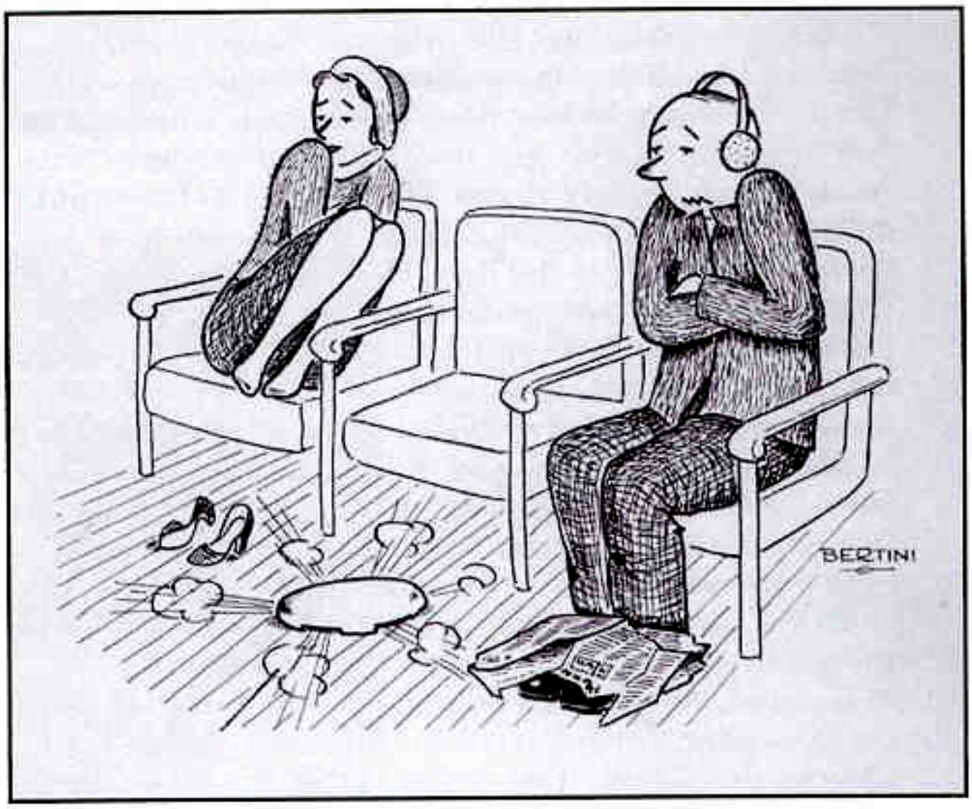


How the Public Viewed Early Cinema Air Conditioning with Cold Air Introduced at Floor Level. The Carrier System Changed all that by using Downwards Air Distribution [4/564, 16].

PART-3

MANUFACTURING THE WEATHER
Air Conditioning & Refrigeration

Describing
The Science of
VENTILATING
WARMING
COOLING
for
PUBLIC BUILDINGS

Carrier Engineering Company Ltd
24 Buckingham Gate, London.

CEC catalogue on comfort cooling, 1930s [6/567, title page].

3.1 COMFORT AIR CONDITIONING OF BUILDINGS

1921 THE COUNCIL CHAMBER, LONDON COUNTY HALL

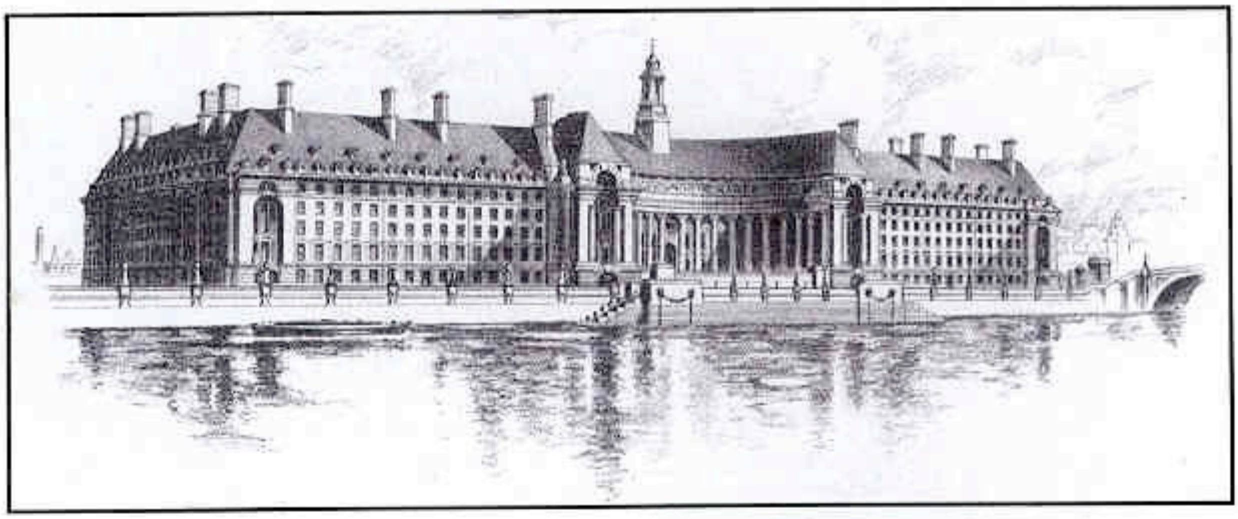
A booklet of 1922 [839] describes the main heating and ventilating contract as being carried out by a consortium of contractors headed by J Jeffreys & Co Ltd with R Crittall & Co Ltd, G N Haden & Sons Ltd and Norris & Dutton Ltd, but records the contract for the Special Plenum Ventilation of the Council Chamber Suite as being secured by The Buffalo Forge Co Ltd. However, it appears the actual work was carried out by CEC, as it is listed in their brochures [6/502, 5 and 6/567, 7]. The installation is described in *Scientific American* ["Individual Atmospheres Made to Order: How Push Buttons Control the Ventilating and Heating System at Each Seat in the Recently Completed London County Council Building," November 1922, 328-9].

The group of sketches shows the air conditioning central plant with a chilled water spray dehumidifier, the water being chilled in an ice-tank, or ice-bunker, system, the blocks of ice presumably being purchased from a local cold store. [London's largest ice distributor, United Carlo Gatti, Stevenson & Slaters Co, had premises in nearby Battersea.] The sketches also show the arrangement of the fresh air inlets and the "air corridor" and the air distribution ducts, described as the "Octopus" in the void under Council Chamber.

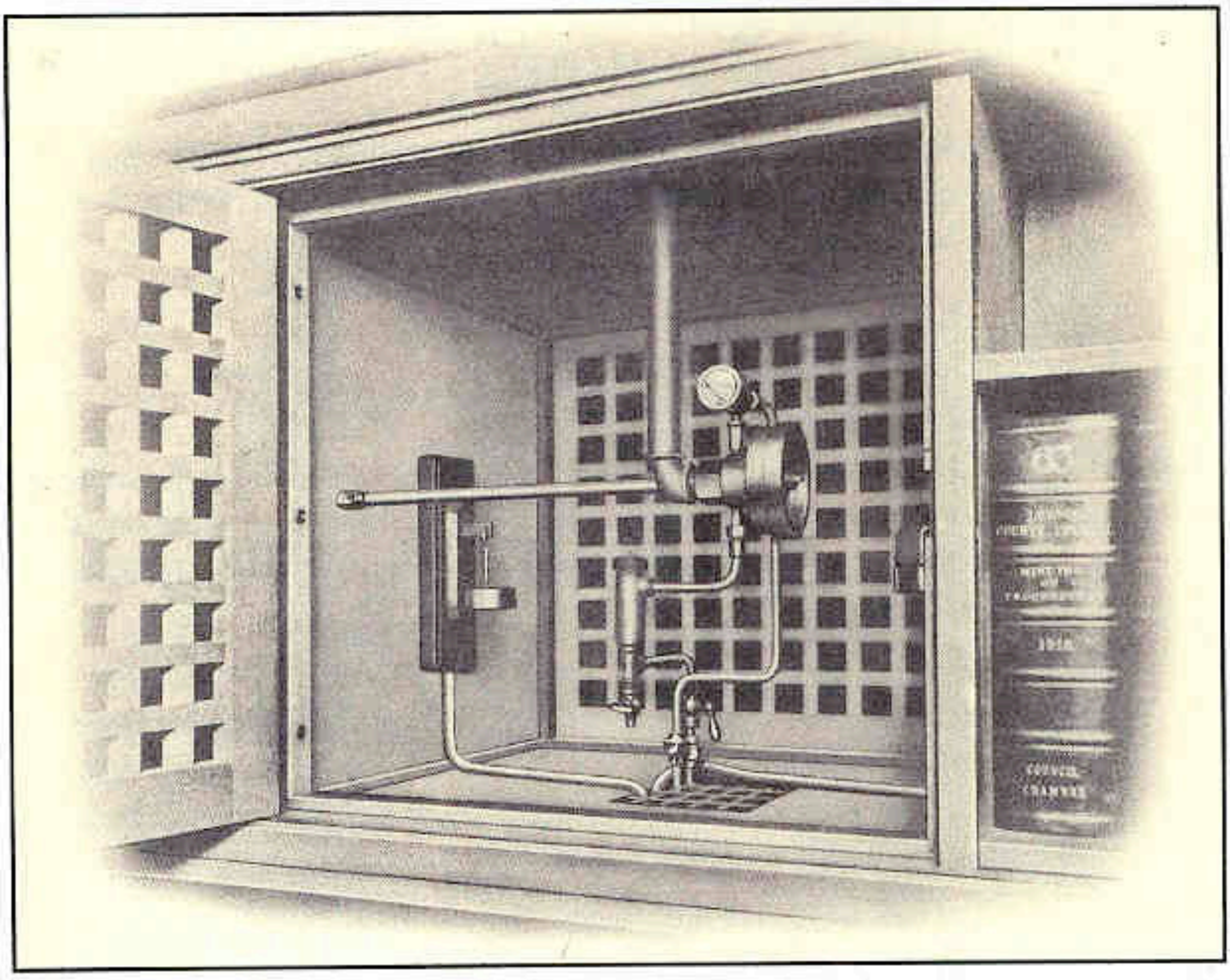
The most unusual feature of the installation is the arrangement for air distribution and control provided at each individual seat in the chamber, shown in the top right-hand corner of the composite sketch:

"It will be noted that each member's desk is provided with two ducts, one for bringing the fresh air supply to the desk, and the other for removing the vitiated air. The first or fresh air duct is divided between two outlets, one placed above and in front of the desk, and the other below the desk. The object of these two outlets is to enable the member to direct the incoming conditioned air either vertically or toward himself. To simplify the graphic explanation, the front desk has been eliminated, only the duct and control mechanism being shown, while the seat and the desk just behind it are shown in full. The normal supply of fresh air, which is supplied automatically and without individual control, comes through the outlet at the end and just below he seat, while the vitiated air is withdrawn through a register below the front end of the seat. The sliding button control is clearly indicated."

