Building Services

HERITAGE

Front cover
Portway Patent Tortoise slow
combustion stove, size 2
St Leonard, Rodney Stoke

Sponsored by:

FABER MAUNSELL

Gifford

Haden Young

HOARE LEA CONSULTING ENGINEERS

ANDREWS WATER HEATERS

POTTERTON COMMERCIAL

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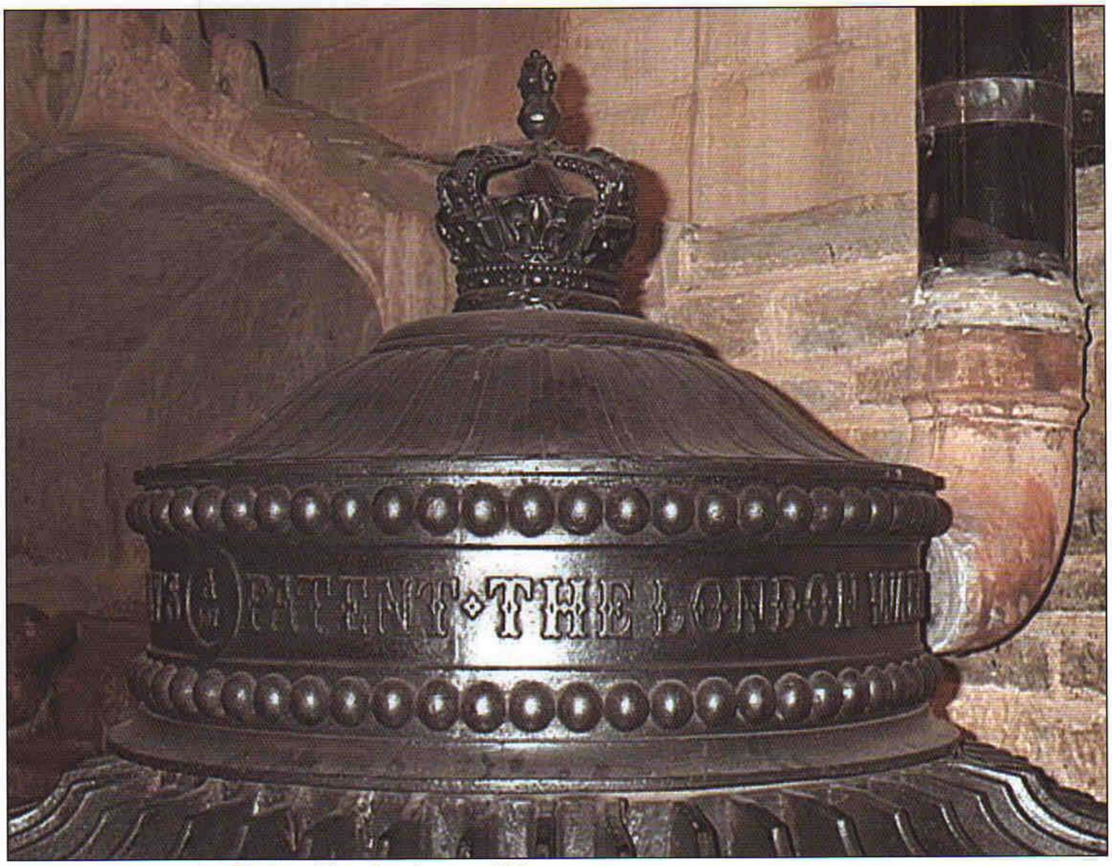
ENGLISH HERITAGE

Building Services
HERITAGE

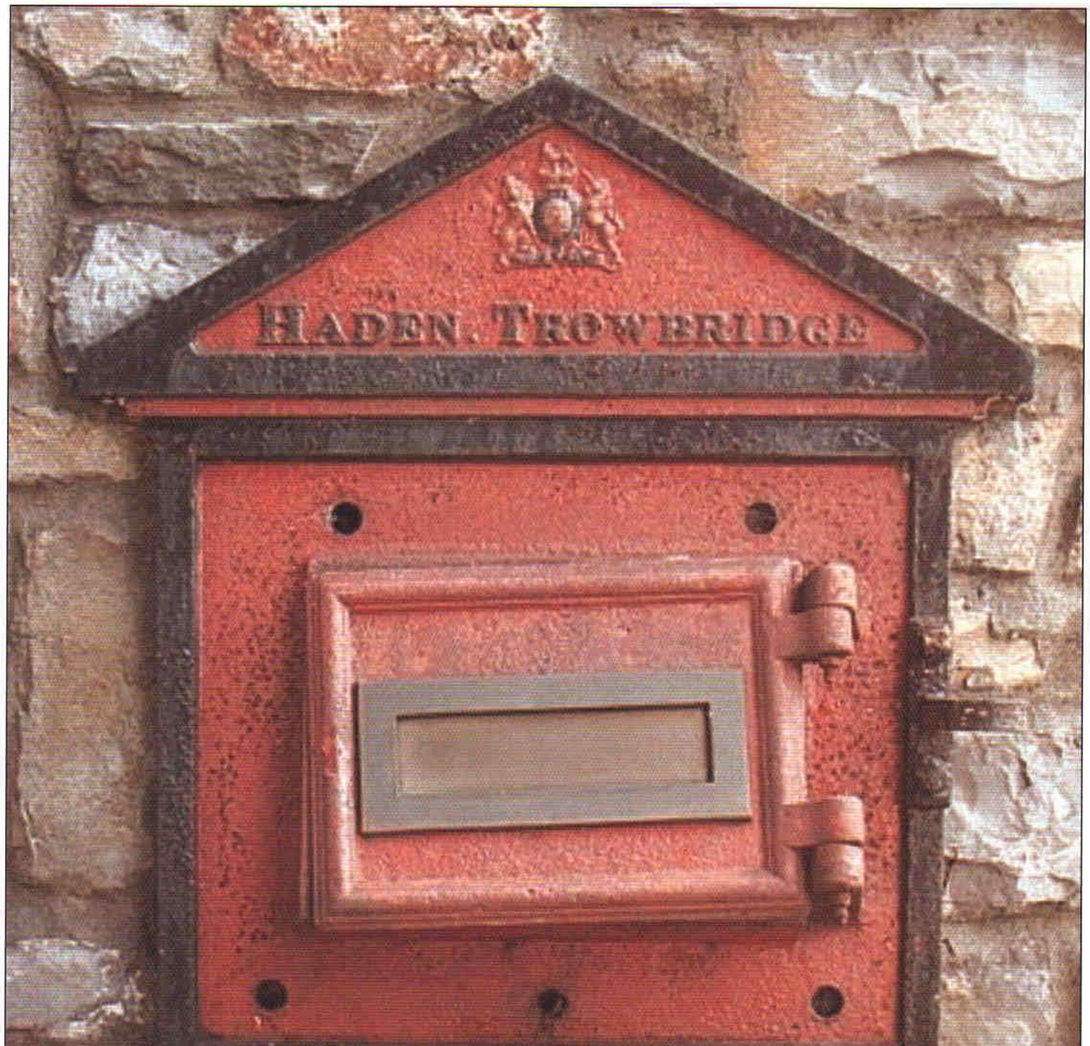
Brian Roberts
Chairman, CIBSE Heritage Group

Selected examples from England, Scotland, Northern Ireland and Wales of building services engineering in the 19th & 20th centuries.



Gurney Stove c.1875 at Tewkesbury Abbey

Published by Paul Yunnie of Andrews Water Heaters.



Haden stove front used as a private post box near Bristol. Discovered by Frank Ferris.

Stove top at Edmondthorpe

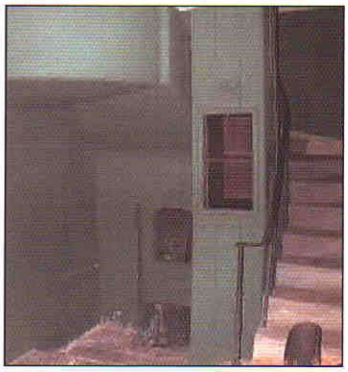
CONTENTS

ERDDIG, WREXHAM

James Haden

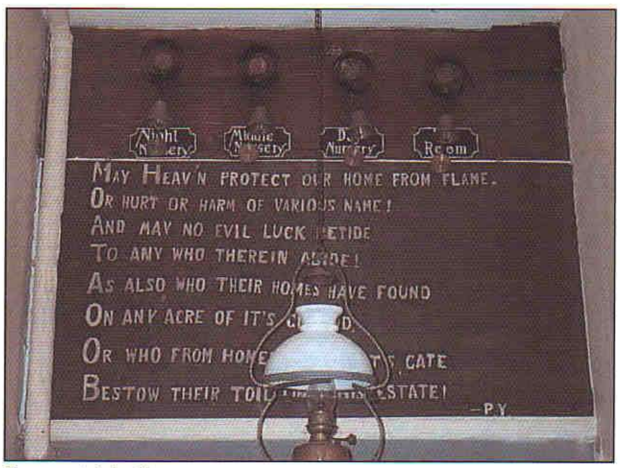
Erddig, near Wrexham, Clwyd, 1687, improved 1820s

The original house was built in or between 1684 and 1687. Wings were added to either side in the 1720s. The Yorke family inherited the property in 1733 and made improvements in the 1770s. The noteworthy dining room was designed in 1826 by Thomas Hopper. On 16th August in the same year Hopper ordered a heating stove from G & J Haden of Trowbridge. This is still in position, being the earliest remaining example so far discovered [No.94 in the Haden Order Book.]. A steam engine to drive the sawmill was installed about 1860. The workshop still houses a Cornish boiler, vertical steam engine, an oil fed, water-cooled secondary engine and various drive shafts, belts and pulleys. The rusting remains of a Musgrave warm air stove can be seen in the Garden Museum. In the house, there is also a decorative iron-heating stove labelled *Paragon No.1*, possibly of US origin c.1890s. The house was badly damaged through subsidence caused by colliery workings directly beneath it and from 1922 to 1966 it became derelict and badly damaged by rainwater. It was taken over by the National Trust in 1973 and has been carefully restored.

