAVE BEEN AWARDED.

Makers of Boilers, Ward Stoves, Radiators, Ventilators, & Ranges.

BOOK CONTAINING A THOUSAND TESTIMONIALS FORWARDED ON APPLICATION.

The well-known firm of HAMPTON & SONS, Pall Mall East, London, S.W., write:

Mr. JOHN GRUNDY, 30, Duncan Terrace, London, N.

Nov. 5th, 1903.

Dear Sir,

In response to your letter of the 3rd inst., we have much pleasure in stating that your Heating Apparatus is used with great success at our Depositories at Battersea. The best proof of our satisfaction is that we are having your Heating Apparatus installed into our additional blocks of Depositories now in course of erection. We are of opinion that for safety, hygienic and all useful purposes, your mode of heating is the best. We have no trouble in working the apparatus, which is simple and very efficient. We have pleasure in giving you this testimonial, and wish you the success your system deserves.

Yours truly,

HAMPTON & SONS,

W. HAMPTON, Managing Director.

Head Office: 30, DUNCAN TERRACE, CITY ROAD, N.

Show Rooms and Work Rooms:

Torrens Street, Islington, N., & 393a, City Road, London, N.

Factory: THE TYLDESLEY IRON WORKS, nr. MANCHESTER.

Telegrams—"JOHN GRUNDY," LONDON. National Telephone—No. 552, KING'S CROSS.

31. *Advertisement: Heating and Ventilating Engineer, Manufacturer and Patentee. John Grundy, City Road, London. (Grundy was the first President of IHVE, 1898.)* Heating by Hot Water, *Walter Jones, 1904, p. xv.*

The KAISER-I-HIND
INDIAN TRADE & INDUSTRY SUPPLEMENT
No. 3097 BOMBAY, 18TH MAY, 1941. Vol. LX

FORTY YEARS OF AIR CONDITIONING PROGRESS

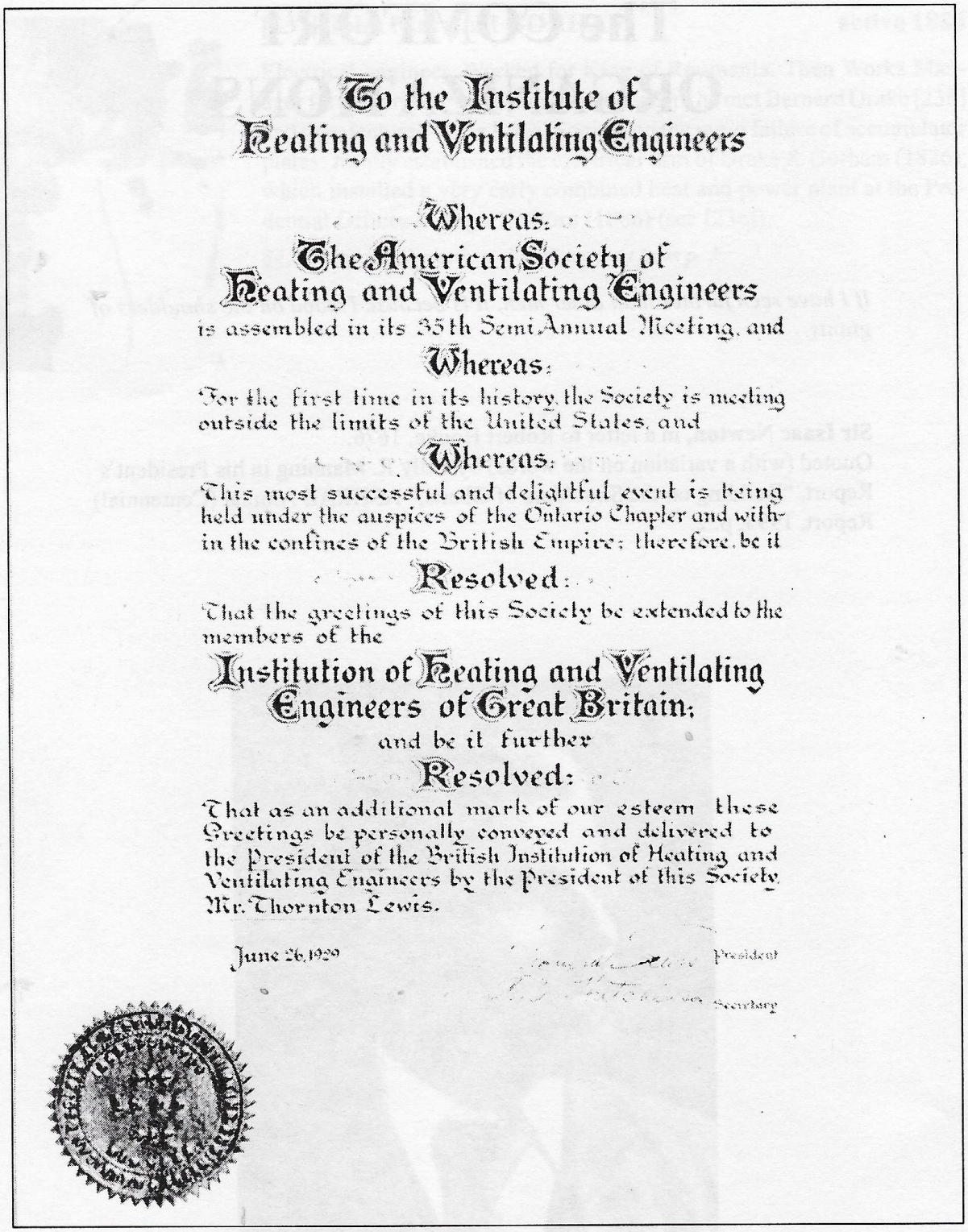
INDIA FINDS NEW BENEFITS

TREMENDOUS AID TO INDUSTRIAL PRODUCTION

IN 1915 the Carrier Corporation was established, with Willis H. Carrier as its head. He had looked into the future and had seen air conditioning as a major industry.....a vital function in the scheme of things .....influencing life, business, and industry.....

(Continued on page 7)

32. Advertisement: Carrier Air Conditioning by Volkart Brothers, Bombay. The Kaiser I-Hind newspaper, 18 May 1941. (CIBSE Heritage Group Collection)



To the Institute of
Heating and Ventilating Engineers

Whereas:

The American Society of
Heating and Ventilating Engineers
is assembled in its 35th Semi Annual Meeting, and

Whereas:

For the first time in its history the Society is meeting outside the limits of the United States, and

Whereas:

This most successful and delightful event is being held under the auspices of the Ontario Chapter and within the confines of the British Empire: therefore, be it

Resolved:

That the greetings of this Society be extended to the members of the

Institution of Heating and Ventilating
Engineers of Great Britain;
and be it further

Resolved:

That as an additional mark of our esteem these Greetings be personally conveyed and delivered to the President of the British Institution of Heating and Ventilating Engineers by the President of this Society, Mr. Thornton Lewis.

June 26, 1929 President

Secretary

33. *Greeting from ASHVE to the Institute (sic) of Heating and Ventilating Engineers. From the 35th Semi-Annual Meeting held in Ontario, Canada, signed by ASHVE President Thornton Lewis, 26 June 1929.* Proclaiming the Truth, *ASHRAE, 1994, p. 82.*

34. Council of the Institution of Heating and Ventilating Engineers, 1910.

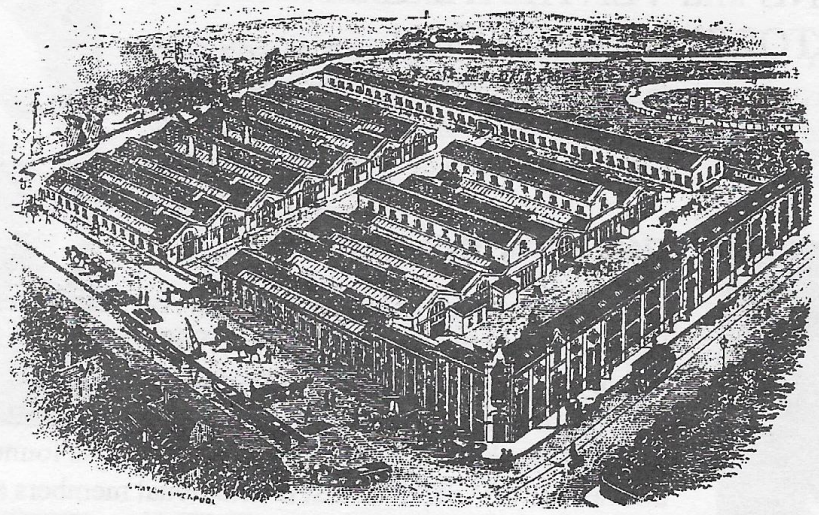
(left to right, from top row) John S. PALMER [244] Robert E. ATKINSON*
Walter JONES [240] Chas MASON Walter YATES [74]
Thos POTTERTON [41] E.W. MAYNER [238] Louis F. PEARSON [243]
W.R. MACGUIRE [241] C. Ingham HADEN [269] S. NAYLOR [49]
John GRUNDY [239] C.T.O. TROTMAN George CRISPIN [245] E. TAYLOR
W. Nelson HADEN [246] J. Nelson RUSSELL [242] J.N. GREENHALL
A.B. SIMPSON [247] A.B. TAYLOR J.L. SAUNDERS

This composite picture includes nine of the first ten IHVE Presidents, plus two later Presidents. The exception is David Nesbit [268] whose portrait is on the title page.*

Communications as a Means to Survival, K.W. Dale, IHVE Presidential Address, IHVE Journal, *May 1974, p. 28.*

*(*Nesbit and Atkinson were the first and second U.K. engineers, respectively, to join the ASHVE.)*

35. Portraits of the first ten Presidents of ASHVE.
Proclaiming the Truth, *ASHRAE, 1994, p. 4.*



JONES & ATTWOOD. TITAN WORKS. *STOURBRIDGE.*

Heating Specialists and Consulting Engineers.

We manufacture at the Works illustrated above.
Heating Appliances of every description.
Estimates for **Heating** by High Pressure, Low Pressure, or Steam.
Plans and Specifications prepared for the Trade by **trained Experts.**
1,000 Boilers from 50 to 5,000 feet **Heating Power** always in stock.
Radiators, Pipes, Valves, and other **Fittings** in great variety.
Hot Water Supply a Speciality.
Our **Indirect System** is a safe **cure** for trouble caused by sediment deposit.
We **examine** and **report** on any existing apparatus.
We **undertake** to turn failures into **successes.**
We **guarantee** to **correct** any defects, however serious.
Arbitrations undertaken in case of disputes.
Inspection invited. Orders promptly executed. **Success guaranteed.**
Medals awarded 1875, 1881, and 1904.

Telegrams—"HEAT." Telephone—No. 10. } STOURBRIDGE CATALOGUES FREE.

JONES & ATTWOOD STOURBRIDGE

36. *Advertisement: Heating Specialists and Consulting Engineers. Jones & Attwood, Stourbridge. Mr. Walter Jones (second IHVE President, 1899) was a pioneer investigator into the causes of boiler explosions.*
Heating by Hot Water, *Walter Jones, 1904, p. xxxii.*

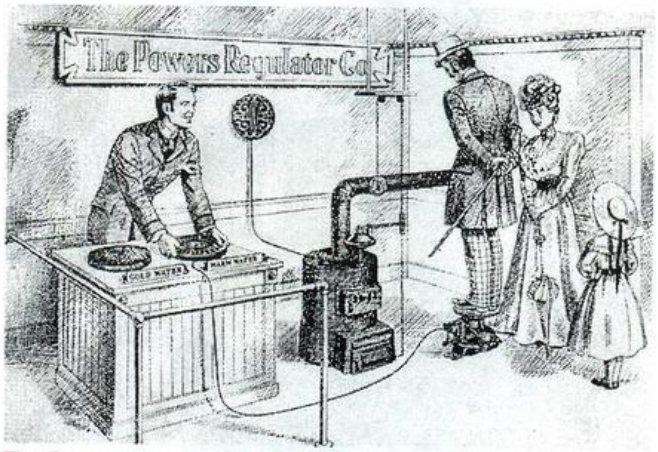
The COMFORT CONTROLLERS

Warren Johnson is one of the great benefactors of humanity. I wouldn't swap him for a dozen Marconis, a regiment of Bells, or a whole army corps of Edisons.

H.L. Mencken, quoted in *Right for the Times*, (Johnson Controls, 100th Anniversary), 1985, p. 9.

Andrew URE [125]

24. *Advertisment: Electric Heat Regulator Co., New York.* Domestic Engineering, *Vol. 9, June 1985.*



The Powers Regulator Company demonstrates temperature control technology in the 19th Century. (Courtesy of Landis & Gyr Powers.)

25. *An Early Demonstration of Temperature Controls. The Powers Regulator Co., Chicago. The V in ASHRAE: A Historical Perspective, John E. Janssen,* ASHRAE Journal, *August 1994, p. 130.*

[116] Cardinal Nicolas DE CUSA 1401-1464

German theologian and mathematician. Studied at Heidelberg and Padua. Described a humidity measuring instrument called the *hygroscope*: "If you suspend from one side of a large balance a large quantity of wool, and from the other side stones, so they weigh equally in dry air, then you will see that when the air inclines towards dampness, the weight of the wool increases, and when it tends to dryness, it decreases."

98. *Billington and Roberts, Chap. 11.*

[117] GALILEO 1564-1642

Full name Galileo Galilie. Italian physicist and astronomer. Devised the *thermoscope* (1593), a primitive attempt to measure changes in temperature: "Galilie took a glass vessel about the size of a hen's egg, fitted to a tube the width of a straw, and about two spans long; he heated the glass bulb in his hands and turned the glass upside down so that the tube (could be) dipped in water contained in another vessel. As soon as the bulb cooled down the water rose in the tube the height of a span above the level of the vessel. This instrument he used to investigate degrees of heat and cold."

98. *Billington and Roberts, Chap. 11. Portrait from his* Istoria *(1613), frontispiece.*

[118] Cornelius DREBBEL 1572-1634

Dutch inventor. Worked for James I of England. Devised a temperature regulator: "Drebbel's apparatus consisted basically of a box with a fire at the bottom and above this an inner compartment containing air or alcohol with a U-shaped neck topped by mercury. As the temperature in the box rose, the increased pressure of the heated air or alcohol vapor pushed up the mercury, which in turn pushed up a rod; this mechanical force was applied to close a damper and throttle down the fire." Drebbel also demonstrated a submarine boat and a thunder-and-lightning machine. According to Francis Bacon [139], Drebbel showed the king an early cooling (air conditioning) device in the Great Hall at Westminster that "reduced the temperature in the Hall to such a degree that James and his attendants fled, shivering."

20. *David, p. 66.* **98.** *Billington and Roberts, Chap. 11.*

[119] Robert HOOKE 1635-1703

English scientist. Curator of experiments at the Royal Society (the only paid post). Produced Hooke's Law on elasticity, discussed development of the steam engine with Newcomen [7], and argued with Newton [143]. Hooke made a *hygroscope* that exploited the water-retaining properties "of the bristle of the wild oak."

[120] Guillaume AMONTONS 1663-1705

French physicist. Interested in scientific instruments. Invented a new hygrometer (1687). Improved the air thermometer of Galileo [117] by trapping the air with mercury rather than water.

[121] Gabriel Daniel FAHRENHEIT 1686-1736

German-Dutch physicist. Invented a practical mercury thermometer (1714) to overcome many of the limitations of the alcohol, fluid type, then in use. His later report earned him election to the Royal Society (1724).

[122] Louis Francois de BOURBON 1717-1776

Prince of Conti. Devised a stove temperature control (c. 1760).
From **106.** *Usemann.*

[123] BONNEMAIN active 1777

French engineer. Heated an incubator by means of hot water pipes (1777). His system contained correctly laid and vented pipes, an expansion tank, and automatic control of the boiler. "The primary air control was by water temperature, relying on the expansion of a rod to close the boiler damper." He was awarded a prize for his invention, which may have been suggested by the compensated grid-iron pendulum of the clockmaker, James Harrison (1726), and his later true bimetallic strip (1761). The "heat regulator" of Bonnemain "was founded upon the unequal dilatation of different metals by the same degree of heat."

98. *Billington and Roberts, p. 110.* **99.** *Donaldson and Nagengast, pp. 193-194.*

[124] Horace Benedict de SAUSSURE 1740-1799

Swiss scientist. Professor at Geneva University. Devised a hygrometer that made use of the moisture absorbing properties of human hair to measure atmospheric humidity (1780).

98. *Billington and Roberts, Chap. 11.*

[125] Andrew URE 1778-1857

Born in Scotland. Doctor of Medicine (Glasgow, 1801). Professor of Chemistry and Natural Philosophy. Appointed analytical chemist to the Board of Customs in London (1830). Granted a patent for *An Apparatus for Regulating Temperature in Vaporisation, Distillation and Other Processes* (BP 6014: 1830). He coined the word *thermostat*. He designed an air-heating stove with thermostatic control (BP 6016: 1830). Ure is also remembered for his *Dictionary of Arts, Manufactures and Mines* (1839).

99. *Donaldson and Nagengast, pp. 194-195. Portrait from Ure's* Dictionary.