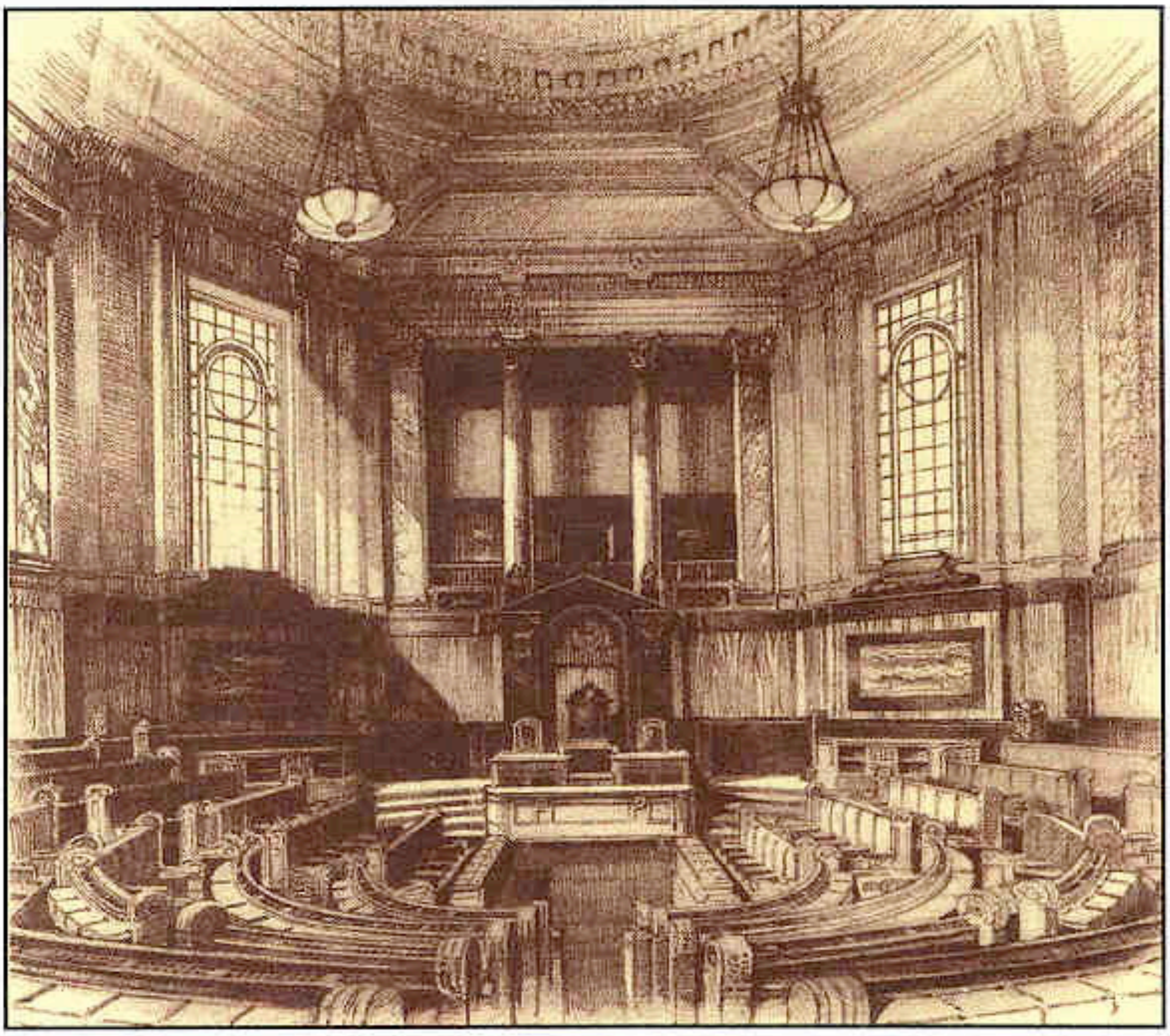
[This air distribution method appears to predate by some 60 years the system of providing a separate air supply to individual work stations as introduced in various City electronic dealing rooms.]



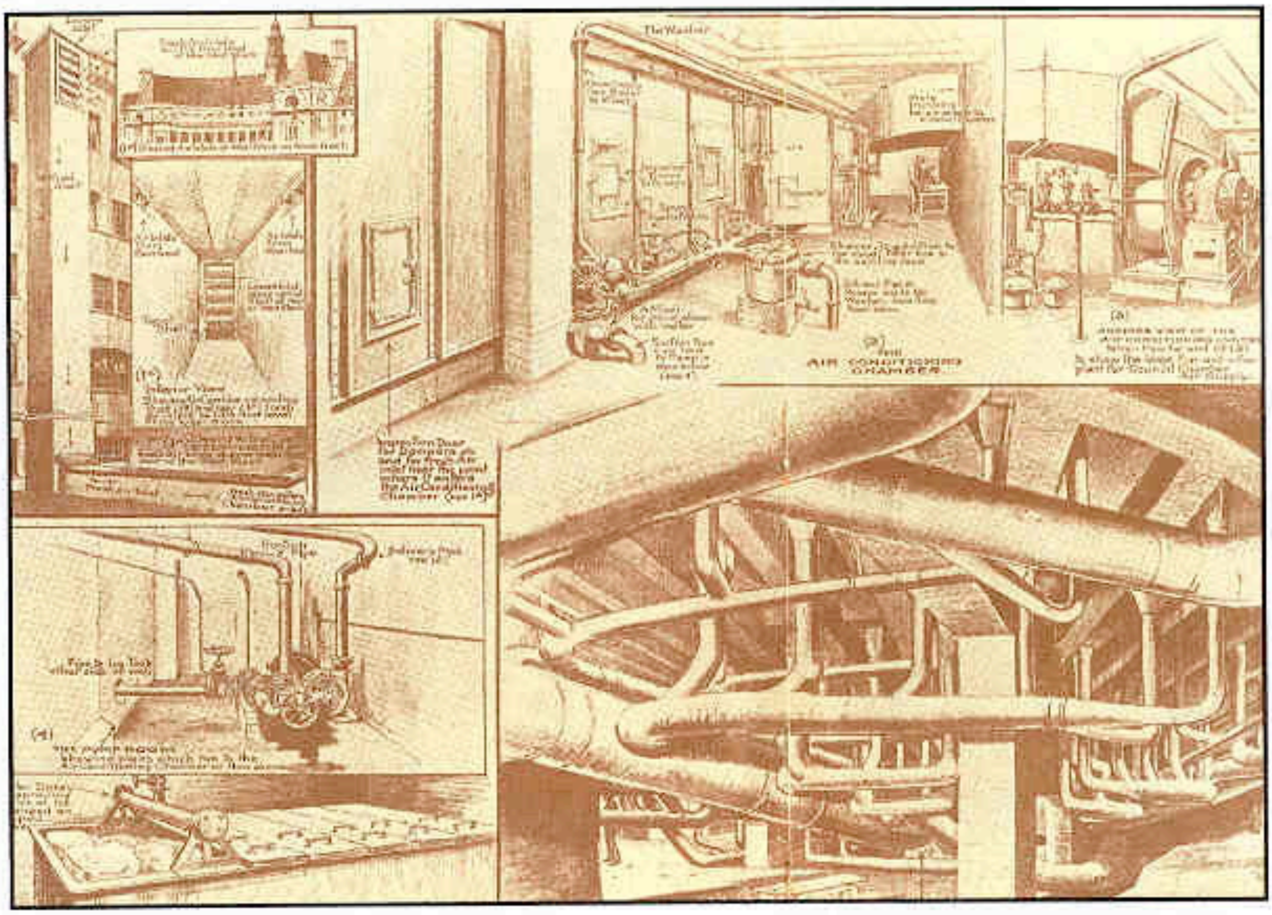
London County Hall, 1921 [drawing from 6/567, page 7].



London County Hall, CEC thermostat concealed in bookcase [6/567, page 19].



London County Hall, Council Chamber air conditioned by CEC, 1921 [6/567, page 9].



Cooling system for Council Chamber Suite, London County Hall, 1921.
[Scientific American, November 1922].