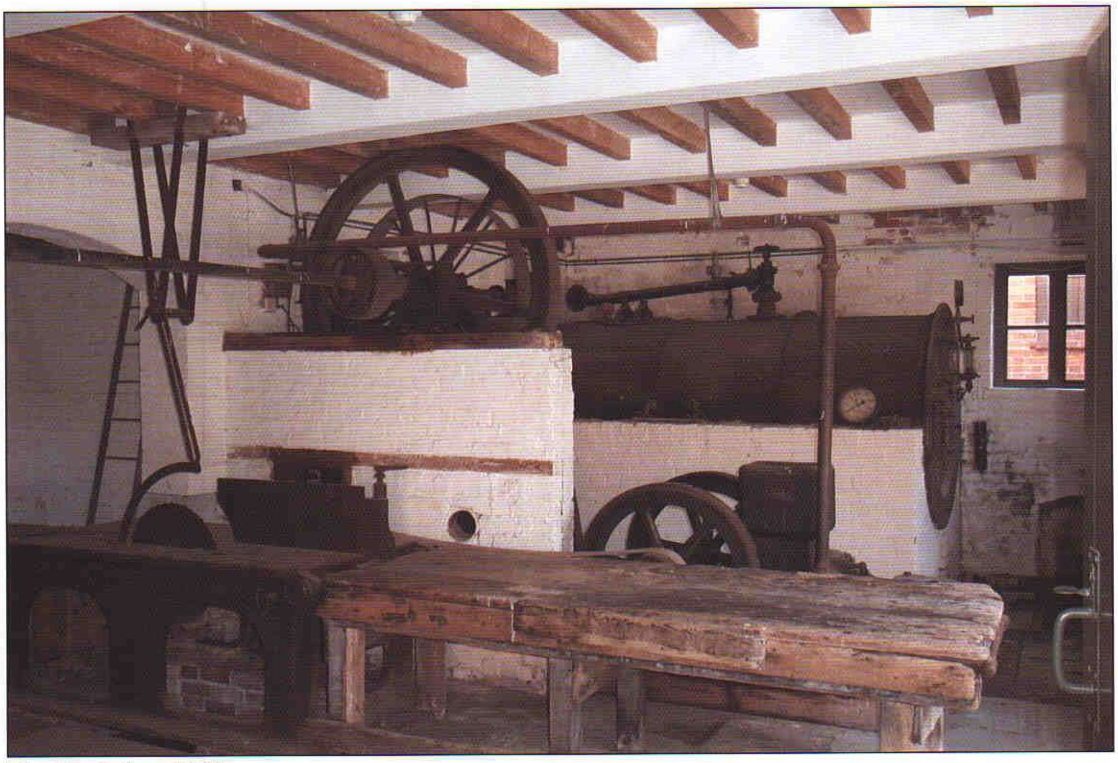


Haden stove of 1826 in situ

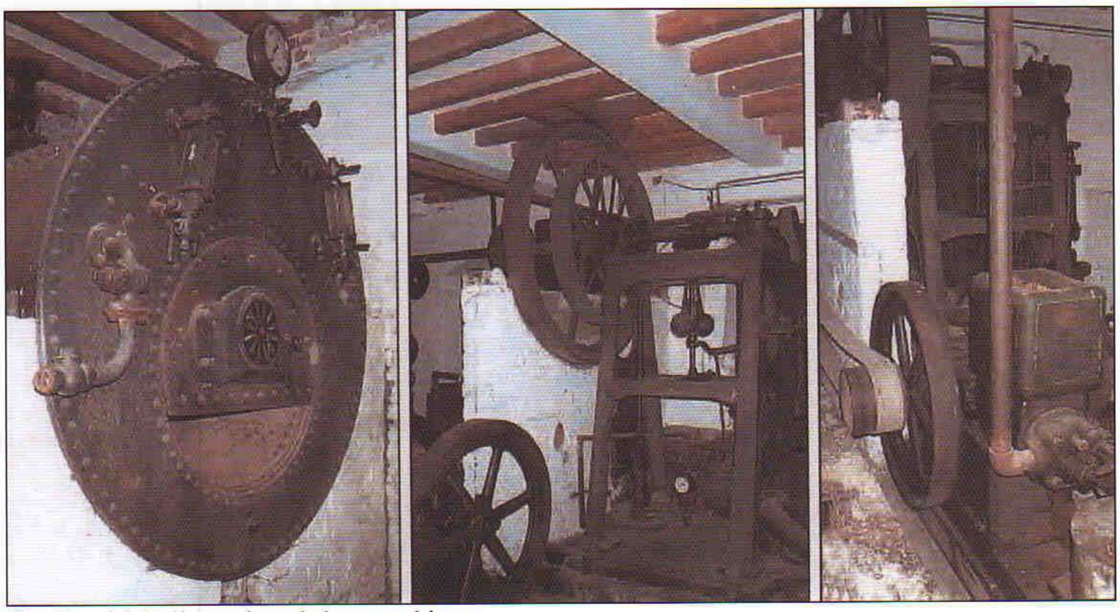
Paragon No.1 stove



Servants' bells



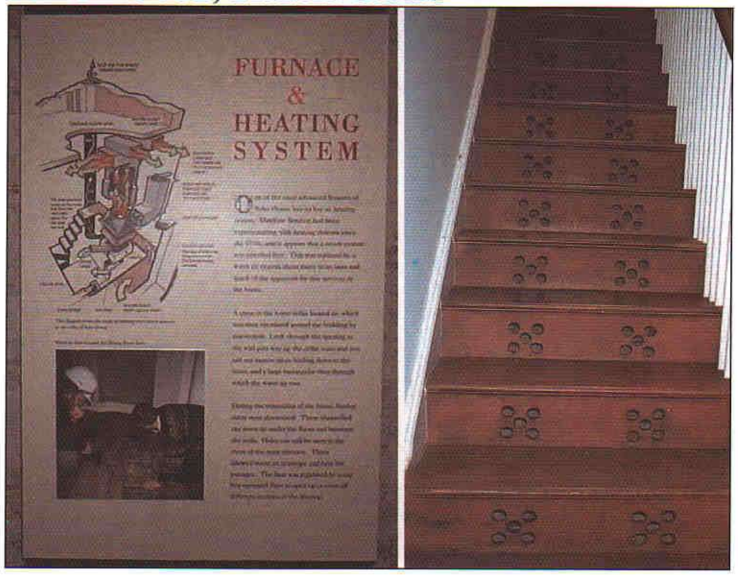
The Workshop 2002



The Cornish boiler and workshop machinery

SOHO HOUSE, BIRMINGHAM

Soho House



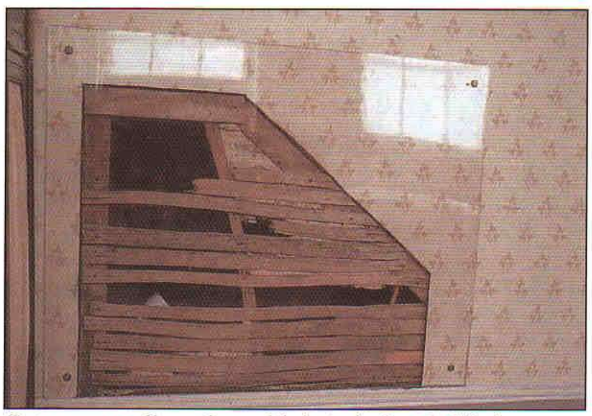
Heating system diagram and staircase hot air supply outlets in staircase risers (right)

Soho House, Handsworth, Birmingham, 1766

This house was the elegant home of the industrial pioneer Matthew Boulton who lived here from 1766 to 1809. His business became world-famous after the formation of his partnership with James Watt in 1774 when Boulton & Watt began the manufacture of steam engines. The nearby Soho Foundry was opened in 1796. In 1784 Watt used steam to heat a metal box radiator in his office. Boulton used a similar device in his manufactory and in 1789 used steam to heat his bath at Soho House. But warm air had more success than steam in early systems and used an iron *cockle* inverted over a fire. Air was passed over the external surface of the cockle before rising in ducts to the room to be heated. Boulton used this system when redeveloping and extending Soho House. Distribution ducts were either built into brick walls or were beneath the wooden floors of rooms; airflow was regulated by a series of butterfly dampers. This possibly makes it the first centrally heated house since Roman times. An interesting fact is that George Haden Sr was an employee of the firm and it was this connection that in 1816 led to his sons setting up in business as G & J Haden in Trowbridge to act as Boulton & Watt agents for the erection of steam engines in the West Country.

The Hall

Matthew Boulton



Cut-away wall section with hot air duct behind

ST ANDREW, OMBERSLEY

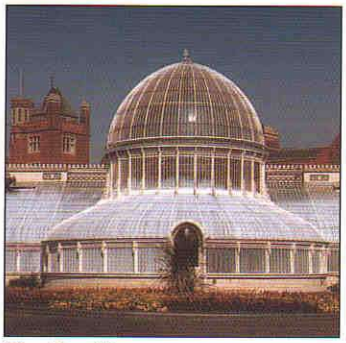
Howden Gothic stove

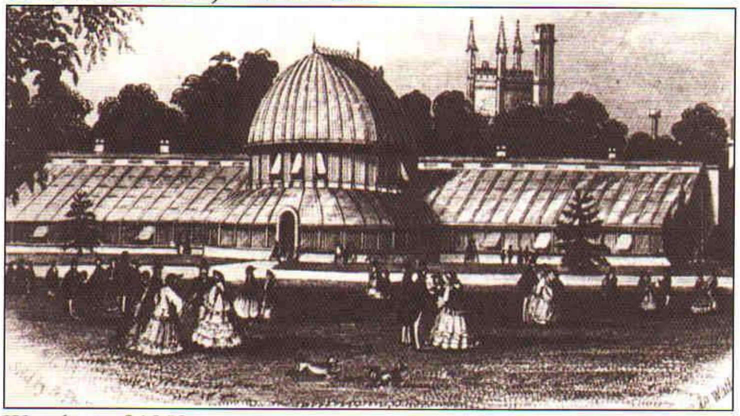
St Andrew's fireplace

St Andrew's Church, Ombersley, Hereford & Worcester, 1825-29

The architect Thomas Rickman designed St Andrew's in the 14th century manner so outside, it resembles a medieval church. The inside, according to John Betjeman, looks like a Nonconformist meeting-house. It has a remarkable warm-air iron stove in High Gothic style bearing the inscription: *Robert Howden, Inventor and Patentee, Old St Road, London.* Also, in the church, is a highly decorative fireplace.

PALM HOUSE, BELFAST


The Pavilion

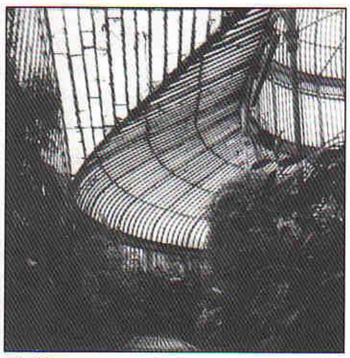

Woodcut of 1853

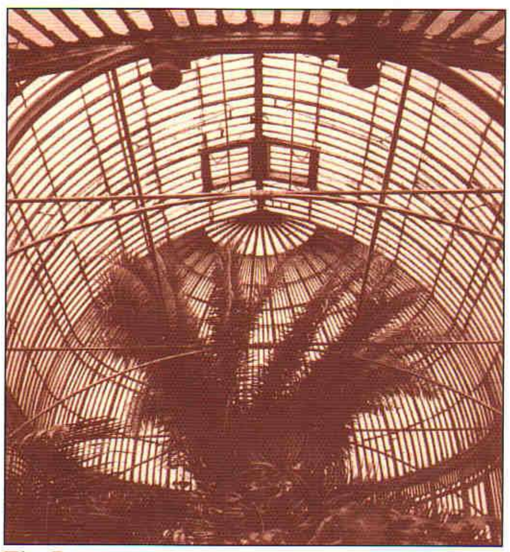

Richard Turner

Palm House, Belfast, 1839-40

The architect for the Palm House was Charles Lanyon, but the design was changed during construction by Richard Turner of Hammersmith Works in Dublin who pioneered the use of curved ribs and curved glass and later took on the building of the Palm House at Kew. The Belfast Palm House was 175 ft long by 46 ft high; the dome was 67 ft wide. In 1862 the heating, effected by two brick flues, was deemed unsatisfactory. The firm of Musgrave Bros was engaged to provide a new boiler and hot water heating system. It is recorded that the boiler was *Cockey's Patent*. In severe weather, the old brick flues were also utilised. It is said that new boilers were installed in 1871 and 1881. Also, gas lighting was provided in 1881. It is recorded that two Hartley & Sugden boilers were installed in 1892 by John Hall of Queen Street. [One report says these were called *Red Rose* but the most famous H&S boilers were the *White Rose* series.] A new aboveground boiler house was built in 1982.

The Palm House is described in "Houses of Glass," G Kohlmaier & B von Sartory, MIT Press, Cambridge, Mass, 1990, 158-160.]

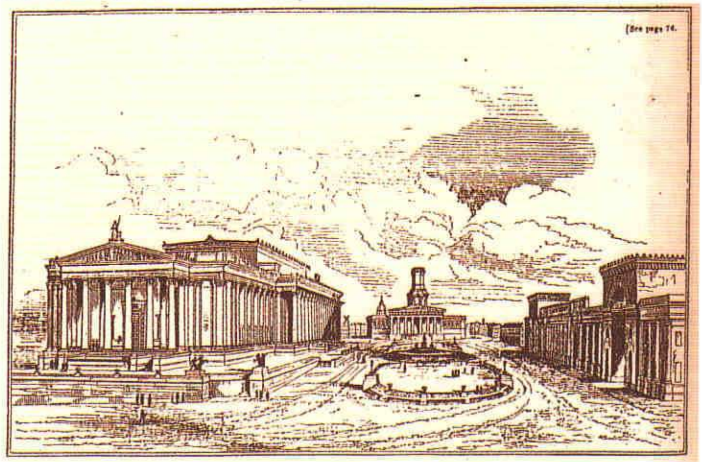

Gallery around dome

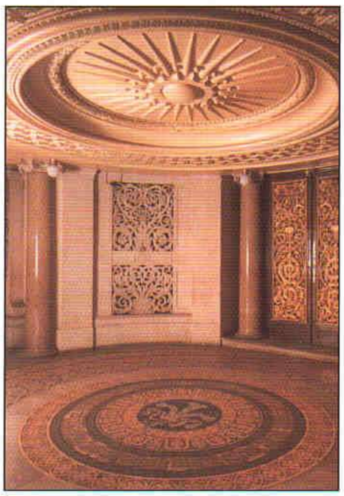

The Dome

Heating duct with grating cover

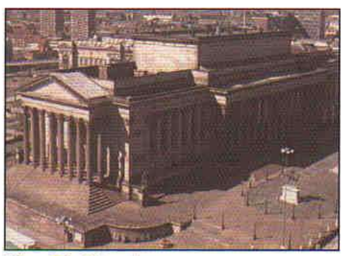
ST GEORGE'S HALL, LIVERPOOL

Dr David Boswell Reid





Beneath the Organ Gallery 1990s

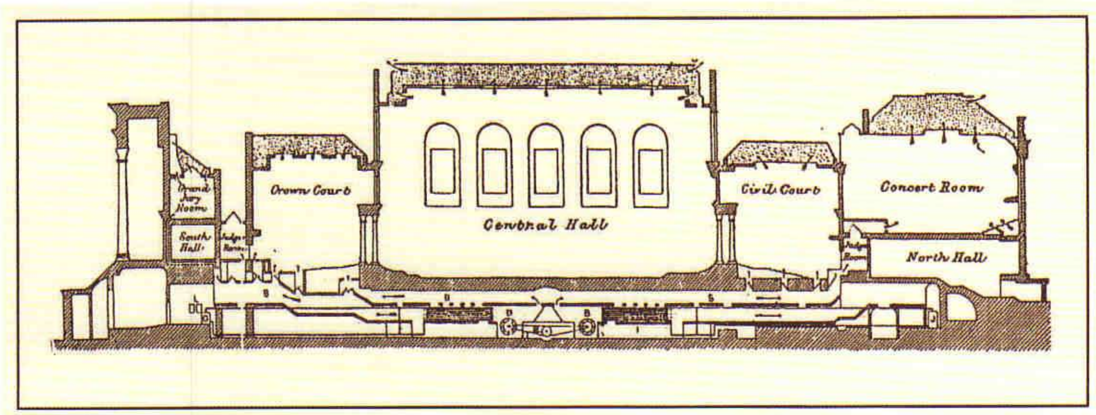


The Hall today

St George's Hall, Liverpool, 1842-51

Harvey Lonsdale Elmes drew up the orginal plans with the interior design inspired by the Roman Baths of Caracalla. The building has been described as perhaps the finest neoclassical building in England. But, when in 1847 Elmes died of consumption at an early age, his great work was completed by Professor C R Cockerell. Dr David Boswell Reid was engaged to design a heating and ventilating system, not included in Elme's scheme but now instigated by the city surveyor, Dr W H Duncan, concerned that infectious diseases seemed to spread due to lack of proper ventilation. [Liverpool had experienced a severe outbreak of cholera in the 1840s.] In Reid's design, air was taken into the building through two shafts and warmed by five batteries of hot water pipes served from four boilers. Natural convection of the heated air was assisted by a 10 hp steam engine driving four 10 ft fans. Cold-water sprays in the main shaft cooled and cleaned the incoming air, which was introduced behind sculptures in the Great Hall and through risers in the seating tiers in other rooms. Vitiated air was exhausted through grilles incorporated in the decorative ceilings, passing into the roof space, its movement aided by gas burners sited in shafts at the corners of the Great Hall. Heating and cooling of the various zones of the building was accomplished by a small army of workers in the basement controlling the passage of air by canvas flaps and doors connected to a system of pulleys and ropes. Much of Reid's system is still in place today.

