The AIR CONDITIONERS

Page 43-54

The AIR CONDITIONERS

He wrote books about the air / And its techniques with rare
Knowledge, intuition told / Of it's problems manifold.
How to cool it, how to heat, / Whether fast or slow the speed,
Where the pressure high, where low, / Whether strong or soft the blow.
Whether air was much too dry / Or humidity too high -
"Health and comfort through good air" / Was his watchword everywhere.

A poem sent to Willis Carrier on his 70th birthday in appreciation of his lifetime's work, from **Dr. Albert Klein**, Germany, 14 February 1947.

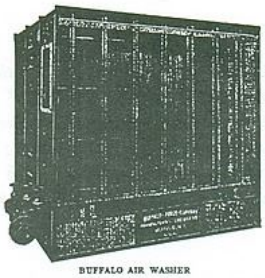
Dr. Willis Haviland Carrier [101]

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.

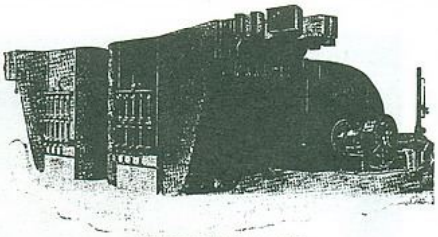
Adapted to occupy any space.

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

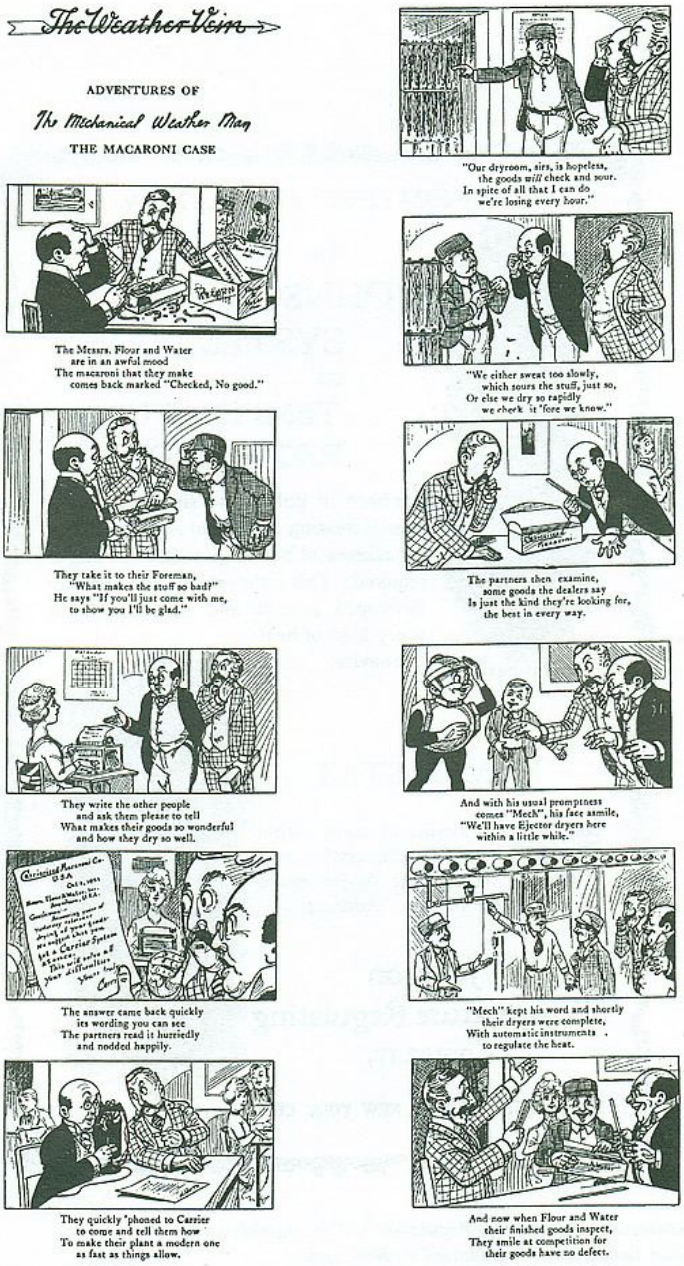
Buffalo Forge Company
Buffalo, N.Y.