The installation had a remarkably sophisticated automatic control system for that time, though the description of its operation is could hardly be described as technical:

"Every rainfall or spell of sunshine sets the thermostatic and humidity controls in operation, and the air-conditioning equipment is regulated in accordance with the changed state of the outside air which is constantly being drawn into the system.

More remarkable still perhaps, is the fact that a single member coming into the council chamber in warm weather, automatically effects the entrance of an additional portion of cool air to balance the minute rise in temperature."

It is interesting that the *Scientific American* wrote that this English installation was more elaborate than anything which had come to their attention in the States.

1928 J LYONS, OXFORD STREET CORNER HOUSE, LONDON

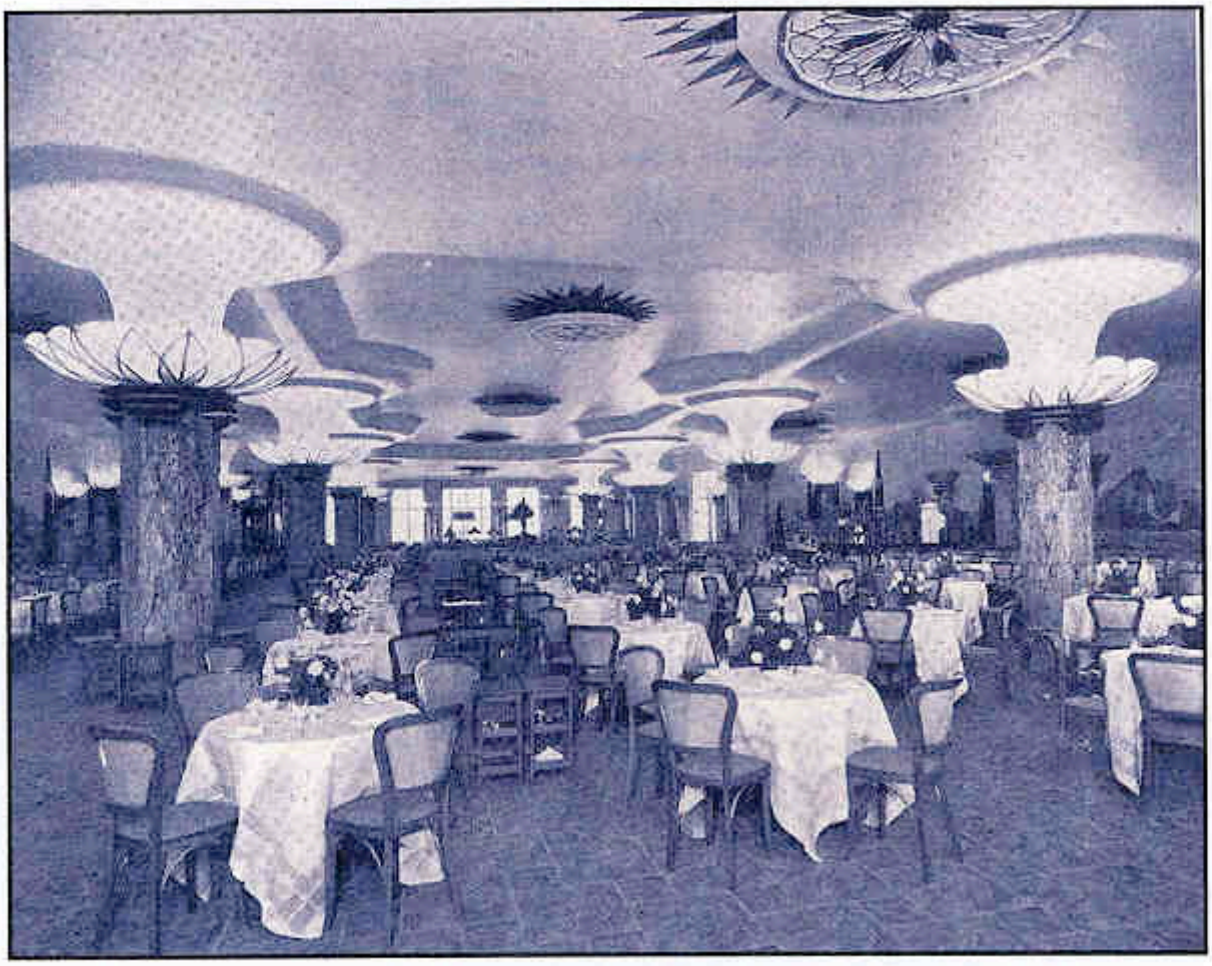
This description is based on notes compiled in August 1977 by Ernest H Arthur, design engineer with CEC from 1928-1966 [5/485]; plant data is approximate only.

The name of this restaurant and shopping complex was taken from the Oxford Music Hall, dating from 1861, which had previously occupied this site on the corner of Oxford Street and Tottenham Court Road. The plans by the architect, F J Wills [with whom CEC later worked on the Cumberland Hotel at Marble Arch] allowed for an upward system of air distribution as proposed by the Chief Engineer for Joe Lyons, S Joliffe Butler, and his deputy, J Sierra. However, CEC recommended downflow air distribution for the scheme which was to use evaporative cooling only, with no refrigeration. This was accepted with the proviso that the design should be capable of reverting to upward flow should the CEC system prove unsatisfactory. This feature though duly incorporated was never used.

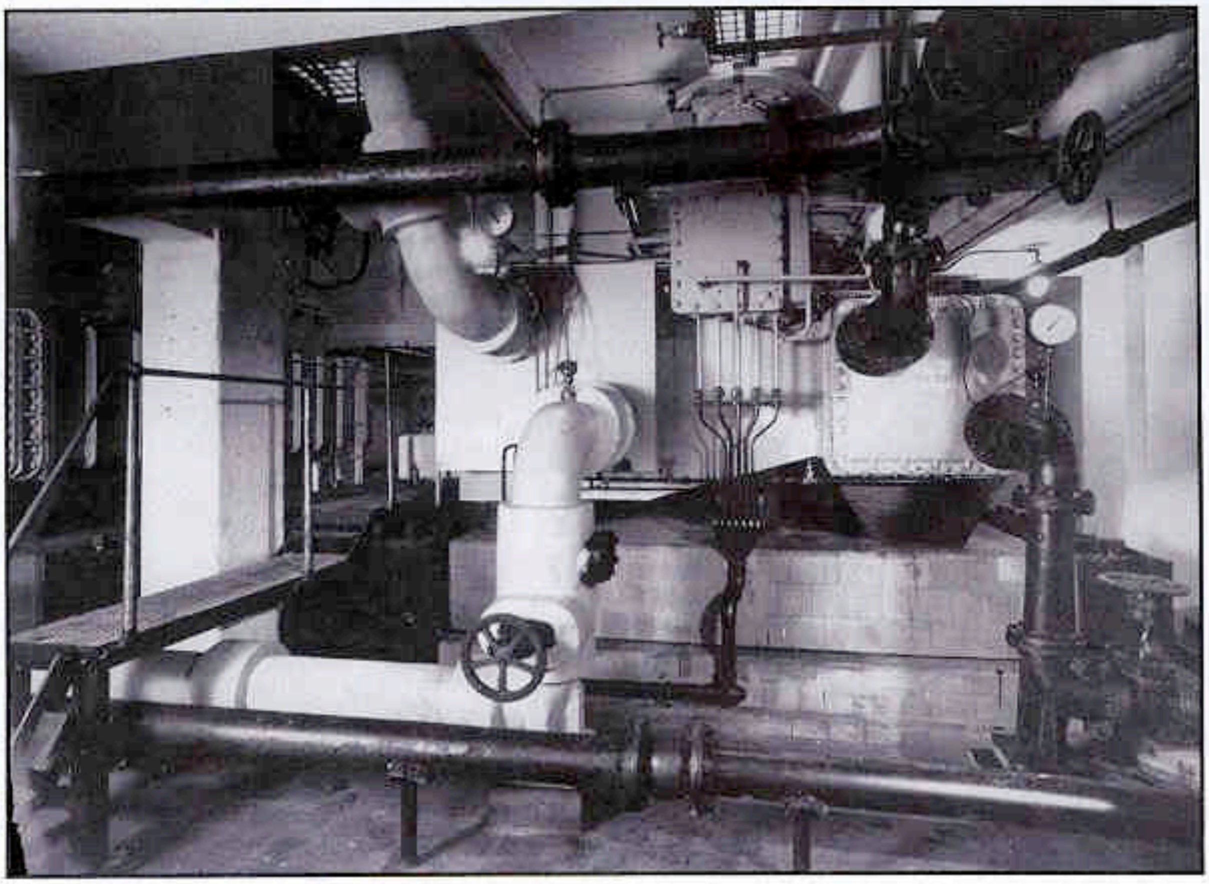
There were three very large restaurants -basement, ground floor with an extensive shopping area, and first floor. Each floor had its own ventilation plant at roof level. Each was of the same capacity, about 22,500 ft^3/min with the fan coupled to a compound steam engine. Filters seem to have been oil-wetted metal-shavings type. Evaporative cooling was achieved by recirculating water spray washers.

The plants were converted around 1936 to include refrigeration, using a Carrier 250 TR centrifugal machine, mounted on a first floor above the Tottenham Court Road shop, with a roof mounted cooling tower. CEC was warned that any noise transmitted from the refrigeration machine to the next door Malzy's Restaurant would result in an injunction from the neighbour. E H Arthur recalls that the centrifugal was mounted on a large reinforced concrete base, which in turn was mounted on large adjustable spring mounts, all specially designed by another CEC engineer, J Sharpley (Papa) Jones. Arthur also recalls, with horror, the tremendous size of recirculation air ducts that were necessary to minimise resistance to air flow in the very long system.

