

Dr Willis H Carrier (left) with the first centrifugal refrigerating machine of 1922.

The Story of Comfort Air Conditioning

**Appendix-1 Pioneers of ventilation and air
conditioning**

Air Conditioning Pioneers

This appendix provides outline biographical information, in alphabetical order, on leading pioneers involved in the ventilation, cooling and air conditioning of buildings, most of whom are referred to in the main text of this book. The list includes designers, manufacturers, engineers, doctors, architects and others, including a curate, a scientist, a soldier and a gardener. Those pioneers named in **teal blue** have a portrait included.



BILLINGS

Dr John Shaw BILLINGS 1838-1913

Eminent American surgeon and librarian. Designed and supervised the construction of the New York Public Library (from 1895), which consolidated a number of important collections. Served as its Director until his death. Considered the leading American authority on ventilation, he wrote *The Principles of Heating & Ventilation* (1884) and *Ventilation & Heating* (1893). Recommended 60 ft³/min of ventilating air per person to minimise the spread of disease and 30 ft³/min as adequate for comfort. As a physician he was considered ineligible for membership of the ASHVE but was elected its first Honorary Member (1896).



BOYLE

Robert BOYLE Jr active 1898

Ventilating engineer. Not to be confused with the illustrious scientist of the same name. Carried on the engineering work of his father Robert Boyle Sr (1821-78). Boyle Jr was a passionate advocate of natural ventilation and strongly opposed to mechanical methods. Robert Boyle & Son published *Natural & Artificial Methods of Ventilation* (1899) which refers to the work of many pioneer ventilators and hygienists including Billings. Boyle refers to “*the evils of forced draught ventilation and of hot-air heating (he believed heating and ventilation should be separate from each other) and the dangers of open-window ventilation in cold weather.*”



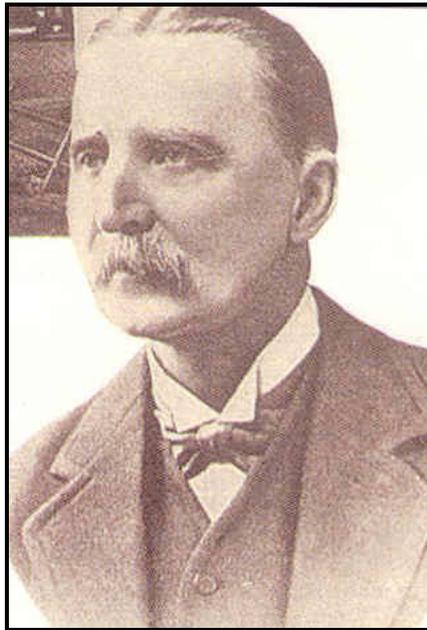
CARRIER

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, NY. Won state scholarship to Cornell University. Graduated with degree of Mechanical Engineer in Electrical Engineering (1904) and then joined Buffalo Forge. Responsible for what has been claimed to be the first scientifically designed industrial 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. 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, department stores and restaurants. He developed the first centrifugal refrigerating machine (1922). He introduced unit air conditioners to the home and high velocity induction systems (1939-40) for skyscraper offices. Carrier’s achievements have earned him the title “*Father of Air Conditioning.*”

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. He independently discovered some of the relationships used by Carrier to arrive at his rational psychrometric formulae, but is remembered for his air conditioning work relating to textile mills and in the industrial field, rather than comfort applications.



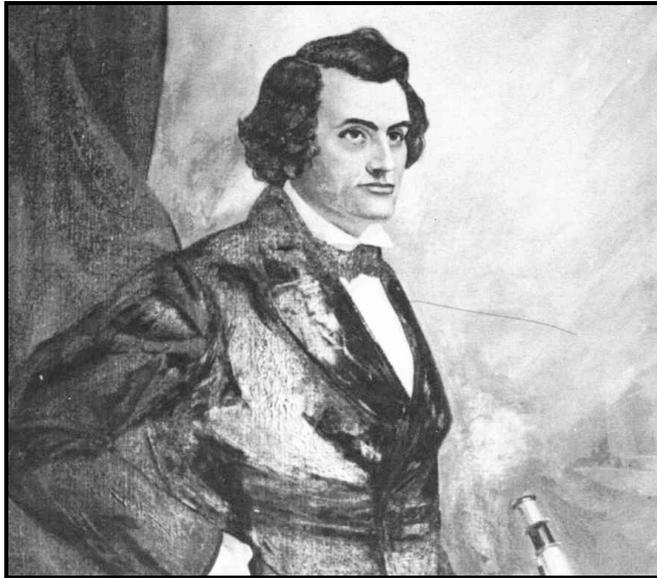
DAVIDSON

Samuel Cleland DAVIDSON 1846-died after 1909

Belfast fan manufacturer. Patented his “Sirocco” multiblade centrifugal (BP 4609: 1898). The Davidson fan was extremely successful: “*It has enjoyed a success unrivalled by any other design and has been manufactured in greater numbers than any other form of flow machine. Apart from its compactness it is remarkably silent in operation. There is no other fan which operates as silently at comparable pressures.*” Davidson was also involved in the designing, installation and maintenance of the pioneer cooling system at the Royal Victoria Hospital, Belfast (1903).

