



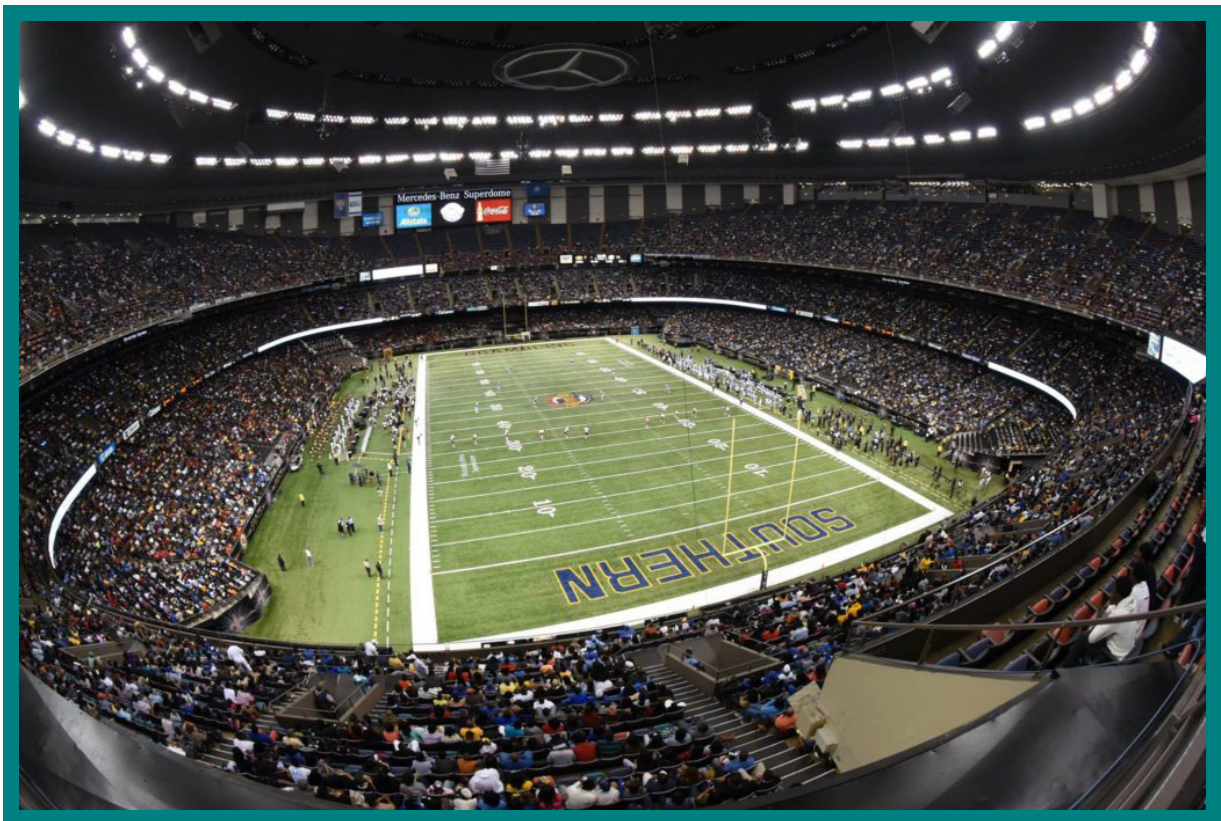
Building Engineering Services
HERITAGE REVISITED
PART FOUR

Brian Roberts
CIBSE Heritage Group



The new air conditioned British Library in London's Euston Road, said to contain some 200 million items, opened in 1998; the planning, design and construction taking over 30 years.

NEW ORLEANS SUPERDOME



The New Orleans (now Mercedes-Benz) Superdome, opened in 1975, is a fully air conditioned enclosed sports and exhibition stadium capable of seating up to 76,000 people. The dome encloses 125 million cubic ft, is 253 ft high and has a diameter of 680 ft.

VICTORIA & ALBERT MUSEUM, LONDON



Opened in 1852, the V & A Museum has a permanent collection of over 2.2 million objects

INTRODUCTION

This is a continuation of the first *Building Services Heritage* and later *Revisited Parts-1 & 2*, being a sequel to Part-3. All the buildings and structures have been visited or stayed in by the writer. Some are included because of their historical importance. For most of those in the UK, from the 1960s onwards, the writer has been involved in the air conditioning design or installation.

CONTENTS

HISTORICAL BUILDINGS

Kew Palm House, London-*front cover-3* , Bicton Palm House, Devon-*inside front cover*, V & A Museum, London-3,
Royal Pavilion, Brighton-4, Eltham Palace, London-44, Westminster RC Cathedral-*inside back cover*

HOTELS & RESTAURANTS

Moana Hotel, Honolulu-10, Royal Hawaiian Hotel, Honolulu-11, Lyons Corner House, Oxford Street, London-12,
Peachtree Plaza Hotel, Atlanta-14, Bonaventure Hotel, Los Angeles-15

THEATRES

Empire Leicester Square-16, New Victoria, London-17, Radio City, New York-18

OFFICES & DEPARTMENT STORES

Southampton Docks Transport Offices-20, Cadbury Office Block, Bournville-21,
Bentalls Store, Bracknell-22, Fenwick Store, Brent Cross-23,

SKYSCRAPERS

Empire State, New York-24, Galfa Tower, Milan-26, Britannic House, London-27, Connaught Centre, Hong Kong-28,
Kings Reach Tower, London-30, La Tour Maine-Montparnasse, Paris-31, Sun Hung Kai Centre, Hong Kong-*back cover*

