# Keeping things under CONTROL



An Electronic Book for the CIBSE Heritage Group Website Front cover Advertisement: Electric Heat Regulator Co, 1895 [Honeywell: The First 100 Years, 1985]



Automatic refrigeration expansion valve produced by Mads Clausen in 1933 [The Danfoss Journal, 50 year Jubilee brochure, 1983]

# Keeping things under CONTROL

1

#### Eur Ing Brian Roberts CEng Hon.FCIBSE Life Member ASHRAE



Damper Regulator by the Pascal Ironworks of Philadelphia [The Engineering Building Record, USA, 1870]

#### **CONTENTS**

#### **GENERAL**

#### Title 1, The Author 2, Introduction 3

#### **CONTROL PIONEERS**

In alphabetical order

Appold 6; Arnott 6,13 Billman 10; Bonnemain 5; Butz 7 Carrier 9; Clausen 11; Colman 8

de Cusa 4; de Sausurre 5; Drebbel 3,4 Galileo 4; Grundy 10; Gyr 9 Honeywell 10; Hooke 5

> Johnson 8 Landis 9 Perkins 6,12; Powers 8

> Reid 7; Robertshaw 10 Sauter 9; Sweatt 7 Taylor 11

> > Ure 5 Wild 11

#### **CONTENTS**

#### **CONTROL COMPANIES**

In alphabetical order

Barber Colman 28-29; Belimo 48; Billman 52; British Thermostat 33 Carrier 31; Comyn Ching 13; Consolidated 20-21 Danfoss inside front cover, 26-27; Drayton 49

Electric Heat Regulator front cover, 22-23 Honeywell 44-45

Johnson Controls inside back cover, back cover, 14-17, 53

Landis & Gyr Powers 42-43 Magnetic Valve 32; Minneapolis Honeywell 24-27 Nash 30; Negretti & Zambra 32

Pascal Ironworks 1; Penn 34; Powers Regulator 18-19 Radiovisor 40; Ranco 35; Rheostatic 38 Satchwell 50; Sauter 41, 46; Staefa 46

> Teddington 51 Watford 39; White Rodgers 47



"Home Check 2020," home automation of the future? [ACHR, USA, 30 April 2001]

#### The Author

Brian Roberts, now retired, has over 60 years experience in the building engineering services industry, having been Chief Air Conditioning Engineer for Brightside, Company Chief Engineer for Drake & Scull and Technical Director of Airpower [later Carrier-Holland Heating]. He has served on technical committees of IHVE/CIBSE, HVRA/BSRIA, ASHRAE, the HVCA and British Standards. He was Chairman of the CIBSE Heritage Group for 27 years and is now Group Archivist.

Printed books by the CIBSE Heritage Group include: The Quest for Comfort, The Magic of Hot Water, Building Services Heritage, HVCA @ 100 and Hadens of Trowbridge.



Drebbel's thermostat, early 17<sup>th</sup> century. [Origins of Feedback Control, O Mayr, Scientific American, Oct 1976]

#### Introduction

The German Cardinal, Nicolaus de Cusa [15C] described a *hygroscope* for measuring humidity, which was improved upon by the Englishman Robert Hooke [17C] and by de Saussure [1780] who relied on the moisture absorbency of human hair. A primitive attempt to measure temperature was made by Galileo when he devised his *thermoscope* [1593]. However, the first thermostat is credited to the Dutch engineer, Cornelius Drebbel [17C], though the word *thermostat* was only coined later by the Scotsman Dr Ure [1830]. Shortly after, Dr Neil Arnott produced his *thermometer stove* [1836], A M Perkins his HPHW boiler draught regulator [1840], while Appold introduced his apparatus for "regulating temperature and keeping the air in a building at any degree of moisture" [1866]. But it was Wheatsone's *bridge* [1843] and the *potentiometer* of Poggendorf [1841] that formed the basis of many later electrical control devices.