[126] Neil ARNOTT **1788-1874**

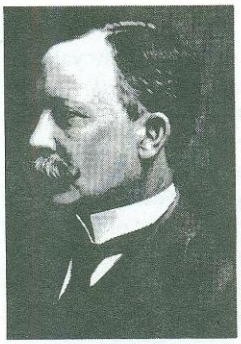
Doctor of Medicine, FRS, and Physician Extraordinary to Queen Victoria. Lectured to the Royal Institution on his Thermometer Stove (1836). Went on to write the book, *On Warming and Ventilating with Directions for Making and Using the Thermometer-Stove, or Self-Regulating Fire, and Other New Apparatus* (1838). Arnott described the use of fires, chimneys, and stoves, explained heating by steam, hot water, and hot air, their application to various buildings, and how to make a thermometer-stove. He believed his stove would reduce England's consumption of coal by half, if controlled by one of his thermometer regulators. "In one design he used a long bimetallic strip, one end of which was fixed to the casing of the stove and the other was attached to the combustion air damper. Other regulators described by Arnott relied upon the expansion of air in a tube closed by mercury: a float on the mercury surface was linked to the damper. All these devices controlled the temperature inside the stove casing, not that of the room."

98. *Billington and Roberts, Chap. 11.*

[127] John George APPOLD **c. 1851**

English inventor. His apparatus for regulating temperature and keeping the air in a building at any desired degree of moisture is described in the Proceedings of the Royal Society of London (1866-1867) and explained by Billings [73]: "This instrument consists of a glass tube having bulbs at each end. The tube is filled, as also about half of each bulb, with mercury, the lower bulb, containing ether to the depth of half an inch, which floats on the mercury. The tube is secured to a plate of boxwood, and supported on knife edges, on which it turns freely. At the end of the plate, underneath the highest bulb, is a lever to which a string is attached. This string is carried by means of bell cranks to the supply valve of a gas stove or the damper of a furnace." (The evaporation/ liquefaction of the ether with temperature moved the balance assembly and controlled the string.)

98. *Billington and Roberts, Chap. 11.*



[128] Warren S. JOHNSON 1847-1911

Born in Vermont. Worked in Wisconsin as printer, superintendent of schools, and then a surveyor of the Plains. Later appointed Professor at the State Normal School, Whitewater (1876). Used his laboratory for experiments with electric storage batteries. Johnson also experimented with control of the school's heating system. As recounted by his son, Paul, many years later (1939), "The Normal School was heated by enormous hot-air furnaces. On cold days when they were going full blast, from the large registers in the floor of the lower halls, we could see the red glow of the cast-iron furnaces. The only control of room heat was by hand-operated dampers at the furnaces. Once an hour or so, the janitor would make the rounds of the rooms and note which rooms were too warm or too cold. He would then go to the basement to open or close dampers accordingly. This disturbed the classes considerably, so Professor Johnson installed electric thermostats in each room and connected them to annunciators, which he invented, so that when the thermostat made contact on the warm side, the indicator for that room would show 'Warm' and ring a bell, and when the contact was on the cold side, the indicator showed 'Cold.' All the janitor had to do besides firing his furnaces and keeping the place clean, was to watch the annunciator every time it rang and shift the proper damper. That was the first Johnson System of Temperature Regulation." Warren Johnson was granted a patent (USP 281,844: 1883) for an *electric tele-thermoscope.* Two years later the Johnson Electric Service Co. was established in Milwaukee. However, Johnson soon received a patent for his first pneumatic system of temperature regulation (1885) using his experience of developing giant public clocks powered by air pressure. He went on to obtain some 50 patents in fluid-powered control devices.

45. *Johnson, pp. 3-12. Portrait from Johnson Controls, Inc.*

[129] Alfred BUTZ 1849-1904

Born in Switzerland. Emigrated to America at the age of eight. Served with Union Army toward the end of the Civil War. Formed Butz & Mendenhall Hand Grenade Fire Extinguisher Co. (1884). Developed a spring motor and crank to operate a boiler or furnace damper, known as the Butz *damper flapper.* Established Butz-Electric Regulator Co. in Minneapolis (1885) and obtained patents (USP 341,093: 1886; 347,866: 1886). Butz later worked for Chicago Heat Regulator Co. (1888), having sold his patent rights to the company that was to become Honeywell. His obituary said, "He had been an inventor for many years, and had only recently perfected a heat regulator, which was recognized by experts as being of great value."

42. *Honeywell, pp. 2-3.*

[130] William Richard SWEATT 1867-1937

Established the Sweatt Manufacturing Co. in Minneapolis to make wooden wheelbarrows and wooden washing machines (1891). Invested in the Electric Thermostat Co., which was then manufacturing the *damper flapper* of Butz [129]. After a number of difficult years, Sweatt bought out the other stock holders (1900). Later (1905), the company made a thermostat and two types of damper motors and that year introduced a clock thermostat. The company became (1912) the Minneapolis Heat Regulator Co. The company expanded and prospered under the direction of his son, Harold W. Sweatt, later (1927) merging with the business of Mark Honeywell [133].

44. *Rodengen, Chap. 2. Portrait from* Trade Winds, *Minneapolis-Honeywell Regulator Co., February 1960, p. 9.*

[131] William Penn POWERS c. 1890

American businessman. Started W.P. Powers & Co. in LaCrosse, Wisconsin (1867). Later became interested in automatic controls and established the Powers Regulator Co., Chicago (1890). Its first thermostat design was round (15-in. diameter) and used in a church, being connected to a large diaphragm motor that controlled double mixing dampers on a fan heating system (1893). The company grew and prospered: two of its most famous control installations (c. 1930) were for New York's Chrysler and Empire State buildings.

99. *Donaldson and Nagengast, pp. 198-202. Portrait from* The Aerologist, *June 1927, p. 11.*

[132] Howard D. COLMAN 1873-1942

American engineer and co-founder (with W.A. Barber) of Barber-Colman Co., controls manufacturer of Rockford, Illinois. Invented an automated knot-tying and finishing device for the textile industry (1894). With a group of engineers, he identified needs and developed further inventions, both for the textile industry and in other fields: fractional horsepower motors, electric fans, and various temperature control systems.

45. *Barber-Colman, p. 5. Portrait from* Barber-Colman, Centennial Celebration, *23 October 1994, back cover.*

[133] Mark HONEYWELL **active 1920s**

American inventor. Went into business as a plumbing and heating engineer in Wabash, Indiana (1906). Later invented the Honeywell Heat Generator that allowed heating systems to be pressurized. Formed the Honeywell Heating Specialty Co. and its success eventually led to a merger (1927) between the Minneapolis Heat Regulator Co. of Sweatt [130] and Honeywell. The new company soon became the U.S. leader in home heating controls and developed into one of the world's leading automatic control manufacturers.

44. *Rodengen, pp. 27-50. Portrait from* 42. *p 9.*

[134] Mads CLAUSEN **1905-1966**

Danish engineer and businessman. Like Carrier [101], he was born on a farm. Founded Danfoss (1933) and directed his first efforts to the production of controls for refrigerating plants. His first success was with an expansion valve. Clausen was described as "a man who could both inspire people and see matters from all sides, while never losing sight of the main objective." The company he founded has grown to one of the largest in its field.

41. *Danfoss Journal, June 1983 with portrait from p. 1.*

[135] John E. HAINES **1903-1967**

American businessman and controls engineer. President ASHRAE (1955). Introduced the classic *Engineering Manual of Automatic Control* (Honeywell 1958, first published in 1934). This manual and Haines' textbook, *Automatic Control of Heating and Ventilating*, explained the art of controls engineering to a wider audience by extensive use of system and control schematics.

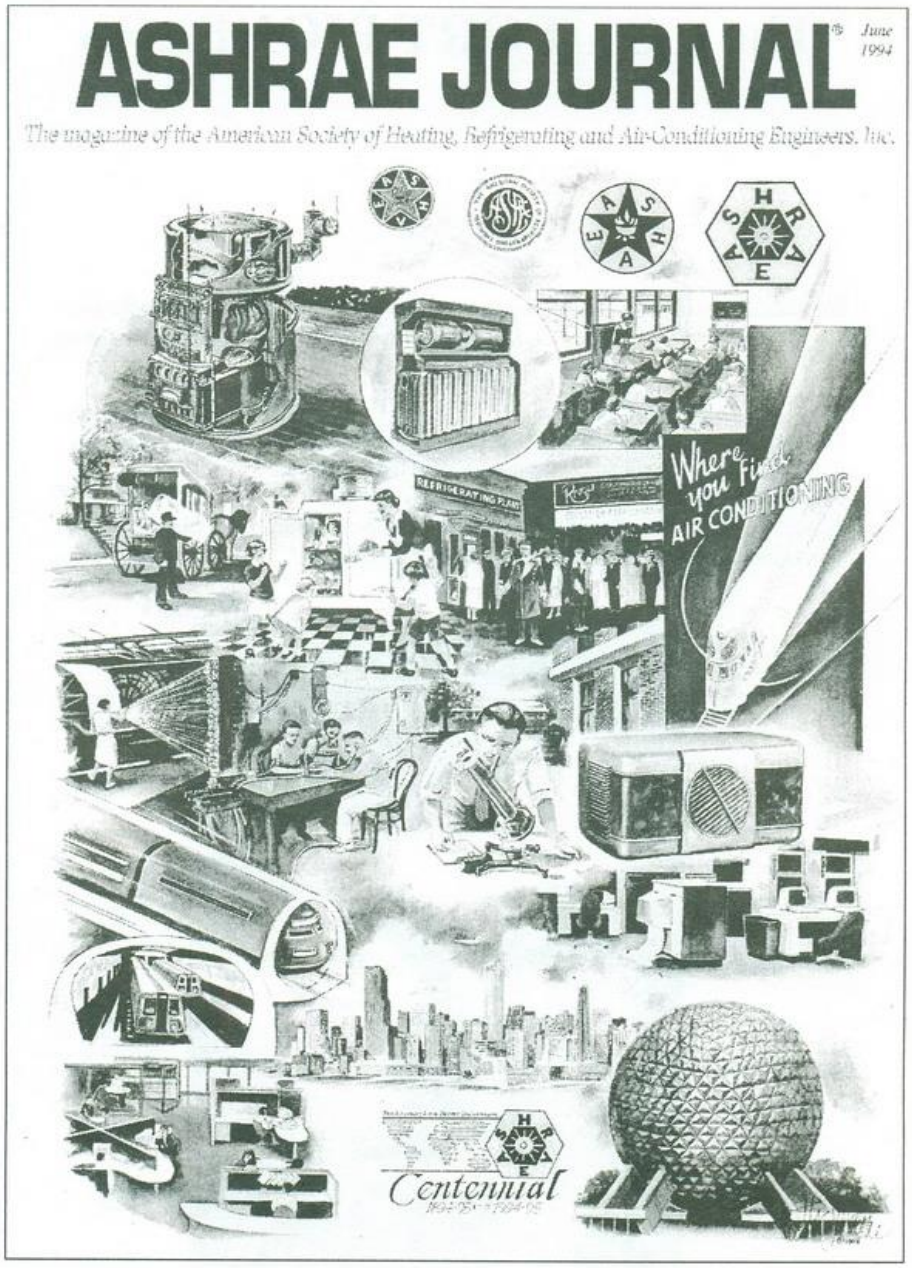
Portrait from 94. *p. 190.*

The COMFORT PIONEERS

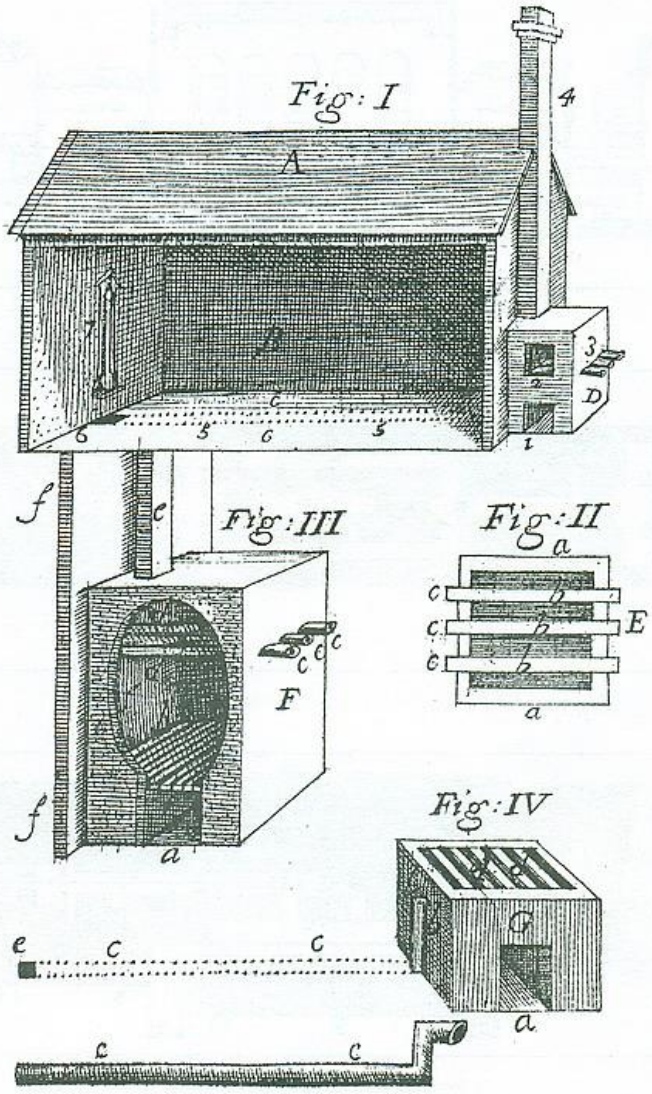
The roads you travel so briskly lead out of dim antiquity, and you study the past chiefly because of its bearing on the living present and its promise for the future.

Lt. Gen. James G. Harbord, 1866-1947.
U.S. Army and American Member of Council at London,
The Newcomen Society of England.
Quoted on the back cover of *Dr. Willis H. Carrier: Father of Air Conditioning*,
Newcomen Society, New York, 1949.

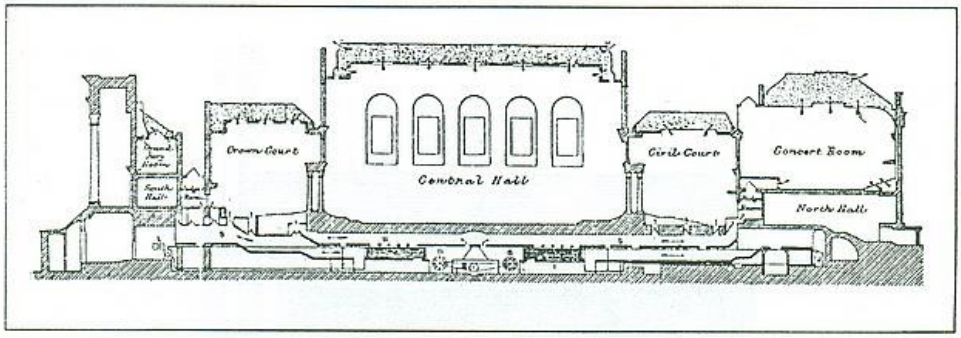
Nicolas Léonard Sadi CARNOT [159]



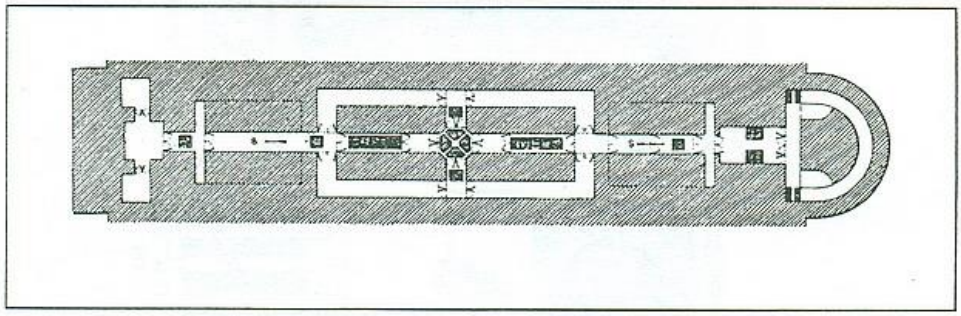
26. The Comfort Pioneers.
ASHRAE Journal, *June 1994, front cover.*



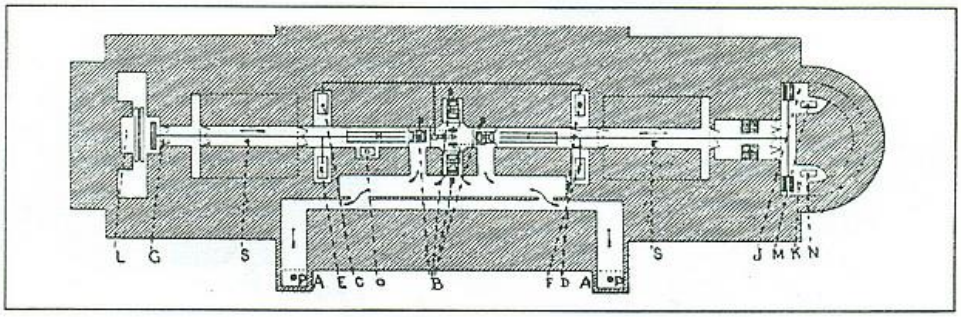
27. John Evelyn's Greenhouse Furnace, 1664.
Kalendarium Hortense, *1691.*



a. Longitudinal section of St. George's Hall.



b. Basement plan, St. George's Hall, at level of upper air channels.



c. Basement plan, St. George's Hall, at level of lower ducts.

28. *Section and Plans: St. George's Hall, Liverpool, 1854.*
The Mechanical Ventilation and Warming of St. George's Hall, Liverpool,
The Heating and Ventilating Magazine, *October 1907.*

An appreciation of the work of some of the early pioneers is given by the late Gershon Meckler in his introductory essay **51.** *to the ASHRAE Centennial Book (1994),* **99.** *by Donaldson and Nagengast.*

[136] EMPEDOCLES c. 493-433 B.C.