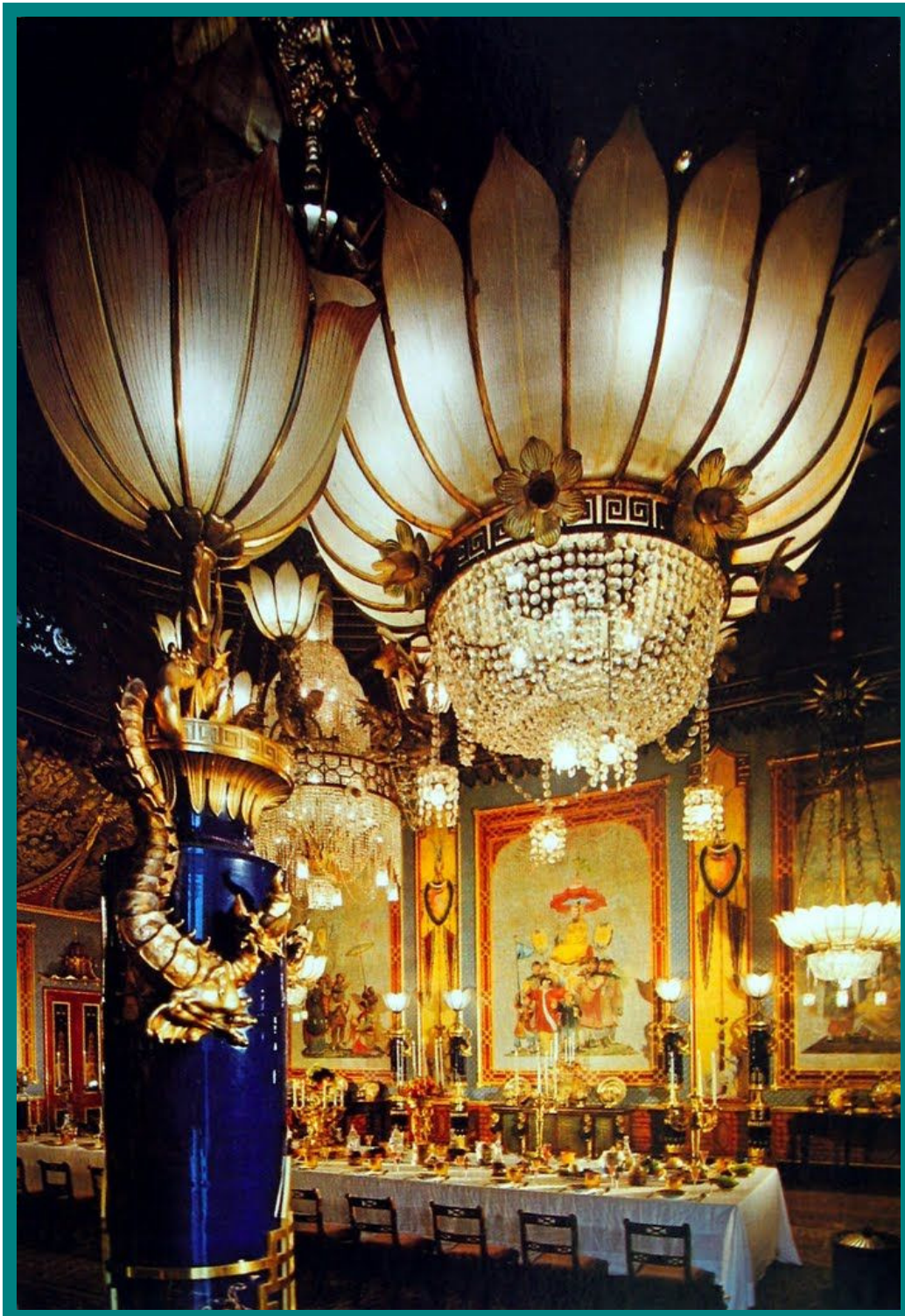
STRUCTURES & INDUSTRIAL

Carrickfergus Gas Works, Belfast-8, Statue of Liberty, New York Harbour-32, Kai Tak Airport, Hong Kong-34,
Rockefeller Ice Rink, New York-36, San Francisco Bay Area Rapid Transit-38, W.D. & H.O. Wills, Hartcliffe, Bristol-40

OTHER

British Library, London-1, New Orleans Superdome-2, Cable & Wireless, Hong Kong-42,
Royal Hallamshire Hospital, Sheffield-43

ROYAL PAVILION, BRIGHTON



The original building dating from 1757 was redesigned by John Nash around 1820, serving as a Royal Residence for the Prince Regent and others. The Music Room (pictured above) had extravagant gas chandeliers (now electric) and the Pavilion had an underfloor hot-air heating system, hot and cold water supplies, water closets and a bathroom.

ROYAL PAVILION, BRIGHTON



The kitchen was entirely steam heated and equipped with a steam table, kitchen range, steam kettles and hot closets, stewing stoves and a kitchen grate with revolving spits powered from a chimney fan. The high ceiling had sash windows for ventilation and suspended oil lamps for lighting.

There was a wide range of ancillary rooms and equipment including a water tower, pumped water storage and an extensive piping system. Other rooms were devoted to confectionery and pastries, with a bakery and provision for plate cleaning. There was an ice-house in the grounds and an ice storage room.

KEW PALM HOUSE, LONDON



Opened in 1848, the Palm House is the first greenhouse to be built on this scale and claims to be the first large structure using wrought iron. The building is 361 ft long and 100 ft wide, rising to a height of 66 ft. It is made up of 5500 components and has some 16,000 panes of glass.

The original hot-water heating plant consisted of two hand-fired coal boilers of Burbidge, Healey & Company manufacture connected to about 27,000 ft of heating pipes laid underground. The pipes were laid along the facade beneath a series of 4 ft square cast-iron gratings. The heating system was designed to provide a temperature of 80 degF inside the Palm House when the external temperature was 20 degF.

The boilers were housed in two cellars close to the hothouse. Provided with sufficient storage for fuel, they were connected by a 558 ft long tunnel to a coal bunker adjacent to a nearby road. The coal was supplied and the ashes taken away by a truck pulled along the rails in the tunnel. To avoid the necessary masonry chimney spoiling the view of the greenhouse, a campanile-style tower was built some distance away.

Over the years, there have been many changes to the heating plant- new boilers, changes to the piping circuits, relocated boilers and the tunnel being used only to house piping systems. Between 1984 and 1988, this Grade I listed building was completely dismantled, restored and rebuilt.

KEW PALM HOUSE, LONDON

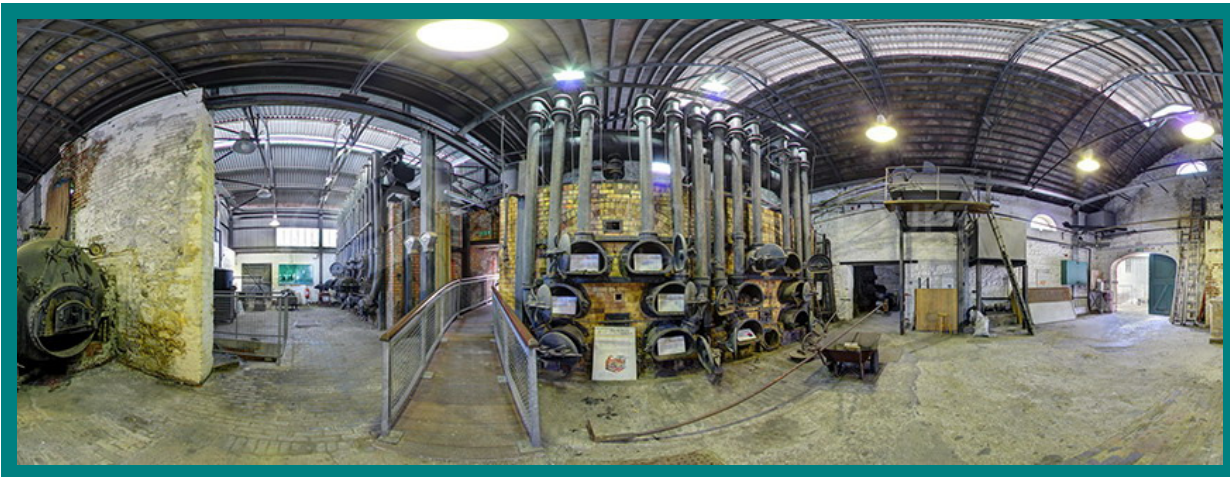


Restoration underway in October 1985, the underfloor heating pipes having been removed