8 BRANCHES IN ALL THE LARGER CITIES

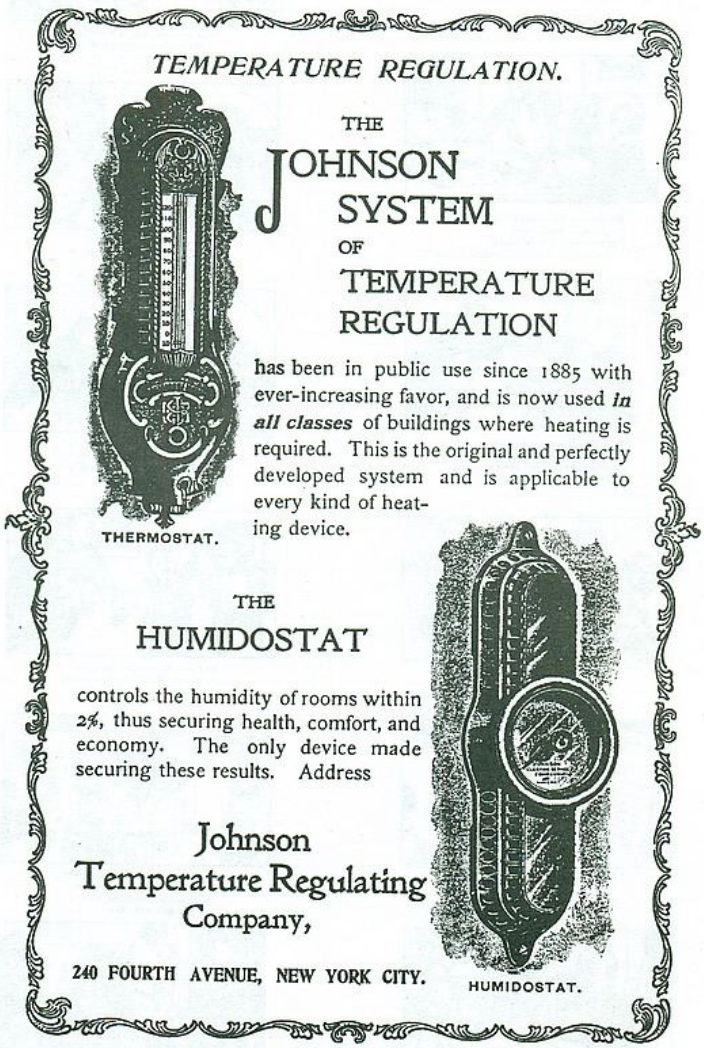
Heating and Ventilating Engineers

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.



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.*



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.*

[96] Dr. John GORRIE 1802-1855

American physician. Worked in Apalachicola, Florida. Concerned with the problems of heat and humidity in the southern states, became interested in the possibilities of using mechanical refrigeration for humanitarian reasons. Said to have devised an air-conditioning system (1833) to treat fever stricken sailors by blowing air over suspended buckets of imported ice into hospital sick rooms. (Although Gorrie worked for the Marine Hospital Service, there is no record of a Marine Hospital in Apalachicola and local tradition is that he cooled rooms in his home.) Suggested the cooling of entire cities in an article, *Refrigeration and Ventilation of Cities* (1842). Then, using the pen name Jenner (1844), published *A Description of a Machine for the Prevention of Malarial Diseases*. Next, Gorrie constructed a working air-cycle refrigeration machine that he described as "an engine for ventilation, and cooling air in tropical climates by mechanical power." The machine compressed air using a double-acting piston pump, forcing it into a storage tank, through a "weighted valve," then into a "double-acting" expansion engine. This engine was connected to the compressor, which could be operated by horse, water, or steam power. He also suggested roof-mounted wind-driven sails with the cool, dry air distributed through fireplace chimneys. He tried, unsuccessfully, to commercialize his machine. Obtained patents (USP 8080: 1851; BP 13.234: 1850). Later (1854), developed an improved machine for multiple ice-can cooling. A version of his machine was constructed in London by Wollaston Blake, and a number of important modifications suggested by William Siemens were used by later air-cycle refrigeration pioneers.