John Théopile DESAGULIERS 1683-1744

French/English physicist and engineer. Introduced a “Fanning Wheel,” similar to those described in Saxon mines by Agricola for ventilation at the Royal Society, London (1734), having previously (1727) made a fan for the Earl of Westmoreland “*to clean foul air out of mines.*” Went on to apply his fan “engine” to ventilate the House of Commons (1734/36): “*a Committee was appointed to order me to make such a machine, which accordingly I effected, calling the Wheel a centrifugal, or blowing Wheel, and the Man that turn’d it a Ventilator.*” This apparatus was a wooden paddle wheel 7 feet in diameter with radial blades 1 foot wide in a wood casing with rectangular ducts, and remained in use for many years (until 1791).



GORRIE

Dr John GORRIE 1802-55

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). Also constructed an air-cycle refrigeration machine which he described as “*an engine for ventilation, and cooling air in tropical climates by mechanical power.*”



HALES

Rev Stephen HALES c.1700-61

Perpetual curate of Teddington in Middlesex. Scientist, botanist, and inventor. He became interested in ventilation by fans and bellows. Wrote his *Treatise on Ventilators* (1758). Worked on the design of bellows ventilation of the county hospital and county jail in Winchester, the Savoy Prison and Newgate Prison.

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 the air treatment plant at the Royal Victoria Hospital, Belfast (1903). Key may have designed the air treatment plant for Mackintosh 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 UK.



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 was also active around this time. Lea introduced new methods of artificial ventilation based on the plenum system of Key. 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.”*

LE CORBUSIER 1887-1965

Charles Edouard Jeanneret. Swiss born, French architect, town planner & 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; some 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 neutralising wall (mur neutralisant), to offset the effects of outside conditions on the interior of a room. 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 court rooms.

Lewis LEEDS active 1860-70

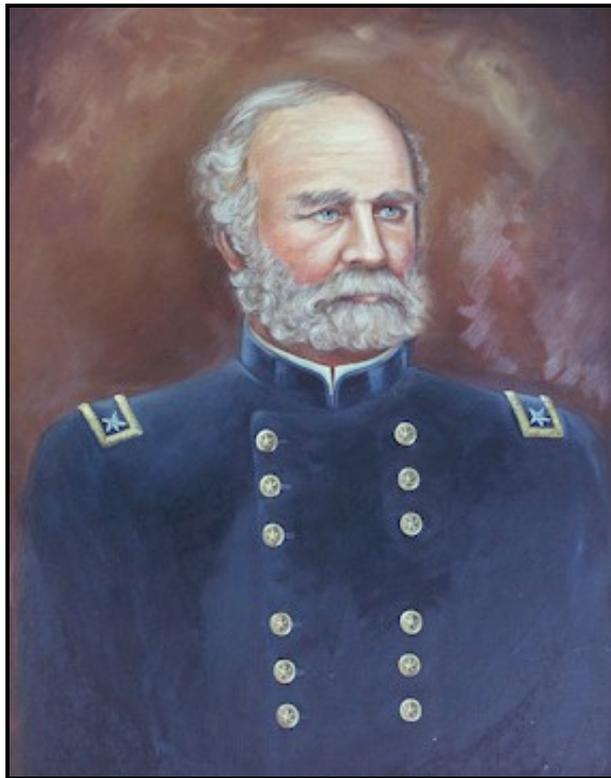
American ventilating engineer. Devoted his attention to the ventilation of Government Buildings, especially hospitals, during the Civil War. He was influenced by the work of Reid. Gave a popular exposition of the principles of warming and ventilation through a series of cartoon illustrations projected by magic lantern onto a screen in a series of lectures at the Franklin Institute, Philadelphia (1866-67). These were called *Mans' Breath is His Greatest Enemy*." Later wrote *Treatise on Ventilation* (New York, 1871). His catchphrase was "If you would be healthy, always keep your feet warmer than your head, and your back warmer than your face."