The installation is described in "The Mechanical Ventilation and Warming of St George's Hall, Liverpool," Charles R Honiball, *The Heating and Ventilating Magazine*, Vol.4, New York, October 1907, 15-23.

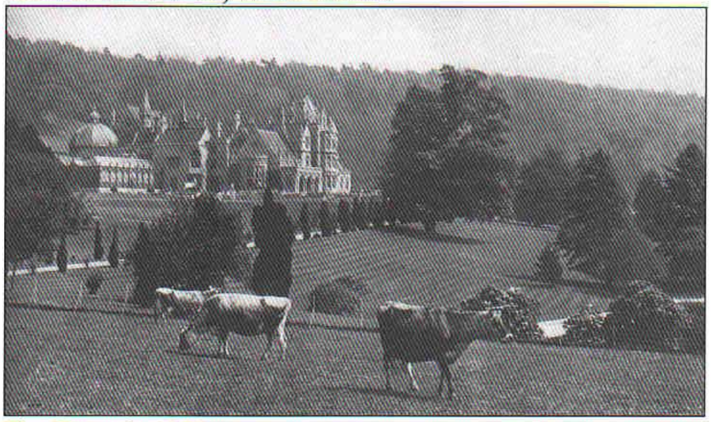


Section illustrating Dr Reid's scheme of 1854

Heating chamber and coils as existing today

TYNTESFIELD, WRAXALL

Ice-box refrigerator



The House in 1878

Column radiator

Wm Graham ventilating radiator

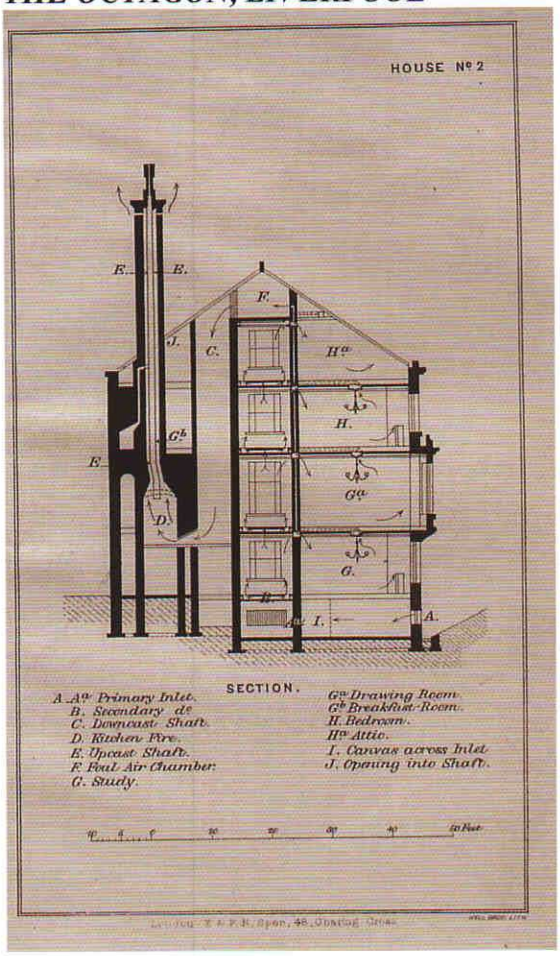
The House 2002

Tyntesfield, Wraxall, Somerset, 1863-66

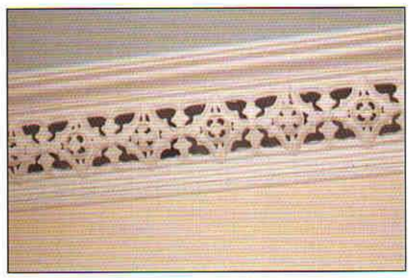
The fortune of Antony Gibbs & Sons was founded on the importation of guano (sea-bird droppings) from the Pacific coasts of South America, this being the principal fertilizer in use in mid-nineteenth century England. In 1843, William Gibbs bought an estate and small country house called Tyntes Place, a few miles to the west of Bristol. During the 1860s he remodelled it entirely, using the services of the Bristol-born architect John Norton and the builder William Cubitt & Son. Gibbs renamed the house Tyntesfield. His wealth endowed many churches and he contributed to the restoration of Bristol and Exeter Cathedrals. A large chapel, designed by Sir Arthur Blomfield, was added to Tyntesfield in 1873-75. The National Trust acquired the building and estate in 2002. The building services at Tyntesfield were comprehensive and state of the art. The house was heated by a warm air system. The house, the stables, the lodges and even the clock-face in the great tower were illuminated by gas, fed from gasometers near the kitchen garden. Two water-wheels were used to pump water to reservoirs situated on the hill above the house. The kitchen roof was of fireproof construction and fire hydrants were located around the house. A large bath and shower was provided on the first floor. Electricity was installed in the 1880s and at some time a hydraulic lift was fitted near the kitchen. The warm air heating system has long since been removed though grilles still remain in some of the ground floor rooms. A hot water heating system still exists. A number of radiators were manufactured by the firm of G N Haden & Sons Ltd at their ironworks foundry in Trowbridge, suggesting an installation date in the 1880s. Other rooms are fitted with ventilating radiators, manufactured by William Graham & Son of Trig Lane, Castle Yard & 35 Upper Thames St, London, EC. The CIBSE Heritage Group is assisting both the National Trust and English Heritage with surveying and identifying the various engineering services.

A history of Tyntesfield is given in "The Victorian Country House," Mark Girouard, Yale University Press, New Haven, 1979, 243-251.

THE OCTAGON, LIVERPOOL



The House



Decorative cornice grille

Present interior

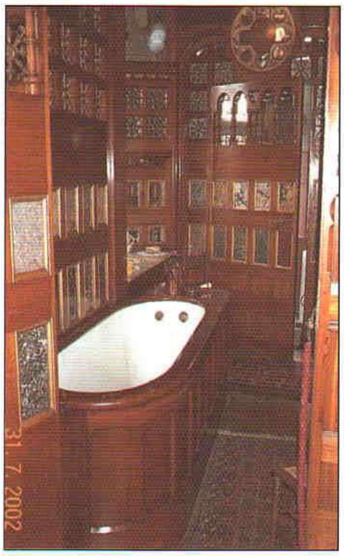
The Octagon, Liverpool, 1867

Dr Hayward's ventilation scheme for his house, the Octagon, is described in the 1872 textbook, *Health and Comfort in House Building*. Fresh air was collected and warmed in the basement. The roof space was used as a foul air chamber into which the vitiated air of all the rooms was collected, being drawn by the kitchen fire into a shaft passing down to the ground floor, then ascending behind the fire and up the kitchen chimney stack [an arrangement not uncommon at this time]. However, a feature of the design is the way in which all principal rooms opened off closed lobbies, separated by doors from the hall and staircase, which formed a vertical supply duct delivering filtered warmed air. Conventional fireplaces and ventilating gas lamps, arranged to promote the desired air circulation patterns, supplemented the heating. The original scheme included five coils of Perkins' one-inch diameter hot water pipes (presumably a high-pressure system) but new low pressure hot water heating was installed around 1970.

The Octagon and its ventilation features in "The Architecture of the Well-Tempered Environment," Reyner Banham, The Architectural Press, London, 1969, 35-39.

CARDIFF CASTLE

Decorative wash hand basin



Panelled bathroom

Blue & white WC pan

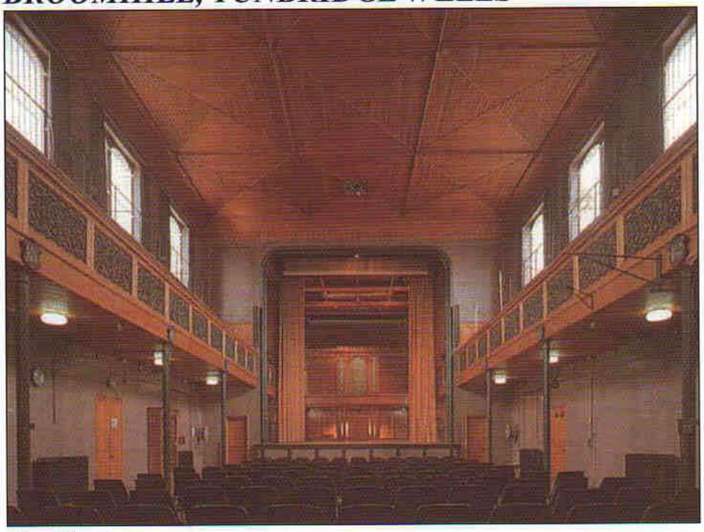
Box radiator & cabinet

Heater enclosure

Cardiff Castle, Glamorganshire, restored 1866-86

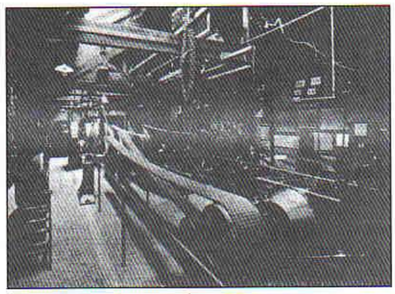
The second Marquess of Bute, realising that the growing coal and iron industry of South Wales needed an outlet, undertook the financing of the construction of docks at Cardiff. After his death in 1848, the firm of marine engineers, Walker, Burges & Cooper took over the completion of the East Bute Docks. This brought the third Marquess into contact with William Burges, the architect son of Alfred Burges, the marine engineer. William Burges was interested in medieval design and Gothic architecture and Lord Bute was to become the principal support of Burges's practice. In 1865 Burges suggested to Lord Bute that he restore Cardiff Castle. Work started with the clock tower and continued with the main castle buildings and apartments, all lavishly decorated to Burges's incredible Gothic designs. A link between the Victorian engineer, Wilson Weatherley Phipson, and the heating installation has been established. The Castle still has a remarkable collection of decorated Victorian sanitary ware.