J Lyons, Oxford Street Corner House, London, 1928 [HVE, June 1928, 351].
Cooling by Carrier Engineering Company. Refrigeration added in 1936.



J Lyons Restaurant, Oxford Street Corner House, London.
Air conditioned by CEC [HVE, August 1928, 48]



Carrier 250 TR centrifugal refrigerating machine, Oxford Street Corner House, London, 1936 [P-601].

1929 THE PARAMOUNT THEATRE, PARIS

The Paramount Theatre in Paris, designed by the architects Frank Verity and Auguste Bluysen, was air conditioned by CEC, and equipped with a Carrier centrifugal refrigerating machine of 150 TR capacity.

1930 THE ASTORIA CINEMA, FINSBURY PARK, LONDON

Designed by E A Stone & Partners, the Astoria was one of the first "atmospheric" cinemas to be built in the UK, looking internally like a Moorish courtyard under a starlit sky. Like its sister cinema, the Astoria at Brixton (1929), it was advertised by CEC as air conditioned, though it is believed to have had a spray washer system only, no evidence of refrigeration having been discovered. Converted to a church, it is now a Listed Building.

1931 BROADCASTING HOUSE, LONDON

Situated in Portland Place, at the top of Regent Street, Broadcasting House was built to house the activities of the British Broadcasting Corporation (BBC) in London. Opened in 1931, the architect was G Val Myer and the engineer for the BBC was M Tudsbery. A CEC brochure "An Air Conditioning Achievement by Carrier: Manufactured Weather for Broadcasting House" describes the services [5/562]. The title page reads *"Describing the Most Complete Air Conditioning Equipment in the World -With some notes on the problems with which this great task was beset and their solution."*

The brochure then describes (in the language of the day) the building and the problems faced by the air conditioning designers:

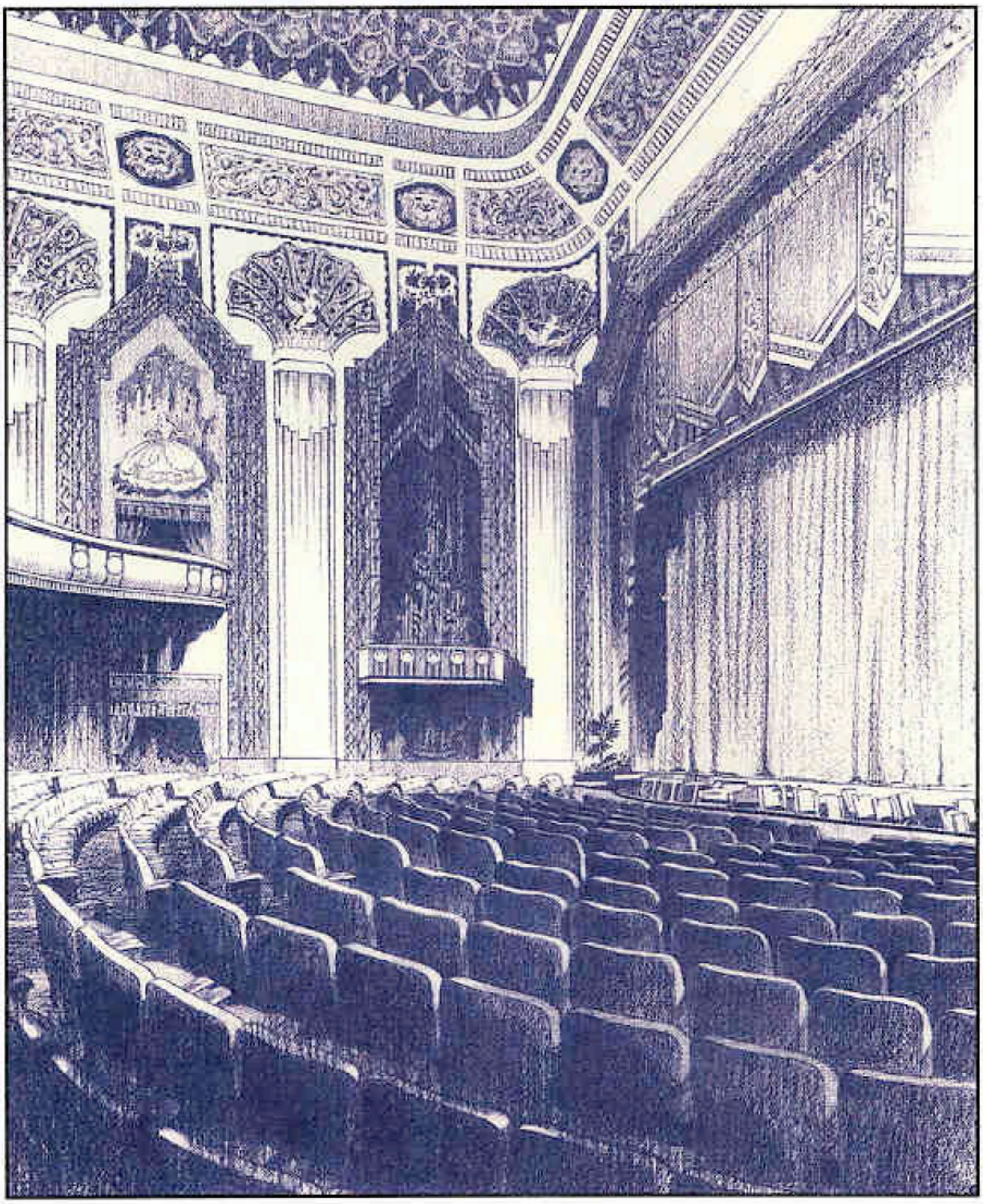
Broadcasting House, of course, is devoted to that form of entertainment suitable for transmission by wireless telephony, a purpose which distinguishes it from all other buildings and places of entertainment, such as theatres and public halls. Apart from the administrative offices, the building comprises a group of studios of varying sizes. No extraneous sound must enter these studios: a statement which in itself explains the design and methods of construction adopted.

The exterior presents to the public the appearance of an imposing office building, which is but a screen to the central tower in which the studios are situated. The building has no interior wells for the admission of light or air, so that all the inner rooms depend on artificial lighting and ventilation.

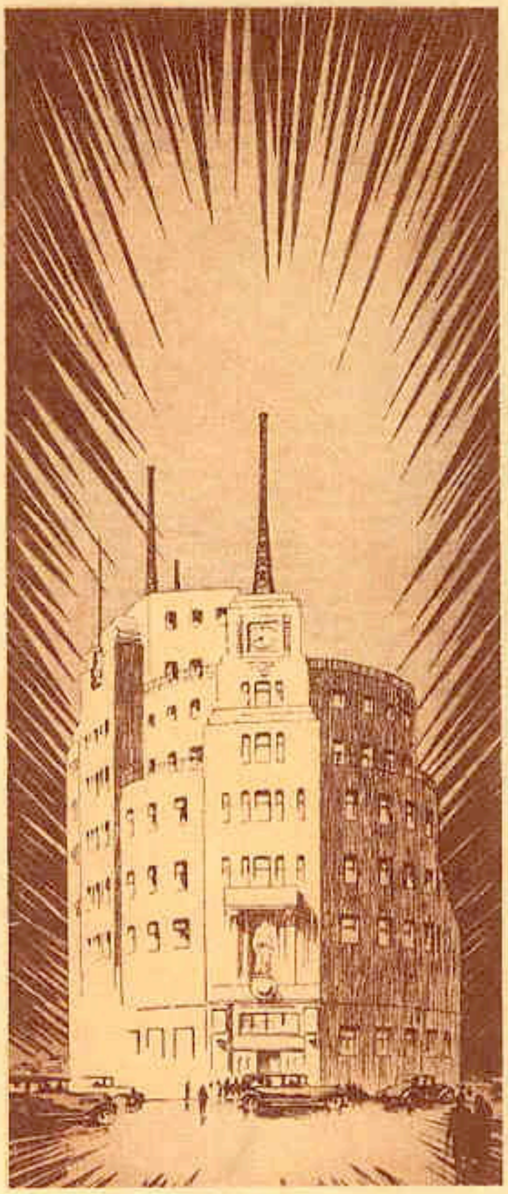
The central tower is a massive brick structure carried on a separate concrete raft, a peculiar construction adopted to exclude the noise of the street traffic. The studios are independent of each other, access to all of them being gained by means of a corridor, through the centre of the tower on each floor.

The only communication from one studio to another is the ventilation ducting. The studio walls are acoustically treated to prevent the passage of sound inwards, and to absorb sound produced in the studio in order to prevent excessive reverberation or echo.

Le Paramount, Paris, 1929 [drawing from 6/567, page 21].



The Astoria, Finsbury Park, London, 1930 [drawing from 6/567, page15].



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

CEC catalogue, c.1932 [6/567, back cover]

The studios are thus enclosures from which sound cannot escape, and into which no external sound can penetrate. The insulation is equally effective against heat, so that the heat generated within the studios by the occupants and lights would cause a continual rise in temperature were no special precautions taken.

The above description of the building immediately presents the difficulties that had to be overcome in designing and constructing the ventilation equipment. [surprising that the term air conditioning is not used].

The equipment was called upon to supply fresh air to the studios and to maintain specific conditions of temperature and humidity, yet at the same time to avoid transmission of sound from one studio to another, as well as to make no noise in its operation.....................