MACKINTOSH

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 utilise the new technologies of his time, including central heating & 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.



MEIGGS

General Montgomery Cunningham MEIGS 1816-92

While a Captain in the US Army Engineers, Meigs was appointed (1853) by the Secretary of War, Jefferson Davis, to be Superintendent at the Capitol in Washington for the rebuilding and enlargement. This placed him over the architect, Thomas U Walter, and gave him responsibility for co-ordinating the overall design and installation of the heating and ventilating system. Later (1861) he noted, the system having been in use for some time that it *“realised all that I undertook to accomplish in regard to light, warmth, ventilation and fitness for debate and legislation,”* though this opinion was not unanimous.



PAXTON

Sir Joseph PAXTON 1803-65

English gardener and architect. Built the Great Conservatory at Chatsworth (1836). Best known for designing the Crystal Palace, erected in London's Hyde Park for the Great Exhibition of 1851. As a temporary structure it was unheated, but was provided with innovative controllable ventilation louvres and sun screens.

Wilson Weatherley PHIPSON 1838-91

English civil engineer, specialised 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.*" 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 innovator. He carried out a number of important projects including the Strand Music Hall (1864), Glasgow University (from 1864), Royal Holloway College, Egham (1882); and in London: the Natural History Museum (1873), Royal Albert Hall (1871), Alexandra Palace (1874) and the Empire Theatre in Leicester Square (1890).



REID

Dr David Boswell REID 1805-63

Scottish doctor, chemist and ventilating engineer. He devised the heating, ventilating and cooling of St George's Hall in Liverpool (1842-51). Reid also worked on the ventilation of the House of Commons (rebuilt after the Great Fire of 1834). He proposed to introduce filtered and humidified air through holes in the floor, and to extract the vitiated air by means of a chimney at its base. The scheme included provision for summer cooling "*by nocturnal ventilation, by evaporation of water, by passing cold water through a heater battery, and in rare cases by the ice of ice (a rudimentary form of air conditioning).*" He wrote *Illustrations of the Theory & Practice of Ventilation* (1844) which was a major influence on ventilating engineers for many years thereafter.

Hermann RIETSCHEL 1847-1914

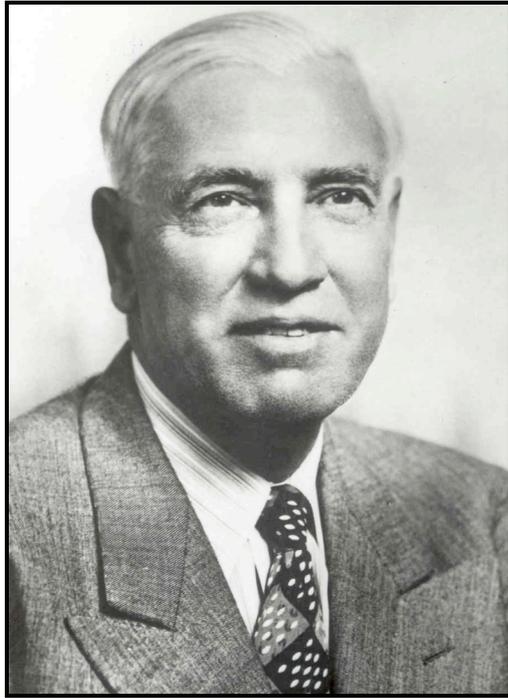
German scientist, academic, and heating & ventilating engineer. Founded his own company in Berlin to specialise in the design of heating, ventilating, gas & water systems (1871): "*The success of the firm was due primarily to Rietschel's systematic application of general physical and engineering principles to the design.*" He determined to put H&V system design on a surer, more scientific footing. Published a wide range of significant technical papers and reports, but 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 *Kühlung 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), and he published a step-by-step approach for calculation of cooling plants.*"



STURTEVANT

Benjamin Franklin STURTEVANT born c.1824-died?