BROOMHILL, TUNBRIDGE WELLS

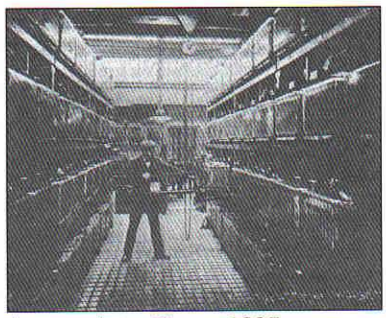


The Theatre

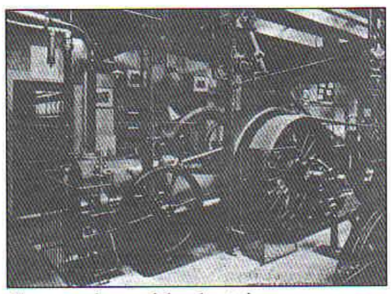
The House



Dynamos in Engine House 1897



Accumulator House 1897



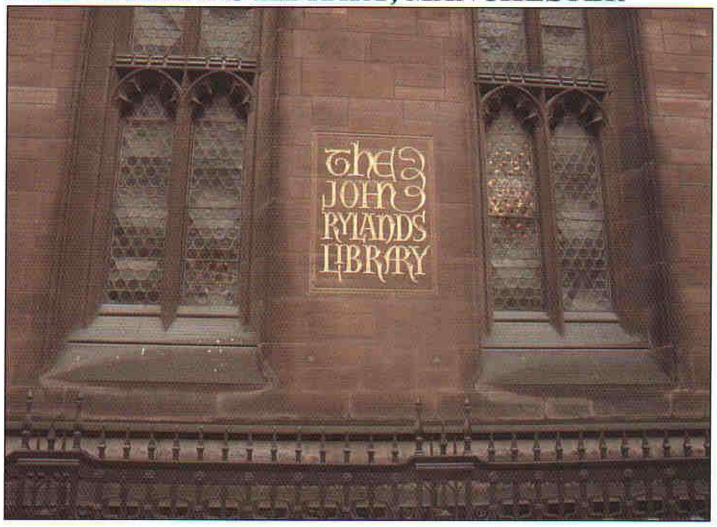
Gas engine with electric starter 1897

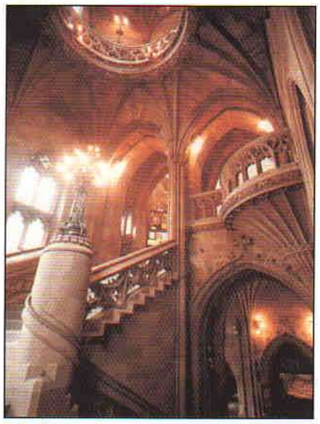
Broomhill, near Tunbridge Wells, Kent, extended 1876-94

In 1829 the first Sir David Salomons bought an elegant small villa known as Broomhill and engaged the eminent architect Decimus Burton to convert it into a substantial property. On his death in 1873, the first Sir David was succeeded by his nephew, David Lionel Salomons. He was an electrician, engineer, craftsman, photographer and an expert on motor cars. Acting as his own architect he embarked upon further alterations. A water tower was completed in 1876 and workshops in 1882. In 1894, work commenced on the theatre [the largest privately constructed theatre in England at that time] to which was attached a photographic studio, dark rooms and a chemical laboratory. He also devised a machine to measure the speed of light and constructed a magic lantern which cost £6000, a very large sum in those days. As early as 1874 there was an arc light in the workshops. By 1882 there were sixty lamps running at 50 volts and supplied by accumulators [this lasted until 1911 when electricity was supplied from the Tunbridge Wells plant]. In 1896, Broomhill had its own dynamo installed to serve one thousand 16-candlepower lights. Salomons described the Broomhill plant in 1897: "The present installation consists of two shunt-wound dynamos, each of which gives a maximum current of 150 amperes at 150 volts, a compound-wound dynamo for a current of 200 amperes at 110 volts, a compound-wound dynamo giving a current of 90 amperes at 50 or 100 volts at pleasure, and lastly, an alternator for a current of 60 amperes at 100 volts. There are two gas engines, each working at up to 33 ihp."

For fuller details see "The Broomhill Electrical Installation," Sir David Salomons, Bart, *American Electrician*, Vol.IX, No.5, New York, May 1897.

JOHN RYLANDS LIBRARY, MANCHESTER

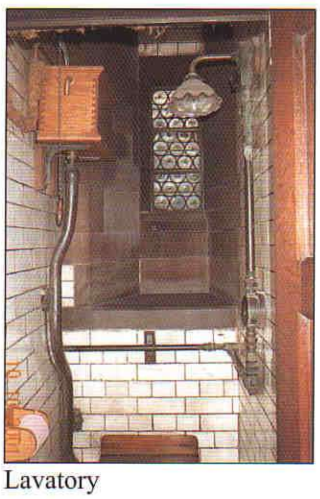




Main staircase

Radiator grille

Electrical distribution board

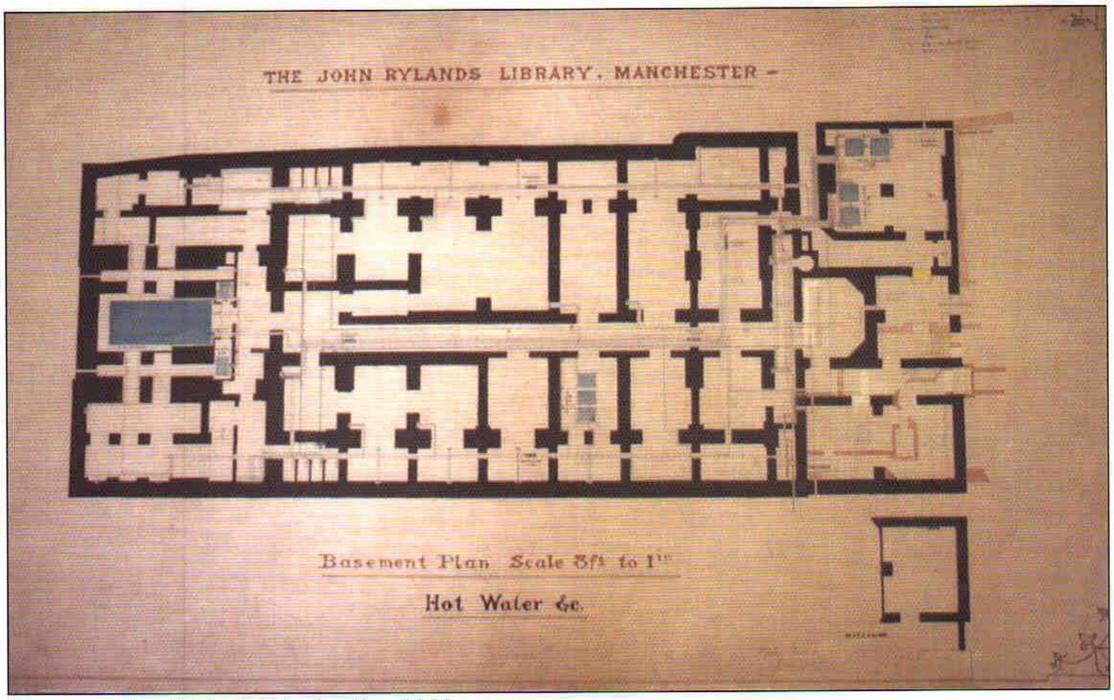


Lavatory

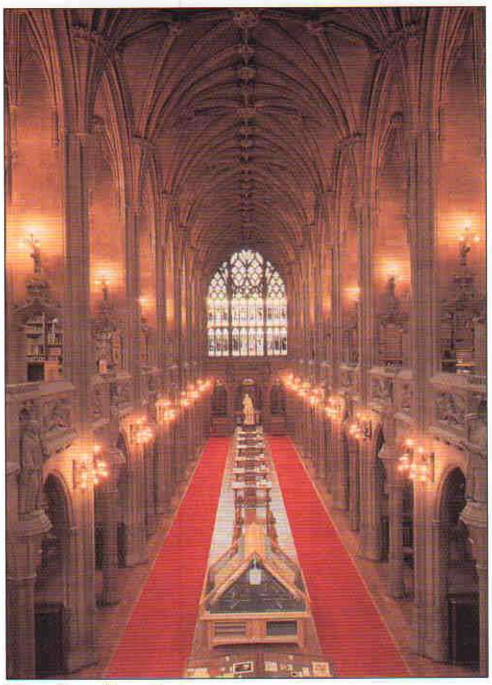
The John Rylands Library, Manchester, 1890-99

John Rylands was born in St Helens in 1801 and became Manchester's most successful cotton magnate. He died in 1888. None of his children survived him and his widow Enriqueta decided to build a magnificent public library in his memory. Basil Champneys was appointed architect. The engineering consultant was Charles Hopkinson. Work began in 1890 and the building was formally dedicated in 1899. The library was one of the first public buildings in Manchester to have electric lighting. This was provided to a standard much higher than the Phoenix Fire Office Rules. Initially, electricity was generated on site in an annexe housing three Crossley gas-engines, each driving a 45 kW Edison-Hopkinson dynamo to provide a 110 volts DC supply to some 1450 16-candlepower carbon filament vacuum lamps. Electric switches resembled gas taps and those in the main library are set in large bronze plates finished with an ornamental scroll. Cables were manufactured by The India Rubber Gutta-percha & Telegraph Works Ltd of Silvertown and were all replaced during the 1990's re-wire. Wires and cables are encased in solid drawn copper tubing with conduit accessories of gunmetal or bronze. Surface cables are encased in trunking made of coinage metal with ornamental covers. A mechanical ventilation system used a distribution system of twin ducts, one of warm air, the other unheated, allowing mixing to be accomplished by dampers on the inlet to each room. Other services included an hydraulic lift, a telephone in the librarian's office and speaking tubes to other rooms, plumbing and drainage. The original ventilation proved unsatisfactory, due to the inadequacy of the propeller fans used, and fan capacity was increased in 1911 by adding a centrifugal fan. A sympathetic restoration of the services is currently being carried out under the direction of Gifford & Partners.

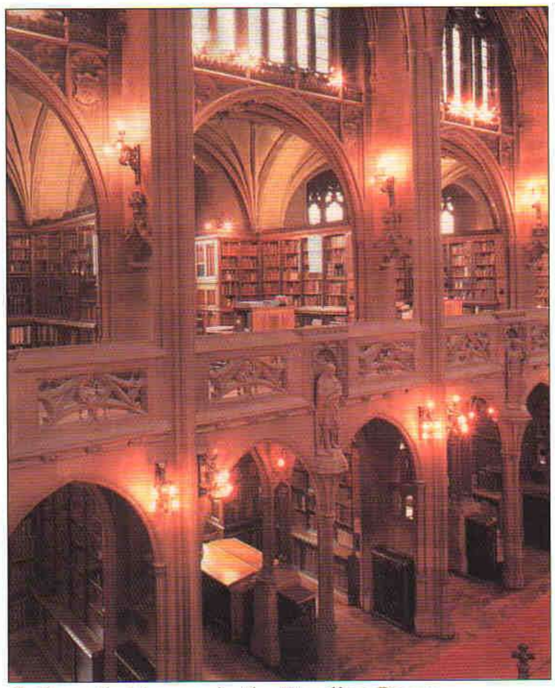
An illustrated guide to the present building is "The John Rylands Library," The University of Manchester, 2000.



Basement plan for hot water heating 1899



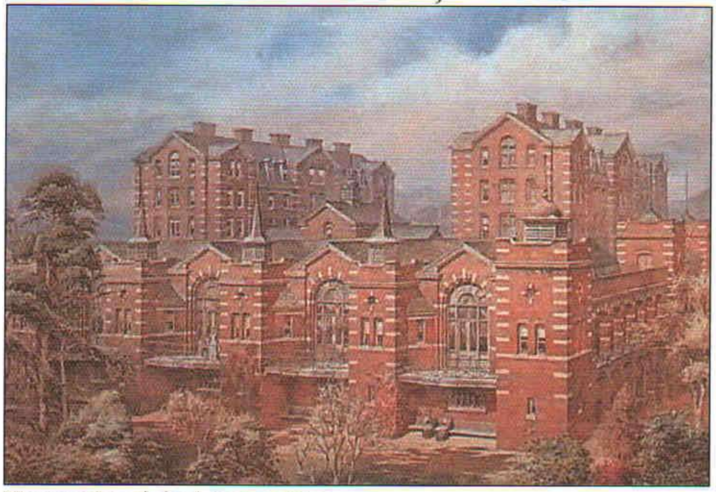
The Reading Room



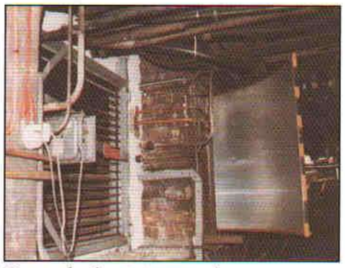
Gallery & Alcoves in the Reading Room

ROYAL VICTORIA HOSPITAL, BELFAST

Henry Lea



Henman's original perspective



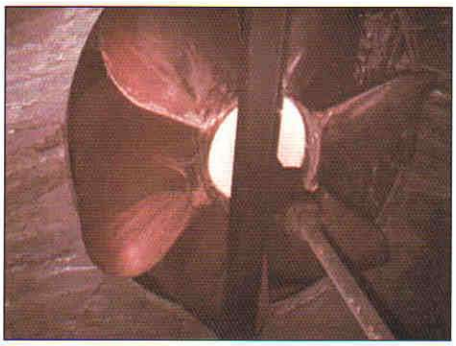
Branch duct to ward

Louvered extract lantern

Royal Victoria Hospital, Belfast, 1898-1903

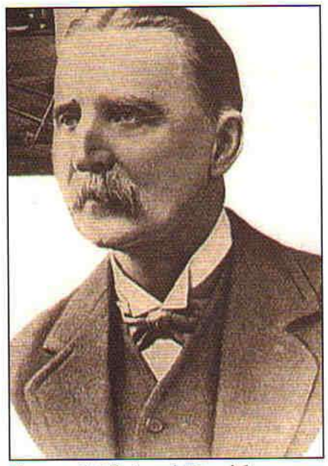
The architect and engineer for the Birmingham General Hospital of 1893-97 were William Henman and Henry Lea, assisted by the Glasgow engineer William Key, a pioneer of plenum ventilation. In 1898, Henman and Lea were appointed for the new Royal Victoria Hospital in Belfast. Both knew there was scope for the improvement of environmental systems. Operating theatres and 17 wards were provided under a continuous roof. A very large brick lined air duct 9 ft wide and 433 ft long ran beneath the main corridor. Lea determined this size was necessary to provide 7 air changes/h in winter and 10 in summer. Two fans, each of 9 ft 2 in diameter were provided, driven by a steam engine, with the exhaust steam used to heat domestic hot water. The local engineer Samuel Cleland Davidson played an important role. The Davidson Works was producing some of the world's most advanced centrifugal fans and was responsible for designing, installing and maintaining much of the central plant. A sprinkler system, used to moisten the fresh air filters, was regulated on the basis of regular readings of wet and dry-bulb temperatures, a very early example of the conscious control of humidity. Much of the central plant remains in place, including the steam engine which is still operational.