An electric thermostat was developed by Alfred Butz of Minneapolis [1883] while Warren Johnson in Wisconsin introduced a pneumatic thermostat [c.1880) and William Powers of Chicago devised a vapour pressure thermostat [1889]. Later, Willis Carrier introduced his *dewpoint* thermostat [1911] and his *differential hygrostat* [1911]. Thus, automatic controls were first developed in the USA. Their introduction and use in the UK and Europe was much slower. In 1941, in an address to the Newcomen Society, A F Dufton commented, "It is difficult to understand the prejudice against automatic control. It is not many years ago that a President of the IHVE, deprecated in his own practice the elaboration of automatic control mechanisms because, in his view, they were not needed, and, in the second place, they were liable to get out of order...." How times have changed!

[A fuller history is available in "Automatic Control," Chapter 11 of "Building Engineering Services: A Review of Its Development," Neville S Billington & Brian M Roberts, Pergamon Press, 1982]



German theologian and mathematician. Studied at Heidelberg and Padua. Described a humidity measuring instrument called the *hygroscope*: " If you suspend from one side 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."

#### Galileo Galilie 1564-1642



Italian physicist and astronomer. In 1593, devised the *thermoscope*, a primitive attempt to measure changes in temperature: "This instrument he used to investigate degrees of heat and cold."

#### **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 vapour 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."

Cardinal Nicolas de Cusa 1401-64

#### Robert Hooke 1635-1703

English scientist, curator of experiments at the Royal Society [the only paid post]. Famous for his Law on elasticity, discussed development of the steam engine with Newcomen and argued with Newton. Hooke made a *hygroscope* that exploited the water-retaining properties "of the bristle of the wild oak." No likeness of Hooke has been found.

#### **Bonnemain** [active 1777]

French engineer. Devised an incubator heated by means of hot water pipes. "The primary 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, in 1726, and his later true bimetallic strip of 1761. The "heat regulator" of Bonnemain "was founded upon the unequal dilation of different metals by the same degree of heat." The author has been unable to find any likeness of Bonnemain.

#### Horace Benedict de Saussure 1740-99



Swiss scientist, Professor at Geneva University. In 1780 he devised a hygrometer that made use of the moisture absorbing properties of human hair to measure atmospheric humidity.

#### Dr Andrew Ure 1778-1857



Born in Scotland. In 1801 qualified as Doctor of Medicine in Glasgow, then Professor of Chemistry and Natural Philosophy. In 1830 appointed analytical chemist to the Board of Customs in London. Granted patent BP 6014: 1830 for "An Apparatus for Regulating Temperature in Vaporisation, Distillation and Other Processes" [picture above right]. He coined the word *thermostat* and designed an air-heating stove with thermostatic control. Ure is also remembered for his "Dictionary of Arts, Manufactures and Mines," published in 1839.

#### Dr Neil Arnott FRS 1788-1874



Doctor of Medicine, Fellow Royal Society, Physician Extraordinary to Queen Victoria. Lectured the Royal Institution on his Thermometer Stove in 1836. Wrote his book, On Warming and Ventilating with Directions for Making and Using the Thermometer Stove, or Self-Regulating Fire, and other New Apparatus, in 1838. 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." His device controlled the temperature of the stove casing, not that of the room.

#### **Angier Marsh Perkins 1799-1881**

Born Massachusetts, son of Jacob Perkins [refrigeration pioneer], came to England as a boy. He devised the Perkins system of high-pressure hot water heating [BP 6146: 1831]

including the furnace, the thick-wall small bore distributing tubing and coiled heaters. His furnace was controlled by a draught regulator which relied on the linear expansion of the flow pipe to open or close the furnace damper. A nut on the pipe served to adjust the setting of the regulator. There is a portrait of Jacob, but no likeness of A M Perkins has been found.



John George Appold 1800-65

English inventor. His apparatus [above right] for regulating temperature and keeping the air in a building at any degree of moisture was described in the Proceedings of the Royal Society of London for 1866-67. "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."

