AJ SfB (92)
Building Illustrated UDC 725.16

GPO tower

London w1

designed by	Directorate General of Works, Ministry of Public Building and Works
chief architect	E. Bedford
senior architect in charge	G. R. Yeats
senior structural engineer in charge	S. G. Silhan
senior mechanical and electrical engineer in charge	J. J. Taylor
senior public health engineer	R. A. Parker

The GPO *tower is an engineering dominated building. Its main features are determined by the physical laws of the earth, and in spite of the restaurant, human life and movement are not strongly evident. But its contribution to the man made environment and its primary role in human communications draw it into the inescapable involvement of all buildings with people*

STRUCTURAL REQUIREMENTS

The structure is called upon to support sensitive radio-telephonic aerials at a height of not less than 355ft and preferably more. At this height the deflections of the structure must be kept within strict limits to maintain the accuracy of the narrow beam transmitters. It must provide, within 150ft of the aerials, the receiving and transmitting equipment required for the translation of wireless to wired impulses. These are the primary criteria that the architect and structural engineer had to consider. Secondary requirements arise from the consequent significance of the structure as a major feature in London's skyline, its possible use as a tourist attraction, and the confined site on which construction had to take place.

The most significant superimposed loading on the structure is that of wind. The vertical load at foundation level is approximately 13,000 ton. The wind induced moment is 75,000 ton/ft. The wind speeds assumed in estimating this moment were approximately two-thirds of those arrived at if the procedure set down in BS CP 3—Chapter V (1952) *Loading* had been followed.

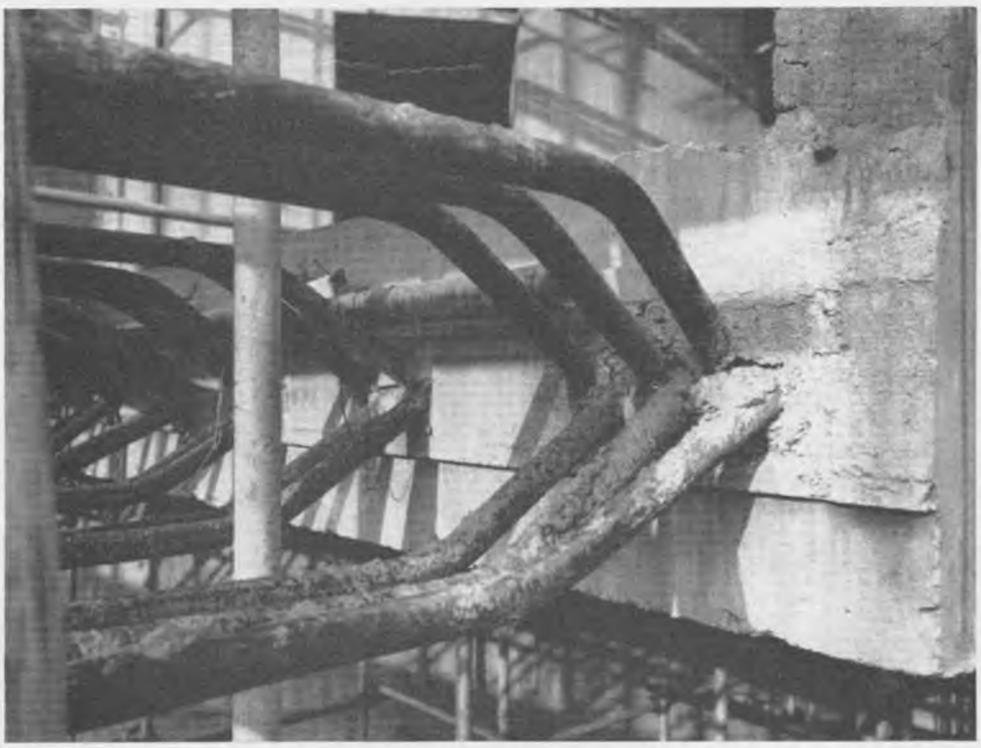
It is commonly felt that these procedures are conservative when applied to structures of this height and these proportions. Gauges have been incorporated in the structure and it will be of great value to see the published figures on the actual loads measured compared with those assumed for design.

Basic structure

The basic structure (see page 1541) of the tower is simple: a vertical concrete shaft 580ft high supported on a heavy raft foundation and braced back to the adjacent low structure at

1 *Detail of reinforcement at junction of bridge link slab (roof level of low block) and tower, 84ft above foundation level*