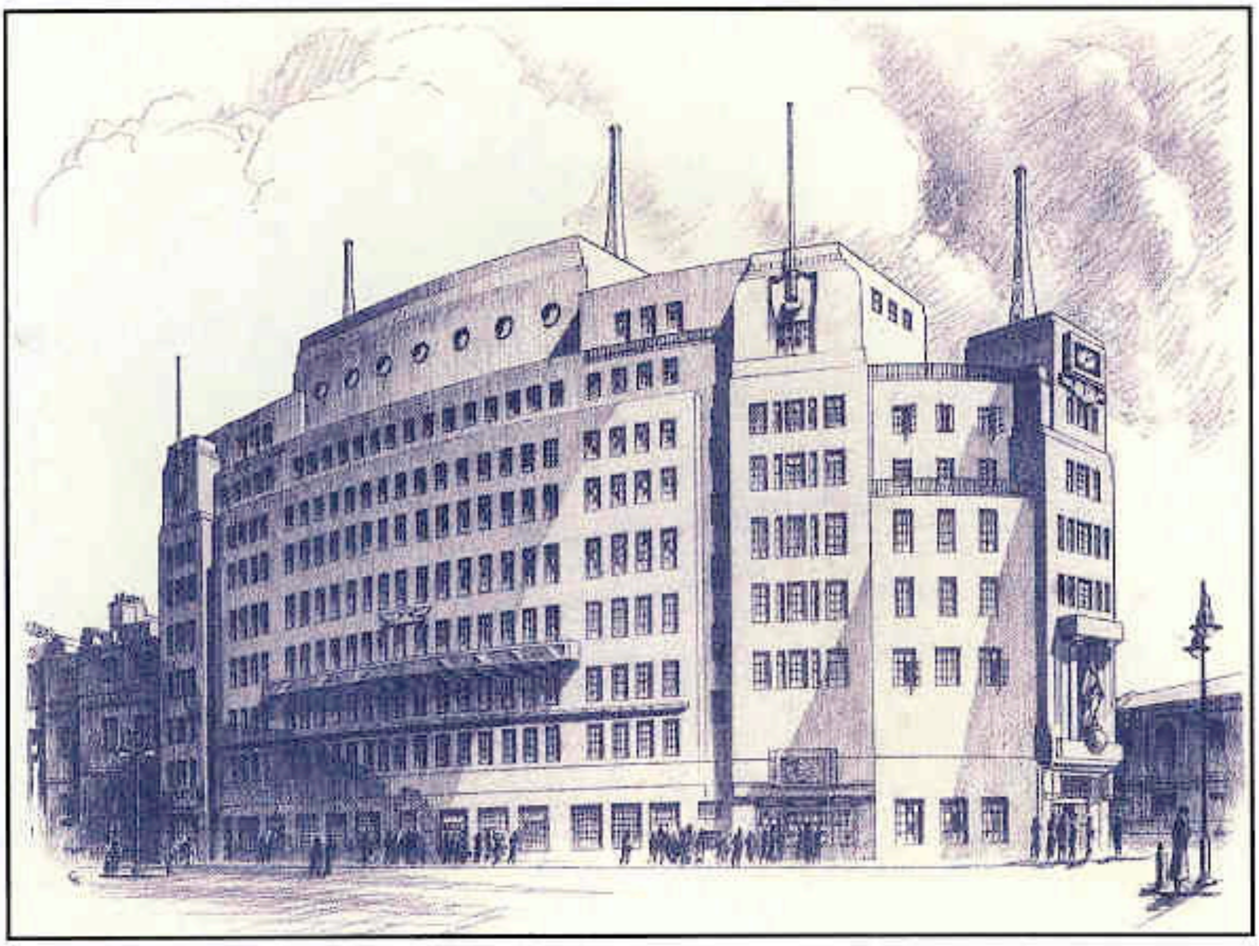
All of the studios in the central tower were supplied with conditioned air from four air handling plants, each comprising a supply fan, spray chamber washer, pump, heater batteries, automatic controls and an extract fan. Each plant drew in fresh air from the roof through a brick shaft and mixed this with a small proportion of recirculated air.

The automatic control system was quite sophisticated for the time. It employed automatically controlled air mixing dampers and control valve arrangements to heat or cool the spray water temperature, allowing winter humidification of the supply air, or cooling and dehumidification in summer (the latter being achieved when the spray water temperature was set below the dew point temperature of the incoming air). Studio temperature control was maintained by duct mounted steam reheat batteries. Each plant was driven by three electric motors (supply fan, extract fan, spray pump), each motor capable of being operated separately, or together. The Master Control Panel contained start and stop buttons with indicator lights for each plant, with distance reading thermometers to show external dry and wet bulb temperatures.

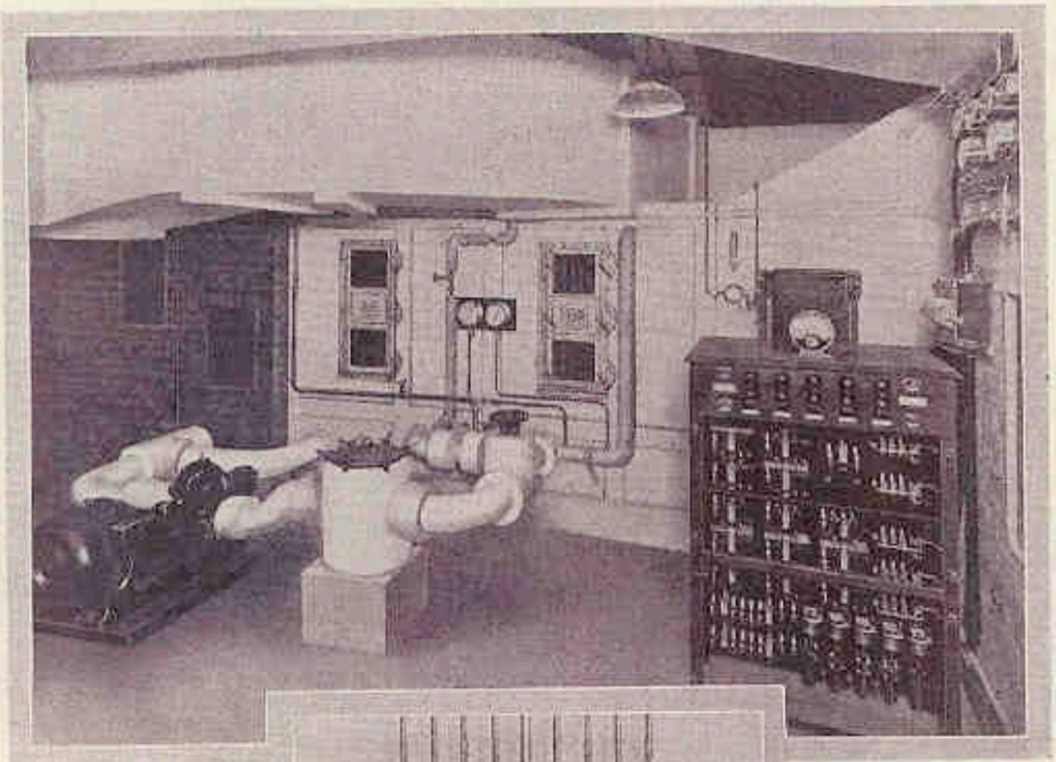
Chilled water was provided by a Carrier centrifugal refrigerating machine of 200 TR capacity, driven by a 275 hp electric motor, and located in the basement. The brochure description says that a cooling tower was not employed (as would have been used in an industrial application) due to lack of space, but describes pumping the condenser water through sprays in a roof chamber through which air was drawn by a fan. This is, in fact, a mechanical induced-draught cooling tower. The description implies that general practice for industrial air conditioning projects was to use a natural draught cooling tower, that is with no fans. Steam was generated to serve the heating calorifiers and air conditioning batteries by two oil-fired return tube boilers, each with a capacity of 6,700 lb/h of steam, and each fired by two low pressure oil burners (ie. four in total). It was noted that oil fuel was selected for ease of storage and handling [as opposed to coal?] The external office areas in Broadcasting House were heated by an accelerated low pressure hot water system using radiators.

The brochure concludes with the inevitable statistics, so beloved at that time:

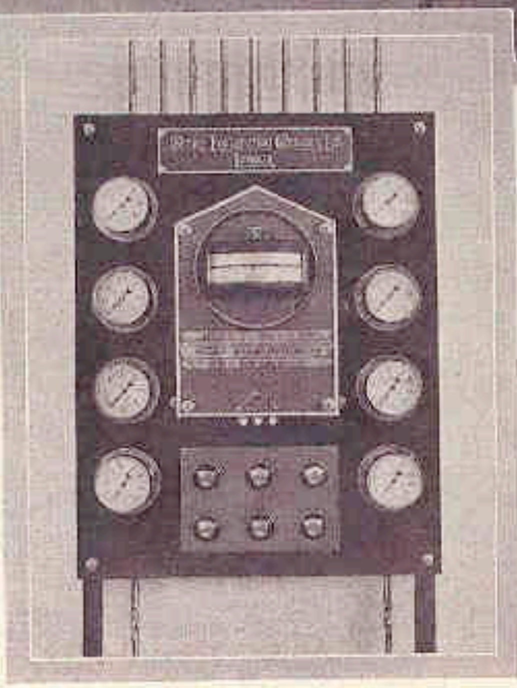
There are 32 fans handling 614 tons of air per hour, 16 pumps delivering 641 tons of water per hour under pressure, 54 electric motors having a combined capacity of 504 hp, sheet metal ducting weighing 120 tons, and 60 independent automatic controls.



BBC, Broadcasting House, London, 1931 [drawing from 6/567, page5].