#### 7

#### Dr David Boswell Reid 1805-63



Scottish doctor, chemist and ventilating engineer. Admitted to the Royal College of Physicians, Edinburgh, in 1831. Investigated respiration and fresh air needs. Worked on the fire-assisted ventilation of the House of Commons, rebuilt after the Great Fire of 1834, but the MPs disliked his system. Reid was more successful with the heating and ventilation of St George's Hall, Liverpool, in the 1850s, where he used steam-driven fans. A remarkable feature of his installation was the provision of an alarm system fitted to the steam boilers. Ordinary mercury-in-glass thermometers were provided with electrical contacts in the stem: when the boiler became too hot, the circuit was completed and an alarm bell rang.

#### Alfred Butz 1849-1904





Born in Switzerland. Emigrated to America at the age of eight. Served with Union Army towards the end of the Civil War. Developed a spring motor and crank to operate a boiler of furnace damper, known as the Butz flapper-damper [above right], for which he obtained two patents in 1886. In 1885, he had formed the Butz Thermo-Electric Regulator Company but the business was unsuccessful. He sold his patent rights to his Minneapolis attorneys who, in 1888, renamed the business the Consolidated Temperature Controlling Company. Many years later the firm became part of Honeywell.

#### William Richard Sweatt 1867-1937





Established Sweatt Mfg Co in Minneapolis in 1891. Invested in the Electric Thermostat Co, then making the flapper-damper of Butz. Later acquired the Company, products including a thermostat, damper motors, and a clock thermostat. In 1912 became the Minneapolis Heat Regulator Co, which prospered under the direction of his son Harold W Sweatt [above right], later merging with the business of Mark Honeywell.

#### **Professor Warren S Johnson 1847-1911**





Born in Vermont. Worked in Wisconsin as printer, superintendent of schools and surveyor. Appointed Professor at the State Normal School, Whitewater. Experimented with electric storage batteries. Unhappy with the hand-operated dampers in the school heating system, he installed electric thermostats in each classroom, connecting them to annunciators of his invention, to show "Warm" or "Cold" adjacent to the furnace dampers. Obtained patent [USP 281,844: 1883] for *an electric tele-thermoscope*. In 1885 established the Johnson Electric Service Co in Milwaukee and went on to develop his world-famous range of pneumatic controls.

#### William Penn Powers [active 1890]





American businessman. Set up W P Powers & Co in 1867 in La Crosse, Wisconsin. Became interested in automatic controls and established The Powers Regulator Co in Chicago in 1890. He devised his first round thermometer/thermostat in 1893 [above right]. Two of the Company's most famous installations were for New York's Chrysler and Empire State buildings.

#### Howard D Colman 1873-1942





American engineer and co-founder with W A Barber [above right] of Barber-Colman Co, controls manufacturer of Rockford, Illinois. Invented an automatic machine for the textile industry, and went on to develop fractional horsepower motors, electric fans and various temperature control systems.

#### Fritz Sauter [active 1910]





In 1910, began the manufacture of time switches [above right] in a small workshop in Grindlewald, Switzerland. Later opened a larger factory in Basle. During the First World War developed an electric boiler and added a thermal appliances division. Became a limited company in 1920, founded a French partnership in 1923, appointed a Swedish agent in 1925, and formed a German subsidiary in 1925. In 1948, a factory making thermostats and control equipment was established in Saint-Louis, France.

#### **Heinrich Landis**



#### Dr Karl Heinrich Gyr



In 1896, Richard Theiler set up the company of Electrotechnisches Institut Theiler & Co in Zug, Switzerland. His partner was Adelrich Gyr-Wickart. The Company produced electricity meters, telephone magnetos and phonographs. In 1904, Heinrich Landis became a partner, the Company being renamed Heinrich Landis. In 1905, Heinrich Landis took Dr Karl Heinrich Gyr into partnership, the firm becoming Landis & Gyr. Over the next 20 years the Company expanded across Europe and into the USA and Australia. The thermal technology department was set up in 1940. In 1987, the Company acquired MCC Powers of Chicago. In 1996, a majority shareholding was acquired by the Elektrowatt Group, and Landis & Staefa was formed. In 1998, this became part of Siemens Building Technologies group.