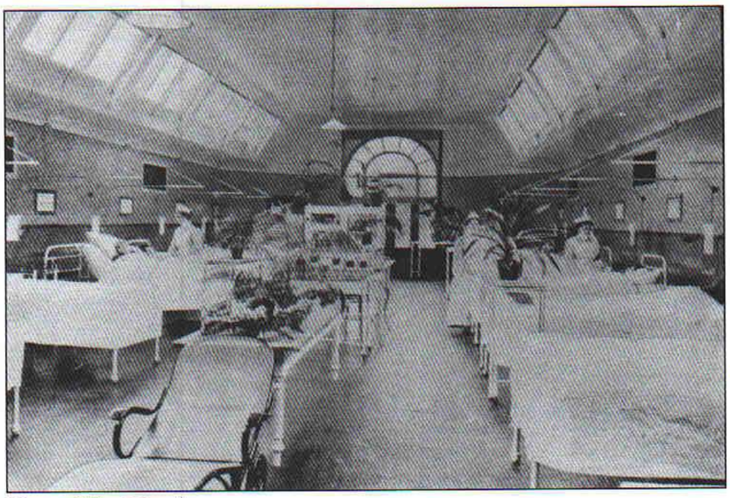
More information is contained in "Henry Lea, Consulting Engineer, 1839-1912," Henry Tovey, Hoare Lea & Partners, undated.

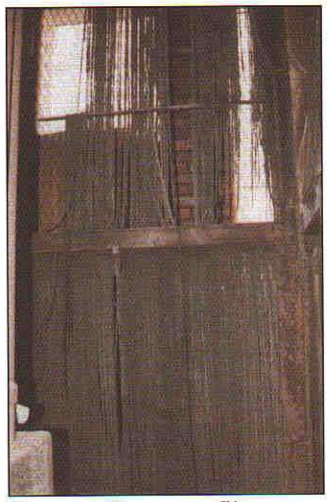


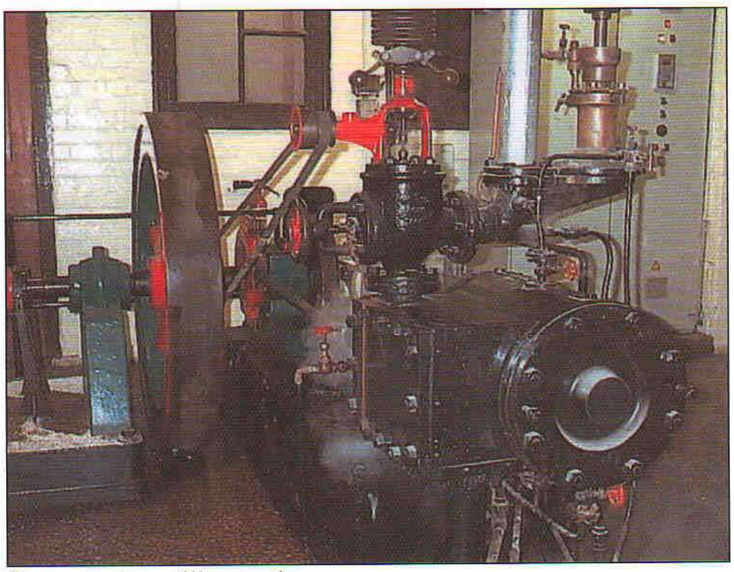
Davidson fan


South side of ward block 1903


Samuel Cleland Davidson


One of the Wards

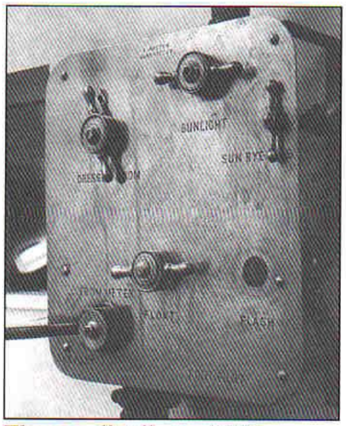

Coconut fibre rope filter wetted by sprinklers


Steam engine, still operating

BUXTON OPERA HOUSE

The auditorium

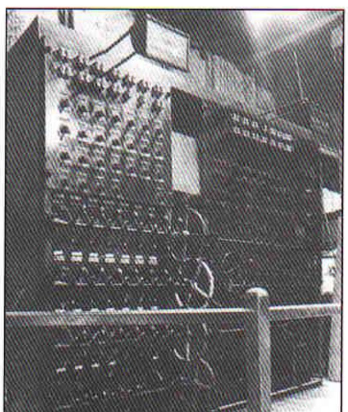
Buxton Opera House, Derbyshire, 1903



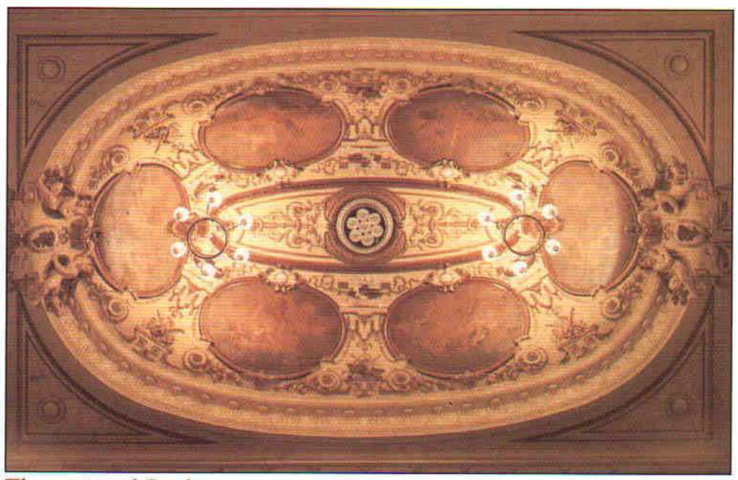
The gas distributor 1903

The designer was Frank Matcham, possibly Britain's finest theatre architect. The Opera House, which seats 946 people, was equipped with both gas and electrical lighting systems. The original natural ventilation system, now reinstated, includes the gas-fired ventilating light or Sunburner, modified for natural gas and located in the centre of the dome of the auditorium. The gas distributor, housed on-stage, had a series of controls covering pilot, sunlight (sun burner), sun bye-pass, and controlled the flow of gas to the dressings room and to the Float (footlights). The Float was a sophisticated triple system: pilot, flash and main supply. The pilot lit the flash and the flash lit the whole of the footlights, providing safe and gentle ignition (a patent of 1888). The gas distributor was taken out of use in 1938 when an electrical control board was provided by Strand Electric. An ambitious programme to restore the Opera House was completed in 1979.

A brief description of the refurbishment is in "Buxton Opera House," Arup Associates and others, Peak Press, c.1981.

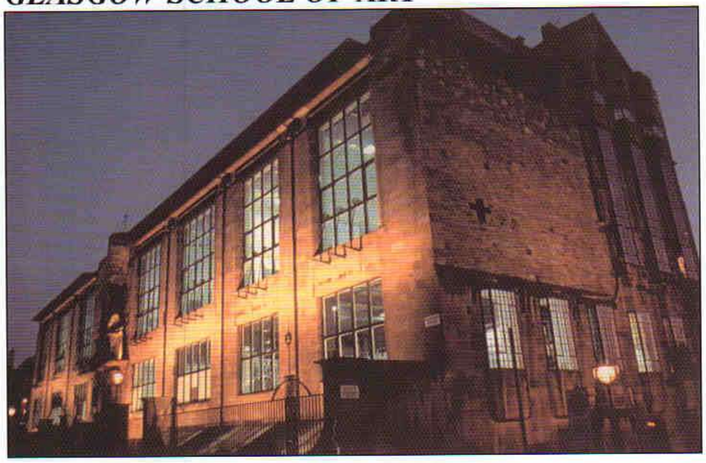


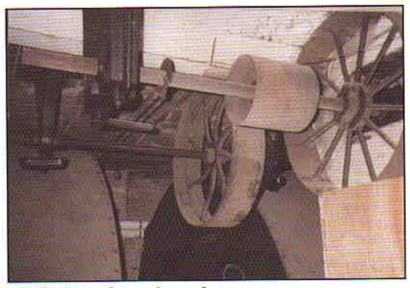
The electrical control board



The restored Sunburner

GLASGOW SCHOOL OF ART



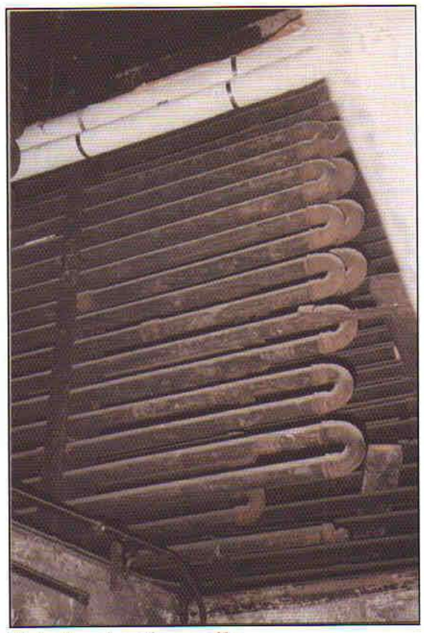


Existing fan chamber

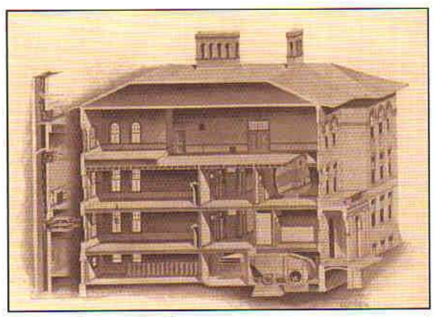
Glasgow School of Art, 1897-1907

The winner of the architectural design competition for the School was Honeyman and Keppie, within which Charles Rennie Mackintosh was a salaried architect. Keppie had earlier worked with the engineer William Key who had designed a plenum system for the Glasgow Victoria Infirmary, opened in 1890. Key, with Robert Tindall, took out British Patent No. 19,900 in 1892 which detailed a basic air conditioning system to control temperature, humidity and air cleanliness, using water sprays, blocks of ice, steam coils and hanging rope filter screens. The specification of 1896-97 for the first phase of construction of the School refers to a ventilation system having water sprays and hung rope air filters, but no direct link with Key has been established. The detailed design was the responsibility of the contractor. In this, B F Sturtevant, who illustrated the principles of such systems in their catalogues of the era and who were suppliers of the two main centrifugal supply fans, may have rendered assistance. During the second phase of construction in 1907-9, both filters and sprays were renewed. The plenum system was taken out of use in the 1920s and replaced by an intrusive radiator system. Recent surveys have shown that the original fans remain with steam heating coils, basement and ceiling ducts and the dampers and grilles largely intact.

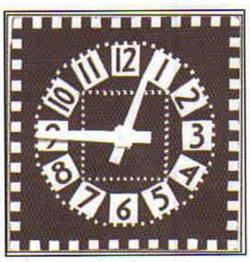
A modern study of the environmental systems is "Glasgow School of Art," George Cairns, Charles Rennie Mackintosh Society, Newsletter No.66, Winter/Spring 1995.