Born in Silicy. Greek philosopher. Put forward a theory of four indestructible elements, fire, air, water, and earth, of which, variously blended, all material substances are composed. This idea was taken up and improved on by Aristotle, who identified the four qualities dry, wet, cold, and hot.

[137] Gauis Sergius ORATA active c. 80 B.C.

Roman businessman. Lived near Naples. He described the heating of fish ponds and oyster ponds and the development of the heating of baths by means of warm air ducts under the floor. It is recorded: "Builders learned to apply the Oratan systems, called a 'hypocaustum' (from the Greek words for 'under' and 'burning') to whole buildings. Romans who went to live in the northern provinces of the Empire built 'hypocaust' houses."

99. *Donaldson and Nagengast, p. 5.*

[138] Leonardo DA VINCI 1452-1519

Florentine artist. Military engineer and scientific observer. Drew all sorts of mechanical devices and war engines. He proposed an odorless toilet, a cooking spit driven by a chimney fan (powered by the hot rising gases), and an anemometer. Said to have constructed the first elevator, including one for the Milan Cathedral. Produced amazing drawings relating to hydraulics and water flow, including a jet issuing from an orifice. The works of da Vinci had a profound effect on later scientists and researchers.

Leonardo (in three volumes: The Inventor, The Scientist, The Artist*), Hutchinson, 1981.*

[139] Francis BACON 1561-1626

English philosopher. Also, member of Parliament, lawyer, scientist, and essayist. Prominent at the Court of Elizabeth I; later a favorite of James I, becoming Lord Chancellor, then Baron Verulam. Shortly after becoming Viscount St. Albans (1821), he fell from grace. Summarized much of his scientific and philosophical ideas in *Novum Organum* (1620). He concluded, "Heat is an expansive motion restraining and striving to exert itself in the smallest particles." Bacon advocated rational experimentation to uncover the fundamental laws of nature. He was said to have been unprincipled and the Pope described him as "the wisest, brightest, meanest of mankind." We are told Bacon jumped out of his coach in a snowstorm on Highgate Hill (North London) to stuff a dead hen with snow to prove his theory that cold could delay putrefaction. For this exploit, from which it is said he caught a fatal chill, Bacon has been called the "Father of Refrigeration" (though a number of ancient civilizations, including the Chinese, the Egyptians, and the Romans, used ice and snow to cool drinks, the Romans also cooling fish and fruit in the time of Nero).

20. *David, p. 66.* 98. *Billington and Roberts, p. 239. Portrait is a detail from the frontispiece of the first history of The Royal Society of London for Improving Natural Knowledge, Thomas Sprat (later Bishop of Rochester), 1667 (The Royal Society).*

[140] Otto von GUERICKE 1602-1686

German physicist and engineer. Appointed Mayor of Magdeburg (1646), serving for 35 years. Became interested in philosophic arguments regarding the existence of a vacuum and decided to settle this by practical methods. Constructed the first air pump and experimented with evacuated vessels. In his famous demonstration (1654), he used two metal "Magdeburg" hemispheres that fit together along a greased flange. After evacuation of the air inside, teams of eight horses pulling in opposite directions failed to separate the two halves. This led to the historic work on the physical properties of gases by Boyle [142].

Portrait from 124. *p. 17.*

[141] Evangelista TORRICELLI 1608-1647

Italian physicist. Succeeded Galileo [117] as court mathematician to the Grand Duke of Tuscany. Urged by Galileo to find out why ordinary lift pumps could not raise water more than 32 feet, he suspected atmospheric pressure played a role. Torricelli then devised a mercury barometer (1643) and demonstrated both atmospheric pressure and the existence of a vacuum prior to the classic demonstration of Guericke [140].

[142] Robert BOYLE 1627-1691

Physicist and scientist. Born in Ireland. Influenced by Bacon [139]. Came to believe in the value of experimentation. After hearing of the experiments of Guericke [140], he set about building his own air pump. Ably assisted by Hooke [119], his investigations were reported in his *New Experiments Physico-Mechanical Touching the Spring of the Air and its Effects* (1660). This led to his important conclusion, now known as Boyle's Law (1662), on the behavior of gases. Boyle was a principal player in the early days of the Royal Society. He experimented with freezing mixtures, publishing the results in *Experimental History of Cold*, and has been called "the man who opened the door to the science of refrigeration."

Portrait by permission of the President and Council of Royal Society.

[143] Sir Isaac NEWTON 1642-1727

English scientist and mathematician. Universally acknowledged as one of the greatest thinkers of all time for his work on gravitation, the laws of motion, calculus, astronomy, and optics. Carried out thermometric experiments and stated what is now termed *Newton's Law of Cooling* (1701). He and Hooke [119] were in continual conflict. Newton was elected President of the Royal Society (1703) but only after Hooke's death. Pope wrote, "Nature and Nature's laws lay hid in night:/ God said, Let Newton be! and all was light."

Portrait from 4, January 1982, p. 10.

[144] Daniel BERNOUILLI 1700-1782

Swiss mathematician (born in the Netherlands). Professor of Physics at Basle. Made significant contributions to the study of fluid flow in *Hydrodynamica* (1738), containing the outline of the now famous *Bernouilli Equation*. Also pioneered the kinetic theory of heat.

[145] Edward Gerald NAIRNE 1726-1806

Scottish researcher. Continued some of the research started by Cullen [76]. Observed the strong absorption of water in concentrated sulfuric acid in an evacuated bell jar (1777), the fundamental principle of the absorption refrigerating machine, using water as refrigerant. This idea was later developed by Leslie [150].

[146] Joseph BLACK 1728-1799

Scottish chemist (born in France). Student of Cullen [76]. Considered the founder of scientific calorimetry. Clarified the concepts of quantity of heat, intensity of heat (temperature), and specific heat (1757-1764). Experimented with melting ice and boiling liquids. Introduced the idea of *calicorum latens* (1761). This "latent heat" concept was employed by Watt [13] in developing the steam engine.

Portrait from **46.** *p. 38 (drawn by Michael Ayrton).*

[147] Joseph PRIESTLEY 1733-1804

English Unitarian church minister. Said to have embarked on a scientific career after meeting Benjamin Franklin [8]. Wrote histories of electrical research and optics before turning to chemistry. Discovered (1750s) "fixed air" (carbon dioxide). Later (1774) isolated "dephlogisticated air" afterwards recognized (1777) as oxygen by Lavoisier [148]. Priestley demonstrated that fixed air would not support combustion and that mice soon died when placed in it. He found that in dephlogisticated air "a candle burnt...with a remarkably vigorous flame" and he studied the respiratory response of a mouse placed in it. Spent his last years in the United States (from 1794), where he gained the friendship of Thomas Jefferson [188] and returned to religion.

Portrait from **119.** *p. 501 (Engraving by W. Holl after a painting by Gilbert Stuart).*

[148] Antoine Laurent LAVOISIER 1743-1794

French chemist. Often called the "Father of Modern Chemistry." Constructed the first table of elements and helped establish the metric system. His many interests included street lighting, the manufacture of gunpowder, and the process of combustion. He met Priestley [147] and, repeating his experiments with air, discovered and named oxygen. He also studied the behavior of animals in air, oxygen, and nitrogen and measured the amount of metabolic heat they produced. There were two actions he would later regret. He became a farmer-general (tax-collector), and he made an enemy of Jean-Paul Marat. Worked with the young Laplace (1782-1784) on heat, perfecting the "ice calorimeter" of Black [146]. Later, he published his *Elementary Treatise on Chemistry* (1789), the year of the French Revolution. In due course, as a tax-collector, he was arrested; the officer remarked, "The Republic has no need of scientists." His trial was a farce, with Marat, who became a revolutionary leader, eager to settle old scores. Marat was assassinated (1793), but Lavoisier still went to the guillotine.

[149] Jacques Alexandre César CHARLES 1746-1823

Professor of Physics, Paris. Friend of Franklin [8]. Studied the properties of gases and established the relationship between pressure, volume, and temperature. Sometimes called *Charles' Law* but he did not publish his findings, which were later repeated by Gay-Lussac [154]. He also constructed the first hydrogen balloon (1783).

[150] Sir John LESLIE 1766-1832

Scottish Professor of Mathematics at Edinburgh. Improved on the earlier laboratory cooling researches of Nairne [145] and was able to make 2.7 kg of ice in less than an hour (1810). (Later 1824, John Vallance of Brighton improved on this apparatus.) Experimented with absorption refrigeration and provided the scientific basis for its later commercial development. Suggested that artificial cooling be introduced into hospitals and aboard ships (1813).

Portrait from Smithsonian Institution, Division of Engineering and Industry.

[151] John DALTON 1766-1844

English chemist. Professor at Manchester. Famed for his meteorological observations. Studied the composition of air and created what is now known as *Dalton's Law of Partial Pressures* (1801). He developed atomic theory and published *New System of Chemical Philosophy* (1808). His work contributed to the later development of air-cycle refrigeration and, in time, to the development of psychrometric charts and tables, an indispensable tool of the air conditioning engineer.

Portrait from **46.** *p. 50 (Drawn by Michael Ayrton).*

[152] Jean Baptiste Joseph FOURIER 1768-1830

French mathematician. Professor at military school. Accompanied Napoleon to Egypt (1798) where he served as a governor. Later, turned heat studies into a theoretical science. Made a Baron (1808) then joint secretary of the Academy of Sciences (1822). In his paper *The Analytic Theory of Heat* (1822), he presented mathematical theories of heat conduction and radiation. Fourier believed "heat to be essential to health so he always kept his dwelling place overheated."

[153] Sir Humphry DAVY 1778-1829

English chemist. Influenced by the writings of Lavoisier [148] but disagreed with his caloric theory, believing instead that heat was a form of motion. Discovered nitrous oxide (1800). Appointed by Rumford [15] lecturer at the Royal Institution, London (1801). Famous for his electrical experiments, demonstrated his arc lamp (1808) and invented the miners' safety lamp, or Davy Lamp (1815). Took responsibility for improving the ventilation of the House of Lords (1811), providing numerous holes in the floor for air distribution, combined with ceiling screens and heated metal tubes to accelerate the upward air movement. As recounted, "For boring twenty-thousand holes/ The Lords gave nothing. Damn their souls." Some consider Davy's most far-sighted decision was the appointment of the young Faraday [158] as his assistant (1813).

[154] Joseph Louis GAY-LUSSAC 1778-1850

French Professor of Chemistry, Paris. Established rules relating to the expansion of gases (1802), the *Gay-Lussac Law* (earlier discovered by Charles [149], who did not publish his findings). This work led to Avogadro's hypothesis that equal volumes of different gases at equal temperatures contain equal numbers of particles. Gay-Lussac made important improvements in a number of industrial processes, including the manufacture of sulfuric acid.

[155] William PROUT 1785-1850

English chemist and physiologist. Pioneered research into organic chemistry and the digestive system. Investigated the concentration in air of carbon dioxide resulting from respiration and perspiration, a subject later researched by Pettenkofer [165].

[156] Pierre Louis DULONG 1785-1838

French Professor of Physics. His most important work was on specific heats, in collaboration with Petit [157]. Together they studied the heat loss from surfaces by radiation and convection. Dulong also studied respiration in humans.

[157] Alexis Thérèse PETIT 1791-1820

French Professor of Physics. Best known for his collaborative heat transfer research with Dulong [156].

[158] Michael FARADAY 1791-1867

Outstanding English physicist and chemist. Initially assistant to Davy [153]. Renowned for his electrical discoveries, particularly magnetic induction (1831), which led to the generation of electricity and the electric motor. He studied the liquefaction of gases and was able to liquefy (from 1823) chlorine, ammonia, and carbon dioxide—important for the later development of refrigerating machines. He is commemorated by the name *farad*, given to the SI unit of electric capacitance.

Portrait from 115. *p. 43.*

[159] Nicolas Léonard Sadi CARNOT 1796-1832

Military engineer and French physicist. Studied heat engines (from 1819). Published *Reflections on the Motive Power of Heat and on Machines Appropriate for Developing this Power* (1824), which "secured a place for Carnot among the immortals of science." This work led to the later formulation of the Second Law of Thermodynamics by Clausius [167] and Kelvin [168]. Carnot conceived an ideal, reversible engine cycle, the "Carnot Cycle," which came to form the basis of the study of mechanical refrigeration. Though he used the caloric theory of heat in his analysis, most historians now agree his notes show he had serious doubts about it. Through his brilliant work, Carnot is generally regarded as the founder of thermodynamics. He died of cholera at an early age.

51. *Meckler, pp. xvi-xvii. Portrait from* 4. *April, 1982, p. 257.*

[160] James APJOHN 1796-1886

Irish chemist. University of Dublin. Put forward the theory of adiabatic absorption of moisture by air (1835-1836) but was unable to prove it. This was that the wet-bulb temperature was related to the total heat (enthalpy) of moist air, a fundamental of psychrometrics.

[161] James GLAISHER c. 1808-1903

English meteorologist. Made what was probably the first attempt to tabulate psychrometric data (1847). He computed reliable tables of the stationary wet-bulb and dry-bulb temperatures. These were used in the *Cotton Cloth Factories Act* (1889).

[162] Julius Robert von MAYER 1814-1878

German physicist. Trained as a physician and while serving as a ship's doctor became interested in animal heat. His resulting paper (1842) presented a value for the mechanical equivalent of heat. Along with Joule [163] he recognized the principle of the conservation (indestructibility) of energy. His work was virtually ignored, and after attempting suicide, he was committed to a mental institution (1851). Later released, it was only near the end of his life that his work was recognized.

[163] James Prescott JOULE 1818-1889

English physicist. Son of a wealthy brewer. Suffered poor health, so his father provided a home laboratory. He was tutored by Dalton [151] and influenced by Faraday [158]. Showed exceptional aptitude for experimental work, his efforts culminated in a paper (1845) on the free expansion of compressed gases and when (1850) he derived a value of 772.5 footpounds of work per British thermal unit as the mechanical equivalent of heat. His initial work gained little attention until cited by Helmholtz and Kelvin [168]. Joule subsequently presented his paper to the Royal Society when Faraday was his sponsor. He was elected Fellow (1850) and was awarded their medal (1856). He is commemorated by the name *joule*, given to the SI unit of energy, work, quantity of heat.

[164] William John Macqourn RANKINE 1820-1872

Scottish engineer. Trained in physics. Took up civil engineering. Professor of Engineering at the University of Glasgow (1855). Designed a fan with a spiral, or scroll-shaped, housing (1857). Wrote *Manual of the Steam Engine* (1859) and "introduced working engineers to the realm of thermodynamics."

[165] Max Joseph von PETTENKOFER 1818-1901

German chemist. Obtained medical degree at Munich (1843). Studied under the famous German chemist Liebig. He specialized in hygiene, being appointed professor in this subject at Munich (1865). Like Reid [58] earlier, Pettenkofer made a particular study of the effects of ventilation on health. Through the generosity of an enlightened Elector of Bavaria, he built a human respiration chamber, where his researches included measurement of the exhalation of carbon dioxide at varying rates of activity.

Portrait from the program of CIBSE Heritage Group Christmas Lecture1997 on Pettenkofer (by Harald Loewer, Technical University of Hamburg).

[166] Florence NIGHTINGALE 1820-1910

English nurse. Ran the military hospital at Scutari (from 1854) during the Crimean War and later at Balaclava. Became immortalized as "the Lady of the Lamp." Battled incessantly against incompetence and medical jealousy to successfully introduce cleanliness and sanitation. Finally a Royal Commission on the Sanitary Condition (health) of the Army was appointed (1857). Her privately printed *Notes* stressed the importance of general hygiene and her phrase, "Our soldiers enlist to die in the barracks," caught the public ear. The battle against officialdom continued for many years. She acquired Galton [171] as a useful ally. After visiting hospitals across Europe, she reached the conclusion that lack of drainage and ventilation was a prime cause of patient deaths and in *Notes on Hospitals* (1859) championed the "Pavilion" layout. She became involved in hospital design and construction, including the new St. Thomas's, London (1871), where she insisted on the importance of natural ventilation and free circulation of air. Though a virtual invalid in later life, Nightingale devoted herself to reform of the living conditions of soldiers in India. She was the first woman to be awarded the Order of Merit (1907).

Florence Nightingale, *Elspeth Huxley, Weidenfeld and Nicolson, 1975.*

[167] Rudolf Julius Emanuel CLAUSIUS 1822-1888

German theoretical physicist. Contributed to the kinetic theory of gases. In a classic paper (1850) at the Berlin Academy, *On the Motive Power of Heat and the Laws Which Can Be Deduced from It for the Theory of Heat,* he brought together the ideas of Carnot [159], Mayer [162], Joule [163], and Kelvin [168]. He derived the concept of *entropy* and is generally considered the discoverer of the Second Law of Thermodynamics.

Portrait from 4. *April, 1982, p. 258.*

[168] Lord KELVIN (William THOMSON) 1824-1907

Scottish physicist. Born in Belfast. Studied physics and mathematics at Glasgow University (from the age of ten), then Cambridge University. Worked in Paris on steam thermodynamics with Regnault [234]. Enabled Joule [163] to obtain recognition for his work (1847). He proposed the absolute temperature scale, later called the *Kelvin* scale (1848). Wrote the classic paper, *On the Dynamical Theory of Heat, with Numerical Results Deduced from Mr. Joule's Equivalent of a Thermal Unit, and M. Regnault's Observations on Steam* (1850). Kelvin's outstanding contribution to HVAC&R technology was his *On the Economy of the Heating or Cooling of Buildings by Means of Currents of Air* (1852). This accorded him recognition as the inventor of the heat pump.

51. *Meckler, pp. xviii-xix.*

[169] Francois-Marie RAOULT 1830-1901

French physical chemist. His study of solutions and partial pressures led him to formulate *Raoult's Law* (1886), which is of significance in the fundamental theories of absorption refrigeration.