30. *Gladstone.* **32.** *Nagengast.* **99.** *Donaldson and Nagengast, pp. 119-124. See also* **105.** *Roberts, fig. 72. Portrait from Florida State Archives.*

[97] Daniel SOMES active 1867

American entrepreneur and politician. Member U.S. Congress. Wrote *Mr. Somes's Inventions for The Preservation of Food, Animal or Vegetable, for the Cooling of Hotels, Theatres, Halls, Churches, and all Other Buildings, Ventilation, etc.* (New York, 1865). Obtained numerous U.S. patents for comfort cooling ideas (1867-1869). Included proposals for cooling buildings by spraying air mists on building roofs and walls, or distributing air to them that was cooled by underground ducts or pipes in which cold water circulated. Also suggested that "hospitals may be so arranged that heat, flies, nor dust, need ever be present to torment the patients. This is accomplished at a cost so comparatively small as scarcely to deserve a mention. Had Mr. Somes made no discovery but this, he would be entitled to (and receive) the gratitude of the (human) race." It was said of him, "only a politician could promise so much at almost no cost."

99. *Donaldson and Nagengast, pp. 267-268.*

[98] William KEY active 1890

British engineer. His patent (1890) included "filtration by horse hair or hemp, air heating or cooling by pipe coils, insertion of blocks of ice for air cooling, and water sprays for humidity control." He is believed to have influenced the design of Lea [208] for the air treatment plant at the Royal Victoria Hospital, Belfast (1906). Key may have designed the air treatment plant for Mackintosh [200] at the Glasgow School of Art (1904). Many consider both these systems may justifiably be considered as among the first air-conditioning installations in the U.K.

105. *Roberts, pp. 115-117.*

[99] Hermann RIETSCHEL 1847-1914

German scientist, academic, and heating and ventilating engineer. Founded his own company in Berlin to specialize in the design of heating, ventilating, gas, and water systems (1871). His colleague, Rudolf Henneberg, joined him as a partner (1872). The business flourished and opened offices in Dresden and Vienna. "The success of the firm was due primarily to Rietschel's systematic application of general physical and engineering principles to the design." He was determined to put heating and ventilating system design on a surer, more scientific footing. Revised the *German Building Handbook* (1880). Founded the VDI (German Engineer's Association) for heating and plumbing (1880). Set up as a consulting engineer in Berlin (1881). Responsible for heating and ventilating systems in the Reichstag building. Appointed to the newly formed Chair of Heating and Ventilating at Berlin's Technical University (1885). Published a wide range of significant technical papers and reports, including *Guide to Calculating and Design of Heating & Ventilating Installations* (1894). His many successful projects covered "heat transfer coefficients for water-air and steam-air heat exchangers, the economy of heat insulation, pressure drop and friction coefficients in metal and masonry ducts, pressure drop values for air filters, and pressure drop and friction coefficients for steam and water flow in pipes." He was involved with the design of the thermal power station in Dresden (1895), investigated the performance of low-pressure steam control systems (1902), and produced an analysis of district heating (1902). He still found time to produce a monograph, *Church Heating*, based on his studies of churches in Ulm and Strasbourg. However, it is only in recent years that the importance of his writings on air conditioning have been fully appreciated in English-speaking countries. His textbook (1894) includes a chapter, *Kuhlung Geschlossener Raume*, "perhaps the earliest comprehensive example of a real scientific approach to room cooling. Hermann Rietschel advocated a scientific approach before the turn of the century (thus predating Carrier [101]), and he published a step-by-step approach for calculation of cooling plants."