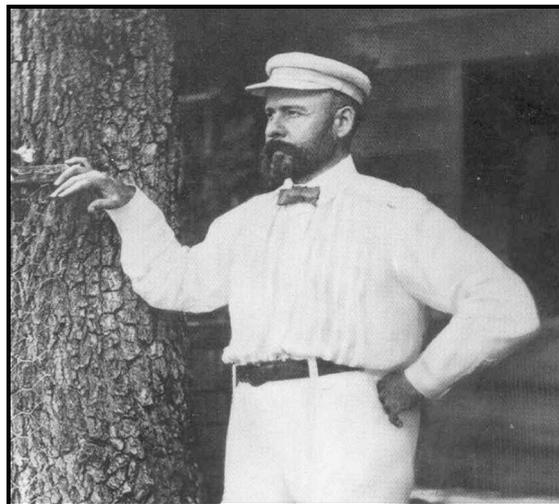
American fan engineer, one of the most important names in ventilation during the second half of the 19th century. *“Started out as a shoemaker and cobbler. Being a very large man he was greatly bothered with the heat....so he rigged up, (in) about 1850, a stand with a disc (4 blade) fan run by a belt on an eccentric pulley to a pedal which he worked with his foot.”*. Started commercial fan manufacture (1855). Later set up the Sturtevant Blower Co in Boston.



TRANE

Reuben TRANE died 1954

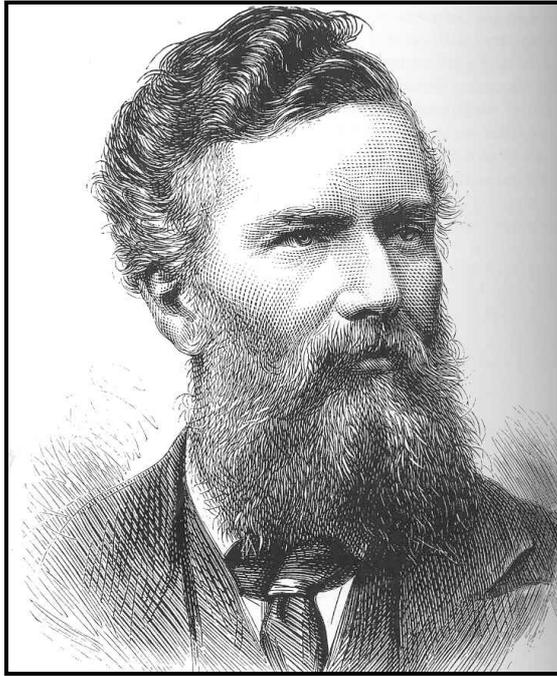
American engineer, inventor and business executive. Founded the Trane Co with his Father (1913). Secured 28 patents, including a fan-coil unit (1933) and the first hermetic centrifugal refrigerating machine (1938). Reuben Trane was inducted into the ASHRAE Hall of Fame (1997).



SULLIVAN

Louis Henri SULLIVAN 1856-1924

American architect. Pioneer in the design of metal-framed buildings and early skyscrapers of the Chicago School. Coined the dictum "*Form Follows Function*". Designed the Wainwright Building, St Louis (1891) and the Guarantee Building, Buffalo (1895). He trained Frank Lloyd Wright and has been termed the "*Prophet of Modern Architecture.*"



WATERHOUSE

Sir Alfred WATERHOUSE 1830-1905

Leading English architect. His most famous work is London's Natural History Museum (1881), where the order for the warming & ventilation was secured by Phipson in competition with Haden. Phipson's successful proposal included a surprisingly tight performance schedule, guaranteed to supply 3 air changes/h, as well as balancing the humidity. Waterhouse was also Company Architect for the Prudential Assurance Company and designed their new head office in High Holborn (1878/1906), where Phipson was involved in specifying steam-driven dynamos for the electrical services with exhaust steam utilised for space heating -an early and significant example of combined heat and power.

Frank Lloyd WRIGHT 1869-1928

Generally considered America's greatest architect and ranked alongside Walter Gropius, Mies van der Rohe and Le Corbusier as one of the leading architects of the 20th century. Employed in his early years by Louis Sullivan. Achieved renown for his domestic architecture. 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).

Frederick WITTENMEIER died 1928

German immigrant to USA. Joined heating contractor and boiler manufacturer Kroeschell Bros, Chicago (1896). Convinced Kroeschell to enter ice-machine business. Claimed to have introduced CO₂ 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 Pompeiiian Room, Congress Hotel, Chicago (1906), and for the Larkin Building, Buffalo (1909) for architect Frank Lloyd Wright. Installed cooling systems in Blackstone Hotel and Planters Hotel, both Chicago, and in Rogers Hotel, Minneapolis. Wittenmeier designed air cooling systems, including Central Park Theatre (1917) and Riviera Theatre (1920), both Chicago. Later established his own company.



WOLFF

Alfred R WOLFF 1859-1909

American consulting engineer in New York. Designed many important heating & 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. Wolff seems to have been the first to have introduced the scientific approach, as practised in Germany, into the USA (from 1889) and it is believed he was aware of the methods of Rietschel. 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). Wolff's Stock Exchange scheme 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.