[170] Dr. William Henry DUNCAN 1805-1863

Medical Officer of Health for Liverpool (1847-1863) and the first in the U.K. When the original design for St. George's Hall (completed 1855) was drawn up by the architect Elmes [194], it did not include any system of heating and ventilating. It was at the instigation of Duncan that Reid [58] was engaged to undertake this task. Duncan was concerned at the way infectious diseases seemed to spread where there was a lack of adequate ventilation, for Liverpool had recently experienced severe outbreaks of cholera (1847 and 1849).

Duncan of Liverpool, *W.M. Frazier, Carnegie, 1997, with portrait from frontispiece. Early Heating, Ventilating and Air Conditioning in the United Kingdom, Paul Yunnie,* ASHRAE Trans., *1995.*

[171] Sir Douglas Strutt GALTON 1822-1899

English "man of science." His mother was related to William Strutt of Derby [22]. Captain Royal Engineers (1855). Secretary to Railway Commission. Referee for plans for main drainage of London (1857). Member Royal Commission on the improvement of the sanitary conditions of military barracks and hospitals (1858), member army Sanitary Committee (from 1862). Also involved with Atlantic telegraph cable and formation of a national physical laboratory. Galton was particularly associated with sanitary science. Designed Herbert Hospital, Woolwich (1860-1862). Invented Galton's ventilating fire grate (early 1860s) adopted for barracks and hospitals. Wrote numerous papers relating to heating, ventilating, and sanitary engineering and to hospital construction. Member many learned societies, including Chairman Council Sanitary Institute (he urged their motto should be *Prevention is better than cure*). He died of blood poisoning.

107. *Billington. Portrait from* **59.** *p. 66 (Illustrated London News).*

[172] Professor E.P. BONNESEN active 1892

Worked at the Technical College in Denmark. Credited with being among the first to carry out calculations for systems for distributing heat and air.

From **106.** *Usemann.*

[173] Josiah Willard GIBBS 1839-1903

American physicist. Ph.D. Yale (1863) then Professor of Mathematics (1871). Wrote some 400 papers including *Graphical Methods in the Thermodynamics of Fluids*. He originated temperature entropy and volume entropy diagrams and later the *Gibbs-Dalton Law* relating to the properties of mixtures. Gibbs' contributions were significant in thermodynamic analyses of heating and cooling, combustion processes, refrigerants and refrigerating machines, and he assisted technological development. Later (from 1900), his work was important to psychrometry and the understanding of air-conditioning processes. His contributions went largely unrecognized in Europe until the turn of the century.

51. *Meckler, p. xx-xxiii. Portrait from* 119. *p. 237 (Courtesy Burndy Library).*

[174] Professor Osborne REYNOLDS 1842-1912

English researcher into hydraulics. Best known for his analyses of fluid motion and for the *Reynold's number* (Re). Responsible for important improvements to the design of centrifugal pumps. Later (1875) patented the multi-stage centrifugal pump and subsequently introduced guide vanes to enable the fluid kinetic energy to be converted to pressure head within the pump, thus increasing efficiency.

98. *Billington and Roberts, p. 378.*

[175] Sir James DEWAR 1842-1923

Scottish chemist and physicist. Educated at University of Edinburgh. Professor at Cambridge (1875), then worked at the Royal Institution (1877). His most important work was in the field of low temperatures and the liquefaction of gases, stimulated by the researches of Pictet [91] and others. He invented the double-wall *Dewar flask*, or vacuum flask (1892). He was the first to prepare liquid and solid hydrogen (1898-1899).

Portrait from 46. *p. 130 (Drawing by Thomas Freeth).*

[176] Dr. Heinrich Rudolf HERTZ 1857-1894

German physicist. Studied under Helmholtz and Kirchoff. Renowned for his electromagnetic studies and the name *hertz* (Hz) describing frequency in SI units. He also devised a graphical method of defining changing conditions in moist air (1884).

From 106. *Usemann.*

[177] Dr. Mary E. PENNINGTON **active 1908**

First female member of ASRE. Chief of the Food Research Laboratory in the U.S. Department of Agriculture. Consultant on development of ice usage and cold storage. Regarded as the foremost American authority on home refrigeration. Presented paper on the influence of low temperatures upon perishable produce at the First International Congress of Refrigerating Industries, Paris (1908). Pioneered cold storage of eggs and poultry. Experimented with transportation of meat and poultry by rail using ice-wagons (from 1912). Later directed the Household Refrigeration School.

17. *Thévenot.* 94. *p. 83. Portrait from ASHRAE: 100 Years of Progress, ASHRAE Journal, June 1994, p. 36.*

[178] Dr. E. Vernon HILL **1876-1950**

American comfort researcher. ASHVE President (1920). Developed the *Synthetic Air Chart* (1922), which "offers a means of determining the percentage of perfect ventilation by considering all the known factors that make up the air conditions in a room." He also developed (1925) a set of rules, *Don'ts for Theatre Ventilation*.

94. *with portrait from p. 178.*

[179] F. Paul ANDERSON **1867-1934**

ASHVE Laboratory Director (1921-1925). During his tenure, some 62 scientific papers were published. Most notable the *Comfort Zone Chart* (1924), "superimposed upon the Effective Air Chart and can be used to determine the relative comfort of ordinary indoor conditions from the dry- and wet-bulb temperatures of the air." ASHVE President (1927). Later, Dean of Engineering at Kentucky State University until his death. The F. Paul Anderson Award (established 1930) is awarded annually by ASHRAE for notable scientific achievement relating to HVAC&R. Anderson was one of the first members inducted into the ASHRAE Hall of Fame.

ASHRAE Journal, *September 1994, p. 10.* 94. *pp. 32 and 35. Portrait from* ASHRAE Hall of Fame, *ASHRAE Headquarters.*

[180] Francis HUTCHINSON **active 1930**

American pioneer in the air-conditioning and refrigeration industry. Professor of Mechanical Engineering at the universities of Berkeley and then Purdue. Saw the potential of solar energy as a heat source with a research program for Purdue Housing Research Association. Hutchinson was a specialist in thermodynamics and heat transfer in heating and cooling panels and co-author (with B.F. Raber) of *Panel Heating and Cooling Analysis* (1947). He was one of the first members inducted into the ASHRAE Hall of Fame.

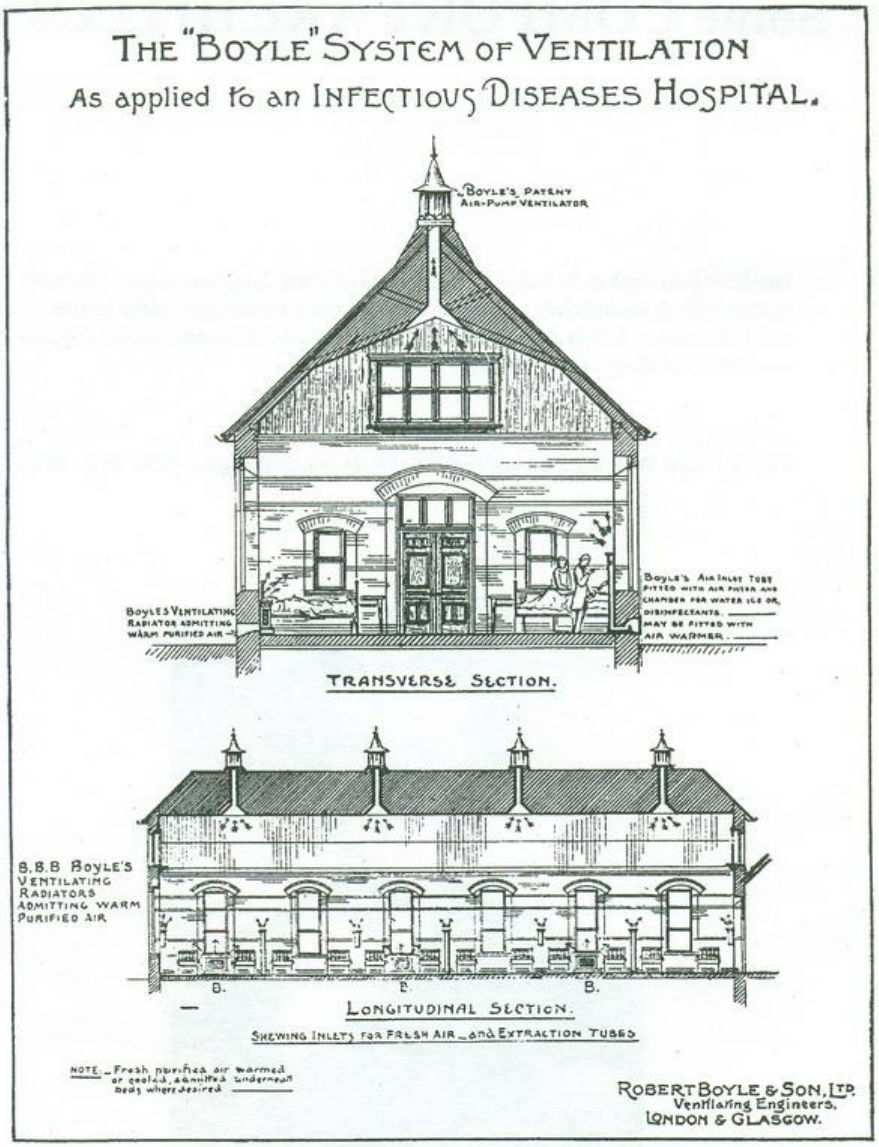
ASHRAE Journal, *September 1994, p. 10, with portrait.*

Some COMFORT ARCHITECTS

I took the next train to Buffalo to try and get the Larkin Company to see that it was worth thirty thousand dollars more to build the stair towers free of the central block, not only as independent stair towers for communication and escape, but also as intakes for the ventilating system.

Frank Lloyd Wright, *Frank Lloyd Wright: An Autobiography*, New York, 1943.

Sir Joseph Paxton [192]



29. Catalogue Illustration: Natural Ventilation by the Boyle System of the South West Fever Hospital in London. An example of collaboration between architect and ventilation engineer. The Boyle System of Ventilation, Robert Boyle & Son, Ltd., High Holborn, London, c. 1900.

Cost for Annual Maintenance of Apparatus
Working all day and night in Winter
Night only in Summer.

		£ s d
Fuel for 200 days and nights Warming and Ventilation for heating apparatus	210 Tons @ 16/	168. 0. 0
Fuel for Steam Engine 24 hours 365 days including service of Baths	84 Tons .	77. 0. 0
Two Stokers at 30/ per week		156. 0. 0
Sundries Repairs Oil and Wipings &c		30. 0. 0
		£ 439. 0. 0

Cost of Warming and Ventilation per bed per annum

The number of beds in the Hospital being 588 will shew taking into consideration the service of the Baths and Ventilation and Warming of the other Rooms, that the cost would be about 11/8 per bed per annum.

Cost of the Apparatus

From the best of my judgment I consider that the cost of the apparatus for carrying out my proposed plan will not exceed the sum of £1928. . .

This Sum would include all personal superviseion of the Work during the erection of the Building and supplying all the necessary apparatus, Steam Engine, Boiler, Fans, Gearing, Heating apparatus, Cast Iron Air Gratings for Escape and Inlet, Regulating Valves, Indicating Dials &c &c but exclusive of all Brickwork for the formations of Engine Rooms, Air Chambers and Flues and Channels.

General Remarks

This is in a few words the Plan, I should propose for the Ventilation and Warming of the new St Thomas's

/5

30. *Handwritten Report: Costs for Annual Maintenance and Apparatus. Proposals for Ventilation and Warming of St. Thomas's Hospital, Lambeth, London. Submitted by the engineer W.W. Phipson, dated 20 November 1865. The scheme was not adopted. (CIBSE Heritage Group Collection)*

[181] VITRUVIUS — active A.D. 70

Marcus Vitruvius Pollio. Roman architect and engineer who recorded the considerable knowledge of the Empire in *The Ten Books of Architecture.* He described the construction of Roman baths and of the underfloor warm air heating (hypocaust): "The hanging floors of the hot bath rooms are to be constructed as follows. First the surface of the ground should be laid with tiles a foot and a half square, sloping towards the furnace in such a way that, if a ball is thrown in, it cannot stop inside, but must return itself to the furnace room; thus the heat of the fire will more readily spread under the hanging flooring."

75. *Morgan (Vitruvius), p. 157.*

[182] APOLLODOROS OF DAMASCUS — died c. 149

Greek architect. Chief architect and engineer of the Emperor Trajan. Designed the great Baths of Trajan in Rome, built A.D. 104-109, a complex occupying some 23 acres, with heated, tepid, and cold baths. This was one of the Imperial *thermae*, which comprised 15 major public baths built over 300 years, where Roman citizens met to bathe and exercise, conduct business, and socialize.

See 99. *Donaldson and Nagengast, p. 11.*

[183] Lucius Septimus SEVERUS — 146-211

The giant Baths of Caracalla in Rome were begun by Emperor Severus and built about A.D. 206-216. They occupied nearly 30 acres, could seat some 1600 bathers, and were built over a large warm air heating system (hypocaust). The pool water was heated in 28 hypocaust chambers, supplemented by brass furnace heat exchangers (milarium), each surrounded by a leaden vessel filled with water circulating from the pools. Caracalla took all of the water from one of the 14 aqueducts serving Rome. (The baths are immortalized in the famous Victorian painting, *The Baths of Caracalla,* by Alma-Tadema).

99. *Donaldson and Nagengast, p. 14.*

[184] Ibn AL-AHMAR — reigned from 1237/died 1273

King Ahmar (Muhammad I of the Nasrid dynasty) commenced the building of the Alhambra Palace on a hill overlooking Granada, Spain. It was provided with a running-water system, a hypocaust heating system, and later a public bath-house.

64. *Barrucand and Bednorz, pp. 183-195.*

[185] Leone Battista ALBERTI — 1404-1472

Italian architect and artist. Developed the laws of perspective. His ten-volume treatise, *De Re Aedificatoria* (1485), was the first printed book on architecture. He suggested the chimney-register, a sliding metal plate, to reduce or close a chimney flue.

8. *Wright, p. 90.*

[186] Andrea PALLADIO 1508-1580

Italian architect, responsible for the Palladian style, much copied in England and America. Wrote *Quattro Libri Dell'Architettura* (1570), an architectural design sourcebook. He set rules for the construction of flued fireplaces. "Chimneys are made in the thickness of the wall; and in order that they may convey the smoke into the air, their funnels are raised above the roof. These funnels are not to be made too wide nor too narrow, because if they are made too wide, the air eddying through them will prevent the free ascent and escape of the smoke, and when too narrow, the vapor not having a free passage, will accumulate in the funnel and return to the room."

11. *Bernan, Vol. 1, pp. 131-132.*

[187] Sir Christopher WREN 1623-1723

English architect and scientist. Teacher of mathematics and professor of astronomy. His best known work is the redesign of St. Paul's Cathedral after the Great Fire of London. He was also involved with improving the chamber of the House of Commons (1692),and later (1701) with improving the ventilation. Wren provided exhaust air openings in the ceiling but it was not a great success; subsequently the challenge of ventilating the chamber was taken up by Desaguliers [52].

70. *Cooke, pp. 44-46.*

[188] Thomas JEFFERSON 1743-1826

Third President of the USA (1801-1809) with a strong interest in art and architecture. He designed and supervised the construction of his country house "Monticello," built on a remote hilltop in Virginia. The house expanded over the years, influenced by the designs of Palladio [186], an innovative feature being the portholes provided in his bedroom for natural ventilation. Jefferson also initiated the plans for the University of Virginia at Charlottesville (1816) when he was 73, taking a particular interest in the heating of the ten pavilions lining the central lawn. He had traditional wood-burning fireplaces installed on the ground floors but used the more efficient Pennsylvanian stoves of Franklin [8] on the upper floors.

97. *Peterson, Chap. 17 by Nichols.*

[189] Sir John SOANE 1753-1837

English architect who embraced traditional heating by fireplaces and stoves but took advantage of the developing central systems using steam, hot water, and hot air. Responsible for the rebuilding of the Bank of England, London, where he used a variety of heating stoves and designed an underfloor hot air system (modeled on the Roman hypocaust), which was not executed. He initiated the installation of hot water heating by A.M. Perkins [224] in the Court Room (1833). In his own office and museum, at Lincoln's Inn Fields, Soane experimented with a variety of heating systems over a 45-year period. He tried fireplaces, stoves, steam apparatus, two types of hot water system, and various hot air systems with varying degrees of success. Many of the details were recorded by his assistant, C.J. Richardson [35]. At Dulwich picture gallery, Soane employed a steam system by Matthew Boulton and James Watt, sons and namesakes of their illustrious fathers [12 and 13], but it was not a success.

7. *Willmert.*

[190] John Claudius LOUDON 1783-1843

Scottish landscape gardener, architect, and builder of glasshouses. Prolific author on horticultural topics. Foresaw the use of central steam heating in glasshouses, for country estates, baths, laundries, and the like. Loudon tested flue and insulation systems for his garden hothouses: *A Short Treatise on Improvements recently made in Hot-Houses*, 1805. He experimented with artificial climates for plants with controlled heating, ventilation, and humidification, including the use of weight-driven and clockwork fans: *Remarks on the Construction of Hot-Houses*, 1817.

68. *Hix, Chap. III.*

[191] Sir Charles BARRY 1795-1860

English architect. Designed the new Houses of Parliament, from 1839, assisted by A.W.N. Pugin. Barry was in continual conflict with Dr. Reid [58] over the means of ventilation, and they each obstructed the work of the other. To break the stalemate, Reid was left to design the ventilation for the House of Commons, while Barry was given charge of that in the Lords. He employed a skilled engineer, Alfred Meeson, who appears to have carried out most of the work.