Existing heating coils

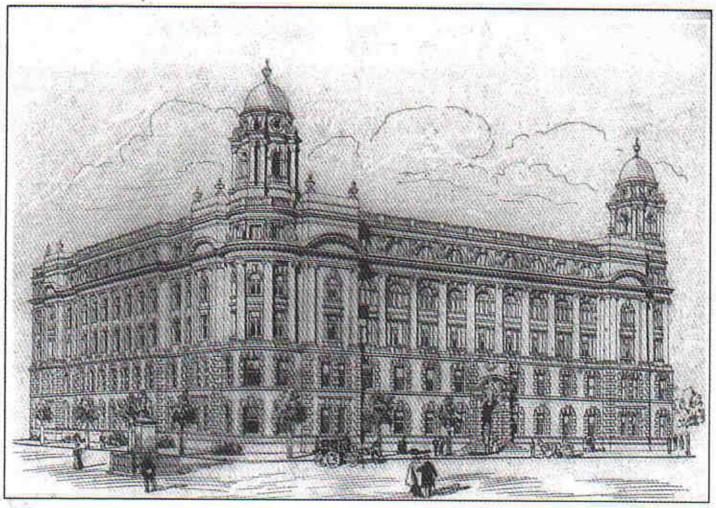


School ventilation
[Sturtevant catalogue 1896]



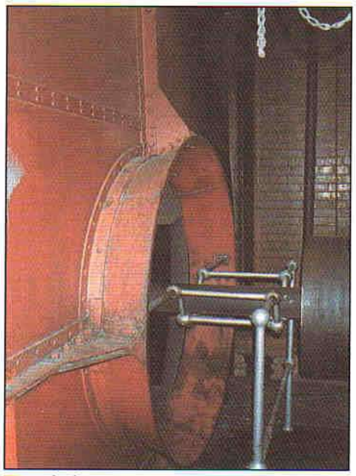
Master clock system

MUNICIPAL TECHNICAL INSTITUTE, BELFAST



Musgrave "Ulster" fan nameplate

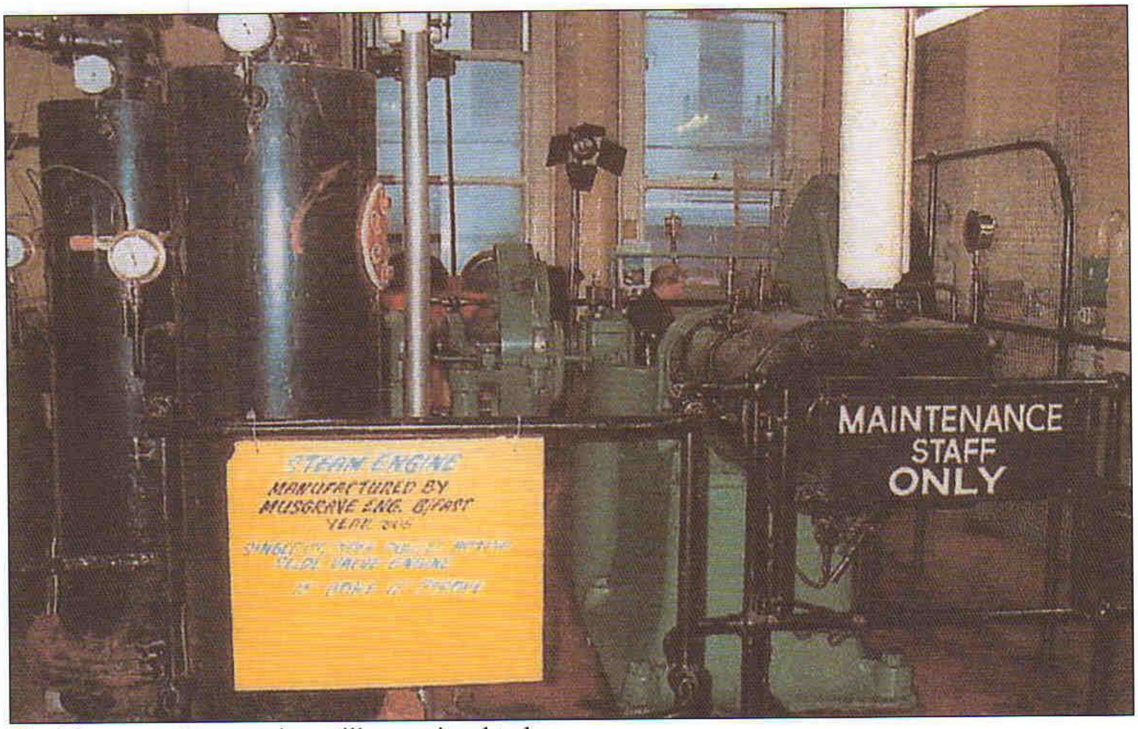
Henry Musgrave



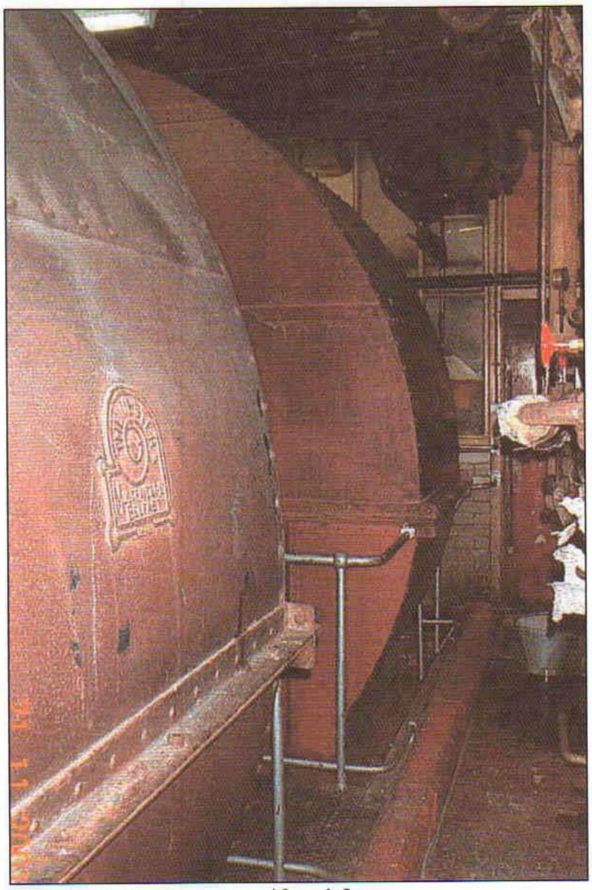
Fan inlet

Municipal Technical Institute, Belfast, 1900-7

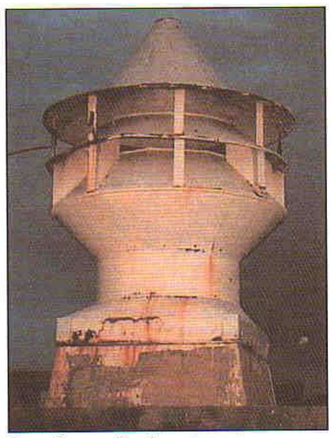
The choice of architect, Samuel Stevenson, without competition, and the choice of style, provoked much controversy. Stevenson had designed the enormous Gallaher factory. The completed Institute was attacked as a straight crib from the War Office in London, considered by many to be a deplorable building. The Heritage Group has discovered the Estimate for Heating & Ventilating submitted by Musgrave & Co Ltd, dated 14th August 1905. Their main quotation proposed using their "Fan" system, renewing the air within the building up to four times per hour, delivering 140,000 cu ft/min and giving individual control of the temperatures and air volumes to each room. The scheme was based on using a Tempering Coil of 5200 sq ft with a Main Heating Coil of 4000 sq ft, both supplied with hot water by forced circulation. Two Musgrave "Ulster" centrifugal fans with 11 ft diameter wheels would be driven by a single horizontal steam engine with alternative provision for driving from a 42 or 50 hp electric motor. The scheme included 60 air inlet gratings, 150 extract gratings, 4 main dampers and 128 patent "Curtain" air regulating valves. The Musgrave Tender amounted to £2660. Various options were offered, including a Musgrave Patent Rainbow Washer for £220. This was actually a 9ft diameter spinning disc humidifier, of the type supplied to Glasgow Technical School. An alternative bid, using steam for heating, came to £1570. Much of the original installation survives, including fans, the steam engine, the washer, gratings and heating apparatus.



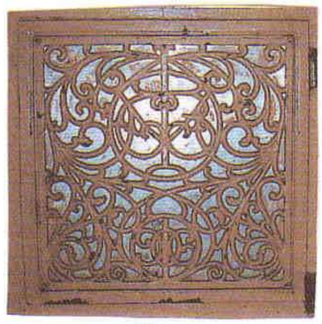
The Musgrave steam engine, still operational today