#### Dr Willis Haviland Carrier 1876-1950





American engineer and inventor. Born on a farm in Angola, NY, later graduated from Cornell University before joining Buffalo Forge. In 1908, established the subsidiary Carrier Air Conditioning Corporation of America. Produced the Carrier Psychrometric chart, devised the Dew-Point Method of Humidity Control and patented many types of control. He recognised that the dewpoint system of humidity control could not always "be applied to advantage" and around 1911 developed his hygrostat [above right] that measured both dry-bulb and wet-bulb temperatures. He recognised that this difference was not constant at all percentages of humidity and made clever use of differential screw threads in a compensating mechanism. In 1914, started Carrier Engineering Corporation. For his later pioneering work he has been called "The Father of Air Conditioning."

#### Frederick W Robertshaw [active 1904]

It is said that in 1899, Frederick W Robertshaw, an American father of 8 children, became exasperated with the water system in their house "being alternately scolded or frozen by their home water supply." After several experiments he made a sensor using copper tubing which expands and a carbon rod, which does not. This device proved successful. He received patent USP 761,402: 1904 for his thermostat and reversing valve. In 1907 he formed The House Utility Manufacturing Company, later Robertshaw Controls Company.

#### Herbert Hamilton Grundy 1888-1932



His father, John, established a stove-making business at Tyldesley, Manchester, and was the first IHVE President in 1898. From around 1910, Herbert "engaged upon perfecting and manufacturing apparatus for an electrical system of heating; also an electrical method of thermostatic control." He was IHVE President for 1915-16.

#### Mark Honeywell [active 1927]



American inventor. In 1906, went into business as a plumbing and heating engineer in Wabash, Indiana. Later invented the Honeywell Heat Generator that allowed heating systems to be pressurised. Formed the Honeywell Heating Speciality Co and in 1927 its success led to a merger between the Minneapolis Heat Regulator Co of Sweatt and Honeywell. The new Company became a leader in home heating controls and developed into one of the world's major manufacturers of automatic controls.

#### Stig K M Billman [active 1932]



Swedish engineer. In 1929 developed a temperature regulator. In 1932 started the Billman Company in Stockholm. Siemens acquired Billman Regulator AB in 1971. Billman was awarded the Chevalier de l'Ordre National du Merite in 1981.

#### Mads Clausen 1905-1966



Danish engineer and businessman. Directed his first efforts to the production of refrigeration controls, founding Danfoss in 1933. Developed an expansion valve [see inside front cover]. He was described as "a man who could both inspire people and see matters from all sides, while never losing sight of the main objective."

Educated Imperial College, Royal College of Science, London University. Graduated with Honours Degree in Chemistry. Awarded Doctorate in 1932. In 1935, he founded Thermocontrol Installations Co Ltd. MD in 1938 until 1952 appointed Chairman. Joined IHVE 1934, served as President 1961-62. Pioneered the fully automatic solid-fuel boiler and the application of electrically operated controls gas-fired installations.

#### Ernst Wild [active 1962]

In 1962, Ernst Wild established Staefa Control System in Staefa, near Zurich, Switzerland. He launched what was claimed to be the first electronic control loop with a modulating magnetic valve in Europe and went on to develop a range of equipment for the control of HVAC systems.

#### Dr Frank M H Taylor d.1963

**Angier Marsh Perkins** 



Diagram of Perkins' Governor or Heat Regulator, [Patent Apparatus for Warming and Ventilating Buildings, 1840 Paul Yunnie Collection]



#### Dr Neil Arnott & Comyn Ching

Many years since, this principle was perfected at our Works under the direct superintendence of Dr. ARNOTT, and though many new plans for economically and effectually heating apartments, churches, &c., have since been introduced, the continued and steady sale of these, prove, that they still compete successfully, with the many newer methods. With these Stoves you reduce the supply of air to the smallest that can be, to support combustion; thus reducing to the minimum the

amount of heat lost to use by escaping through the flue. By Cook's Patent Compound Bar, you actually make your fire regulate itself, for as it begins to burn too fiercely, the Compound Bar becoming heated curves gradually and thus shuts off the supply of air.