The restored interior

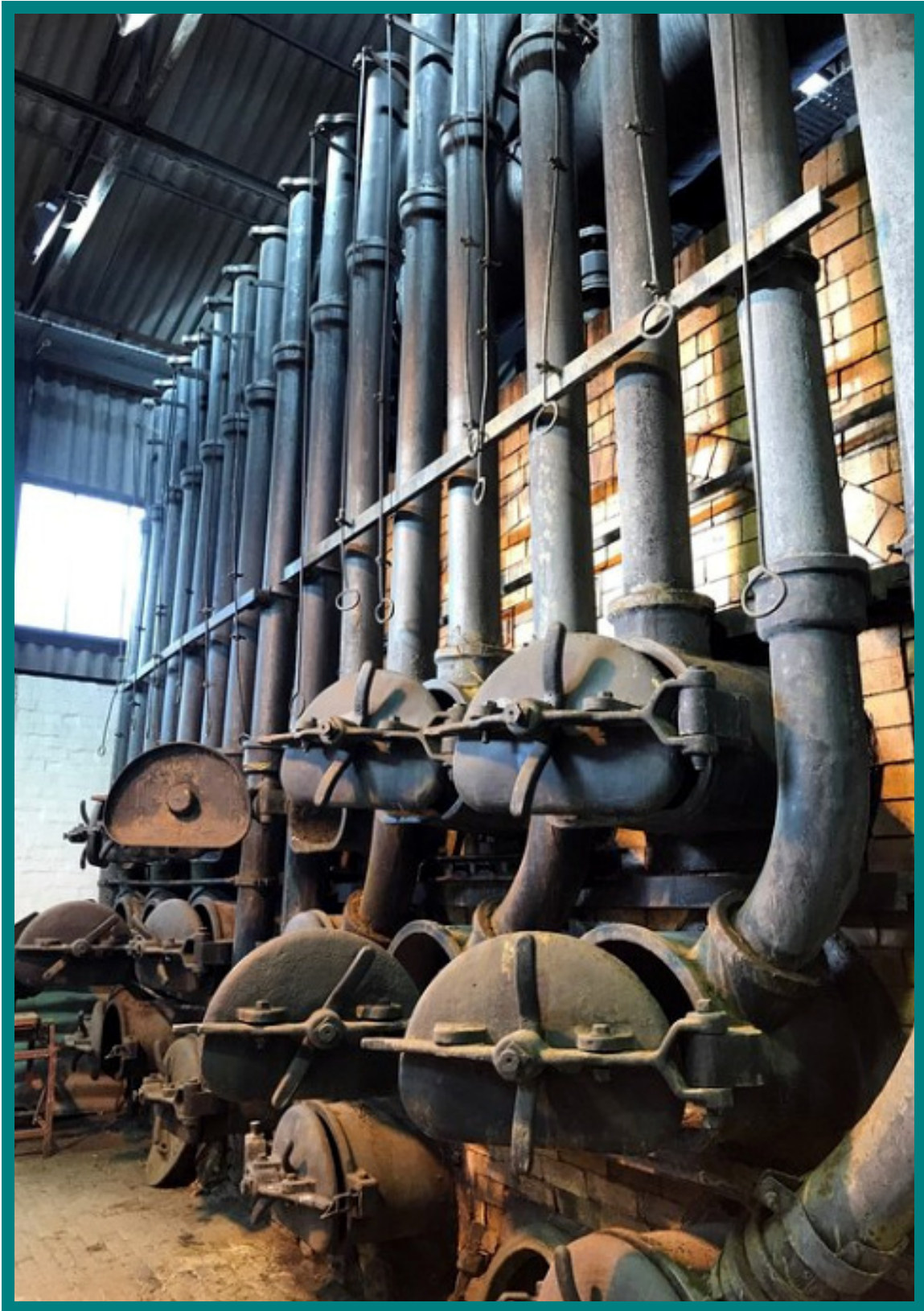
CARRICKFERGUS GAS WORKS, BELFAST



The Gas Works and a 360 degree panoramic view of the interior

Now the Flame Gas Museum, the works are one of only three surviving coal gas works in the UK. Opened in 1855, it supplied Carrickfergus until 1965 and was closed in 1967. It was restored and has been a Museum since 2002.

CARRICKFERGUS GAS WORKS, BELFAST



The retorts once used for the manufacture of coal gas

MOANA HOTEL, HONOLULU



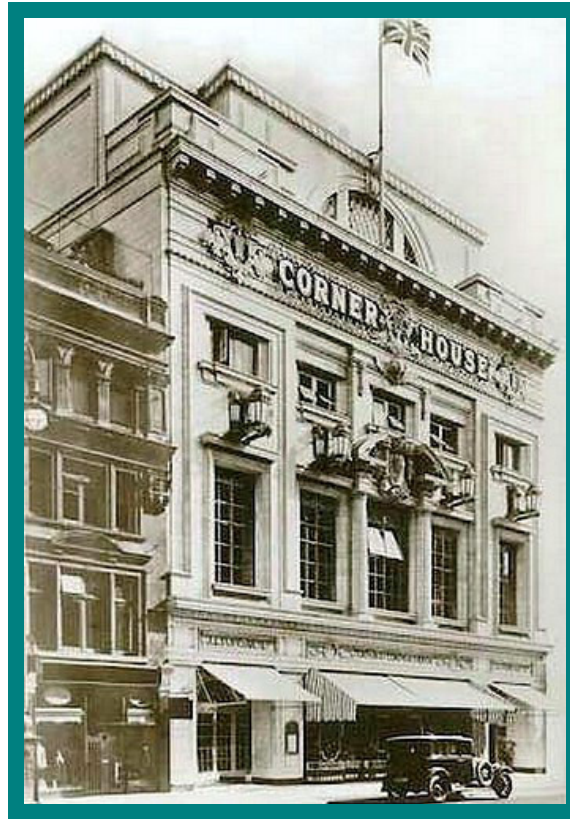
Designed in the Colonial style and opened in 1901, the then 75-bedroom hotel (before air conditioning) was the first on Waikiki beach, and designed for natural cross ventilation taking advantage of the beach breezes. Unusually for the time, some bedrooms had bathrooms and telephones. The hotel also had its own ice-plant and electrical generators. Two floors and wings were added in 1918 and bungalows built in the grounds in the 1930s.

ROYAL HAWAIIAN HOTEL, HONOLULU



Built in 1927, with 400 rooms, the luxury Royal Hawaiian Hotel on Waikiki Beach has been host to numerous celebrities and world dignitaries, including President F.D.Roosevelt during the Second World War. Its architecture in the Spanish/Moorish style and its bright pink concrete stucco facade has earned it the nickname of "The Pink Palace of the Pacific."

LYONS CORNER HOUSE, LONDON

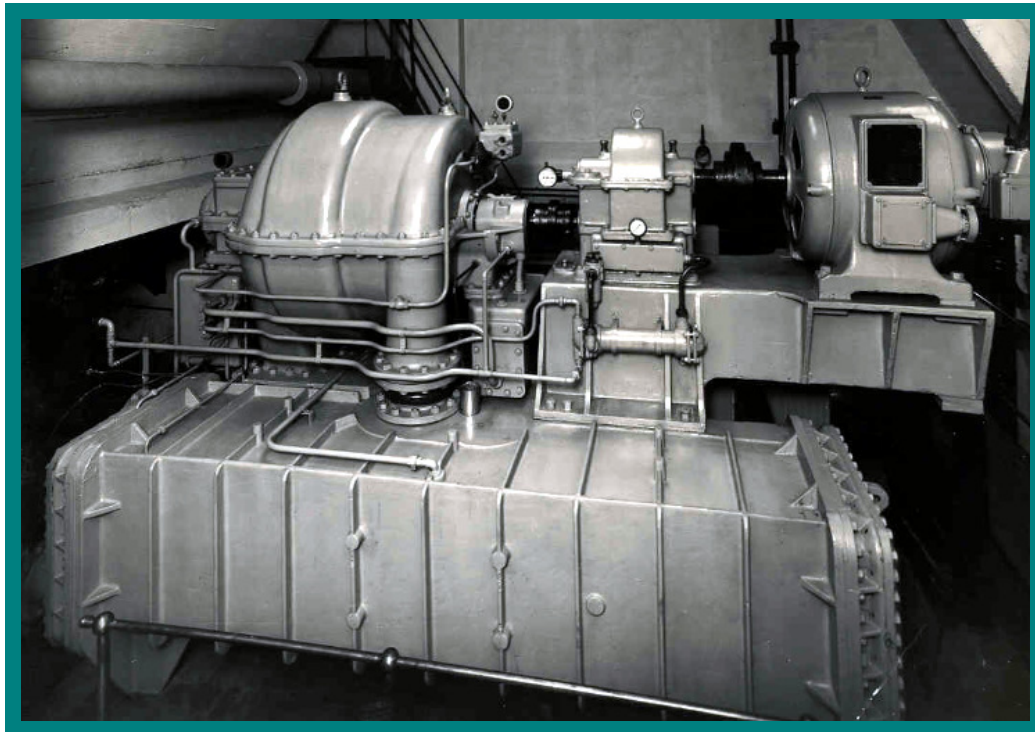


When opened in 1928, the Oxford Street Corner House was the last of the three major restaurants operated by the catering firm J. Lyons. Corner houses included a number of dining rooms and restaurants, each having their own distinctive style and atmosphere with a lavish interior, some with an orchestra and having kitchens, a food hall, even an hairdressing salon and a travel bureau, and as many as 400 staff.