The two Musgrave centrifugal fans

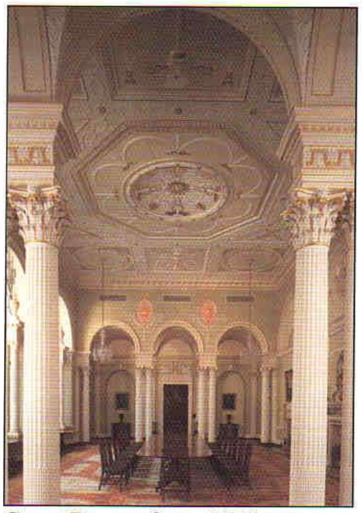


Roof ventilation turret

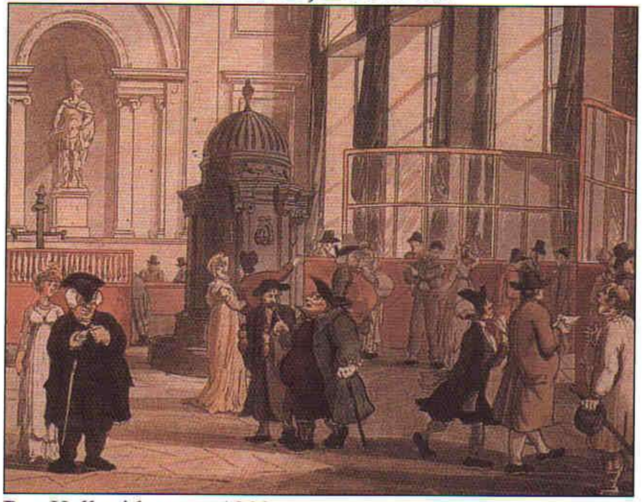


Musgrave grille

BANK OF ENGLAND, LONDON

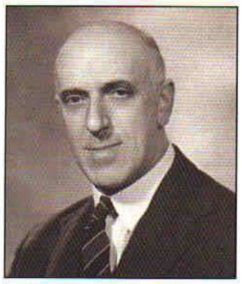


Court Room, from 1760s



Pay Hall with stove 1808

Oscar Faber

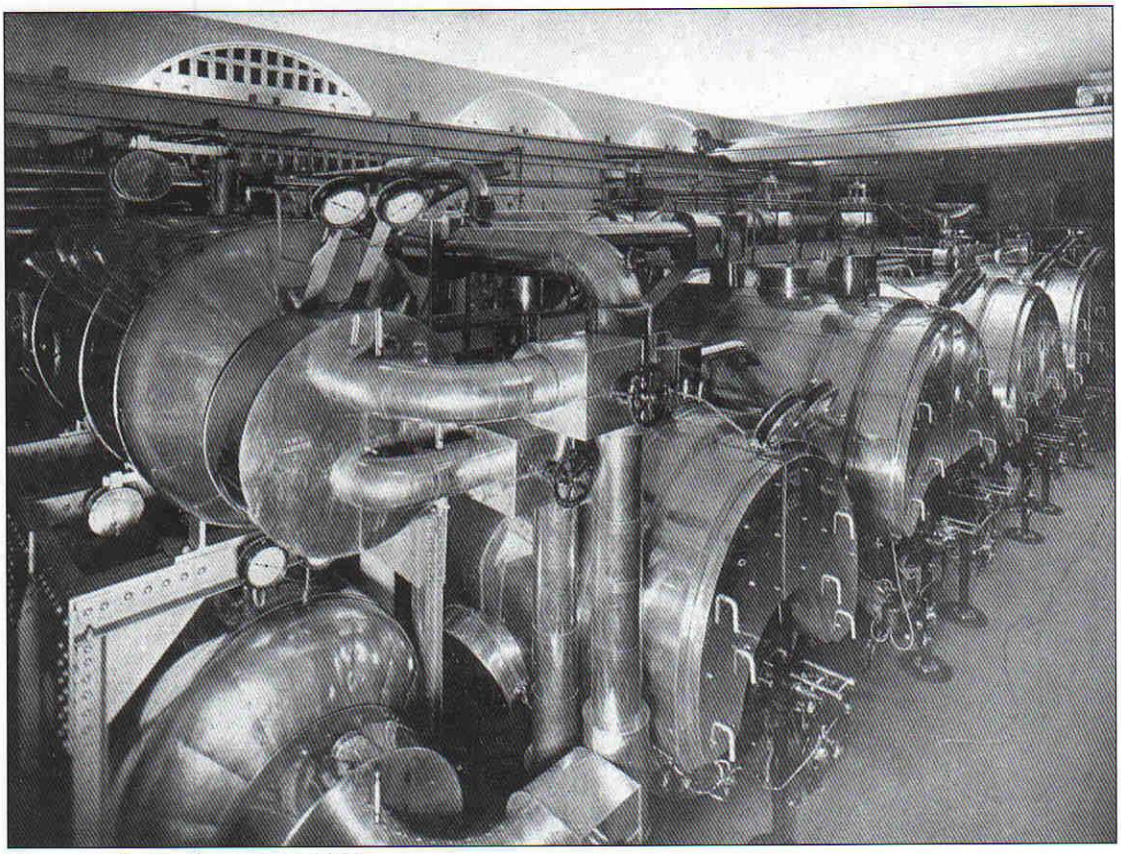


John Robert Kell

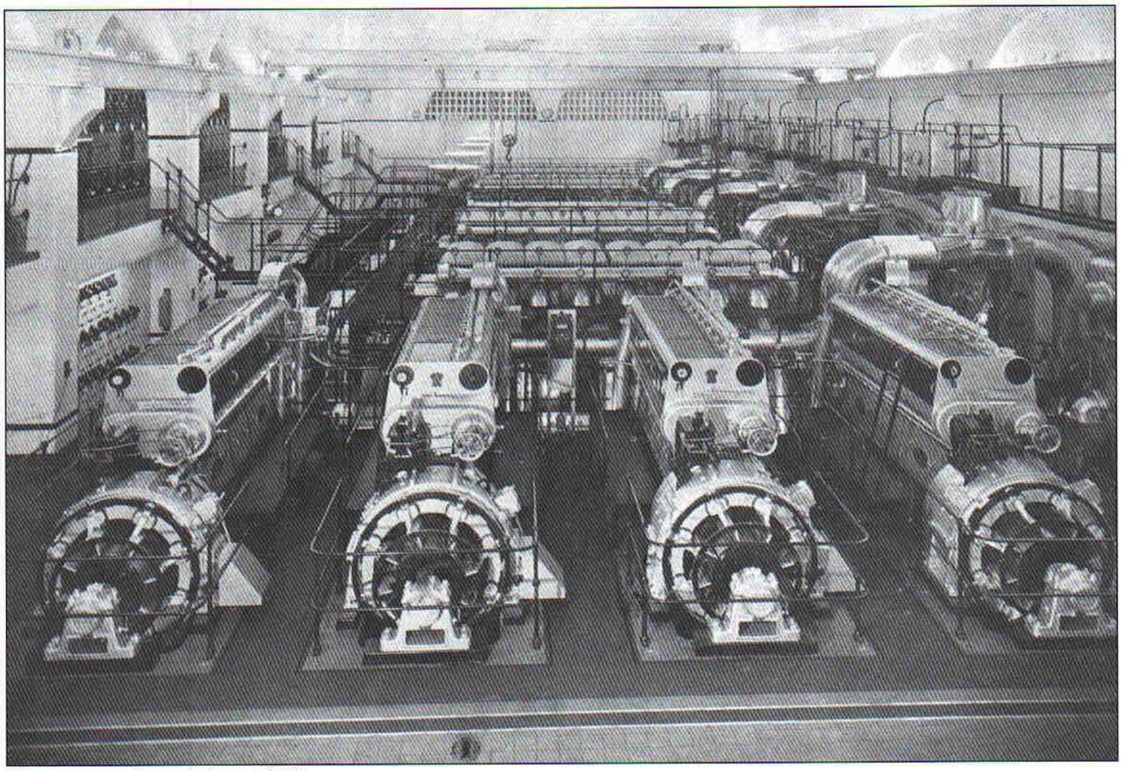
The Bank Of England, London, rebuilt 1921-37

The Bank of England was established in 1694 and its early years were spent in a variety of rented premises. In 1724 the Bank bought a plot of land between Threadneedle Street and Lothbury, gradually buying out various leaseholders and then accepting a plan by George Sampson, so that the foundation stone was finally laid in 1732. Over the next fifty years or so the Bank was gradually expanded to the designs of Robert Taylor, but upon his death in 1788 the Governors appointed John Soane as Architect of the Bank of England. For the next 45 years Soane continued to enlarge and restore the Bank. Soane embraced traditional heating by fireplaces and stoves and at the Bank used a variety of heating stoves and designed an underfloor warm air system, based on the Roman hypocaust, but this latter was not carried out. [Elsewhere, Soane took a keen interest in the development of central heating using steam, hot water and warm air. Many contemporary installations were recorded by Soane's assistant, C J Richardson, who wrote a pioneering textbook *Warming and Ventilation of Buildings* in 1837.] The Bank survived with some alterations until the 1920s & 30s when it was largely rebuilt to the designs of Sir Herbert Baker. Oscar Faber & Partners was appointed as consultants in 1924 and J R Kell supervised the M&E services. The mechanical contractor was Rosser & Russell and their work included the installation of embedded heating panels , acting as a licencee for the proprietary Crittall system. Kell also designed an extensive air conditioning system with carbon dioxide refrigerating plant. The electrical contractor was Drake & Gorham. The generating station operated on combined heat and power principles. There were five 520 kW and four 300 kW diesel generators. The panel heating water was passed through the diesel engine cylinder jackets while the exhaust gases were fed into waste heat boilers, which were backed up by oil-fired boilers. This arrangement produced a total thermal efficiency of 75%.

Outline details of the services are given in "Oscar Faber," John Faber, Quiller Press, London, 1989, 29-33.

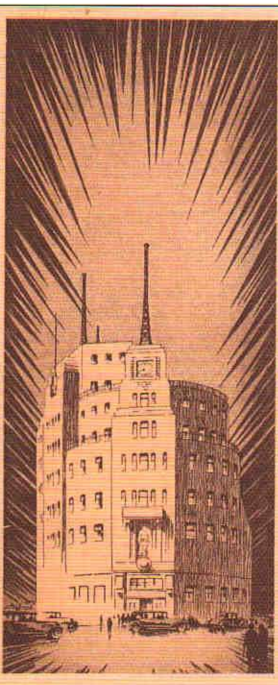


The upgraded boiler room c.1950



The generating station 1920s

BROADCASTING HOUSE, LONDON

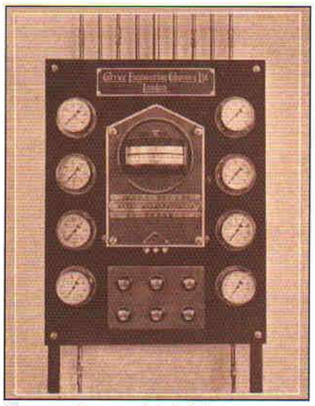


THE BROADCASTING HOUSE OF THE B.B.C. PORTLAND PLACE, W.1
AIR CONDITIONED BY CARRIER

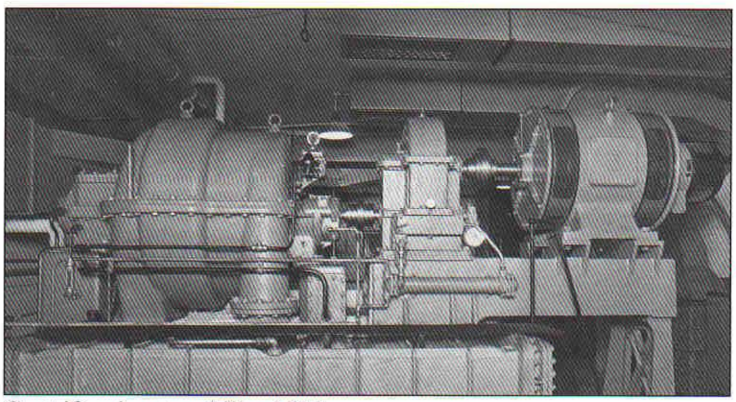
Broadcasting House, Portland Place, London, 1931

The challenge was to combine 22 radio broadcast studios, which had to be acoustically isolated and air conditioned, with administrative offices enjoying maximum natural daylighting. The architect, Val G Myers, solved this problem by placing the studios in an inner core, surrounded by an outer shell of offices. The air conditioning was designed and installed by Carrier Engineering Company Ltd. The studios were served by four air handling plants with chilled water spray-type washers and steam reheat coils. Refrigeration was provided by a 200 TR centrifugal water chiller. The steam raising equipment consisted of two 6700 lb/h oil-fired return tube boilers. A contemporary description of the installation reads: "There are 32 fans handling 614 tons of air per hour, 16 pumps delivering 641 tons of water per hour under pressure, 54 electric motors having a combined capacity of 504 hp, sheet steel ducting weighing 120 tons, and 60 independent automatic controls."

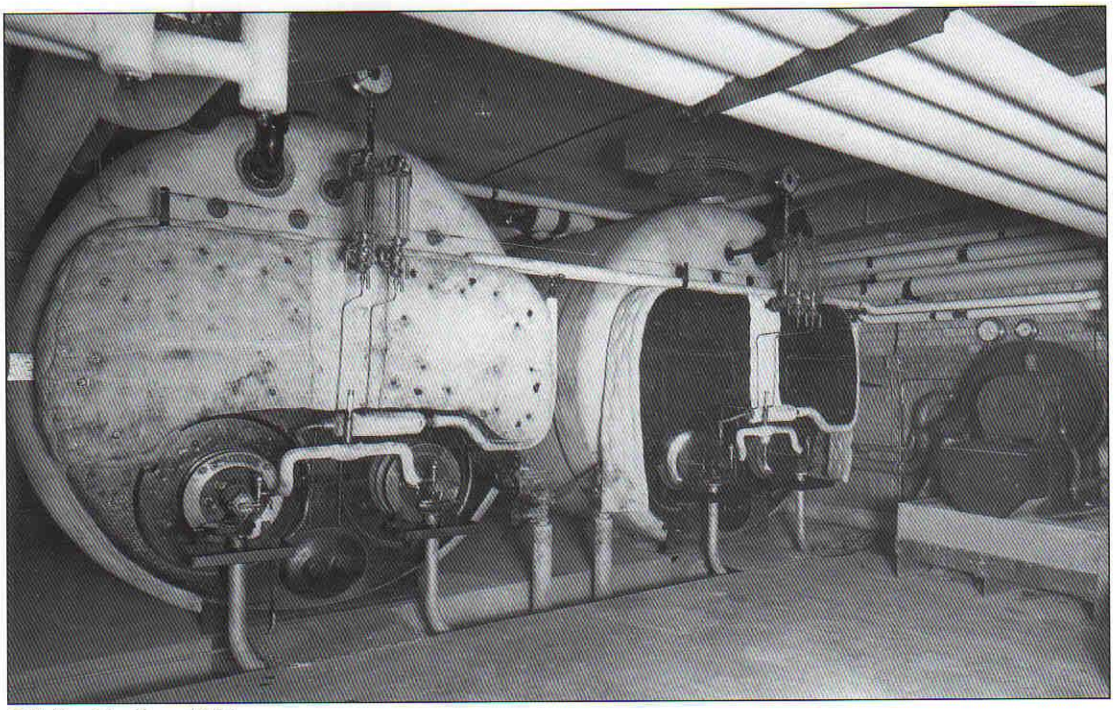
The services are described in "An Air Conditioning Achievement by Carrier," brochure of Carrier Engineering Co Ltd, London, c.1931.