69. *Jones, Chap. 8.* 70. *Cooke, pp. 107-126.*

[192] Sir Joseph PAXTON 1803-1865

English gardener and architect. Built the Great Conservatory at Chatsworth in Derbyshire (1836), heated by eight boilers and seven miles of four-inch pipe. Best known for designing the Crystal Palace, erected in London's Hyde Park for the Great Exhibition (1851). As a temporary structure, it was unheated but was provided with innovative controllable ventilation louvres and sun screens. When the Crystal Palace was re-erected and extended onto a permanent site at Sydenham in South London, it was provided with a large central boilerhouse where "no less than 22 boilers were arranged in pairs, each holding 11,000 gallons of water....Four pipes of 9 in. diameter were attached to each boiler, two flow and two return, and each boiler heated a certain transverse section of the Crystal Palace; the length of one flow and return was a mile and three-quarters, and the total length of heating pipes of all kinds was nearly fifty miles." Paxton also designed Mentmore Towers in Buckinghamshire (1859) for Baron Rothschild. It was an early example of central heating and "unusually employed hot water, at a time when heating by warm air seems to have been the favorite."

72. *Chadwick, p. 148.Portrait from the painting by O. Oakley;* Palace of the People, *Graham Reeves, Bromley Library Service, Kent, England, 1986, p. 10.*

[193] Sir George Gilbert SCOTT 1811-1878

English architect. Worked in the Gothic style: Albert Memorial (1864), St. Pancras Hotel (1865), both in London. Also, the University of Glasgow (1870), where the extensive ventilation and warming systems were designed by Phipson [203] to a brief established by a learned Committee, which included Rankine [164] and Kelvin [168]: "No. 9. The fresh air should be drawn in where the air is pure. No. 10. The fresh air should be forced in by one or any required number of suitable machines." The scheme used a central plenum chamber with a massive network of subterranean passages and heating chambers and upcast air extraction shafts. It was not a success because it did not satisfy Rule No. 5, where the committee had requested individual temperature control by hot and cold supply air mixing for each room.

82. *Barber, pp. 49-50 and 54-56.*

[194] Harvey Lonsdale ELMES 1814-1847

English architect. Best known work is St. George's Hall in Liverpool (1851), with an interior inspired by the Roman Baths of Caracalla [see 183]; has been described as "perhaps the finest Neoclassical building in England." Dr. Reid [58] was engaged to design a heating and ventilating system on the recommendation of Dr. W.H. Duncan [170]. Air was taken into the building through two shafts and warmed by five batteries of hot water pipes served from four boilers. Circulation was aided by steam-engine driven fans. Cold water sprays cooled and cleaned the incoming air. Elmes died of consumption in Jamaica at an early age, and his great work was completed by Prof. C.R. Cockerell.

St. George's Hall, Liverpool, *Loraine Knowles, National Galleries and Museums on Merseyside, 1988, pp. 8-11.* 99. *Donaldson and Nagengast, pp. 70-73.*

[195] George Edmund STREET 1824-1881

Notable church architect. Won the competition for the Royal Courts of Justice in the Strand, London (completed 1882), where the Great Hall has been called, "One of the grandest secular rooms of the Gothic Revival." According to George Haden [223], whose firm carried out the ventilation installation, "The Law Courts in London were fitted with Air Washing Films (achieved by a film of water flowing down a screen, being produced by a jet impinging on a small disc). The fans were driven by Steam Engines; one of the Lancashire Boilers under the main Hall being a Steam Boiler. In this case the water was cooled by refrigerating Apparatus. The Refrigerator was supplied by Halls of Dartford (Kent). Had a capacity of two tons of ice per hour."

85. *Haden documents, Wiltshire Record Office, England, WRO 1325/216.*

[196] Sir Edmund Frederick DU CANE 1830-1903

Major-General in the Royal Engineers. He was an assistant superintendent at the Great Exhibition, London (1851). After a period of supervising convict labor in Australia, he was appointed (1869) Chairman of the Board of Directors of Convict Prisons, Surveyor-General of Prisons, and Inspector-General of Military Prisons. He was responsible for the provision of extra prisons and his greatest work was Wormwood Scrubs in London. "Du Cane's scheme is remarkable for its clean, logical plans, and for the heating and ventilating system which served each cell. Staircases, vents and sanitary stacks were expressed in the building...(his) model plan for Wormwood Scrubs influenced the design of prisons for many generations afterwards."

73. *Curl, pp. 235-237. See also Major Jebb [204] who was earlier responsible for Pentonville Prison, London.*

[197] Alfred WATERHOUSE 1830-1905

Leading English architect. Works include Manchester Town Hall (1877) and Manchester Assize Courts. Haden [223] recorded, "I believe the first Installation for Air Washing was put in at the Manchester Assize Courts in 1863.... The Courts were opened in the Summer, and at the first sitting the Judge complained of the heat as the weather was very hot and asked that the windows, all of which were closed, should be opened. Frederick Blake our Manager sent a note to him to say that if the windows were opened the temperature would probably rise, but the Judge asked for the windows to be opened, which was done, and the temperature went up in a very short time five degrees." Waterhouse's most famous work is London's Natural History Museum (1881), where the order for the warming and ventilation was secured by Phipson [203] in competition with Haden. Phipson's successful proposal included a surprisingly tight performance schedule, guaranteed to supply three air changes per hour, as well as balancing the humidity. In his tender analysis (1873), Waterhouse wrote that Haden did not give an estimated air change and that "they now inform me that in consequence of the Great Rise that has taken place in the cost of labour and material since they delivered their Tender, twelve months ago, they could not undertake the work except at an advance upon their tender of from 15 to 20 per cent." The ventilation scheme employed large masonry ducts under the basements, conveying cold (unheated) fresh air and warm air in a dual-duct arrangement, which could be mixed locally. (From his earlier experiences with Scott [193], Phipson had apparently learned the value of Rule No. 5). Waterhouse was also Company Architect for the Prudential Assurance Company and designed their new head office in High Holborn (1878-1906), where his association with Phipson continued. In 1886, Phipson was involved in specifying Marshal steam-driven dynamos for the electrical services with exhaust steam utilized for space heating—an early and significant example of combined heat and power. The installation was carried out by Drake and Gorham [236 and 237].

55. *Cook.* 65. *Hinchcliffe.*

[198] Dankmar ADLER 1844-1900

Engineer. Partner of Sullivan [199] in Chicago and between them successfully designed many theatres, most notable being that in the Auditorium Building, Chicago (1889). The Auditorium Theatre has been described as "a happy marriage of science and art" and with a capacity of 4237, was among the largest ever erected. Adler's engineering talents included a thorough knowledge of acoustics. The rake of the stalls and the rise of the balconies were designed on a principle called the "isocoustic curve," while "the shape of the ceiling was determined almost entirely by acoustic considerations.... Adler's calculations involved absorption, reflection, and reverberation...the result was miraculously successful. The arches, also, besides carrying Sullivan's decorative lights, are used for the ventilation equipment, the air ducts being disguised as ornaments."

66. *Tidworth, pp. 177-180.*

[199] Louis Henri SULLIVAN 1856-1924

American architect. Pioneer in the design of metal-framed buildings and early skyscrapers of the Chicago School. Worked for a number of years with Adler [198]. Coined the dictum "Form Follows Function." Designed the Wainwright Building, St. Louis (1891), and the Guarantee Building, Buffalo (1895). He trained Frank Lloyd Wright [201] and has been termed the "Prophet of Modern Architecture."

62. *Frazier.*

[200] Charles Rennie MACKINTOSH 1868-1928

Scottish architect. Leader of the Art Nouveau movement in Great Britain. His leading work is considered to be the Glasgow School of Art, built in phases (1898-1909). He showed a willingness to utilize the new technologies of his time, including central heating and mechanical ventilation, and to integrate these in a decorative manner into his overall design. The building incorporates an air treatment plant (possibly a very early air-conditioning system) designed by William Key [98].

105. *Roberts, pp. 116-117.*

[201] Frank Lloyd WRIGHT 1869-1928

Generally considered America's greatest architect and ranked alongside Walter Gropius, Mies van der Rohe, and Le Corbusier [202] as one of the leading architects of the 20th century. Employed in his early years by Louis Sullivan [199]. Achieved renown for his domestic architecture, particularly in the Oak Park suburb of Chicago and later for his Prairie Houses. Designed many notable commercial and public buildings, including the Larkin Building, Buffalo (1904), the great Imperial Hotel in Tokyo (1922), the revolutionary Johnson Wax administration building in Racine, Wisconsin (1939), and New York's Guggenheim Museum (1959). For the Larkin offices (a mail-order business), the industrial nature of the site and the proximity of the New York Central Railroad, emitting fumes and noise, led Wright to design a large sealed inward-looking box, dependent on mechanical ventilation and overhead daylighting. He wrote, "The machinery of the various appurtenance systems, pipe shafts incidental thereto, the heating and ventilating intakes...are quartered in plan and placed outside the main building at the four outer corners...(with) the building practically sealed to dirt, odor, and noise." Later (1909), the Kroeschell Bros. Ice-Machine Company of Chicago added a CO_2 refrigerating plant to make the Larkin possibly the world's first air-conditioned office building.

57. *Pfeiffer, pp. 56-61. Portrait from* 119. *p. 689.*

[202] LE CORBUSIER 1887-1965

Charles Edouard Jeanneret. Swiss born, French architect, town planner, and artist. He designed and spoke of houses as "machines for living in." He sought unorthodox solutions to environmental control involving building orientation, structure, daylighting, and passive solar control; many of his buildings are not considered to be entirely successful in this respect. Le Corbusier claimed to have invented the external sunshade (*brise soleil*), and he developed the neutralizing wall (*mur neutralisant*), to offset the effects of outside conditions on the interior of a room. This involved circulating ventilating air, enclosed between twin walls or membranes, where "is blown scorching hot air, if in Moscow, iced air if in Dakar." Le Corbusier's most famous building is the Unité d'Habitation at Marseilles (1952), a massive housing project of 350 flats in eight double-storys, of which Reyner Banham wrote, "His heroic and sculptured air stacks on the roof...must be acknowledged as historically important if only as the first explicit sign for almost twenty years in his work that mechanical services are an expressible form of a building." Later, in his design for the Supreme Court in Chandigarh in the Punjab (1956), he provided an enormous canopy running the full length of the facade, to protect from wind and rain, combined with vertical wall screens providing natural ventilation of the courtrooms.

102. *Banham, Chap. 8.*

The COMFORT DESIGNERS

Henry Lea begs leave respectfully to announce that, by the advice of many gentlemen well acquainted with his qualifications and experience, he has commenced practice as Consulting Mechanical Engineer.

Henry Lea, November 1862. From *Henry Lea, Consulting Engineer, 1839-1912.*

Alfred R. WOLFF [211]

Schemes and Estimates submitted free of charge for installations of Warm Air, Low Pressure Hot Water or Steam Apparatus.

PERFECT EFFICIENCY GUARANTEED.

JOHN GRUNDY,

. . . Heating and Ventilating Engineer,

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"HELIOS" and "SIRIUS" Smoke Consuming Grates for Chimney Pieces.
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27 MEDALS HAVE BEEN AWARDED.

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BOOK CONTAINING A THOUSAND TESTIMONIALS FORWARDED ON APPLICATION.

The well-known firm of HAMPTON & SONS, Pall Mall East, London, S.W., write:

Mr. JOHN GRUNDY, 30, Duncan Terrace, London, N.

Nov. 5th, 1903.

Dear Sir,
In response to your letter of the 3rd inst., we have much pleasure in stating that your Heating Apparatus is used with great success at our Depositories at Battersea. The best proof of our satisfaction is that we are having your Heating Apparatus installed into our additional blocks of Depositories now in course of erection. We are of opinion that for safety, hygienic and all useful purposes, your mode of heating is the best. We have no trouble in working the apparatus, which is simple and very efficient. We have pleasure in giving you this testimonial, and wish you the success your system deserves.

Yours truly,
HAMPTON & SONS,
W. HAMPTON, Managing Director.

Head Office: 30, DUNCAN TERRACE, CITY ROAD, N.

Show Rooms and Work Rooms:
Torrens Street, Islington, N., & 393a, City Road, London, N.

Factory: THE TYLDESLEY IRON WORKS, nr. MANCHESTER.

Telegrams—"JOHN GRUNDY," LONDON. National Telephone—No. 552, KING'S CROSS.

31. *Advertisement: Heating and Ventilating Engineer, Manufacturer and Patentee. John Grundy, City Road, London. (Grundy was the first President of IHVE, 1898.)* Heating by Hot Water, *Walter Jones, 1904, p. xv.*

[203] Wilson Weatherley PHIPSON 1838-1891

English civil engineer, specialized in heating and ventilation. Worked as a consultant and sometimes in a contracting capacity. Educated in Brussels and Paris. Later, a pupil of Dr. Van Hecke of Brussels "who discovered a new method of heating and ventilating which had already given some very satisfactory results." Assisted Van Hecke to warm and ventilate the hospitals Necker and Beaujon in Holland. Came to London (1859) "with the object of introducing a new system of heating and ventilation devised by his old master Van Hecke." Phipson employed mechanical and natural ventilation systems, often together, with varying degrees of success. He was both a pioneer and an innovator. He carried out a number of important projects including Baron Rothschild's residence and bank, the Strand Music Hall (1864), Glasgow University (from 1864), Royal Holloway College, Egham (1882); and in London: the Natural History Museum (1873, and where he beat the firm of Haden in competitive tender), Royal Albert Hall (1871), Alexandra Palace (1874), and the Empire Theatre in Leicester Square (1890). Was also involved (1886) in the early development of the Prudential Assurance building in High Holborn, where he specified steam-driven dynamos with the exhaust steam used for space heating—an early example of combined heat and power. His scheme for the warming and ventilation of St. Thomas's Hospital (1865) was not successful. Was an advocate (c. 1888) of the American developments in steam district heating and of the Boston *Prall* high-temperature hot water heating system. He killed himself through overworking and excessive travelling (over 3000 miles in a fortnight). His practice was taken over by Ashwell and Nesbit [232 and 268].

82. *Barber.* **55.** *Cook and Hinchcliffe (Natural History Museum). His life and achievements are summarized in* Wilson W. Phipson: A Memoir, *a privately published appreciation, 1892. (The CIBSE Heritage Collection holds a Phipson Archive with some 50 items, many original, comprising letters, hand-written notes, sketches, invoices, reports, cost sheets, testimonials, etc. No portrait or likeness of Phipson has yet been discovered.)*

[204] Major Joshua JEBB active 1850

English military officer. Royal Engineers. Responsible for the design and construction of Pentonville Prison (1840-1842), London. This was considered a landmark, both in the design of the prison itself and in its services.* He employed Haden [223] to assist with the design and to carry out the installation, which included for the boiler feed water to be pumped by hand by 12 men in the cells. Jebb wrote, "An equable temperature of from 52°F to 58°F has been maintained in all the cells under circumstances of great variation in external temperature. The consumption of fuel has not exceeded from 2 to 2-1/2 cwt of coal for sixty-six cells, and the ventilation or quantity of fresh air introduced into each cell has been from 30 to 45 cubic feet per minute. The cost of maintaining this temperature and ventilation has been about 1/2 d per cell for 24 hours." He also noted, "the greater fuel consumption in a newly-built structure which has not thoroughly dried out." The tradition of Royal Engineers' prison-building was carried on by Du Cane [196].

Services in the Clink, B.M. Roberts, Building Services *(CIBSE Journal), January 1990. Within these Walls, K.W. Dale,* Building Services *(CIBSE Journal), December, 1992 with photo portrait.* **98.** *Billington and Roberts, pp. 205-207. See also* **105.** *Roberts, p. 110. *Copies of the Commissioner's Report on the Ventilation and Warming by Jebb and others, including a letter to G. and J. Haden are held at* **85.** *Haden Archive, WRO-1325.*

[205] Robert BRIGGS 1822-1882

American civil engineer. Consulting engineer of Boston. Worked with Nason [206] for Meigs [207] on the heating and ventilating installation for the United States Capitol in Washington [from 1855]. The design of the giant fans was based upon methods suggested by Péclet [27] and on a study by Briggs of the workings of a 1/10th scale model. "The passages in which were located the large centrifugal fan rotors...were so shaped that no fan casing was required. The central cone of the fan was of cast-iron; the vanes were of wood, stiffened and fastened with metal angles and rods. The rotor was 14 feet in diameter."* His design was described in his paper, *On the Conditions and Limits Which Govern the Proportions of Rotary Fans* (Institution of Civil Engineers, 1869-1870). Jointly obtained a patent with Nason (1863) "for a steam radiator made up of vertical tubes screwed into a horizontal cast-iron base" (often called the *Nason* radiator). Briggs wrote a number of essays covering ventilation, moisture in the air, and heating of halls of audience. Editor of the Journal of the Franklin Institute (1876-1878).Wrote the textbook (1882), *American Practice in Warming Buildings by Steam* with additions by Wolff [211]. Briggs received the Watt Medal and the Telford Premium from the Institution of Civil Engineers (1871).