LYONS CORNER HOUSE, LONDON

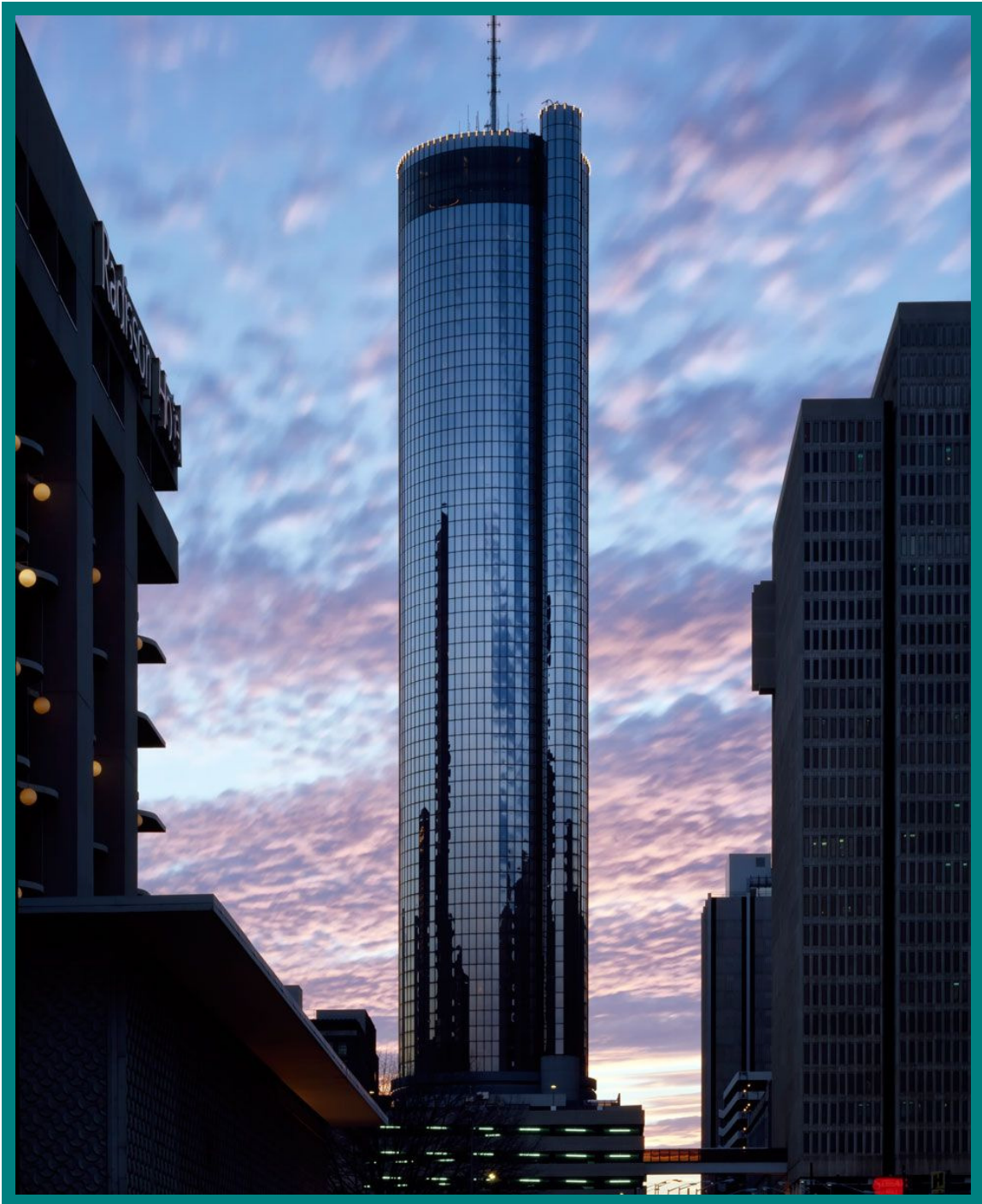


Air conditioned was installed by Carrier, the plant including this air washer



The refrigeration plant was this 145 TR centrifugal water chiller

PEACHTREE PLAZA HOTEL, ATLANTA



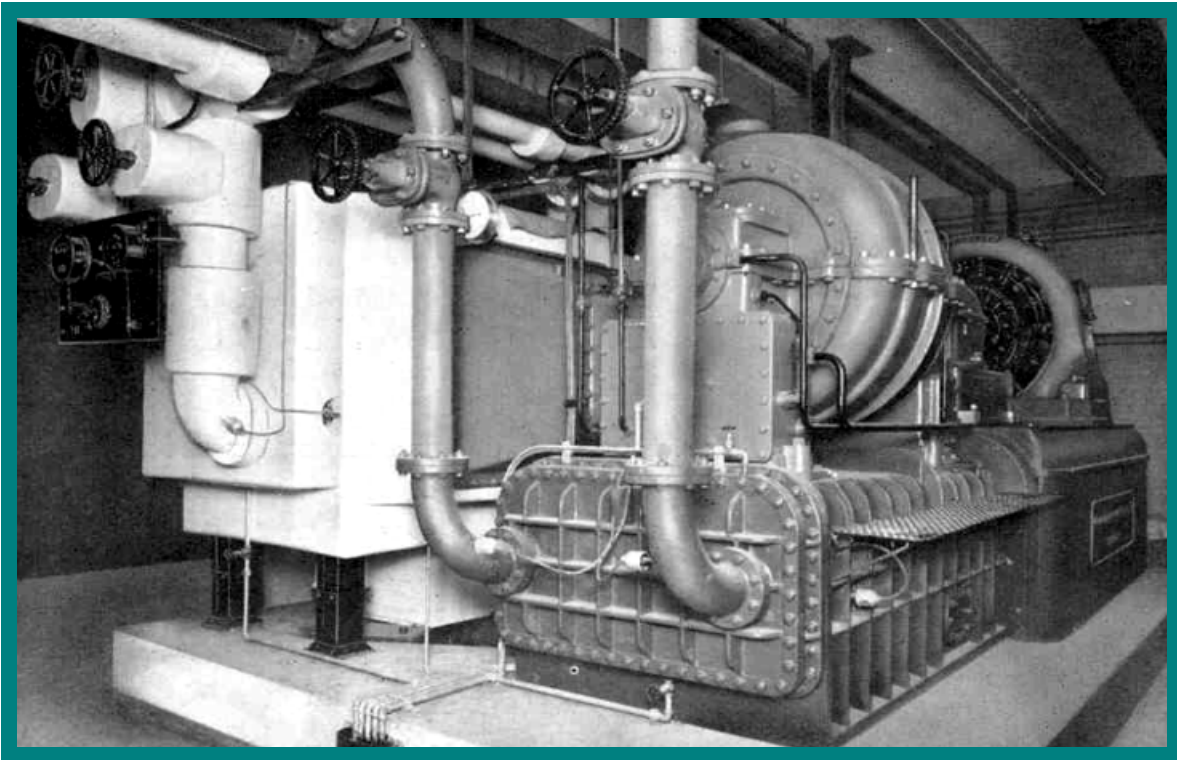
The Peachtree (now the Westin Peachtree) Plaza skyscraper hotel opened in downtown Atlanta in 1976. With 73-storeys, it has a height of 723 ft, the air conditioned cylindrical tower having a diameter of 187 ft accommodating 1073 rooms. The round glass tower has around 5600 windows which are actually flat. Two other features were the revolving roof restaurant and a 7-storey lobby atrium above an half-acre indoor lake (now no more). The hotel was the tallest in the world until replaced by its slightly taller sister hotel in Detroit.

BONAVENTURE HOTEL, LOS ANGELES



The Bonaventure (now Westin Bonaventure) is a 33-storey, (367 ft high) hotel opened in 1976 and is still the largest in Los Angeles with 1358 rooms and 135 suites. Fully air conditioned, it has a roof-top revolving restaurant. There are four banks of elevators (one for each tower) with 3 cars in each (12 total). The layout has been described as "difficult to navigate" since there are no floors numbered "7" or "13" and it proved necessary to colour code the elevator banks (red, yellow, green and blue) to overcome confusion.

EMPIRE LEICESTER SQUARE, LONDON



Originally a Victorian theatre, the Empire (now Cinemax) was remodelled and opened as a cinema in 1927 with 3226 seats as the largest cinema in London's West End. It was air conditioned by Carrier in 1928 the refrigeration being the 250 TR centrifugal water chiller pictured.

NEW VICTORIA THEATRE, LONDON



The New Victoria Theatre (now Apollo Victoria) in Vauxhall Bridge/Wilton Road opened in 1930 with 2860 seats. The auditorium and lighting were designed to represent a "Mermaids Palace," much of it being deep below street level. It remains one of the best preserved UK "super cinemas" of the 1930s.