#### FAT ( ONTRO 1935 1885 FIFTY YEARS PROMOTION DEVOTED TO THE OF AND ECONOMY COMFORT, HEALTH Control. Through all those years the Johnson For half a century, the Johnson organization has devoted its entire effort to the manufac-Service Company has been the leader in the ture, installation, and improvement of the development of automatic control apparatus Johnson System of Temperature and Humidity for heating, ventilating, and air conditioning.

Special problems are not new to Johnson Service Company engineers and installation men. Whatever the means adopted to accomplish heating, cooling, humidification, and dehumidification, there are Johnson devices, tried and tested, to secure the particular effect desired. A back-ground of fifty years of continual development and progress is assurance to architects, engineers, and contractors who refer automatic control problems to the Johnson Service Company. Their clients, the building owners, benefit by the experience of a nation-wide organization devoted to just this one line of business. The Johnson Service Company never has failed to execute any contract entrusted to it.

JOHNSON SERVICE COMPANY - - MILWAUKEE, WIS. BRANCH OFFICES IN ALL PRINCIPAL CITIES Incorporated: November 1885

This ad prepared by Johnson Service Co., 1355 W. Washington Blvd., Chicago

Advertisement celebrating 50th Anniversary of the Company founded in 1885. The Johnson Service Company, Milwaukee, Wisconsin, 1935. [Reprint ASHRAE Journal, Centennial Edition, December 1994]

#### Johnson Service Company



"Family Wealth," Johnson Electric Service Co, McClures magazine 1896.



Johnson sales force 1900.



Slate control board in a school 1920s. [Pictures from Right for the Times, Johnson Controls, 1985]



### THE HNSON 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.

THERMOSTAT.

# HUMIDOSTAT

THE

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.

"Temperature Regulation" and "The Humidostat," Johnson Temperature Regulating Co, New York. [Heating and Ventilating Buildings, Prof. Rolla C Carpenter, 1910]



Early Johnson controls, prior to 1920.



Factory testing a Johnson steam control valve, 1944.



The Johnson JC/80 mini-computer for building control, 1972. [Pictures from Right for the Times, Johnson Controls, 1985]



The Powers Duplex Regulator Co

"Hot Blast Heating," The Powers Duplex Regulator Co, Boston & Chicago. The Company later became the Powers Regulator Company. [Heating and Ventilation, USA, December 1894]



"Temperature Regulated in Large Buildings." The Powers Regulator Company, Chicago. [Heating and Ventilation, USA, April 1897]



The Powers Temperature Regulator. [Heating and Ventilation, 15 May 1895]



Powers thermostat 1903. [Heat & Cold, ASHRAE, 1994]

19



**Consolidated Temperature Controlling Co** 

W R Sweatt, who owned Sweatt Mfg Co, took shares in Consolidated [so named by Butz's attorneys after they took control of the Company] which became The Electric Thermostat Co in 1892. In August, 1893, Sweatt purchased its patents, took over the management of the Company and renamed it the Electric Thermostat Company. [The Legend of Honeywell, Jeffrey L Rodengen, 1995]

INCORPORATED UNDER THE LAWS OF THE STATE OF MINKESOTA 000000 A P. MILLIN SHARES \$ 100 " EACH LAPITAL \$ 500,000 .. This is to ailify that - 20 illiam R. dureatt ---full pard . Theres in the Capital of the CONSOLIDATED TEMPERATURE CONTROLLING CO., Transford the only on the Bertes unpany on person or by lawful . Illerney on surrender of this Contepente In Milness whereof the Resultant and Secretary have because affect the signatures under the experience Seat of the Company at Manapelis Minu this 113- day of 2000-000 - 080 John Man Derup, A.B. Foris

Share Certificate of the Consolidated Temperature Controlling Co. Issued to W R Sweatt in 1891.