Hermann Rietschel's Life & Achievements, K.W. Usemann, ASHRAE Trans., *1995. See also* **51.** *Meckler, p. xxiii.* **99.** *Donaldson and Nagengast, pp. 268,279, 281, and 287. Portrait from* Science & Building Services, *K.W. Usemann,* BSEE (Building Services & Environmental Engineer), *January 1979, p. 12.*

[100] J. Irving LYLE 1874-1942

American engineer and businessman. Worked for Buffalo Forge where he met Carrier [101] who described him as, "The best salesman I ever knew." When the subsidiary Carrier Air Conditioning Co. was established (1908), it was Lyle who sought out the business opportunities. Later (1915) became Treasurer and General Manager of Carrier Engineering Corp. His commercial genius was the perfect complement to the engineering genius of Carrier. Lyle founded Aerofin Corp. (1923) to manufacture lightweight finned coils to the designs of Lawrence C. Soule. Also encouraged Carrier in the development of the centrifugal chiller and made the first "comfort job" sale to J.L. Hudson department store, Detroit (1924). He established Carrier Corp. in the rapidly expanding market for the air conditioning of movie theatres, including in New York: Rivoli (1925), Paramount (1926), and the Roxy (1927). Lyle also sold three centrifugals for the ice-skating rink at Madison Square Gardens (1925). President ASHVE (1917). First Chairman ASHVE Research Bureau Committee (1919). Lyle was an important half of the leadership that built Carrier Corp. "Carrier was the scientist, inventor, engineer; Lyle, the organizer, business man, executive."

40. *Ingels. Portrait from* **94.** *p. 188.*

[101] Dr. Willis Haviland CARRIER 1876-1950

American engineer and inventor. One of the most outstanding men of his generation. Born on a farm in Angola, N.Y. Won state scholarship to Cornell University. Graduated with a degree of Mechanical Engineer in Electrical Engineering (1904). Joined Buffalo Forge, where he met Irving Lyle [100]. Responsible for what has been claimed to be the first scientifically designed air-conditioning system, installed at the Sackett-Wilhelms Lithographing & Printing Co., Brooklyn (1902). Hailed as a "milestone in air conditioning" at the time, it is now known the installation was not a success.* Formed Research Department at Buffalo Forge. Formulated the idea of *Dew-Point Control* of relative humidity and developed spray washers and special controls. Established the subsidiary Carrier Air Conditioning Co. (1908). Presented landmark papers to ASME (1911), *Rational Psychrometric Formulae* and (with Frank Busey) *Air Conditioning Apparatus*. Produced the first famous Buffalo Forge textbook, *Fan Engineering* (1914). Started Carrier Engineering Corp. (1914). Carrier took air conditioning, which initially had been for industrial applications, into the comfort business in cinemas, departments stores, and restaurants. He patented many types of control (1907-1908). Later, he developed the ideas of Leblanc [92] to produce the first centrifugal refrigerating machine (1922), describing his work in *Centrifugal Compression as Applied to Refrigeration* (1926). Stories of Carrier's absentmindedness are legion, for when problem-solving, he concentrated to the exclusion of everything and everyone else. He pioneered air conditioning for railway coaches and passenger liners and introduced unit air conditioners to the home and high velocity induction systems (1939-1940) for skyscraper offices. President ASRE (1927) and President ASHVE (1931). First recipient of ASHRAE's F. Paul Anderson Award (1932). Carrier's achievements have earned him the title *Father of Air Conditioning*, and he was one of the first members inducted into the ASHRAE Hall of Fame (1994).

31. *Wampler;* 35. *Ashley;* 40. *Ingels (the definitive biography). See also* 105. *Roberts, p. 105.* * 37. *p. S71 and* 99. *Note 63 to Chap. 11. Portrait from* 99. *p. 278.*