RADIO CITY MUSIC HALL, NEW YORK



New York's Radio City Music Hall opened in 1932, with 6000 seats, said to be the largest movie theatre ever built. An abstract from a technical magazine of the time (*Heating and Ventilating*, 1932, Vol.29 pp.47-50) described the air conditioning as follows:

The international Music Hall, which forms a part of the Rockefeller Centre project, is one of the numerous buildings to be equipped with a modern air conditioning system. The architectural and building construction called for special designs for most of the supply outlets and considerable care had to be exercised in routing the enormous amount of duct work, of which 40 tons were utilized in the main ceiling alone. The air is supplied through a downward system, entering the conditioned spaces through ceiling outlets and being exhausted through sidewall or floor registers. The air conditioning apparatus includes equipment for refrigerating, washing, filtering and dehumidifying the air. A certain amount of radiation is also used to remove objectionable odours.

With a seating capacity of 6000, the stated provision of 40 cfm of cooled air per person results in a supply air volume of 240,000 cfm. At typical New York design conditions, allowing 10 cfm per person of fresh air gives an estimated cooling load of 600 TR. A note states the supply air was distributed by three independent systems located in top floor fan rooms.

RADIO CITY MUSIC HALL, NEW YORK



Part of the under-stage hydraulic elevator system capable of lifting a full symphony orchestra to auditorium level.

TRANSPORT BOARD, SOUTHAMPTON



Built in 1972, the new office block for the British Transport Docks Board within Southampton Docks seems to be no more, with no photographs or records discovered. It was remarkably like the office building on the left of this undated photograph which may or may not be it.

The 5-storey office was of 30,000 sq.ft, rectangular in shape with the long sides orientated north and south, the latter often requiring cooling in winter (due to high solar gains including radiation reflected from the water in the harbour) while the north required heating. The air conditioning was a 2-pipe induction system with primary chilled and hot water pumps linked to south and north zone secondary pumping systems. An 8000 cfm fresh air primary air plant incorporated a chilled water spray cooling coil. The refrigeration unit was a 96 TR water chiller of Vilter-Porter manufacture linked to a roof cooling tower.

However, the air conditioning incorporated equipment used for the first time in the UK. The induction units were Hi-Jet type Italian manufacture (as used in the Galfa Tower in Milan and later in both the Cadbury and BP buildings, all described elsewhere in this article). The induction units were high pressures type having a much higher ratio of induced air to primary air (and hence higher cooling capacity) compared with those generally in use at the time. Also, for the first time in the UK, the changeover controls included Honeywell solar compensation equipment.

CADBURY OFFICE BLOCK, BOURNVILLE



During the 1960s, new types of comfort air conditioning systems and equipment were being developed, one example being the variable air volume (VAV) type. An early application was at the new Cadbury Head Office in Bournville, near Birmingham, in 1966. The 6-storey block of some 100,000 sq.ft was converted from an existing factory building. The floor-to-ceiling heights were exceptionally high and the windows large. The width of the building required that the air conditioning was able to cater for two external zones, two internal zones and a central corridor.

The decision was taken to treat external areas with a Hi-Jet induction system and use a Barber-Colman Jetronic high velocity all-air system for interior zones. The interior zone system used constant volume induction boxes mounted in the false ceilings, mixing a cold air stream from the central plant with warm air extracted through longitudinal slots in the custom-made Atlas integrated air-light fixtures. The interior zone supply and combined internal/external zone extract operated in VAV mode, having fan inlet guide-vane control. Although designed for full air conditioning the refrigeration plant was omitted.

BENTALLS DEPT STORE, BRACKNELL



The well-known Bentalls Department Store (now the renovated Bentall Centre) in Kingston upon Thames, Greater London opened in 1935. A new Bentalls Store opened in Bracknell in Berkshire in 1973, just as the world oil crisis introduced the watchword "energy conservation." This new store was fully air-conditioned and even had an "Air Curtain" at the main entrance. The air conditioning comprised a series of local all-air systems with a patented 3-Pipe hot water heating/chilled water cooling system, having a mixed temperature common return. The York refrigeration plant used a double-bundle condenser arrangement, with a large sprinkler tank serving as a heat source/sink, while the second bundle provided heating hot water at 120 degF.

FENWICK DEPT STORE, BRENT CROSS



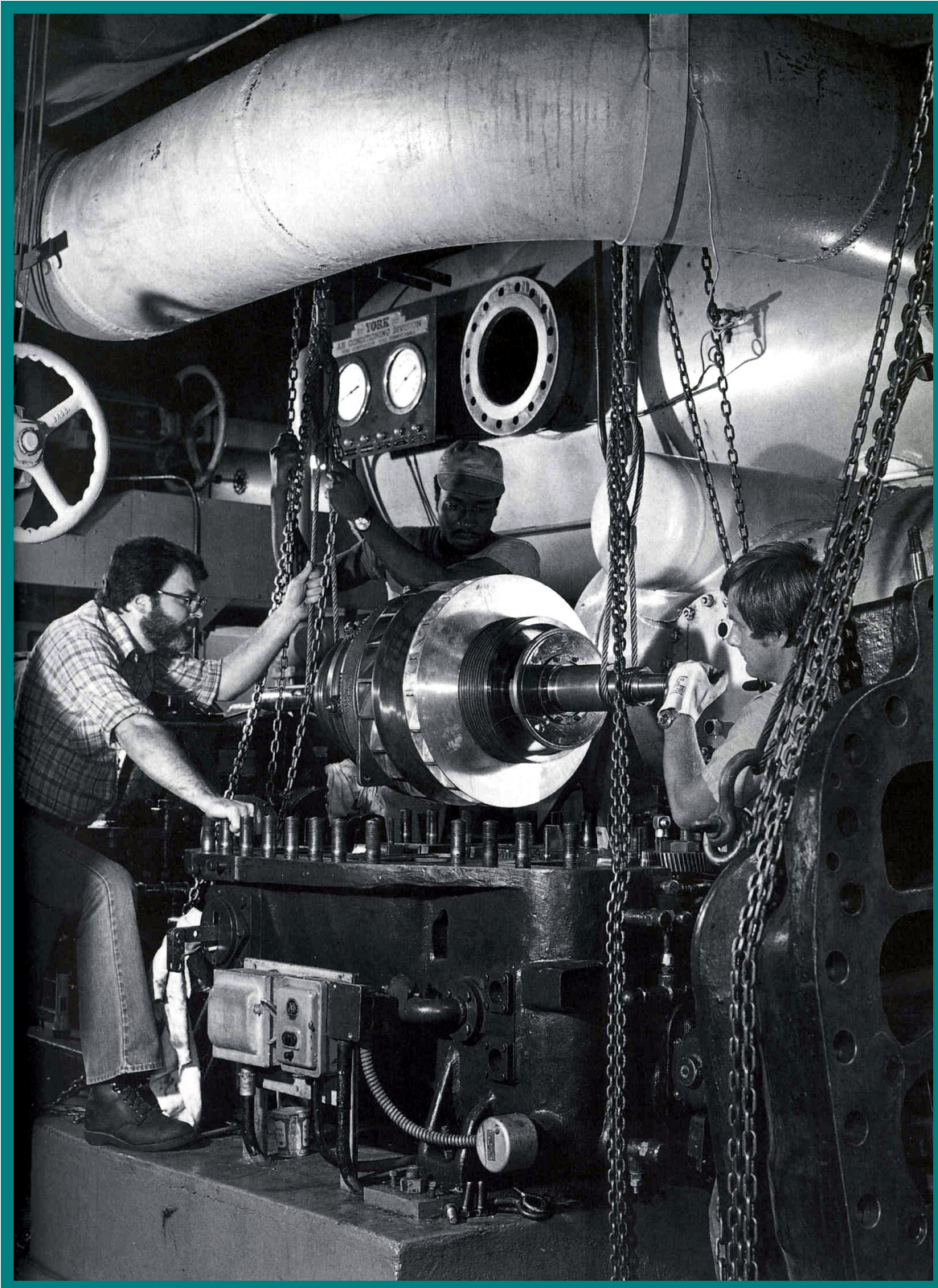
The Fenwick Department Store opened in 1976, being located over three floors within London's Brent Cross Shopping Centre. Fully air conditioned, the refrigeration system employed a triple-bundle condenser providing heat rejection, heating hot water and domestic hot water service.