1888 Century & Harpers

"Automatic Regulators," Consolidated Temperature Controlling Co. From Century & Harpers magazine, 1888. [Pictures from The Legend of Honeywell]



"Minneapolis Heat Regulator," Electric Heat Regulator Co, Minneapolis, Minnesota, 1908. This Company later became Minneapolis-Honeywell. [The Legend of Honeywell, Jeffrey L Rodengen, 1995]



#### "On the Pulse." Electric Heat Regulator Co, Minneapolis. [Heating and Ventilation, USA, 15 May 1895]



"Gold or Silver," Electric Heat Regulator Co, Minneapolis. [Domestic Engineering, Vol.9, June 1895]



The Minneapolis Heat Regulator

"Just Set the Indicator." The Minneapolis Heat Regulator, 1926. [Honeywell: The First 100 Years, 1985]



"Whew It's Hot and Boo It's Cold." Minneapolis Heat Regulator, 1908.



#### It Is a National Campaign

That gives a grand total circulation of over 6,000,000 each month.



"Biff Bang Boom," Minneapolis Heat Regular, 1917. [Pictures from Honeywell: The First 100 Years, 1985]



The Honeywell Round Thermostat, Minneapolis-Honeywell Regulator Co,1959. This Company later became Honeywell. [Honeywell: The First 100 Years, 1985]



Mark Honeywell [5<sup>th</sup> from left] in front of his plumbing & heating shop in Wabash, Indiana, about 1906.



#### **Barber-Colman**





Painting representing Energy Management Systems. [The Many Worlds of Barber-Colman, undated]



#### The Nash Regulating Valve Co

"The Nash System of Temperature Regulation," The Nash Regulating Valve Co, Detroit, Michigan. [Engineering Review, USA, January 1903]

# Carrier Engineering Company Ltd. THE CARRIER COMPENSATING HYGROSTAT 20 Do The Carrier Compensating Hygrostat with Cover removed to show the Hygroscopic Mechanism. "Every day a good day"

**Carrier Engineering Company Ltd** 

The Carrier Compensating Hygrostat.

Dr Carrier set up Carrier Engineering Corporation in the USA in 1915 and went on to establish a London company with a 50% US shareholding in 1921. [Carrier Humidifying Apparatus and Control, Treatise 100, USA, 1920. Reprinted by Carrier Engineering Co Ltd, London, c.1922]



#### The Magnetic Valve Co Limited

"Attention to Temperature," The Magnetic Valve Co Ltd, London. [JIHVE, Vol.6, No.61, March 1938]

#### Negretti & Zambra



"Instrumentation for the H&V industry," Negretti & Zambra, London. [Year Book of the Heating & Ventilating Industry, 1948]



The British Thermostat Co Ltd

"Automatic Temperature Controls," British Thermostat of Sunbury-on-Thames. The Company was founded in Teddington, Middlesex, in 1928 and moved to Sunbury in 1931, later becoming Teddington Controls Ltd. It relocated to St Austell in Cornwall in 1974. [Year Book of the Heating & Ventilating Industry, 1948]

#### **Penn Controls Inc**



"Job-Tested Controls," Penn Automatic Controls, Goshen, Indiana. [Air Conditioning Refrigerating Data Book: Applications, ASRE, 1954-55]

#### **Ranco Inc**



Ranco, specialist in refrigeration controls, Columbus, Ohio. [Air Conditioning Refrigerating Data Book: Applications, ASRE, 1954-55]

#### Danfoss A/S



Danfoss Headquarters Building, Nordborg, Denmark. [Cover: The Danfoss Journal, June 1983]



Danfoss design & drawing office, c.1943.



Danfoss turning shop, 1943.