[102] Alfred E. STACEY, Jr. 1885-1975

American air conditioning engineer. One of the founders of Carrier Engineering Corp. (1915). The company was approached (1925) by the Baltimore & Ohio Railroad to design a cooling system for a passenger coach. "A gasoline engine-driven ammonia compressor was attached to the underside of the floor. Chilled water was supplied to a vertical spray unit placed in one end of the car. Condenser water was obtained from a similar unit in the other end." Later, the B & O Pullman Diner, *Martha Washington*, was similarly equipped. Carrier [101] and Carlyle Ashley (President ASHRAE, 1956) decided that a steam-jet refrigerating unit would provide superior performance (USP 2,010,001: 1932). Stacey (1931) conducted cooling and air distribution tests in an actual railway coach. "Electric lights equivalent to the heat of people were placed in the seats. The air conditioning and three different duct systems were installed. The entire coach was enclosed in a temporary enclosure that could be heated to mid-summer intensity and mugginess." He devised improved methods of air distribution (USP 1,982,125: 1934). Orders from Santa Fe and Union Pacific followed. Stacey was President ASHRAE (1949).

The Romance of Air Conditioning, *L. Logan Lewis, Carrier Corp. (c. 1950).*

[103] L. Logan LEWIS 1885-1975

American air conditioning engineer. One of the founders of Carrier Engineering Corp. (1915). Early cinema air conditioning included two Balaban & Katz theatres, the Central Park (1919) and the Riviera (1920), both in Chicago, probably designed by Frederick Wittenmeier [209]. These systems both used *up-systems* of supply air distribution from floor outlets and caused the audience to complain of cold feet. Lewis decided to reverse the air circulation in his design (1922) for Graumans Metropolitan, Los Angeles, an arrangement termed the *upside-down* system of air distribution. The installation used an air washer and CO_2 refrigerating plant by the Carbondale Machine Co. He also devised a return-air bypass arrangement* to improve humidity control (USP 1,583,060: 1926). Lewis was ASRE President (1941).

37. *Nagengast. *This had earlier (1895) been suggested by Woodbridge for cooling the U.S. Capitol; also (1890s) by Rietschel [99] and by Louis Schimdt (early 1900s). Lewis's ideas were later refined by Fleisher[107]. Portrait from* 94. *p. 185.*

[104] Alfred SIEBERT active 1897-1905

American refrigeration engineer. Worked in St. Louis. Proposed comfort cooling. Like Rietschel [99], he proposed lowering the relative humidity of the air by cooling it to saturation and then reheating to the desired temperature and relative humidity. Showed calculations in *Refrigeration* (*Ice & Refrigeration*, July 1897). Obtained various patents for *Air Cooling Apparatus* (USP 697,679: 1903; 734,975: 1903; 780,385: 1905). His first patent refers to humidity control.

37. *Nagengast, pp. S168 and S175.*

[105] Stuart W. CRAMER 1867-1940

American textile engineer from Charlotte, North Carolina. Credited with coining the term *air conditioning* in his paper, *Recent Developments in Air Conditioning* (1906), read before a convention of the American Cotton Manufacturers' Association. It is believed the term was suggested by the use of the term *conditioning* in the treatment of yarn, cloth, or raw materials before manufacture. Cramer also used the term in a patent (USP 852,823: 1906). He independently discovered some of the relationships used by Carrier [101] to arrive at his rational psychrometric formulae. Carrier used the term when he convinced Buffalo Forge to establish the subsidiary Carrier Air Conditioning Co. (1907). Cramer wrote *Useful Information for Cotton Manufacturers* (1909), which dealt with humidifying practice "based upon sound theory and actual field experience." Obtained a patent for an air-conditioning (humidifying) apparatus (USP: 1,073,475: 1913). After his retirement (1918), the Parks-Cramer Co. published (1924) the classic textbook *Air Conditioning in Textile Mills* based on his work.

Manufactured Weather: A History of Air Conditioning in the U.S., 1902-1955, Gail Ann Cooper, Doctoral dissertation, University of California at Santa Barbara. 37. *Nagengast, p. S174.*

[106] Walter A. GRANT 1904-1990

American air conditioning and refrigeration engineer. Worked at Carrier Corp. Wrote *Modern Air Conditioning, Heating & Ventilating* (1940, with Carrier [101] and Realto Cherne), for many years regarded as the standard textbook on air conditioning. Also wrote *A History of the Centrifugal Refrigeration Machine* (1941), which describes the pioneering work of Leblanc [92] and the construction of a practical machine by Carrier. Grant was President ASHRAE (1960) and recipient of ASHRAE's F. Paul Anderson Award (1967). Later wrote *Milestones in Air Conditioning* (1969).