EMPIRE STATE BUILDING, NEW YORK



New York's Art Deco 102-storey skyscraper, at 1200 ft high, opened in 1931. It was not air conditioned until the 1970s, originally relying on natural ventilation. It survived a fire and a bomber crashing into one of the mid-levels in 1945. It remained the tallest building in the world until overtaken by the no longer existing twin towers of the World Trade Centre in New York. New air conditioning was retrofitted in 2011.

EMPIRE STATE BUILDING, NEW YORK



Working on a York-Borg Warner centrifugal refrigeration rotor in the Empire State (1970s).

GALFA TOWER, MILAN



The 31-storey, 358 ft high skyscraper was completed in 1959. Having a full height glass curtain wall facade the air conditioning perimeter Hi-Jet induction units were recessed into the floor.

BP BRITANNIC HOUSE, LONDON



The design drawing shows the original Tower, part of the Barbican Redevelopment Scheme in the City of London, but now completely remodelled as Citypoint. The 35-storey, 400 ft high Tower opened in 1967 and was fully air conditioned by a 2-pipe induction system using Hi-Jet units and being one of the first to adopt the non-changeover control method (i.e. chilled water throughout the year in normal hours, with the primary air carrying the entire heating load in winter).

Some 3500 induction units were provided. The main refrigerating plant comprised two centrifugal water chillers (1-500 TR, 1-250 TR) together with two absorption chillers (each 475 TR). The total refrigerating capacity, installed at Basement-3 level, totalled 1700 TR of cooling and operated with nine induced draught cooling towers on the 34th floor. The absorption chillers were included to take up spare boiler capacity in summer and reduce electrical maximum demand charges.

The boiler plant comprised four HPHW forced circulation water-tube oil-fired boilers with a total output of 15,236 kW (52 million Btu/h).

CONNAUGHT BUILDING, HONG KONG

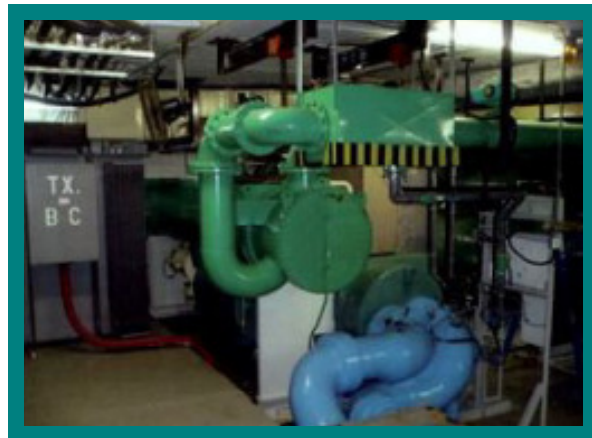


The first major skyscraper to be built in Asia was the fully air conditioned 52-storey, 586 ft high, Connaught Centre (now Jardine Building) in Hong Kong in 1973.

CONNAUGHT BUILDING, HONG KONG



The large unusual porthole windows providing incredible views of the harbour.



Refrigeration plant room

The air conditioning employed floor-mounted "Low-Boy" fan coil units operating in conjunction with a primary fresh air system in the false ceilings. Chilled and hot water piping risers were installed at the four corners of the building. The refrigeration water chillers used 3-150 hp pumps to supply sea water directly to the condensers.

KINGS REACH TOWER, LONDON



At 370 ft high, the 1972, 30-storey Kings Reach Tower on the south side of Southwark Bridge was fully air conditioned by a 2-pipe non-changeover induction system employing Carrier units with self contained air-actuated controls. Refrigeration water-chillers were housed in the adjacent 6-storey office block, the gas LPHW boilers being located at the top of the tower. The building (now Southwark House) has been changed into luxury apartments with 11 floors added.

MAINE-MONTPARNASSE, PARIS



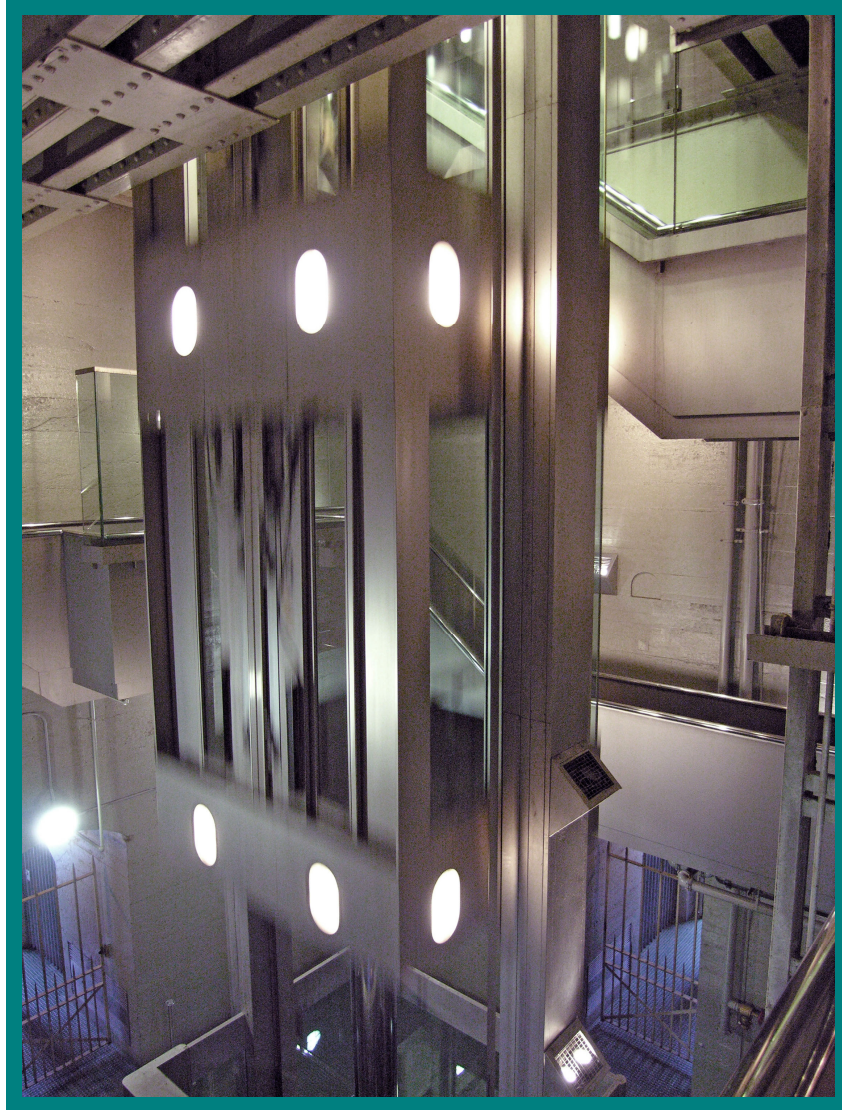
Built in 1974 the 58-storey, 700 ft high, Main-Montparnasse Tower, the first skyscraper to be built in Paris created much discontent as it changed the traditional and much-loved skyline. It was fully air conditioned by a high-pressure induction unit system, having a giant cooling tower sited on the roof of the connected low-level podium block.

STATUE of LIBERTY, NEW YORK



The copper Statue (Liberty Enlightening the World) was a gift to the people of the United States from the people of France. At 51 ft high it was designed by the French Sculptor Bartholdi supported on an iron framework by Gustave Eiffel. Erected on a monumental base on an island in New York harbour it was dedicated in 1886 being 151 ft from ground level to top of the torch.