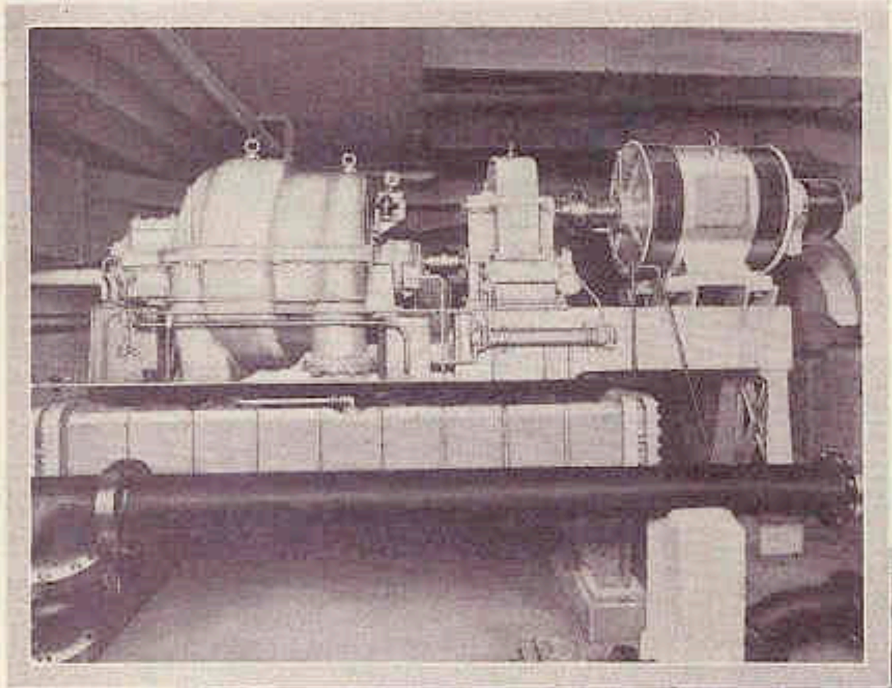


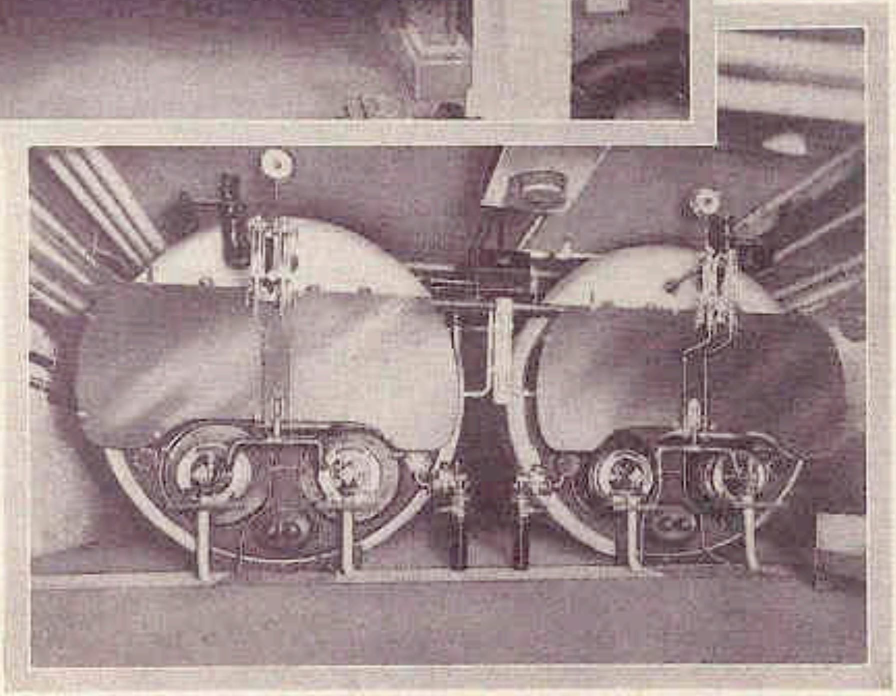
An illustration showing the air conditioning plant No. 2 serving some of the smaller studios. On the right-hand side can be seen the automatic electric control gear for the motors driving the pump and fans.



Showing one of the instrument boards carrying Air Gauges and 12 Point Indicating Thermometer.

BBC, Broadcasting House, London, 1931. Air conditioning plant & instrument board. [6/562, page8].





(Above) In summer the spray water for the dehumidifiers is cooled by means of the " Carrier " Centrifugal Refrigerator shown in this illustration. This machine has a capacity of 200 ice-melting tons, and comprises evaporator, condenser and centrifugal compressor, driven by a 275 h.p. slip ring motor. This machine room is well ventilated by air supplied from the ducts shown at the top of the picture.

(Below) Steam required for heating the building is obtained from the two return tube type self-contained boilers shown in this illustration. The boilers are fired by low pressure air atomised oil burners.

BBC, Broadcasting House, London, 1931. Refrigerating plant & boilers. [6/562, page14].

Other CEC projects are illustrated in the following pages.

1933 CUMBERLAND HOTEL, MARBLE ARCH, LONDON

1938 THE WARNER THEATRE, LEICESTER SQUARE, LONDON

1962 BBC TELEVISION CENTRE, WHITE CITY, LONDON

This project has been well documented [12/R97-35, 3 & 4].

CEC commenced investigations into the air conditioning of Television Studios when as early as 1946, with the co-operation of the BBC, they looked at the operation and heat loads in Studio A at Alexandra Palace [at that time Studio A was using an EMI TV system, while Studio B employed the Baird system]. Studio A, at 80 ft x 30 ft x 25 ft high had a maximum lighting load of 110 kW. Ventilation air was introduced through floor gratings and extracted at ceiling level. However, the supply air was not filtered, neither was it warmed in winter or cooled in summer; floor gratings affected studio operation and caused draughts in winter; air was introduced at fixed positions and not where most needed; there was no flexibility in the air distribution system.

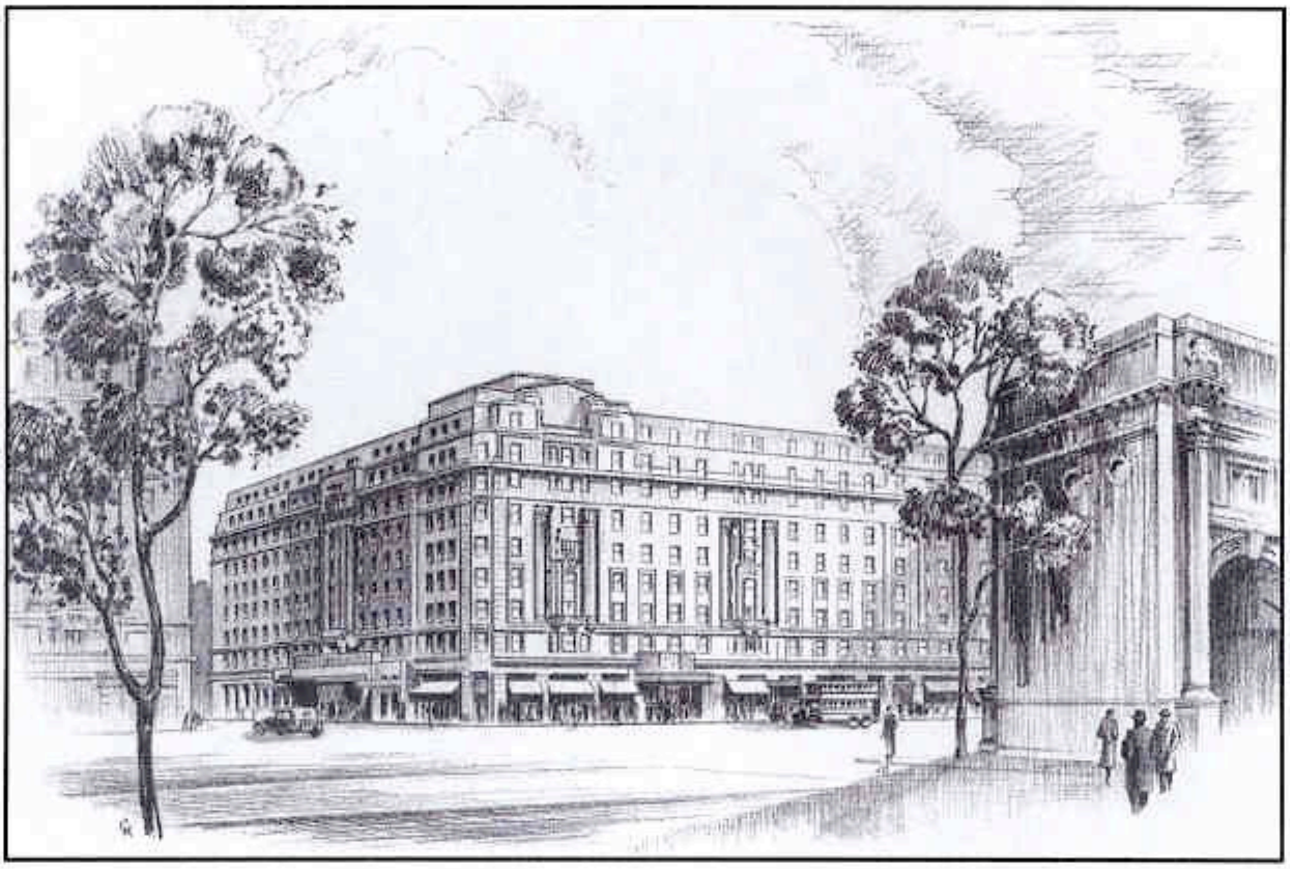
Then in 1950, CEC installed an air conditioning system for the BBC in Studio G at Lime Grove, formerly the film studios of British Gaumont. This installation was intended to serve as a prototype for the future Television Centre. Studio G was 120 ft x 60 ft x 35 ft high with lighting galleries at the 18 ft and 26 ft levels. The typical lighting load was 205 kW. It was decided air distribution should be from a supply ring main running around the studio immediately below the lower gallery, with a large number of outlets arranged for volume control from a central console. The supply air volume was 30,000 ft^3/min with extract air taken back both from below the supply ring main and through ducting above the ceiling. The control system varied the three quantities of supply air, low level extract and high level extract simultaneously, to keep the studio air distribution in balance at all times. Chilled water for the air conditioning was supplied from a CEC absorption refrigeration machine [Appendix-E]. Extensive testing formed the basis for the design of the White City TV Centre.