18. *Grant. Portrait from* **94.** *p. 191.*

[107] Walter L. FLEISHER, Sr. 1888-1959

American air conditioning engineer. Designed the air-cooling system for the Folies-Bergere Theatre, New York City (1911), which "used a Thomas air washer, apparently with no mechanical refrigeration. The Thomas washer was one of the first to be mass manufactured and widely sold. Fleisher admitted that the system was not very good, saying, 'We were able to cool about 7 degrees (F) below outdoors, but only the inefficiency of the apparatus saved the installation from being unbearable'...." Later, improved on the work of Lewis [103] (USP 1,670,656: 1928; 1,751,805/806: 1930). Wrote *Air Conditioning: Its Development in Industry* (1929), which reviewed the application of humidification apparatus in textile mills since the turn of the century. President ASHRAE (1941). His Presidential Address summarized the contribution of the Society and its members to the war effort. Recipient of ASHRAE's F. Paul Anderson Award (1954).

29. *Fleisher.* **37.** *Nagengast p. S49.*

[108] Reuben TRANE died 1954

American engineer, inventor, and business executive. Son of James Trane [44]. Founded the Trane Co. with his Father (1913). Developed a convector *cabinet heater* (1926), a U-shaped copper tube and fin design in a sheet metal enclosure, as an alternative to the cast-iron radiator. Secured 28 patents, including a fan-coil unit (1933) and the first hermetic centrifugal refrigerating machine (1938). Pioneered mechanical refrigeration for railway freight wagons. He inaugurated a company student training program (1925). Later, set up endowments of post-graduate engineering scholarships at Wisconsin and other universities. The Trane Co. established ASHRAE scholarships in his name (1991). Reuben Trane was inducted into the ASHRAE Hall of Fame (1997).

ASHRAE Insights, *June 1997. A Special Tribute to Reuben Trane,* ASHRAE Journal, *August 1997, pp. 18-19 with portrait.*

[109] Margaret INGELS — active 1916-1950

American engineer. One of the first women to earn a degree in Mechanical Engineering (University of Kentucky, 1916). Second female member of ASHVE, joining shortly after Helen Innis (1917). Joined (1921 or 1922) the staff of the ASHVE Research Bureau working under F. Paul Anderson [179] the Bureau's second Director (1921-1925). Ingels was later titled Mechanical Engineer and Research Head (c. 1926). She left the Bureau (1927) and rose to prominence in the industry with her later work in air conditioning as an associate of Willis Carrier [101]. Recognizing the increasing potential of small air-conditioning units, Carrier put "America's first woman air conditioning engineer" in charge of a campaign to educate the public as to the benefits of air conditioning. She made some 200 speeches (1932-1952) including *Petticoats and Slide Rules* (1952). Served as Librarian and Engineering Editor for the Carrier Corp. Ingels prepared a 400-page manuscript (Cornell University Archives) on the life and achievements of Carrier,* which was subsequently reduced "to about 16% of the original" in her biography *Willis Haviland Carrier: Father of Air Conditioning* (1952).

94. *ASHRAE, Chap. 3.* **99.** *Donaldson and Nagengast, pp. 179 and 301 and * Note 62 to Chap. 11. Portrait from ASHRAE: 100 Years of Progress,* ASHRAE Journal, *June 1994, p. 32.*

[110] Harry H. SCHUTZ — active 1926

American engineer. Applied (1926) for a patent for a *Cooling Device*, or a small portable unit air conditioner (granted USP 1,831,825: 1931). His objective "the provision of a portable device for maintaining low temperatures in rooms. This design called for a compressor, water-cooled condenser, receiver, expansion device, evaporator coil, and air circulating means. But no mention was made of how the inventor intended to dispose of the condensate from the cooling coil."