STATUE of LIBERTY, NEW YORK



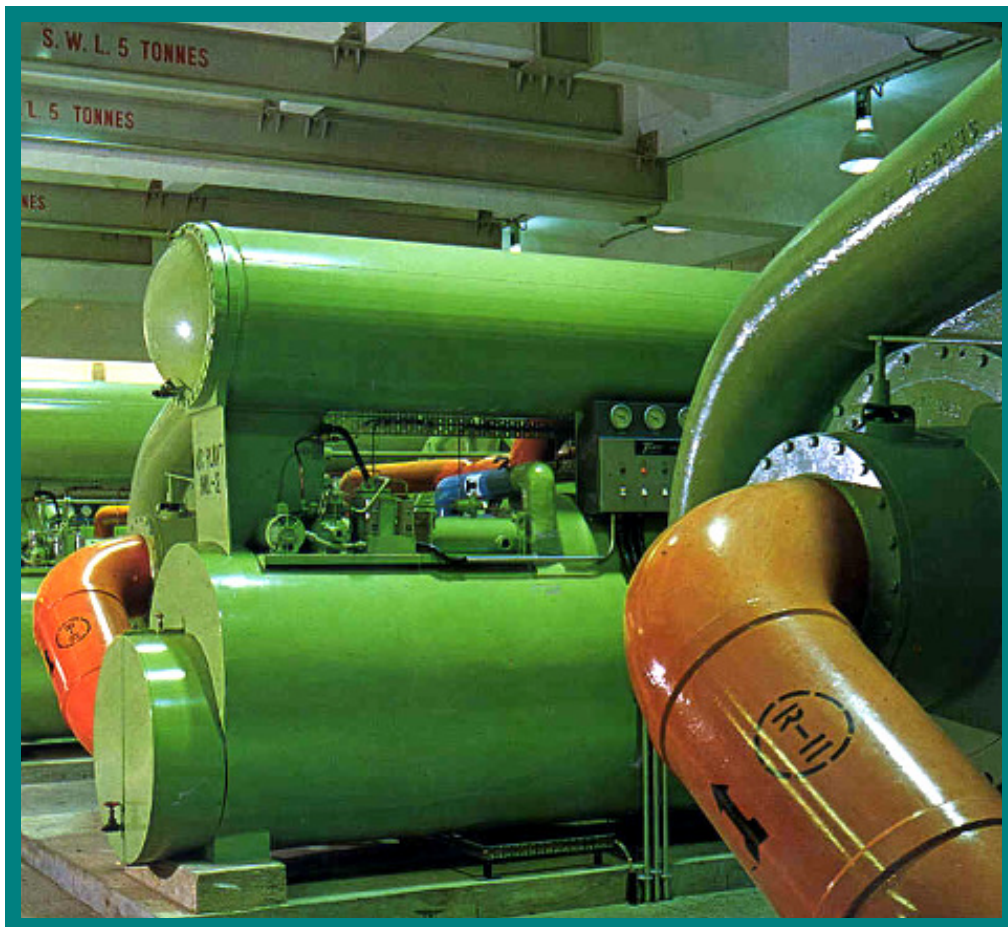
For over 100 years, the public could only reach the head by climbing a long, awkward internal staircase to see the view. However, in 2011 modern elevators and staircases were installed to make visiting easier.

KIA TAK AIRPORT, HONG KONG



Kai Tak operated as an International Airport (1952-98), situated in the harbour on reclaimed land with a very difficult approach, landing aircraft having to be routed around 2000 ft hills before making a last minute, sharp ninety degree, low level turn, avoiding a series of high rise buildings. A modern airport (Chep Lap Kok), 19 miles to the west, now caters for Hong Kong.

KAI TAK AIRPORT, HONG KONG



In the early 1970s, the refrigeration for the terminal building's (above) air conditioning was provided by Trane centrifugal water chillers (operating on R-11 refrigerant)

ROCKEFELLER ICE RINK, NEW YORK



Completed in 1933, the 66- storey, 865 ft high RCA (later GE) skyscraper is part of the Rockefeller complex, at its base a sunken plaza with an outdoor ice-skating rink which opened in 1936.

ROCKEFELLER ICE RINK, NEW YORK



Laying the ice-rink piping grid (from "Works in Progress")



Ice-skating at Christmas

BAY AREA RAPID TRANSIT

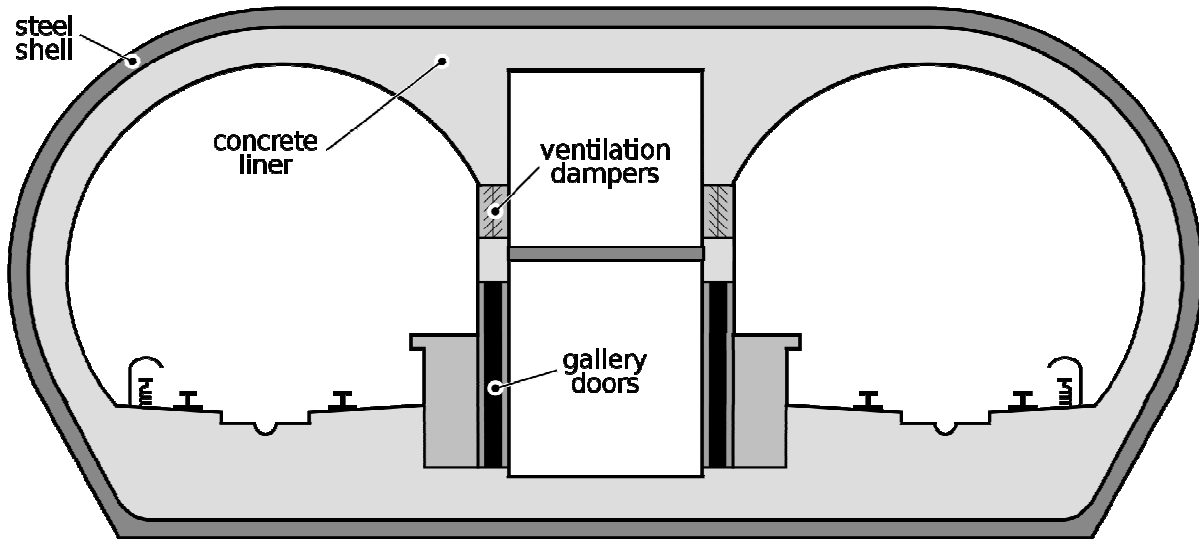


Route of the underwater BART train tube tunnel connecting San Francisco (right) with Oakland



Opened in 1974, the tube section is 3.6 miles long at a maximum depth of 135 ft below sea level. Using the "immersed tube" technique the tunnel was constructed inland in sections, transported to the site, then submerged and fastened to the bottom of the harbour. During peak times, some 28,000 passengers per hour travel through at speeds up to 80 mph. The tube consists of two 17 ft diameter tunnels connected by a central maintenance/pedestrian gallery. The upper space of the gallery is used as a ventilation air duct moving 300,000 cfm. The original air-conditioned control centre in Oakland contained large panels displaying train movement, power supply connections and ventilation fan operation.

BAY AREA RAPID TRANSIT



Typical section of the Transbay Tube



Typical BART tunnel section

W.D. & H.O. WILLS, HARTCLIFFE



In 1975, the building of a new manufacturing facility and administrative headquarters for the Wills Tobacco Company was completed at Hartcliffe, then on the outskirts of Bristol. At the time it was the largest tobacco processing factory in Europe, initially employing 3500 people. Being away from the City, the facilities provided included banks, shops, a post office and restaurants. A large car-park was provided, hidden beneath the factory. There was a bus shelter with link tunnels to both the factory and office block. The offices were designed in the modern "American Style" of the time, which included the damming of a stream to create the lake from which the building rises. Another feature was the structure, which used "Cor-ten steel" a complex alloy designed to oxidise naturally into a maintenance-free, rust-brown finish.

The factory and offices were fully air conditioned, the factory having numerous local air handling units. There was a central boilerhouse, while the refrigeration plant employed four 1000 TR absorption chillers (4000 TR total).

However, with a sharp decline in smoking the factory was closed in 1990 and demolished, the site regenerated over the years, is now is the Imperial Retail Park, a mixture of supermarkets, shops, restaurants and leisure facilities. In 2007, the offices were converted into the Lakeside luxury flats.