1962 CO-OPERATIVE INSURANCE BUILDING, MANCHESTER

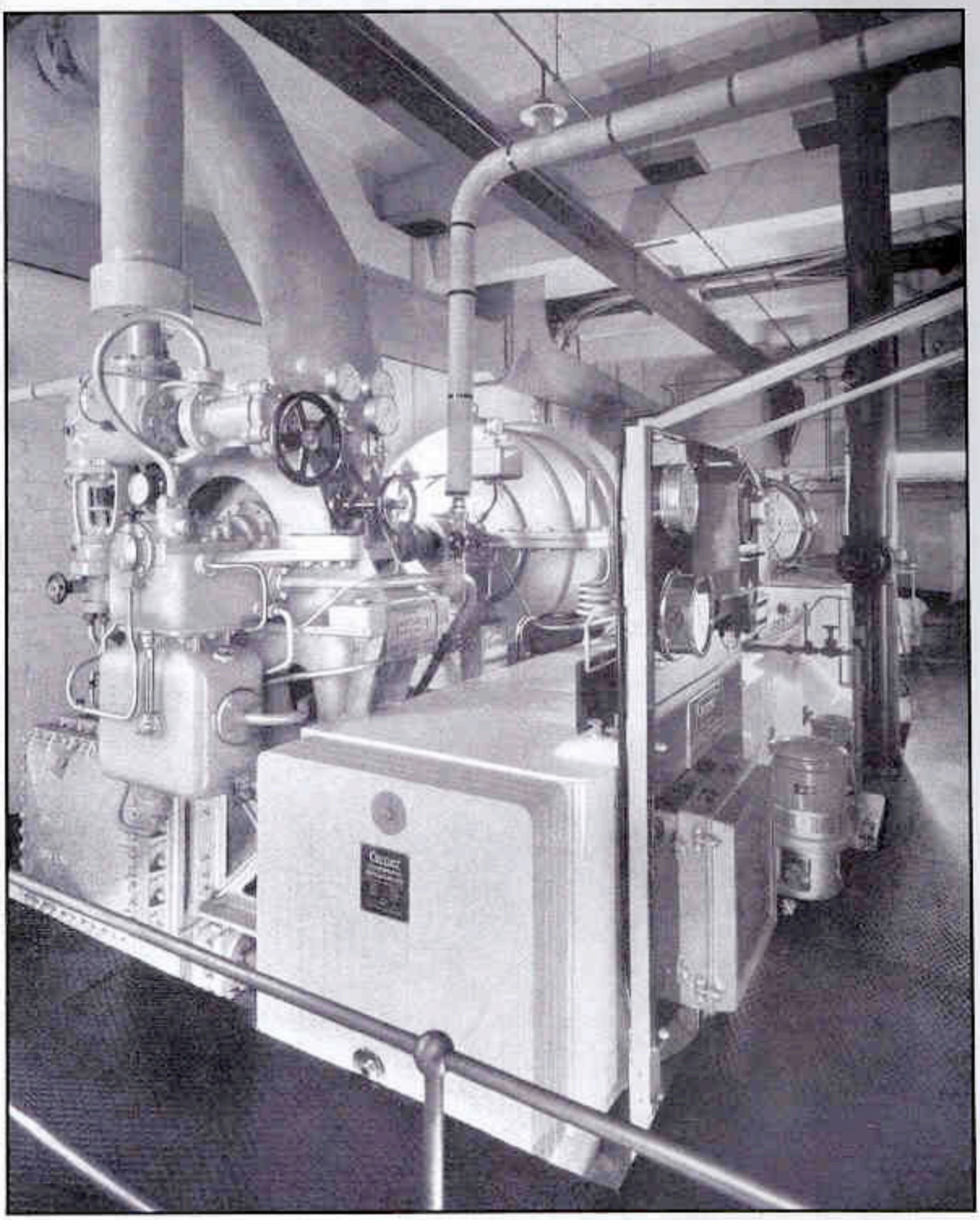
Full details of the building and its services may be found elsewhere [12/R-35, 6]

The CIS Building was one of the first <u>major</u> air conditioned office buildings in the UK [The same year, 1962, also saw the completion of E S & A Robinson, Bristol (contractor: Haden); Shell Centre, London (Haden); Millbank Development, London (Ellis): all seem to have claimed to be first at one time or another.]

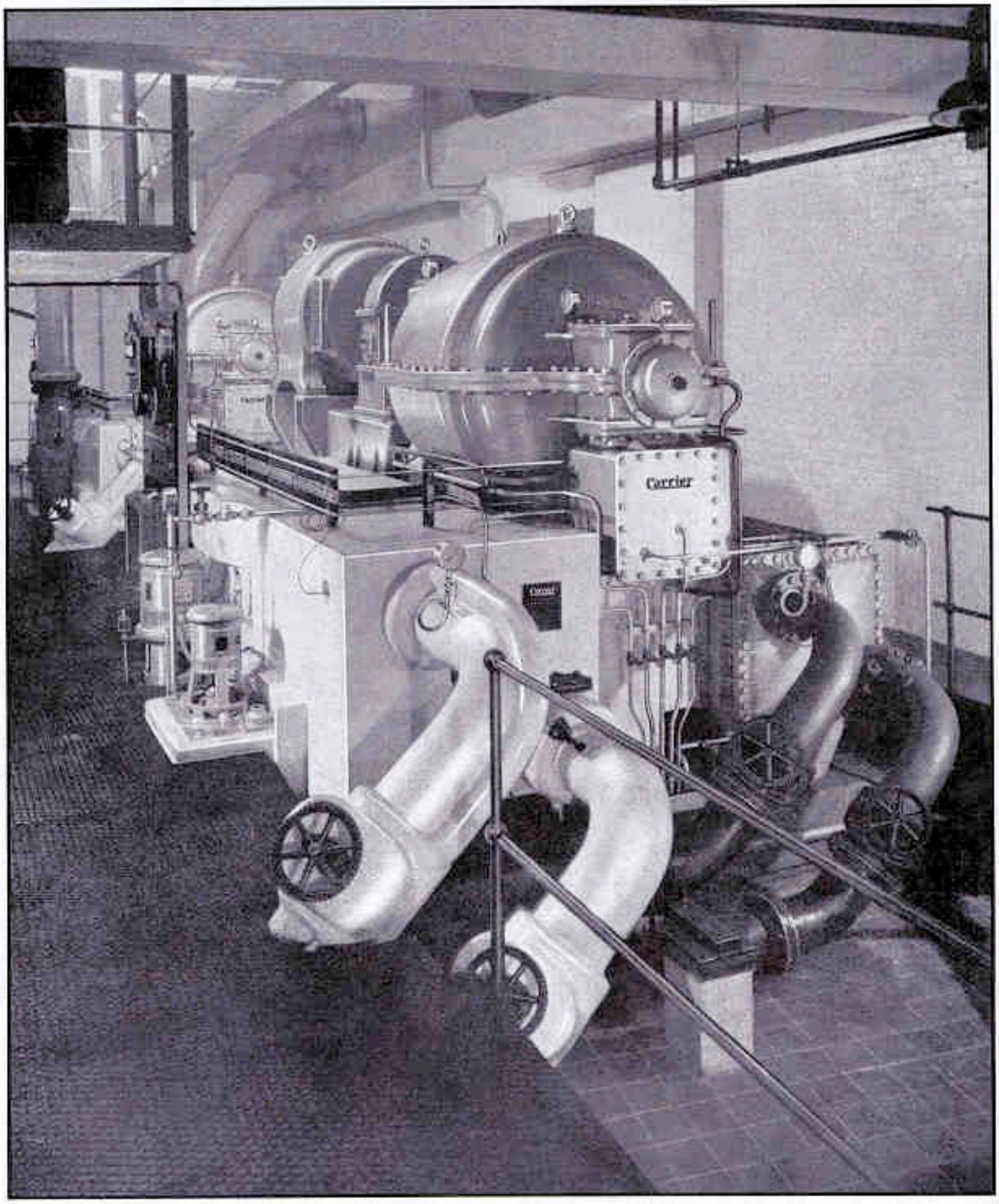
The CIS headquarters consisted of two office towers, one of 25 storeys, one of 14, with a 5 storey podium block alongside, providing over 700,000 ft^2 of floor space. A feature of the taller block is the clear open floor space with all lift shafts, staircases, lavatories and engineering facilities located in an attached services tower [an idea probably copied from the Inland Steel Building, Chicago, 1957].



Cumberland Hotel, London, 1933 [drawing from 6/567, page 11].