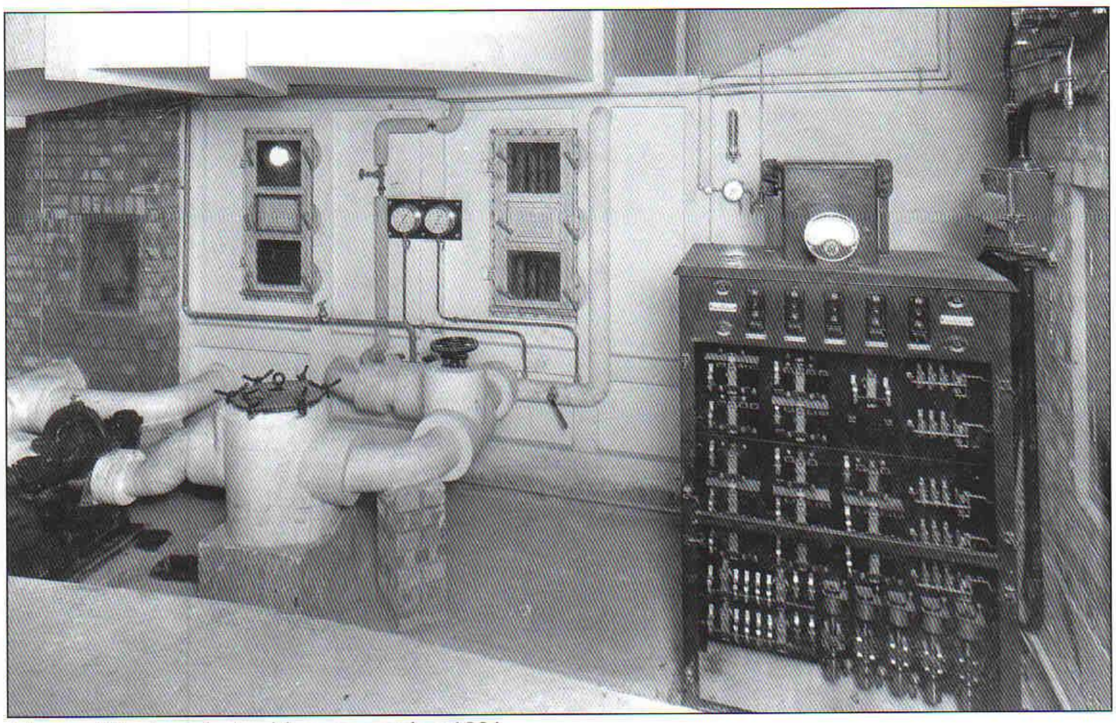
Control panel 1931



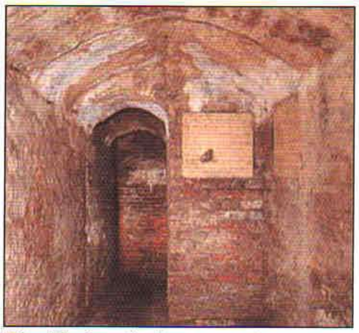
Centrifugal water chiller 1931



Oil-fired boilers 1931

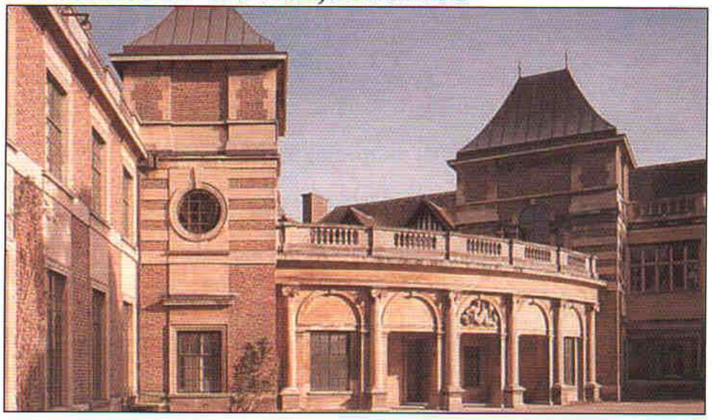


Air conditioning plant with spray washer 1931



The Tudor drainage system

COURTAULD HOUSE, ELTHAM



The kitchen 1936

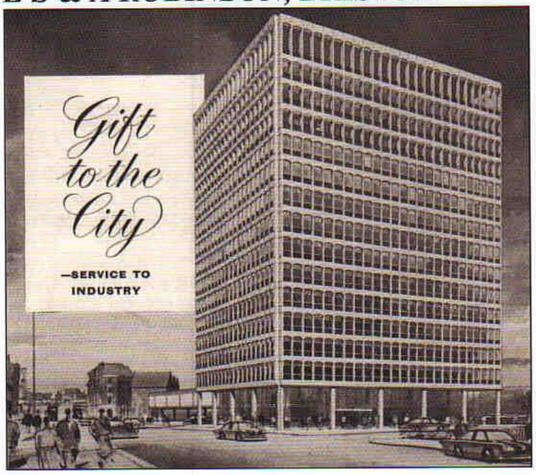
The central vacuum cleaner

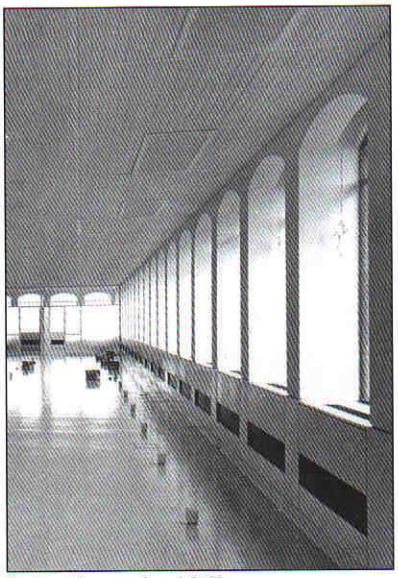
Courtauld House, Eltham Palace, London, 1933

Eltham Palace is one of the few surviving medieval royal palaces in England. It was a moated manor house when it was acquired by the future Edward II in 1305. Many changes were made by Edward IV, including the addition of the Great Hall in the 1470s. Part of Henry VIII's underground drainage system still survives. For 200 years after the Civil War it was a farm. In the 1930s, an ultra-modern private house adjoining the Great Hall was built by Stephen and Virginia Courtauld, a substantial fortune being available to Stephen through his inherited shareholding in the family business empire based on the manufacture of rayon (artificial silk). The architects, John Seely and Paul Paget, sought to blend the new house exterior with the existing palace but the outstanding feature is the quality of the interior décor for which many of the leading designers of the day were employed. There was gas central heating. The principal rooms were heated by hot water panels embedded in the ceilings with embedded floor panels used in the Entrance Hall, Great Hall and bathrooms. The ten en-suite bedrooms had electric fires and heated towel rails. Virginia Courtauld's bathroom had gold-plated taps. There were synchronous clocks throughout the house and a loudspeaker system to relay music to the ground floor. A private internal telephone exchange was provided by Siemens in 1936. The kitchen had two Jackson electric cookers and a Kelvinator refrigerator, rare items at this date. A centralised vacuum cleaning system was supplied by the British Vacuum Cleaner Company and located in the basement. Built-in pipes were connected to skirting sockets in each room, enabling a hose to be fixed to the socket and dirt sucked down into the basement apparatus.

The Courtauld House is featured in the guide "Eltham Palace," Michael Turner, English Heritage, London.

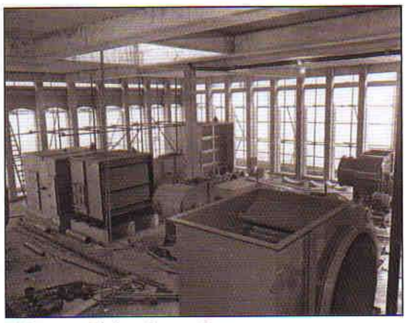
E S & A ROBINSON, BRISTOL

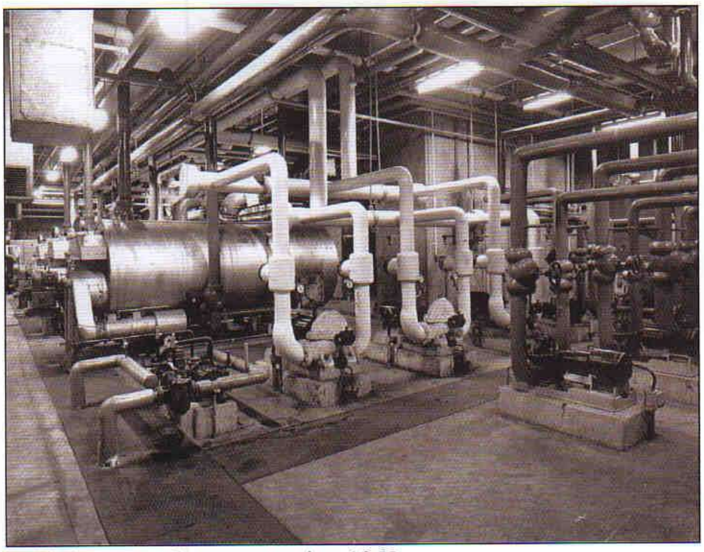



Induction units 1962

E S & A Robinson, Bristol, 1962

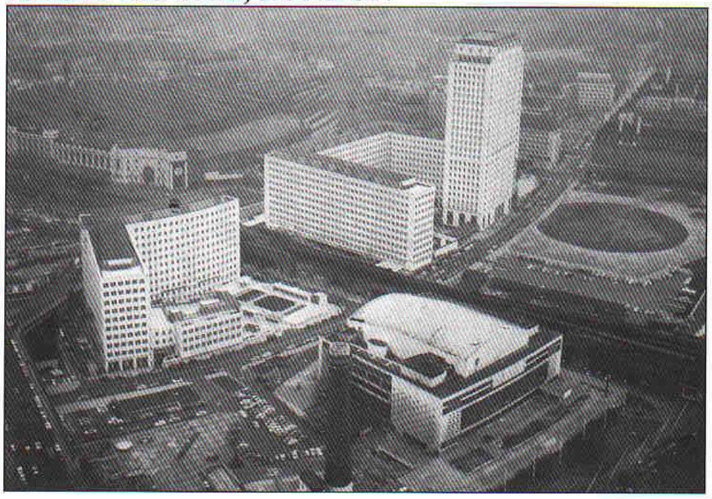
The original office building of the packaging and printing firm of Robinson appears in old Bristol photographs of the 1880s. The building was seriously damaged by fire in 1903 and partially destroyed in the blitz of 1940. The new 15-storey headquarters of the E S & A Robinson Group was designed by John Collins of their architects department. It was one of the first major UK office blocks to be air conditioned, the design and installation being carried out by G N Haden & Sons Ltd. The system was of the perimeter induction type, using 810 units. The refrigeration plant comprised of two centrifugal water chillers, each of 300 TR capacity. The heating plant was three packaged HPHW economic shell type boilers, each rated at 3.25 million Btu/h, operating at 6 bar and 300 degF. Research by the Heritage Group has unearthed original construction photographs, installation drawings and the commissioning plan.


Air conditioning plant awaiting assembly 1962


Boilerhouse under construction 1962


The office block 2002

SHELL CENTRE, LONDON



Shell 1997 (above) and the site in 1962 (right)

Shell Centre, London, 1953-62

The Shell Centre was designed and built as the central offices of Royal Dutch/Shell Group companies in London to accommodate staff previously located in more than thirty different office buildings. The architect was Easton & Robertson, Cusdin, Preston and Smith. At the beginning it was decided that the whole building should be air conditioned with closed windows, the site being both dirty and noisy. The tower block is 351 ft high with 27 storeys above ground; other buildings have 11 storeys above ground. There are large basement areas, restaurant, kitchens, swimming pool and a theatre. The gross floor area of the original building was 1.884 million sq ft, at the time the largest air conditioned office block in Europe. After a design study, which looked at the environmental factors, maintenance, availability and cost of various systems, the choice was a chilled ceiling system with low pressure ducted air. Modular temperature control was achieved using perimeter circuits near the windows to provide heating in winter and cooling in summer, while inner core area circuits provided cooling only. The refrigeration plant comprised of three 900 TR centrifugal chillers using R12 each driven through a speed increasing gearbox by 1050 hp 3.3 kV motors. Condenser cooling was carried out using water from the River Thames. The boiler plant selected was one 40 million Btu/h and one 20 million Btu/h boiler burning heavy grade fuel oil of 6500 seconds Redwood No.1 viscosity. The mechanical services were designed and installed by G N Haden & Sons Ltd. The lighting, designed by Ewbank & Partners Ltd, employed over 38,000 fluorescent lamps and 18,000 fittings providing general office illumination levels of 320 to 375 lux. The refrigeration plant was used until 1995 when it was replaced by four centrifugal chillers, each of 2100 kW capacity, using R134a refrigerant. On the air handling side the original capillary washers have been replaced by dry steam injection. The boilers were refitted with dual fuel burners, using natural gas with 35 second oil as stand-by. The smaller downstream building has been redeveloped as luxury flats.

Secretarial office 1962

Main entrance hall 1962

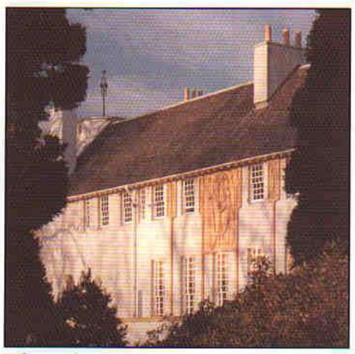
The systems are described in detail in "The Mechanical Services at Shell Centre," H C Jamieson & J R Calland, JIHVE, April 1963, 1-41.

General office in 1962

The restaurant in 1962

HOUSE FOR AN ART LOVER, GLASGOW

Heritage Group Meeting in the Music Room
[l-r: Brian Roberts, Ian Stewart, Bob McWilliam, Stephen Loyd, Mike Barber, Laurie Wilkins. Paul Yunnie took the picture.]



Elevation

Entrance Hall

House for an Art Lover, Glasgow, designed 1900, built 1996

In 1900, the Vienna magazine *Zeitschrift fur Innendekoration* announced a competition for the design of a house for a connoisseur of the arts. No first prize was awarded, but Glasgow architect Charles Rennie Mackintosh won a Special Prize. He died in 1928, his house unbuilt. Then in 1988, Graham Roxburgh, a Glasgow Civil Engineer, took on the challenge of building the Mackintosh house. The story of the fund-raising and the many difficulties, which had to be overcome, are a story in themselves. The completed house stands in Bellahouston Park. It serves as a tourist attraction, conference centre and art school. The M&E engineer was Donald Smith Seymour and Rooley but the services are modern, as required for a public building. However, the decorative lighting is in the true Mackintosh tradition.

"House for an Art Lover," book produced by Glasgow City Council and others, Glasgow, 1996.

Rear cover
Victorian wash hand basin
Cardiff Castle

Heating pipe in St Mary the Virgin, Emley Castle, Worcs.
In Commemoration of the Queen's Jubilee 1887.

ACKNOWLEDGMENTS

I should like to thank all those members, past and present, of the CIBSE Heritage Group who have contributed to this publication through visiting, researching and photographing engineering services in a wide variety of historic buildings. In particular, I must thank Mike Barber (Hon Secretary), Ian Stewart (Hon Treasurer), John Barnes, Geoff Brundrett, David Drewe, Stephen Loyd and Frank Ferris (our Newsletter Editor & Webmaster). A very special thanks goes to Paul Yunnie (Vice-Chairman), not only for his many contributions, but particularly for arranging the sponsorship and printing of this publication. I would also like to thank our friends at English Heritage and the National Trust for their valuable assistance. Last but not least, I must thank our Sponsors without whom this book would not have been possible.

BMR , Tadworth, Surrey, 2003

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