W.D. & H.O.WILLS, HARTCLIFFE



The offices on a lake

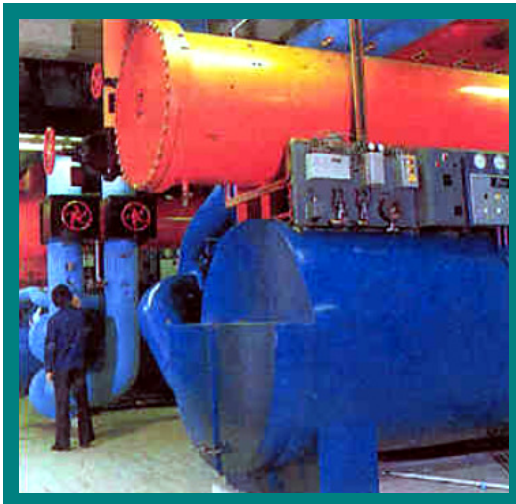


One of the gas-fired Thermax Steam Boilers in the Hartcliffe Power House

CABLE & WIRELESS, HONG KONG

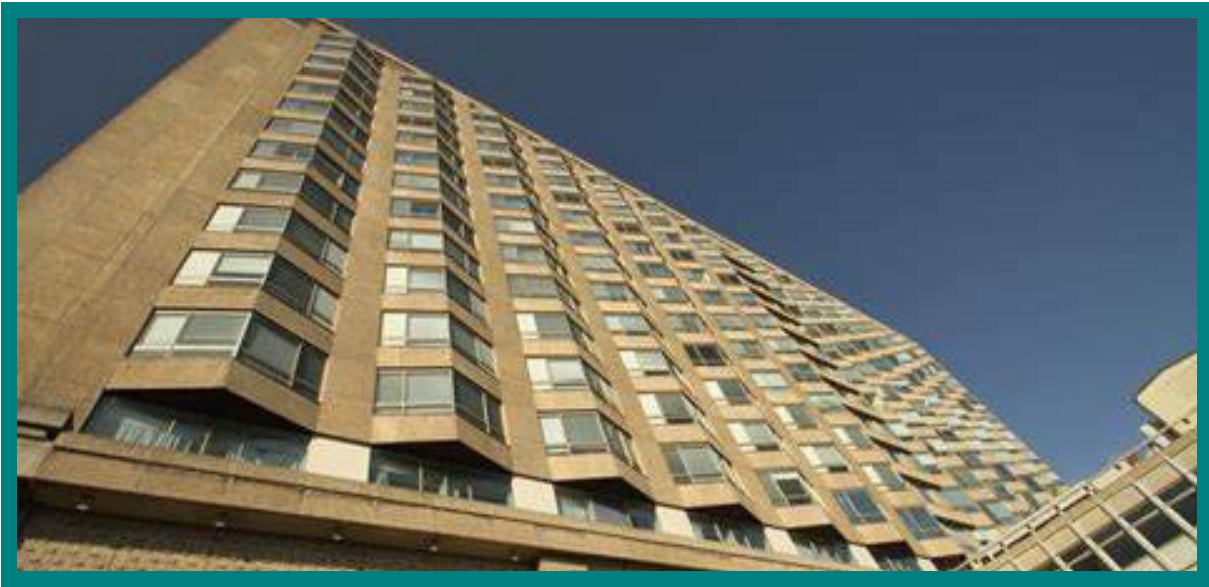


The Hong Kong operation of the British Cable & Wireless Company was established in 1934 and built up communications networks across Asia, moving into Mercury House in the early 1970s.



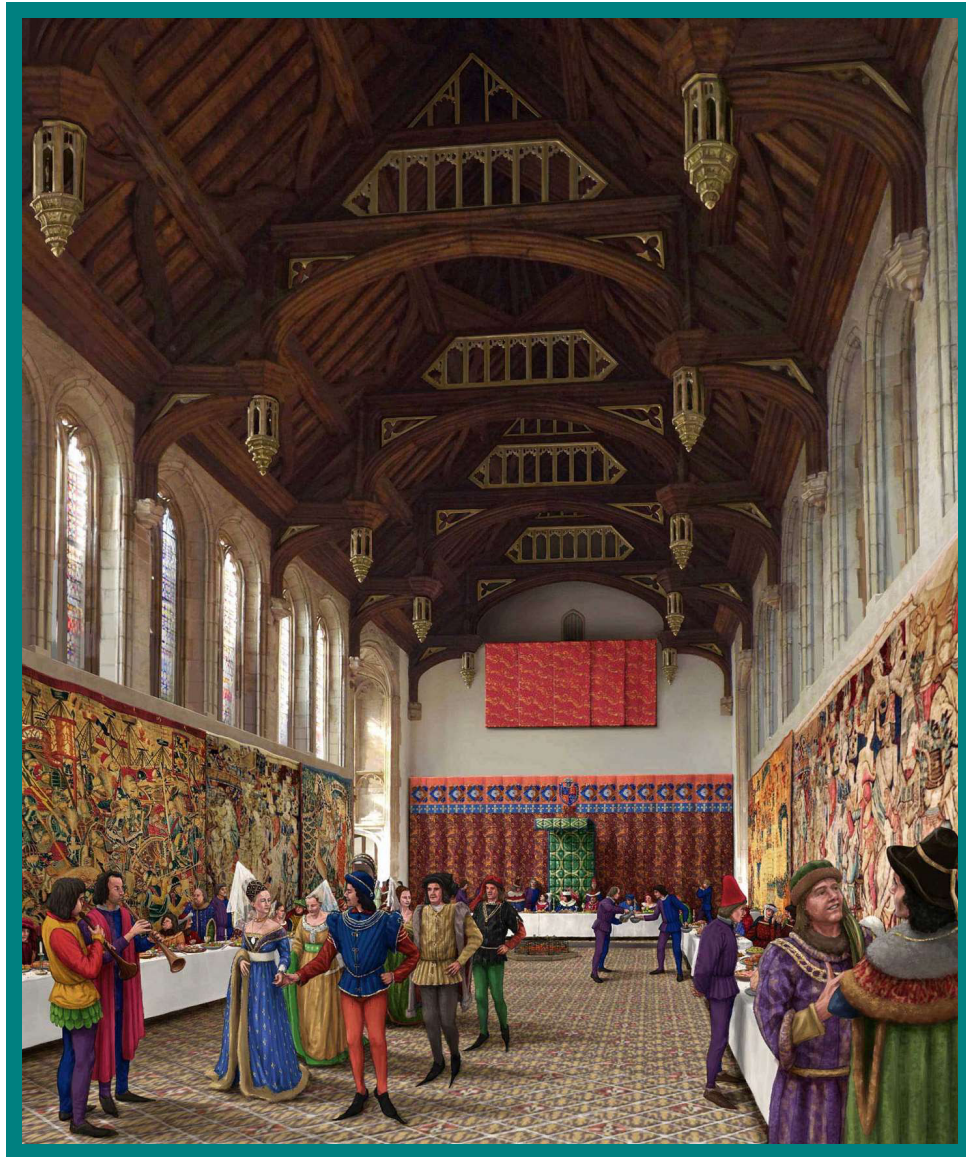
The air conditioning refrigeration plant room which used sea water for the condensers.

HALLAMSHIRE HOSPITAL, SHEFFIELD



The second phase of the hospital (now the Royal Hallamshire) was opened in 1978, a fully air conditioned 21-storey NHS Teaching Hospital. The refrigeration plant comprised six 500 TR absorption chilled water machines (3000 TR total) operating with six induced-draught cooling towers, all this equipment mounted on the roof of the hospital

ELTHAM PALACE, LONDON



A reconstruction (Historic England) of the Great Hall in the late 15th century (a favourite of Henry VIII) showing the famous hammerbeam roof. In the 1930s, the Great Hall was incorporated into the new Art-Deco Courtauld House which featured much of the then-latest technology: gas and electric heating, synchronous clocks, internal telephone and audio systems and even centralised vacuum cleaning.