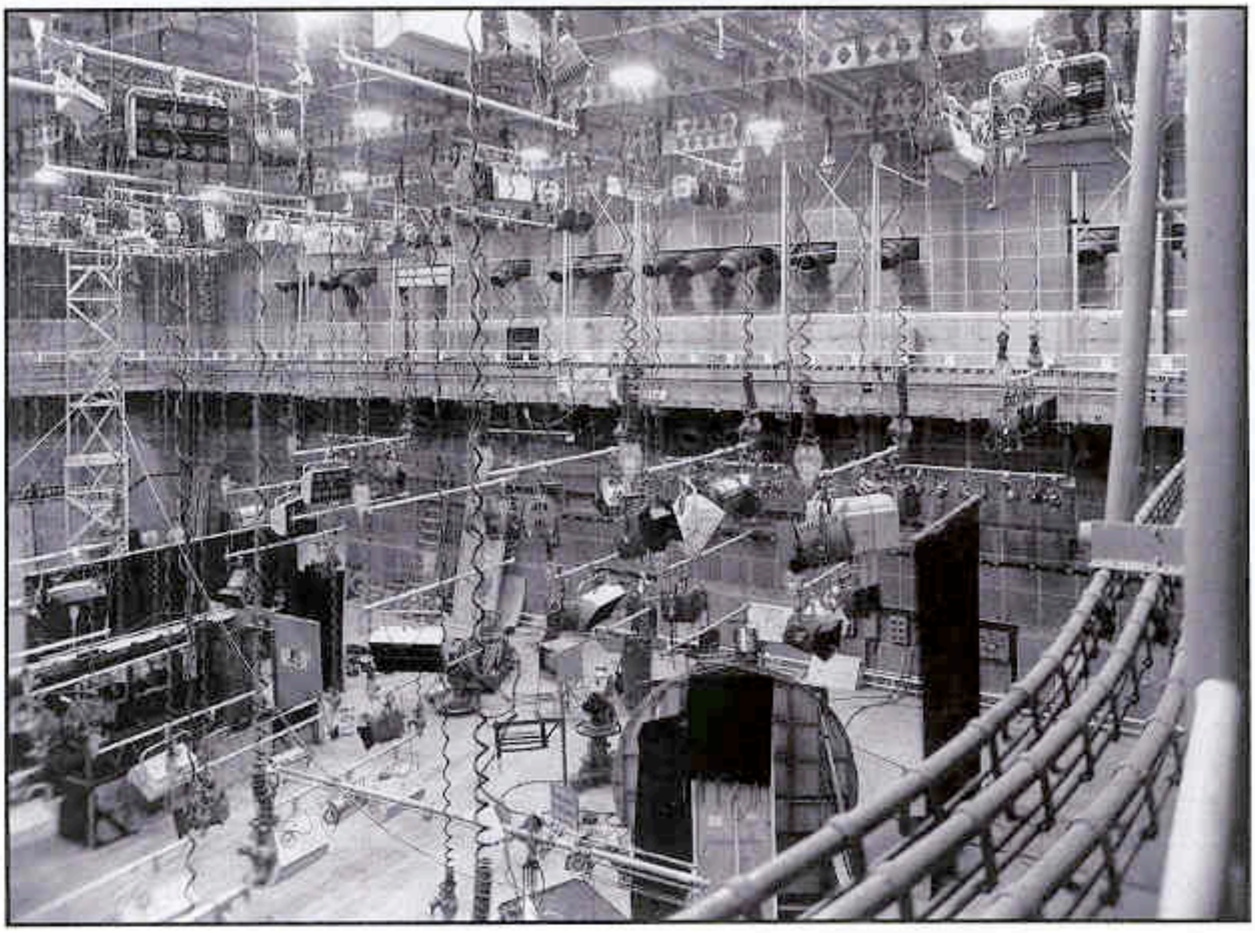


Cumberland Hotel, London, 1933. Steam-turbine driven Carrier centrifugal water chiller. [6/326, page 12].



Cumberland Hotel, London, 1933. Electric motor-driven Carrier centrifugal water chiller.
[6/326, page 13].

The Warner Theatre, Leicester Square, 1938 [P-649].



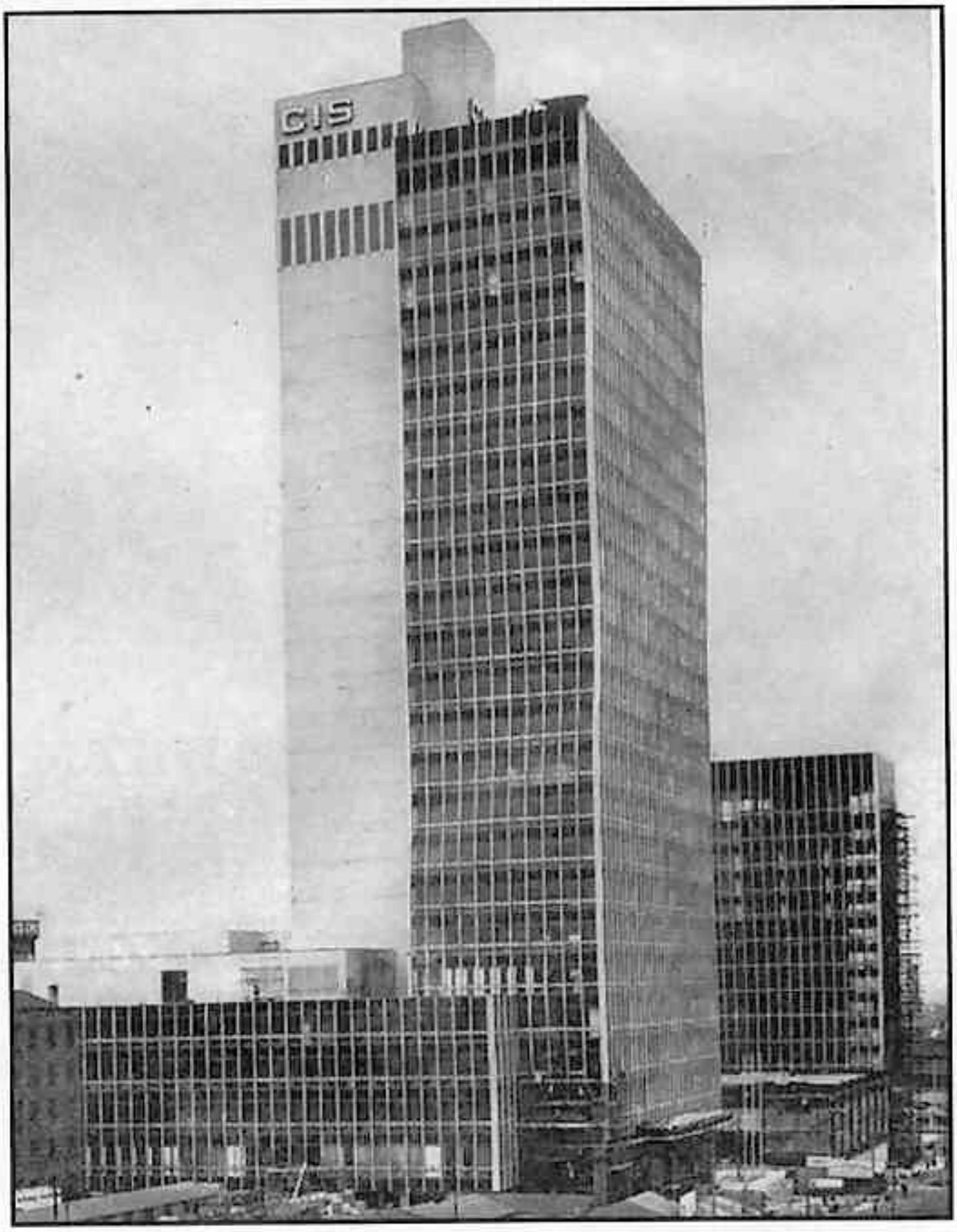
BBC TV Centre, White City, London, Studio 3, 1960.
View from balcony showing air conditioning nozzles and studio lighting [P-664].

The tower is of steel frame construction, with a structural supporting spine of reinforced concrete. The facade is made up of lightweight curtain walling with anodised aluminium mullions and vitreous enamelled sheet steel infilling panels backed with thermal insulation, used with single glazing and internal venetian blinds.

The main offices were air conditioned by a 2-pipe Weathermaster high-velocity, induction unit system, designed and installed by CEC and the Co-op Engineering Department. [The article quotes over 2000 induction units as being used: the CEC listing in Appendix-C says 1580.] The total air volume handled by all the high velocity plants was 220,000 ft^3/min, inner zones of the main tower being served by low velocity systems providing 52,000 ft^3/min. Central areas of the podium block used an integrated air/lighting fixture for supply and extract, one of the first in the UK. The main boilers were high pressure hot water type. The capacity of the refrigerating plant is not given, but for the entire complex appears to be around 1500 TR. A central control room housed a control and supervisory centre with very large mimic diagrams, typical of this period, before the introduction of computerised controls.

1966 BIRMINGHAM POST & MAIL, BIRMINGHAM
Further details [12/R97-35, 5]

This newspaper headquarters complex, designed by architects John H D Madin & Partners, embraces two systems of air conditioning designed and installed by CEC. Comfort air conditioning was provided in the curtain-walled office tower (inspired by the Levers Building in New York), mainly by a Weathermaster induction system (some 400 units), while mechanical ventilation with provision to add refrigeration was installed for the huge, adjoining, almost windowless, works block with a lowest basement floor some 60 ft below pavement level, and with about half its enclosed volume underground. The central refrigeration plant was a single hermetic centrifugal of 240 TR capacity. The total building cost was £7,500,000 for a complex of 500,000 ft^2 gross area. The cost of the air conditioning was £400,000.



CIS Headquarters, Manchester, 1962 [12/R97-35, 6, fig.1].

Birmingham Post & Mail, 1966 [12/R97-35, 5 fig.1].

Birmingham Post & Mail, 1966. The Advertisement Hall. [12/R97-35, 5 fig.5].