Memoir of Robert Briggs, ASCE, Vol. 22, 1896, pp. 567-569. **3.** *Ferguson (including notes 52 and 53, p. 184). See also* **99.** *Donaldson and Nagengast, pp. 78-80. *Another report describes two fans, one 16 ft and one 12 ft in diameter.*

[206] Joseph NASON 1815-1872

American heating and ventilating engineer. Worked for A.M. Perkins [224] in London. Also met Thomas Russell and (with James Walworth) bought Russell's unsuccessful New York business, founding Walworth & Nason (1841). Heated the counting room (1842) at Middlesex Mill, Lowell, Mass. Developed steam heating using small bore piping. Nason is credited with introducing steam heating into the USA at the Eastern Exchange Hotel, Boston (1845), and in the same year at a woollen mill in Vermont. He developed the *Nason Regulator* (1840s) to control steam pressures. The first application of a fan ventilating apparatus in the U.S. was by Walworth & Nason for the Boston Custom House (1846), where "the fan used was a paddlewheel like that used on steamboats which was mounted in a case fitting the ends of the blades with fair accuracy, but leaving area enough about the periphery to permit free escape of air." The installation used a "steam trap which had been invented by Mr. Nason...." Nason also built (1851) a small, upright water-tube boiler to replace the wrought-iron pipe coils typically used at that time. The partnership with Walworth was dissolved (1852) and Nason went to work in New York. Later (1855), at the request of Meigs [207], he planned, with Briggs [205], the heating and ventilating system for the United States Capitol in Washington, described as "the first really scientific and complete job of its kind done in the country." The installation used *trombone* heating coils of distinctive shape, specially designed by Nason. He introduced (1862) the *Nason* radiator.

99. *Donaldson and Nagengast, pp. 76-78, 84, and 195. See also Walworth, 1842-1942, J.A. Murphy. Walworth Company, 1942, and The Early Days of Steam Heating, A.C. Walworth,* Heating and Ventilation, *15 June 1893. A biography is:* Gallant Heritage, *Alice King, Vantage Press, 1965.*

[207] General Montgomery Cunningham MEIGS 1816-1892

While a Captain in the U.S. Army Engineers, Meigs was appointed (1853) by the Secretary of War, Jefferson Davis, to be Superintendent at the Capitol for the rebuilding and enlargement. This placed him over the architect, Thomas U. Walter, and gave him responsibility for coordinating the overall design and installation of the heating and ventilating system. Meigs appointed Nason [206], who in turn enlisted the help of Briggs [205]. Though the House of Representatives moved in 1857, followed by the Senate (1859), the relationship with Walter had deteriorated to the point where Walter refused to share his drawings (reminiscent of the similar feud between Barry [191] and Reid [58] during the rebuilding of the Houses of Parliament.) Meigs (like Reid) was dismissed (1859). Later (1861) he noted, the system having been in use for some time, that it "realized all that I undertook to accomplish in regard to light, warmth, ventilation and fitness for debate and legislation." This opinion was not unanimous. Later (1881-1887), Meigs was responsible for the oldest and one of the largest atrium buildings in the USA—the Old Pension Office in Washington (now, appropriately, the National Building Museum). "One of Meig's primary concerns was the welfare of the workers and the pensioners who visited on a monthly basis. He wanted a thoroughly ventilated building with no dark passages or corners, but curiously the building has no skylights; all natural light for the atrium enters through clerestory (double-pane) windows."

3. *Ferguson.* **97.** *Chap. 12.* **99.** *Donaldson and Nagengast, pp. 78-80. See also* **76.** *Rosenbaum, pp. 44-45 (Pension Office). Portrait from* **119.** *p. 421 (Courtesy National Archives, Brady Collection).*

[208] Henry LEA 1839-1912

English consulting engineer whose expertise ranged widely over the civil, mechanical, and electrical disciplines. Opened an office in Birmingham (1862) and issued a circular letter, "Henry Lea begs leave respectfully to announce that by the advice of many gentlemen well acquainted with his qualifications and experience, he has commenced practice as a Consulting Mechanical Engineer." He may have been the first in the field to describe himself thus, though Phipson [203] was also active around this time. Lea was a pioneer of electric lighting but also introduced new methods of artificial ventilation based on the plenum system of Key [98]. Used it with notable success at Birmingham General Hospital (1893). Then at the Royal Victoria Hospital, Belfast (1903), where, "A sprinkler system, used to moisten the filters through which the fresh air passed, was regulated on the basis of regular readings of wet- and dry-bulb temperatures. This conscious control of humidity gives the Royal Victoria Hospital a place among pioneering air conditioning systems."

78. *Tovey.* **79.** *Building Services.* **102.** *Banham, pp. 75-82. See also* **105**. *Roberts, pp. 102 and 115. Portrait from Hoare Lea & Partners.*

[209] Frederick WITTENMEIER died 1928

German immigrant to USA. Originally a steam-fitter. Joined heating contractor and boiler manufacturer Kroeschell Bros., Chicago (1896). Convinced Kroeschell to enter ice-machine business. Claimed to have introduced CO_2 refrigeration into the USA, using the patents of Julius Sedlacek. Devised a direct-expansion system (1905) used with an air washing system, "first used dry coil surface cooling, later used sprays to wet coil surface for increased heat transfer." Kroeschell provided refrigeration for Pompeiian Room, Congress Hotel, Chicago (1906), for powder room on warship *USS Ohio* (1908), and for the Larkin Building, Buffalo (1909) for architect Frank Lloyd Wright [201]. Invented air cooler (USP 1,003,129: 1911). Installed cooling systems in Blackstone Hotel and Planters Hotel, both in Chicago, and in Rogers Hotel, Minneapolis. Wittenmeier designed air cooling systems, including Central Park Theatre (1919) and Riviera Theatre (1920), both in Chicago. Later established his own company.

31. *Ingels, pp. 125-137.* **98.** *Donaldson and Nagengast, p. 287.*

[210] Frederic TUDOR, Jr. active 1880

American inventor and engineer. Son of the *Ice-King* [78]. Entered the heating business (1880). Said he was interested in "the comfort and convenience of the average citizen, and especially the average woman (who) had not been considered by steam heating engineers." Devised a "jacketed direct radiator with definite air supply and immunity from freezing" (USP 185,146: 1875) with the heat output controlled by an air damper. This was installed in the Hotel Cluny, Boston (1876). Tudor also invented a combination steam and hot water system (USP 278,636: 1883). Contributed much to the development of low-pressure steam systems. Invented a steam orifice (capillary) to control the rate of steam admitted to a radiator (USP 318,401: 1885). Also worked on the design of ventilating systems, including that for the Metropolitan Opera House (1883) and the Union League Club (1887), both in New York City. Though his steam systems did not attract much attention in America, they were well received in France and Germany. His system is sometimes referred to as the *French* system.

98. *Billington and Roberts, pp. 104-105.* **99.** *Donaldson and Nagengast, pp. 82-83 and 89. Portrait from* Heating and Ventilating Magazine, *June 1929, p. 113.*

[211] Alfred R. WOLFF 1859-1909

American consulting engineer in New York. Obtained mechanical engineering degree at age 17. Worked for Charles Emery, renowned consulting steam engineer, as assistant engineer for the U.S. Revenue Marine Service, then formed a consultancy partnership, Wolff & Weightman. Later, set up his own practice. Designed many important heating and ventilating systems and power plants, including the Seigel-Cooper Co. Department Store, the Hotel Astoria, St. Luke's Hospital, Carnegie Music Hall (1891, with provision for ice-block cooling), the New York Life Insurance Building, and the Metropolitan Life Building. In addition, he was the consultant for a number of large residences, such as the Cornelius Vanderbilt II house (1879-1883 and 1892) and the John Jacob Astor IV house (1891-1895). Used a variety of steam, hot water, and hot air systems. Applied heat transfer coefficients for building materials, developed from Péclet [27] and Box [30]. Wolff seems to have been the first to have introduced the scientific approach, as practiced in Germany, into the USA (from 1889), and it is believed he was aware of the methods of Rietschel [99]. Wrote *Artificial Cooling of Air for Ventilation* (1892). Designed cooling systems for the Cornell Medical School (1899) and the Hanover National Bank (1903). His best known achievement is the air conditioning of the board room and the cogeneration system for New York's Stock Exchange (1901), which employed three 100 ton (350 kW) ammonia absorption chillers fed by the exhaust steam from the engines that powered the electrical generators. He told the Stock Exchange Committee "the importance of this plan to the upper portion of the board room is in the abstraction of the moisture and the reduction of humidity. I attach less importance to the reduction of the temperature than to the abstraction of the moisture." Wolff's Stock Exchange (1901) has greater claim to be the first scientifically designed air-conditioning system (at least in the USA) than the Sackett-Wilhelms system (1902) of Carrier [101]. Wolff, a man of strict ethics and a charter member of ASME, refused to join ASHVE "because salesmen were permitted."

81. *Nagengast.* **99.** *Donaldson & Nagengast, pp. 114-116 and 271-276. See also* **105.** *Roberts, fig. 60. Portrait on p. 93, from Robert Wolff family.*

[212] Walter S. TIMMIS died 1928

American consulting engineer, New York. Involved Carrier [101] in the design of the Sackett-Wilhelms printing plant (1902) and suggested trials using calcium chloride brine for dehumidification. President ASHVE (1919). Presidential Address proposed legislation for the protection of health and comfort.

31. *Ingels, pp. 15-19. Portrait from* **94.** *p. 178.*

[213] Konrad MEIER — active 1900

American consulting engineer. Worked in New York. Wrote *Mechanics of Heating and Ventilating* (1912), which included a number of design charts* that were described by Pallot as "not so widely known as they should be, in view of the enormous saving in time and labor, together with the high degree of accuracy and the economy arising out of greater certainty...." Meier produced 10 charts covering pipe and duct sizing.

**Chart VII: Air Blast at High Velocities, included in the Pallot article. Charts I: Forced Hot Water Heating; II: HW Heating by Gravity; V: High Pressure Steam Heating; and VI: LP Steam Heating are in the CIBSE Heritage Collection, items 00238 to 00241. See The Meier Chart, AC Pallot, booklet of IHVE Summer Meeting, 1921.*

[214] Hugo THEORELL — active 1902

Swedish consulting engineer from Stockholm. Listed as the first engineer from Scandinavia to be elected to ASHVE (1902).

94. *ASHRAE, pp. 79-80.*

[215] Kunisuke SEKIDO — active 1903

Japanese consulting engineer. Worked in Tokyo. Listed as the first engineer from Japan to join ASHVE (1903).

94. *ASHRAE, p. 80.*

[216] Arthur H. BARKER 1870-1954

English contractor, consultant, author, and lecturer. Gained B.A. and B.Sc., London. Senior Whitworth Scholar (1895). Worked as a fitter for Henry Berry of Leeds (hydraulic engineers), draftsmen for Gwynne Pumps, engineer at Haden, Trowbridge, and then Technical Managing Director at J.F. Phillips, London. Later set up as consulting engineer. Invented (1903) a steam accelerator, called the *Cable System*, for increasing flow in hot water heating systems. Patented a method of radiant heating (1908) and now regarded as the *Father of Radiant Heating*. Published his classic textbook *Barker on Heating* (1912). Appointed the first lecturer on heating and ventilation at London University. Deduced (with Kinoshita) the 1.3 power law for radiator output (1918). President IHVE (1922). Twice awarded IHVE Silver Medal (1906 and 1909). The CIBSE Barker Silver Medal award is named for him.

107. *Billington.* **93.** *Proc. of IHVE 1922, with portrait. See also* **105.** *Roberts, p. 104.*

[217] J. Roger PRESTON 1878-1949

English contractor, then consulting engineer. Apprenticed to firm of A. Seward, Lancaster. Won first prize at IHVE Assistant's Competition two years running (1906-1907). Awarded Saxon-Snell Prize (1907) of Royal Sanitary Institute for his paper, *Suggestions for Improvements in Sanitary Appliances for Use in Workmens' Dwellings and Labourers' Cottages.* Later, won RSI Special Prize for *Heating and Ventilating of Public Buildings*. Worked for Walter Jones [240] of Jones & Attwood, Stourbridge, helping him with his researches. Then joined (1910) Maguire [241] at Maguire & Gatchell, Dublin, taking charge of the heating department. Later, became a director of Mumford Bailey & Preston, London. Set up (1924) as a contractor, later (1926) turning the firm into a consultancy practice. He developed an electric air speed meter (1907), a double-duct air-conditioning system (1909), and a *Heating Main Calculator* slide-rule. Preston was President IHVE (1929).

80. *J. Roger Preston & Partners with portrait.* **93.** *Proc. of IHVE, 1929. See also* **105.** *Roberts, p. 104.*

[218] Dr. Oscar FABER 1886-1956

English civil, electrical, and mechanical engineer. Made his reputation designing reinforced concrete structures. Chief Engineer, Trollope & Colls, when he worked on many important London buildings. Set up as a consulting engineer (1920). Acted as consultant to the Bank of England (1925-1942) for structure, heating and air-conditioning plant with Kell [219], and electrical systems. Responsible for numerous city banks and for the Earls Court Exhibition Building (1938). He advised on the design of Sydney Harbor Bridge and the Mersey Tunnel. Wrote (1936, with Kell) the standard textbook *Heating and Air Conditioning of Buildings*. President IStructE (1936). President IHVE (1944-1945, serving two terms). Awarded OBE for his work during the Second World War. Involved in the air conditioning of the rebuilt House of Commons (1943-1950), for which he was made CBE (1951). His biography (by his son John) reveals that in spite of his brilliance he was not always easy to work with.

77. *John Faber, with portrait.* **93.** *IHVE Journal, 1944.*

[219] John Robert KELL 1902-1983

English engineer. Initially worked as contractor. Joined (1926) the office of Oscar Faber [218]. He was deeply involved in all aspects of the building services design for the Bank of England, which involved on-site electricity generation with waste heat recovery. Wrote (1936, with Faber) the standard textbook *Heating and Air Conditioning of Buildings.* Later, his work on the 12-acre Earls Court Exhibition Building involved conducting full-scale tests on the special ventilating jet nozzles (*IHVE Journal*, March 1938). Taken into partnership by Faber (1948). Responsible for the air conditioning of the rebuilt House of Commons (1943-1950). President IHVE (1952). Remarked "that of the forty-five Presidents to date, only five have been consultants." Made CBE (1966). Awarded IHVE Gold Medal (1967). Associated with the Abbey Church at St. Albans for many years, Kell has the unusual distinction of having his bust, carved in stone, among the roof gargoyles.*

77. *John Faber, Chap. 3 with portrait.* 93. *IHVE Journal, 1952. * Building Services (CIBSE Journal), April 1980, p. 56.*

[220] Gian Felise BERTOLINI active 1960

Italian consulting engineer. Associate Professor of Engineering at Milan Polytechnic. His projects include one of the first high-rise European office buildings (1960), the 32-floor Galfa Tower in Milan (air conditioned by induction units recessed into the floor). Also involved in cogeneration plant for Comasina district (1961), three major Milan hospitals (1966-1976), and the Carlo Felice Theatre, Genoa (1976). Founding President ASHRAE Italiana (1960). Served three terms as President of AICARR (ASHRAE Affiliate Society). Founded (with Paolo Sonino) the Mostra-Convegno Exhibition and Conference (1960). Later, founded and edited the magazines *AICARR Journal and Hospital Engineering* to which he was a frequent contributor. Inducted into ASHRAE Hall of Fame (1996).

ASHRAE Insights, *June 1996.*

The COMFORT INSTALLERS

When the weather was very inclement, the most robust of my parishioners complained to me of their inability to endure the cold of the Church. We got erected a ventilating stove by Mr. George Haden: the consequence is that our Church is about as warm as any sitting room...from about 52° to 57°....

Reverend Peter Balfour of Clackmannan, testimonial dated 4 February 1840.
Haden 150 Years, The Early Years, p. 13.

Charles SYLVESTER [221]

The KAISER-I-HIND
INDIAN TRADE & INDUSTRY SUPPLEMENT
No. 3097 BOMBAY, 18TH MAY, 1941. Vol. LX

FORTY YEARS OF AIR CONDITIONING PROGRESS

INDIA FINDS NEW BENEFITS

TREMENDOUS AID TO INDUSTRIAL PRODUCTION

IN 1915 the Carrier Corporation was established, with Willis H. Carrier as its head. He had looked into the future and had seen air conditioning as a major industry.....a vital function in the scheme of things .....influencing life, business, and industry.....

(Continued on page 7)

32. Advertisement: Carrier Air Conditioning by Volkart Brothers, Bombay. The Kaiser I-Hind newspaper, 18 May 1941. (CIBSE Heritage Group Collection)

[221] Charles SYLVESTER 1774-1828

Sheffield "chymist" and mechanical engineer. It is said his inventive mind and industry led directly to the founding of contractors Rosser & Russell. He obtained a patent related to metal galvanizing (BP 2842: 1805). Later worked for William Strutt [22] at his Derby Foundry, who "certainly recognized his value as an engineer, for he soon had him working on the development and installation of ventilating systems" and on a heating scheme for Derby Infirmary. Wrote a treatise, *The Philosophy of Domestic Economy as Exemplified in the Mode of Warming, Ventilating, Washing, Drying and Cooking* (1819). Continued work as a heating engineer until his death, leaving his business to his son, John [222].

86. *Rosser and Russell, pp. 4-5.* **96.** *HVCA, photo of bust by Francis Chantrey, inside front cover (Derby Museum and Art Gallery).*

[222] John SYLVESTER 1798-1852

Heating engineer. Developed the business left to him by his father, Charles [221]. Obtained patents related to improvements to the Derby hot-air stove (BP 6273: 1832) and to pressurization of hot fluid heating systems (BP 9986: 1843). Proceedings of the Institution of Civil Engineers recorded his assistance to Captains Parry and Ross, in their explorations to discover the North-West Passage and ascribed "the health of the crews in great degree to the excellence (of scientifically planned heating, cooking, and ventilation...) John Sylvester devised."