36. *Macleod. See also* **105.** *Roberts, fig. 58.*

[111] John Q. SHERMAN — active 1926

American engineer. Applied (1926) for a patent for a unit air conditioner (granted USP 1,890,626: 1932), which related to "ventilating and air cooling systems for residences, offices, hospital rooms, clubs, and the like and more particularly to the installation of a unitary cooling apparatus with means for dissipating the heat incidental to its operation...the object of the invention is to provide a self-contained air cooling unit of a semi-portable character."

36. *Macleod. See also* **105.** *Roberts, fig. 65.*

[112] Earl BABCOCK — active 1931

American engineer. Devised the first *Window-Box** self-contained air-conditioning unit (USP 2,391,859: 1931). "This unit hung on the windowsill, with the compressor, condenser, and condenser fan outboard of the building and only the cooling coil and room fan(s) inside the room".

36. *Macleod. See also* **105.** *Roberts, fig. 65. *Later, window box patents were granted to Matson Terry and Paul Komroff (USP 2,309,224: 1943) and to Paul Moore (USP 2,316,704: 1940).*

[113] John W. COOLING 1888-1980

English engineer. Worked for the firm of Sir W.G. Armstrong, Whitworth & Co., starting in the tool room (1906). Then Mirrlees, Breberton & Day, erecting diesel engines. Later, worked in drawing office of Sturtevant Eng., London, then Royal Aircraft Establishment, Farnborough, before joining Buffalo Forge, London (1918). Then joined J. Jeffreys (1920) as Technical Manager, Plenum Dept.; appointed Director (1925). Later Managing Director of the Air Conditioning Corp. (Jeffreys) Ltd. and Director, Air Conditioning Corp. of Calcutta. Served on IHVE Committees for Fan Standardization and Technical Education. Presented IHVE Paper *Air Conditioning & Air Conditioning Apparatus* (1926). 32nd IHVE President (1932).* Awarded IHVE Gold Medal (1960).

93. Proc. of IHVE, *1932. *His son, J. Michael Cooling, was later the 68th IHVE President (1975) and also a Gold Medallist (1977).*

[114] George L. TUVE 1896-1980

American professor of Mechanical Engineering, researcher, and author. Specialized in heat transfer and fluid mechanics. Coauthored textbook *Mechanical Engineering Practice* (1920s). Worked at Case Institute of Technology in Cleveland, Ohio (from 1930). Carried out fundamental research into the behavior of air jets (from 1942). President ASHVE (1948). Received ASHRAE's F. Paul Anderson Award (1957). Inducted into ASHRAE Hall of Fame (1996).

Portrait from ASHRAE Insights, *June 1996.*

[115] Henry L. GALSON 1900-1963

Born in Austria. Qualified as mechanical engineer, Vienna. Emigrated to USA (1922). Worked in Philadelphia. Filed patent for an improved dryer air circulation system (1924). Joined (1925) Bentz Engineering Corp., an air conditioning manufacturer in Newark, then Cooling & Air Conditioning Corp. in New York (1926). Became Chief Engineer at Philadelphia Drying Machine Co. (1928). After the Depression, joined De La Vergne (1932) and designed a compact self-contained air-conditioning unit. Then added reverse-cycle (1933), said to be the first hermetic with this feature. Grant [106] later wrote, "This console room air conditioner was 20 years ahead of its time." Next, Galson worked on the design of railway sleeping coach air conditioners. His many patents were sold (1937) to a consortium: GEC, Westinghouse, Frigidaire, Carrier, and Sturtevant. Galson then worked for Carrier designing unit air conditioners. During World War II, he improved the British *Hedgehog* anti-submarine weapon. Went on to develop a rotary latent heat exchanger before being made redundant. Set up (1946) as a consulting engineer, specializing in the design of air-conditioning units. Worked for many well-known manufacturers. Later (1952-1953), the top U.S. manufacturers were first, Fedders (200,000 units); second, Mitchell (nearly 200,000); and fourth, Carrier (115,000). Thus, at that moment, some 42% of all unit air conditioners sales could be linked to Galson.

33. *Galson & Galson with portrait from p. 77.*