Danfoss production line, c.1983. [Pictures from The Danfoss Journal, June 1983]

#### The Rheostatic Co Ltd



"Temperature Controls," Rheostatic Co Ltd, Slough. Patented the magnetically controlled micro-gap switch c.1926, which was incorporated in their first room thermostat in 1927. The Company later became Satchwell Controls. [Year Book of the Heating & Ventilating Industry, 1948]



Watford Electric & Mfg Co Ltd



**Radiovisor Parent Ltd** 

Radiovisor "Flamestat" for Oil, Gas & Pulverised Fuel Burners, London. [Year Book of the Heating & Ventilating Industry, 1948]

#### Fr. Sauter AG



Magazine cover feature [detail] promoting Sauter control systems used at the Arch de la Défense in Paris. [BSEE, Vol.21, No.1, September 1997]

Landis & Gyr Powers





[ASHRAE Journal, December 1994]

## Honeywell



"Energy Conservation with Comfort." [The Honeywell Energy Conserver's Manual and Workbook, Honeywell, USA, 1979]



Honeywell Electronic Data Processing, 1966. [Honeywell: The First 100 Years, 1985]



Honeywell Delta 1000 System, Building Operating Centre, 1979. [CIBSE Heritage Group Archives]

#### Staefa Control System



"There's Energy in the Air," Enthalpy Controller, Staefa Control System, 1981. The Company was established in Switzerland in the 1960s, being part of the Elektrowatt Group. In 1996 it was merged with Landis & Gyr to form Landis & Staefa . In 1998 it became part of Siemens Building Technologies.

#### White-Rodgers



Advertisement for White-Rodgers digital thermostat, St Louis, Missouri. In 1937, engineers from Emerson Electric formed Missouri Automatic Controls, which was later renamed after principal engineers, Jim Rodgers and Chesterfield White, and specialised in furnace controls. [ASHRAE Journal, December 1994]

#### **Belimo Automation AG**



"Excellence in Air Control," Belimo electric damper actuators. Belimo Automation AG any was set up in 1975 with its Head Office in Hinwil, Switzerland. [ASHRAE Journal, January 1995]

#### Drayton Regulator & Instrument Co Ltd



Drayton Regulator, West Drayton, Middlesex. Well-known for their range of pneumatic controls. [The IHVE Guide to Current Practice, 1959]

#### Satchwell [Rheostatic]



A Guide to Satchwell Automatic Controls. The firm was still trading as Rheostatic at the time of this advertisement. [The IHVE Guide to Current Practice, 1959]

#### **Teddington Industrial Equipment Ltd**



#### **Billman Electromation Ltd**

## **BILLMAN** Heating & Ventilating Air Conditioning Controls

Billman design and manufacture a comprehensive range of high quality heating and ventilating control units, detectors, actuators and valves. Even more important is that Billman engineers have the world-wide experience and know-how to build these components into individually tailored control systems. Billman's is a complete service with quick delivery—there when you want it—with thorough commissioning and after-sales service. BILLMAN.



#### VISONIK 5000

A full range of electric, electronic, pneumatic and electro/pneumatic controls is available to suit the smallest or largest installation. The above photograph portrays the VISONIK 5000 System, the first supervisory system designed for use in the H & V Industry that incorporates the digital techniques of the computer age. All transmissions of data for control or monitoring are via a co-axial cable.

Whenever you have a control problem then give it to the experts; address as below.



BILLMAN electromation Itd 54-58 HIGH STREET. EDGWARE. MIDDLESEX HA8 7HQ. TELEPHONE 01-952 6921. TELEX 935002

GROUP COMPANIES, ASSOCIATES AND REPRESENTATIVES THROUGHOUT WESTERN EUROPE, CANADA, U.S.A., SOUTH AMERICA, AUSTRALASIA, ASIA.

Billman HVAC controls & the Visonik 5000 Supervisory System.. [IHVE Guide, Book B, 1970]

#### **Johnson Controls**



[Right for the Times, 100th Anniversary, Johnson Controls, 1985]

![](_page_57_Picture_1.jpeg)

Thermostat produced by Warren S Johnson, 1885. Pictographs representative of the Company's history have been added where a thermometer was originally fastened. [Right for the Times, 100<sup>th</sup> Anniversary, Johnson Controls, cover detail, 1985]

![](_page_58_Picture_0.jpeg)

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