86. *Rosser and Russell, p. 6.*

[223]George HADEN 1788-1856

Son of George Haden, Sr., who worked for, and was held in high regard by, James Watt [13]. Apprenticed to the firm of Boulton & Watt. Trained on the steam engine side of the business. With his brother James [228], established G. & J. Haden in Trowbridge (1816) as an agent of Boulton & Watt to erect steam engines for West Country cloth mills. George was regarded as somewhat pious but the more dynamic of the two brothers and probably the better business manager. A natural extension of their work was the installation of the associated steam piping systems and this may have awakened the brothers' interest in heating. The real impetus came from the warm air ventilating stove, which was developed and patented by George (BP 9259: 1842). He also became involved in providing boiler plant and heating for the huge growth in institutional buildings, particularly lunatic asylums and prisons. Haden worked with Jebb [204] on the heating and ventilating of Pentonville Prison. The success of the firm was also due to the installation of their patent stove in many hundreds of churches built in the mid-19th century. James Haden retired in 1855, the company becoming G.N. Haden & Son and continuing under the direction of George's son, George Nelson Haden (died 1892).

85. *Haden Archive. See also* Haden, A Short History of the Company 1816-1991, *with portrait from p. 1.*

[224] Angier Marsh PERKINS born 1799

Born in Massachusetts, son of Jacob Perkins [77]. Went to England as a boy. Later became interested in heating. Worked on high-pressure hot water heating systems utilizing small diameter piping, developed by the firm of John Russell & Son of Staffordshire (1825). He devised the Perkins' system (BP 6146: 1831) using 25 mm tube with 6 mm wall thickness with a furnace apparatus designed to maintain water temperatures at about 350°F, though this sometimes reached a dangerous 550°F. The system initially proved popular in England (1830-1840), being used at the British Museum, the Royal Society of Arts, and Stratfield Saye House (for the Duke of Wellington). It was also used by Soane [189] in his museum and described by Soane's assistant, Richardson [35] in his *Treatise on Warming* (1839).

98. *Billington and Roberts, pp. 115-119.*

[225] Samuel Egan ROSSER 1821-1877

Heating engineer. Worked for John Sylvester [222]. Continued the business after Sylvester's death. Company later restyled as "S.E. Rosser, engineer and heating apparatus manufacturer" (c. 1856). Expanded the firm's work to include hydraulic and mechanical lifts and the design of heating for conservatories and glasshouses. Took out a patent for improvements in the ventilation of pressing irons heated by gas (BP 359: 1865). Later, took into partnership Joseph Russell [233] to establish the firm of Rosser & Russell (1866).

86. *Rosser and Russell, pp. 6-7.*

[226] Wallace C. ANDREWS c. 1833-1889

American businessman. The Common Council of New York City granted a franchise to Francis B. Spinola to lay pipes under the streets of Manhattan and form a company to supply hot air or steam (1878). Andrews bought the franchise and formed the Steam Heating & Power Co. of New York (1879). He then bought a controlling interest in a rival. The companies merged to form the New York Steam Co. (1881) and "dug its first pipelines under the direction of its chief engineer Charles Edward Emery." The first customer to be connected was the United Bank Building, 88-92 Broadway (1882). District steam heating quickly became popular. The NYS Co. soon had 62 customers (end of 1882) and within a few years (1886), this increased to 350 customers with 8 km of mains.

Fifty Years of New York Steam Service, *New York Steam Corporation, 1932.* **111.** *Jackson, pp. 1119-1120.*

[227] Jean Baptiste BLONDEL active 1788

French engineer. Provided the first central hot water supply installation (1788).

From **106.** *Usemann.*

[228] James HADEN **born 1790**

Brother of George [223]. Served a general apprenticeship with Boulton & Watt. Co-founder of G. & J. Haden at Trowbridge (1816). A bachelor and said to be an extremely hard worker, James traveled the country for some 20 years, meeting prospective clients, providing estimates for warm air stoves, and frequently supervising their installation. A five-day itinerary (1826), said to have been typical, covered Trowbridge. Birmingham, Manchester, Blackburn, Preston, Carlisle, and Edinburgh—often travelling by coach through the night. He began by working for the landed gentry and had an impressive list of titled customers. For George IV, he provided a warm air stove for the Royal apartments at Windsor (1826), and when apologizing to other customers for delays took delight in writing, "But I have been much occupied fixing stoves for His Majesty at Windsor." These efforts laid the foundation of the heating business, which upon his retirement (1855) became G.N. Haden & Son.

85. *Haden Archive. See also* Haden: 150 Years, *1966, Chap. 1 Portrait from* Haden: A Short History of the Company 1816-1991, *p. 1.*

[229] Benjamin BIRAM **active 1819**

German engineer. Established the first heating firm in Berlin (1819).

From **106.** *Usemann.*

[230] Johann Jakob SULZER **1806-1883**
[231] Salomon SULZER **1809-1869**

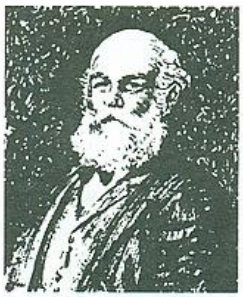
Swiss brothers. With their father's assistance, opened a new iron foundry at Winterthur (1834). The company was Sulzer Brothers. Attention turned to the manufacturing of equipment and they produced their first wrought-iron steam boiler (1841). Later, the Cornish type boiler was manufactured (1860s), the inclined multitubular boiler (Grand Prix, Paris, 1878), and then water-tube boilers (by 1900). Over the years, the company has developed into a manufacturer of heavy machinery, which includes internal combustion engines, compressors, turbines, pumps, process, and textile plant. Now an industrial giant and active around the world, its comfort engineering activities embrace boiler plant, refrigerating machinery, the installation of heating, ventilating, and air conditioning, and district heating.

87. *Sulzer. Portraits from p. 40.*

[232] Frank ASHWELL 1855-1896

Upon completing an engineering apprenticeship, opened a small mill-wrighting workshop in Leicester (1879). Set up a heating department (1884) run by Nesbit [268]. Took up agencies for various heating and ventilating products, including the "Lancaster" steam trap and the "Korting" stove. Specialized in the heating and ventilating of local schools. Purchased the local "Victoria Foundry" (1887), turning out wrought and cast-iron goods, including gas and coal fire ranges. Continued to develop the school heating business with the introduction of his "Propulsion, Impulsion or Plenum System," which typically used a 5 ft diameter Blackman fan, driven by a 5 hp gas engine, and using heater batteries supplied with steam from Cornish boilers. The plenum system was often supplemented by his "Patent Ventilating Solar Radiator." The success of the business led Ashwell to take Nesbit into partnership (1892) to form Ashwell & Nesbit. The same year he took over the consultancy practice of Phipson [203]. The business continued to expand and carried out considerable institutional work including "no fewer than 15 lunatic asylums" (1893-1896), but in the middle of this success, Ashwell died unexpectedly from a brain tumor.

83. *Ashwell and Nesbit. Portrait facing p. 60.*



[233] Joseph RUSSELL 1866-1927

Marine engineer. Went into partnership with Rosser [225]. Guided the company of Rosser & Russell to become a major heating and ventilation contractor. Legend has it the RR initials stood for the Rolls-Royce of the heating industry. Russell was a versatile engineer and patented a number of heating improvements, including one relating to boilers (BP 2771: 1870). A Silver Medal award at the Paris Exposition (1878) details the company's exhibit as containing "A fire and steam stove, a hot water stove, an air-warmer for churches and other buildings, steam cooking pans for institutions, a hydraulic lift, and a reversible (back-to-back) grate." Later, following Royal recognition, the firm was able to style itself, "Horticultural Builders and Warming Engineers by Appointment to Her Majesty the Queen" (1884).

86. *Rosser and Russell, pp. 7-13 with portrait from p. 9.*

[234] P. REGNAULT active 1865

Devised a central warm air heating system "with requirements for hygiene" (1865).

From 106. *Usemann.*

[235] Birdsill HOLLY active 1876

American hydraulic engineer and inventor. Took an interest in the possibilities of district heating and began experiments (1876-1877). Earlier pioneers of "group schemes" include Benjamin Franklin [8], who heated a row of houses from an iron stove-furnace (1748), Loddidge, who steam heated his Hackney nursery with "over half a mile of 4-inch cast-iron pipes (c. 1818), and Paxton [192] at the Sydenham Crystal Palace (1853). Schemes had also been suggested (c. 1834) by Brunel [59] and Wilhelm Siemens for the city of Birmingham (1863). Holly, at Lockport, N.Y., "built a boiler in the cellar of his home. He buried 160 m of 25-mm pipe and successfully furnished (steam) heat to his own and nearby homes. He followed this up with an extension of 160 m of 37-mm pipe to a neighbor's home. This also being a success, Mr. Holly decided to start a heating utility in Lockport. For this, he used a boiler 2 m in diameter and 3 m high, serving a total of 750 m of 50-mm and 100-mm pipeline laid in bored-out wooden water pipe for insulation. Steam service began in October 1877, when 14 customers were connected to the boiler, operated at 300 kPa." To improve performance, Holly invented a steam trap, an expansion joint, a pressure regulator, and a condensate meter. The pioneering work of Holly was reported by Captain Galton* [171], who saw benefits in reducing atmospheric pollution. District steam heating was introduced in New York (1879), largely through the efforts of Andrews [226].

98. *Billington and Roberts, p. 123. Portrait from* Fifty Years of New York Steam Service, *New York Steam Corporation, 1932, p. 13. *The Combination System of Steam Heating for Towns and Villages, D.S. Galton,* J. Society Arts, *9 December 1881.*

[236] Bernard Mervyn DRAKE 1858-1931

Electrical engineer. Pupil of Sir Joseph Whitworth. Worked for Brush Electrical Co. in Madrid and provided the first electrical installation in that city. At 24, he was Managing Director of both the Midland and Great Western Brush Companies. Later Managing Director of Electrical Power Storage Co. (1884), where he met John Gorham [237] and went on to set up the business of Drake & Gorham (1886). Their objective "was to bring the electric light to the stately homes of England." Their finest example was Chatsworth (1893). However, perhaps more significant is the installation of steam-driven dynamos at the Prudential Offices in High Holborn (1886) where Phipson [203] specified that exhaust steam should be utilized for space heating, a very early example of combined heat and power. Drake & Gorham was also later involved in the CHP installation at the rebuilt Bank of England (1926), based on the designs of Kell [219]. Drake & Gorham later (1964) merged with the Bristol plumbing firm of Arthur Scull (founded 1881) to become a major M&E contractor (Drake & Scull).

84. *pp. 2-15 with portrait from p. 3.*

[237] John Marshall GORHAM **active 1886**

Electrical engineer. Worked for King of Roumania. Then Works Manager for Electrical Power Storage Co., where he met Bernard Drake [236] and they lectured to the Royal Society on the rapid failure of accumulator plates. Jointly established the electrical firm of Drake & Gorham (1886), which installed a very early combined heat and power plant at the Prudential Offices in High Holborn (1886) (see [236]).

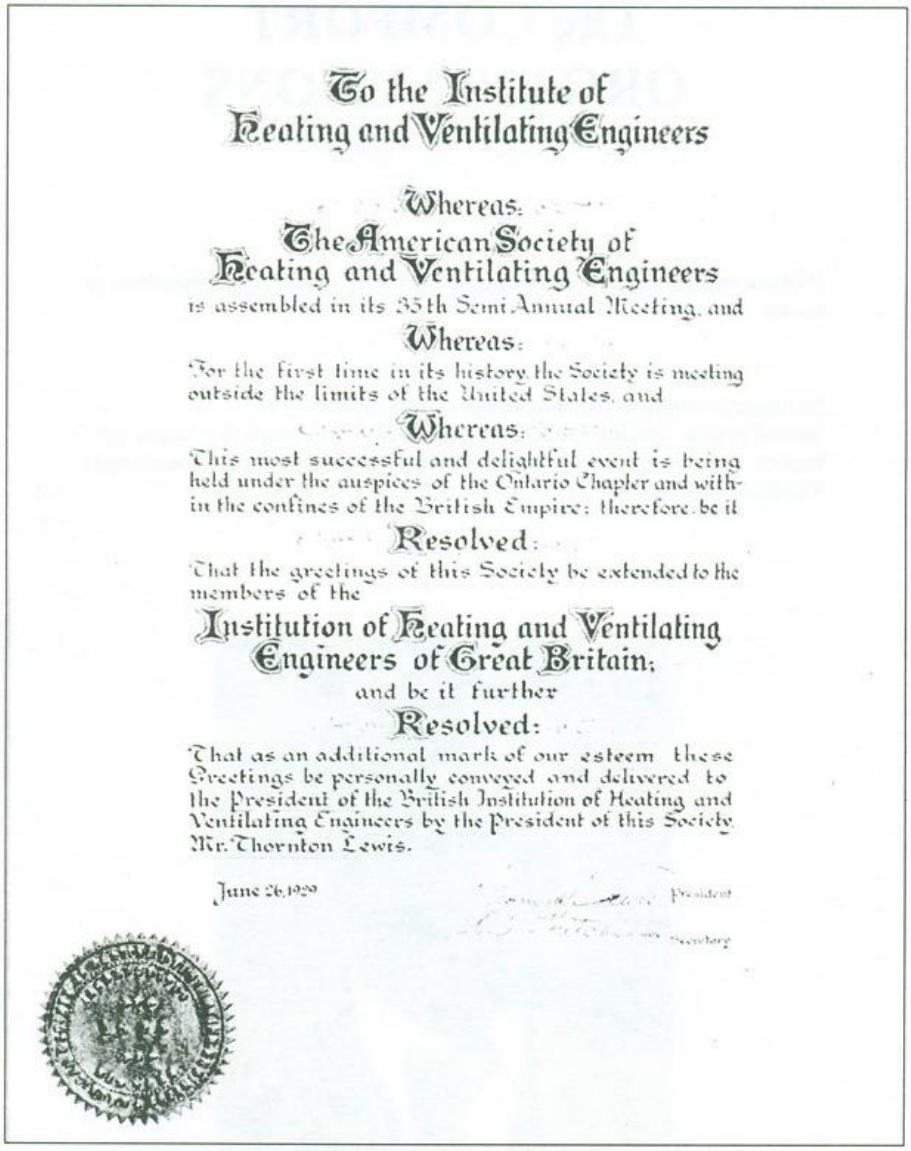
84. *Drake and Gorham, p. 2 with portrait from p. 3.*

The COMFORT ORGANIZATIONS

If I have seen further than other men, it is because I stood on the shoulders of giants.

Sir Isaac Newton, in a letter to Robert Hooke, 1676.
Quoted (with a variation on the words) by Billy R. Manning in his President's Report, "Building on the Shoulders of Giants," ASHRAE Annual (Centennial) Report, 1995, p. 2.

David Mein NESBIT [268]



To the Institute of
Heating and Ventilating Engineers

Whereas:
The American Society of
Heating and Ventilating Engineers
is assembled in its 35th Semi-Annual Meeting, and

Whereas:
For the first time in its history the Society is meeting outside the limits of the United States, and

Whereas:
This most successful and delightful event is being held under the auspices of the Ontario Chapter and within the confines of the British Empire; therefore be it

Resolved:
That the greetings of this Society be extended to the members of the
Institution of Heating and Ventilating
Engineers of Great Britain;
and be it further

Resolved:
That as an additional mark of our esteem these Greetings be personally conveyed and delivered to the President of the British Institution of Heating and Ventilating Engineers by the President of this Society Mr. Thornton Lewis.

June 26, 1929 President

Secretary

33. *Greeting from ASHVE to the Institute (sic) of Heating and Ventilating Engineers. From the 35th Semi-Annual Meeting held in Ontario, Canada, signed by ASHVE President Thornton Lewis, 26 June 1929.* Proclaiming the Truth, *ASHRAE, 1994, p. 82.*

34. Council of the Institution of Heating and Ventilating Engineers, 1910.

(left to right, from top row) John S. PALMER [244] Robert E. ATKINSON*
Walter JONES [240] Chas MASON Walter YATES [74]
Thos POTTERTON [41] E.W. MAYNER [238] Louis F. PEARSON [243]
W.R. MACGUIRE [241] C. Ingham HADEN [269] S. NAYLOR [49]
John GRUNDY [239] C.T.O. TROTMAN George CRISPIN [245] E. TAYLOR
W. Nelson HADEN [246] J. Nelson RUSSELL [242] J.N. GREENHALL
A.B. SIMPSON [247] A.B. TAYLOR J.L. SAUNDERS

This composite picture includes nine of the first ten IHVE Presidents, plus two later Presidents. The exception is David Nesbit [268] whose portrait is on the title page.*

Communications as a Means to Survival, K.W. Dale, IHVE Presidential Address, IHVE Journal, *May 1974, p. 28.*

*(*Nesbit and Atkinson were the first and second U.K. engineers, respectively, to join the ASHVE.)*

The INSTITUTION of HEATING and VENTILATING ENGINEERS

Founded in London in 1897. Granted a Royal Charter in 1976. Later merged with the Illuminating Engineering Society (IES), founded in 1909. Subsequently became the Chartered Institution of Building Services Engineers (CIBSE).

Note: Portraits of all, except [268] Nesbit, are in included in the IHVE composite picture.

[238] Edmund William MAYNER — 1862-1944

Mayner is regarded as "The Father of the IHVE." It was J. Kemsley, Secretary of the Institute of Sanitary Engineers (of which body Mayner was a Member of Council) who put forward a proposal to foster the heating and ventilating trades (1896). Mayner was largely responsible for setting up the IHVE. He was probably the first member and the first practicing engineer to join. He never occupied the Presidential Chair, preferring to hold the post of Chairman of an Executive Committee. It is almost certain that he recruited Walter Jones, David Nesbit, William Maguire, Louis Pearson, and George Crispin, all of whom came to be Chair after John Grundy, the first President. At the time, he was a member of the firm of Townsend, Tamplin & Makooski Ltd. of London and Redhill. Later, he was Works Manager with William Dibben & Sons Ltd. of Southampton and subsequently carried on business in Christchurch, Hants. His considerable efforts in the setting up of the Institution appear never to have been formally recognized during his lifetime.

Obituary, IHVE Journal, *Sept.-Oct. 1944, p. 28.*

[239] John GRUNDY — died 1913

First President of IHVE (1898). Heating and ventilating engineer and manufacturer, London. His company was awarded numerous Exhibition Medals for their boilers and stoves.

[240] Walter JONES — died 1924

Second President of IHVE (1899). Jones & Attwood, Heating Specialists and Consulting Engineers of Stourbridge. Author of classic textbook *Heating by Hot Water* (1890). Twice awarded the IHVE Silver Medal (1903 and 1908). Jones was a pioneer in determining the causes of boiler explosions.

[268] David Mein NESBIT — 1855-1929

Third President of IHVE (1900). *See under HVCA.*

[241] William Robert MAGUIRE — c. 1840-1923

Fourth President of IHVE (1901). Maguire & Gatchell of Dublin. An internationalist, he was an early member of ASHVE. His Presidential Address was *Heating in France and Italy.*

[242] J. Nelson RUSSELL **died 1948**

Fifth President of IHVE (1902). Rosser & Russell Ltd., London. Awarded IHVE Silver Medal (1904). An early member of ASHVE. Granted patent for a fan convector (BP 131,107: 1906).

[243] Sir Louis F. PEARSON, CBE **1864-1943**

Sixth President of IHVE (1903). Chairman of the Beeston Boiler Co., Ltd., of Nottingham. A scientist and philanthropist, Pearson was knighted (1923) for his social, industrial, and public services.

[244] John S. PALMER **died 1909**

Seventh President of IHVE (1904). Syphons, heating contractors of Liverpool. Was not a professional engineer but a very active member of Council during the formative years and an expert on the steam fitting trade.

[245] George CRISPIN **1868-1950**

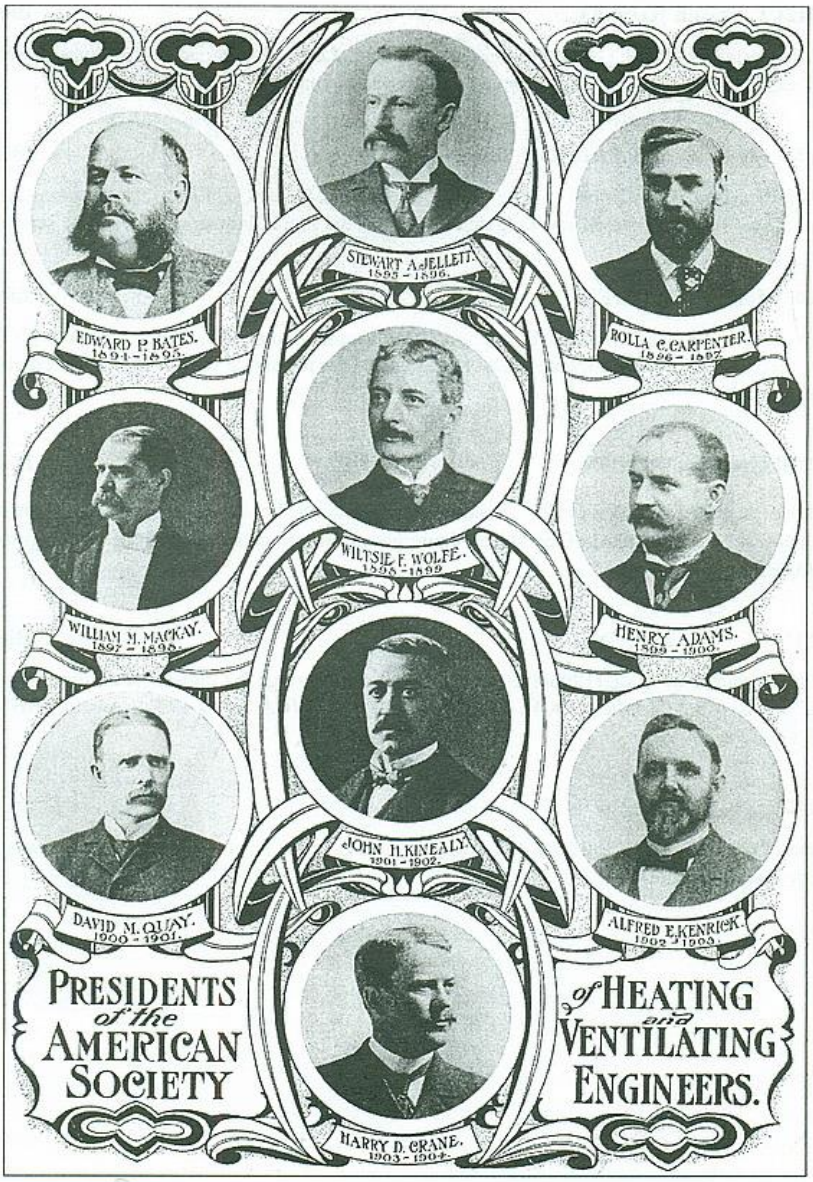
Eighth President of IHVE (1905). James Crispin, Heating, Ventilating and Domestic Engineers of Bristol. A strong advocate of the value of summer meetings and social activities and a gifted singer and entertainer.

[246] W. Nelson HADEN **died 1946**

Ninth President of IHVE (1906-1907). G.N. Haden, Trowbridge & London. IHVE paper *Royal Commission on Coal Supplies* (1904). Eighth President of HVCA (1919-1920). Awarded IHVE Gold Medal (1942).

[247] A.B. SIMPSON **died 1948**

Tenth President of IHVE (1908). J. Simpson & Co., London. His Presidential Address was *Patents, New Developments.*



35. Portraits of the first ten Presidents of ASHVE.
Proclaiming the Truth, *ASHRAE, 1994, p. 4.*

The AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Founded as ASHVE in New York in 1894. Merged with ASRE in 1959 to become the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Many of its founding members belonged to the Master Steam and Hot Water Fitters Association.

Note: Portraits of the first ten ASHVE Presidents are given in the composite picture.

[248] Hugh J. BARRON **1856-1918**

Irish-born, New York contractor. Angered by the reception accorded Nesbit [268] and others when they presented technical papers (1894) to the Master Steam and Hot Water Fitters Association in New York, he wrote, "there was one thing conclusively shown by this convention, and that was that engineers are in a decided minority; the majority are more anxious about getting work and money than about the mere art of heating." He was so incensed that with Hart [249] and Mackay [254], he decided to form a new organization dedicated to the engineering aspects of heating and ventilating. Thus, ASHVE came to be formed (1894), and Barron is generally credited with being the founder.

99. *Donaldson and Nagengast, pp. 161-165. Portrait from* Heating and Ventilation, *July 1898, p. 5.*

[249] Louis H. HART **1859-1897**

American business manager. Worked for the trade magazines *Electrical World* and *Heating & Ventilation* in New York. Barron [248] discussed with him his concerns (1894) on the non-engineering approach of the Master Steam and Hot Water Fitters Association. Between them, the idea of forming a new heating and ventilating engineering organization was born. With Mackay [254], a first meeting of what was to become the ASHVE was organized. Hart became secretary of the newly formed Society and was apparently responsible for writing its constitution. He died unexpectedly at the age of 38.

99. *Donaldson and Nagengast, pp. 161-166. Portrait from* Heating and Ventilation, *February 1897, p. 31.*

[250] Frederick (Fred) P. SMITH **active 1900**

American consulting engineer from Boston, Mass. Specialized in ventilation. Present at the early meetings (1894) with Barron [248], Hart [249], and Mackay [254] in connection with forming a heating and ventilating engineering organization. At the first formal meeting (1894), Smith was elected Chairman of the new Society of Heating and Ventilating Engineers, soon renamed ASHVE. He outlined its purpose as "the promotion of the arts and sciences connected with heating and ventilation, and to encourage good fellowship among its members." Bates [251], the first ASHVE President, was elected shortly thereafter.

99. *Donaldson and Nagengast, pp. 165-168. Portrait from* 99. *p. 171.*

[251] Edward P. BATES **1844-1919**

First President of ASHVE (1894). Bates was a contractor from Syracuse, N.Y. In his Presidential Address, Bates concluded, "In order to carry out the objects of the Society, we shall need, first, the hearty cooperation of all its members; we shall need, further, a practical, intelligent devotion to the purpose for which we are organized. With these points carefully covered by each member, there is a work before us, which never has been thoroughly done, but will be accomplished by the members of this Society, to the credit and the good of the race."

[252] Stewart A. JELLETT **1862-1935**

Second President of ASHVE (1895). Francis Bros. & Jellett, consulting and contracting engineers of Philadelphia, Penn. Jellett summarized the conditions that led to the formation of the Society: "Until about 1890 the business of heating and ventilating had been largely based on the most ancient rule known to engineers, the rule of thumb.... I believe it was the stress of competition, the commercial side of the business, that finally forced the recognition of the necessity for more scientific consideration, both in regard to the manufacture of apparatus and in its application for regular work."

[253] Rolla C. CARPENTER **1852-1919**

Third President of ASHVE (1896). From Ithaca, N.Y. Professor of Experimental Engineering at Cornell University. Author of the textbook *Heating and Ventilating Buildings* (1895). He attempted to rationalize heat loss calculations, building on the work of European pioneers, and conducted some of the first controlled tests on the output of steam radiators (1900-1903), while Chairman of the Tests Committee.

[254] William M. MACKAY **1855-1919**

Fourth President of ASHVE (1897). From New York, N.Y. He was a member of the Committee on Organization that led to the founding of the Society and he was the first Vice-President in its inaugural year. Later he served as Secretary.

[255] Wiltsie F. WOLFE **1854-1913**

Fifth President of ASHVE (1898). From Philadelphia, Penn. He was second Vice-President in the Society's inaugural year and organized the Society's first international display at the Paris Exposition (1900).

[256] Henry ADAMS **1858-1929**

Sixth President of ASHVE (1899). From Baltimore, Md. He advocated the establishment of standards: "I believe that the adoption of rules and regulations governing tests of heating and ventilating apparatus, and the fixing of standards will advance the interests of our Society materially."

[257] David M. QUAY **died 1937**

Seventh President of ASHVE (1900). From New York, N.Y. He led a drive "to secure new members of the right kind; namely, those heating and ventilating engineers who are willing to contribute some of their knowledge of engineering facts, or their opinions on engineering theories, to our transactions...."

[258] John H. KINEALY **1864-1928**

Eighth President of ASHVE (1901). Professor at Washington University, St. Louis, Mo. He believed in the "collecting of individual knowledge and putting it on record for use of all." He wrote *Formulas & Tables for Heating*, a translation of Recknagel and Rietschel [99].

[259] Alfred E. KENRICK **died 1917**

Ninth President of ASHVE (1902). Kenrick Bros., plumbing, ventilating, and heating engineers and contractors of Brookline, Mass. Reported at the AGM that the Society "has leaped into vigorous manhood," having attained a membership of over 175 heating and ventilating engineers.

[260] Harrie D. CRANE **1854-1922**

Tenth President of ASHVE (1903). From Cincinnati, Ohio. He fostered the enlargement of the Society, "because it enrolls in its membership almost all of the brightest minds in the world working on this line."

The AMERICAN SOCIETY of REFRIGERATING ENGINEERS

Founded in 1904 in New York. In 1959, merged with the American Society of Heating and Air-Conditioning Engineers (ASHAE), formerly ASHVE, to become the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

[261] William H. ROSS **active 1904**

At the beginning of the 20th century, most American refrigerating engineers belonged to the American Society of Mechanical Engineers (ASME), or to trade associations such as the Southern Ice Exchange, or to the recently formed (1903) Ice Machine Builders' Association. Ross, employed by the *Cold Storage and Ice Trade Journal*, decided to try and form an association for refrigerating engineers. When ASRE was officially organized (December 1904), Ross was appointed Secretary of the new Society (serving in that capacity until 1927). The magazine, *Refrigerating Engineering*, was later to record, "All charter members give credit to Mr. Ross as the prime mover who conceived of ASRE and pushed its organization."

Portrait from Cold Storage and Ice Trade Journal, *December 1905, p. 32.*

[262] John E. STARR **1861-1931**

First President of ASRE (1905). First New York consulting engineer specializing in the industrial application of refrigeration, principally cold storage plants and ice plants. In his often quoted Presidential Address, he began by saying, "To define our field in a word, I may say that we claim as our own all that relates to the production of temperatures, below the ordinary, for useful purposes." Starr also gave a long list of some of the demands made on the refrigeration industry:

> "Bacchus and Gambrinus rely on us to keep them on their throne.
> Metallurgy, the dean of arts has called to us....
> The Oil King demands our best efforts....
> My Lady Nicotine is wooing us....
> Photography demands great deeds of us.
> Our good brothers, the civil engineers, are calling on us....
> Therapy has made valuable use of our efforts.
> Sweltering humidity asks us to render more pleasant its places of meeting...."

21. *and* **25.** *Woolrich. Portrait from* Ice and Refrigeration, *January 1905, p. 39.*

[263] W. Everett PARSONS **c. 1860-1940**

Second President of ASRE (1906). From New York. Believed that ASRE should be truly international and welcomed overseas members.

Portrait from 94. *p. 173.*

[264] David S. JACOBUS **1862-1955**

Third President of ASRE (1907). From New York. He believed that, "In none of the sciences is there a greater need of a thorough understanding of the theories and of the underlying principles than in refrigerating engineering."

Portrait from 94. *p. 173.*

[265] Edgar PENNEY **1845-1913**

Fourth President of ASRE (1908). From Newburgh, N.Y. He believed, "A refrigerating engineer should be competent in all the branches of his art." During his Presidency, ASRE was represented in the American delegation that attended the First International Congress of the Refrigerating Industries in Paris.

Portrait from 94. *p. 174.*

[266] Louis BLOCK **1850-1926**

Fifth President of ASRE (1909). Working in New York, he described himself as a consulting mechanical engineer specializing "in plants producing odorless distilled water ice in which the combined fuel and harvesting cost is lower than in any other plant."

Portrait from 94, *p. 174.*

[267] Thomas SHIPLEY **1861-1930**

Eighth President of ASRE (1912). Worked in York, Penn. He was instrumental in starting the work on establishing standards in the refrigeration industry. Starting in 1903, the Ice Machine Builders Association set standards for dimensions of ice-cans and worked on defining a standard ton (capacity) of refrigeration. When ASRE was founded (1904), it took over the work of producing technical standards, though it was to be many years (1920) before the definition of a standard ton of refrigeration was agreed upon. The goal set by Shipley in his Presidential Address was that the leading companies in the industry "each could produce a plant that would perform as guaranteed."

Portrait from 94, *p. 175.*

For an insight into the history of some of the early American refrigerating machine manufacturers, refer to "What the Refrigerating Machine Companies Have Contributed," Refrigerating Engineering, *December, 1934. This article includes information on York Ice Machinery Corp., Frick Co., The Carbondale Machine Co., Henry Vogt Machine Co., The Vilter Manufacturing Co., Carrier Engineering Corp., and General Electric Co.*

The HEATING and VENTILATING CONTRACTORS' ASSOCIATION

Founded in London in 1904.

[268] David Mein NESBIT **1855-1929**

First President of HVCA (1904-1909). Ashwell & Nesbit, Leicester and London. Third President of IHVE (1900). Nesbit addressed the Master Steam and Hot Water Fitters' National Association in New York (1894), but the discourtesy shown at his reading of his technical paper so incensed Hugh Barron [248] that, with others, he founded ASHVE. Nesbit was one of ASHVE's first international members and can thus claim the unique distinction of having been involved in the founding of three great "comfort" organizations.

Photo portrait from **83.** *following p. 60.*

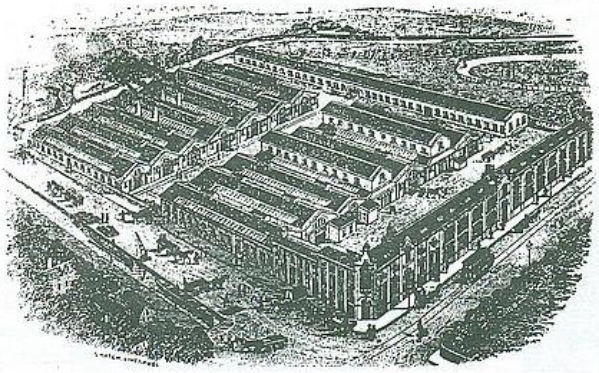
[269] C. Ingham HADEN **died 1947**

Third President of HVCA (1911-1912). G.N. Haden, Trowbridge. Author of two papers for the IHVE (1903 and 1905) on the "circulator" system of Capt. Reck [45]. President of IHVE (1910) and his Presidential Address was *Ventilation of Schools*.

Portrait in IHVE composite picture, p. 109.

[270] Charles R. Honiball **1864-1932**

Fifth President of HVCA (1914-1915). C.R. Honiball, Liverpool. President of IHVE (1912). Awarded Bronze Medal (1907) for his paper, *The Warming of Steamships*. Awarded Silver Medal (1911) for two papers on *Humidity of Air*. Author of classic paper *The Mechanical Ventilation and Warming of St. George's Hall, Liverpool* (executed by D.B. Reid [58] in 1854).



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36. Advertisement: Heating Specialists and Consulting Engineers.
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Heating by Hot Water, *Walter Jones, 1904, p. xxxii.*

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37. Advertisement: The Chimney Sweep, France.
Chaud-Froid-Plumberie, No. 316, Sept. 1972, p. 200.