2 *Anchorage blocks in position for base slab of tower foundation*



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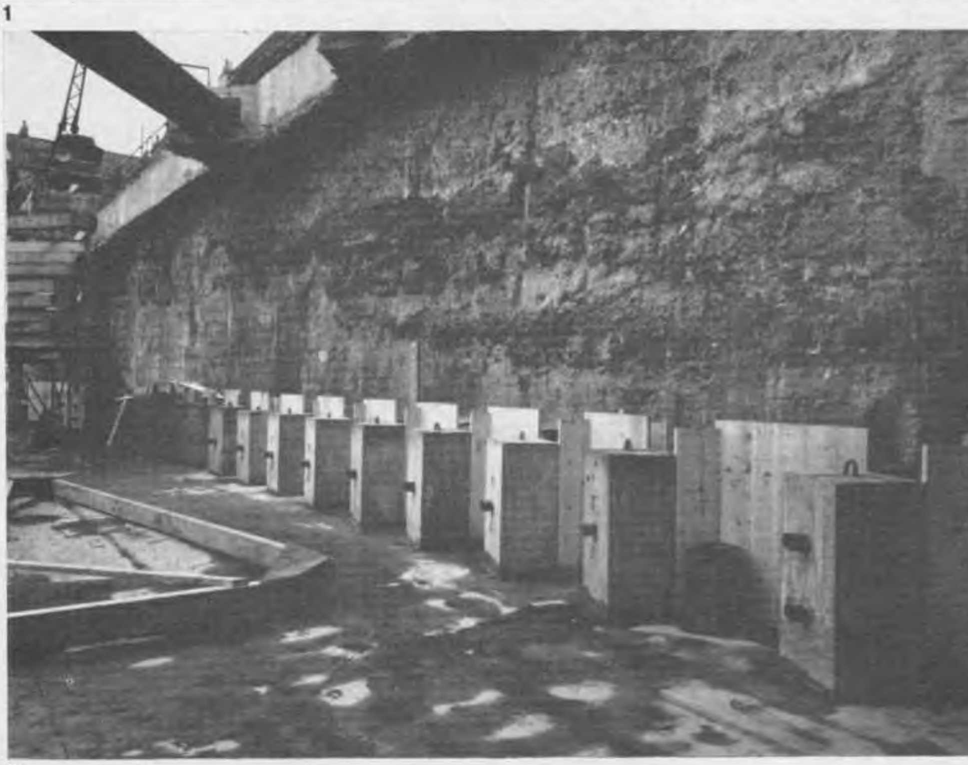

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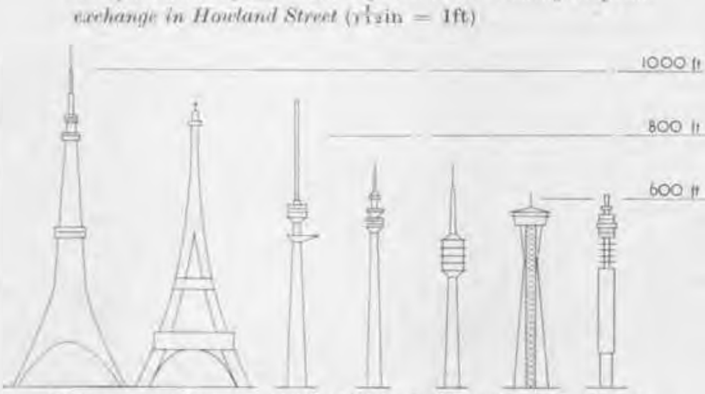
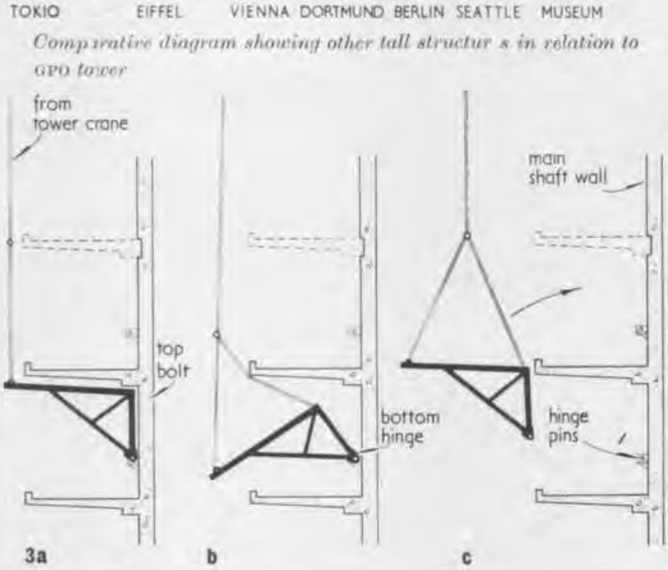
Site plan showing new work adjacent to the existing telephone exchange in Howland Street ($\frac{1}{64}$in = 1ft)



Comparative diagram showing other tall structures in relation to GPO tower



3 *Method of raising shuttering for cantilevered floor slabs:* **a** *first crane sling attached, top shutter bolt slackened, hinge pin dropped;* **b** *shutter frame hinged down and second crane sling attached;* **c** *shutter frame hoisted clear of floor slab and raised to hinge pin on floor above*

4 *Detail of hinge connection between shuttering and tower. The shuttering was in units comprising timber decking fixed to two steel frames. Eighteen units were required for one floor*

84ft above base level **1**. The former needs to be very rigid in order to limit the angular deflection to within ½deg, and with this consideration in mind the thick walled cylinder of the shaft was designed so that the tensile stress in the concrete at no time exceeds 300lb/sq in (see section and plans p1540, 1541)

Floor slabs

The floor slabs were designed as annular discs supported along the inner edge. Model tests indicated that the fixing moment at the support was approximately two-thirds the theoretical fully fixed moment. These floors help to limit secondary stresses and reduce the possibility of circumferential buckling in the main shaft. They are thickened near the shaft to permit the passage of the 'wave guides' from the aerials.

The requirements of rigidity and accommodation for equipment near the aerial platforms results in a structure comparatively easily strengthened to carry additional loads. This facility has been exploited by providing the high level restaurant and public spaces which now form such a well known feature of the tower. The restaurant, cocktail bar and observation gallery floors are similar in construction to the equipment floors, except that the 22ft cantilevers of the restaurant are stiffened near the tower with radial diaphragm walls about 3ft 6in deep.

Bridge link

The stiffness of the structure is increased by the bridge link at the roof level of the low block, 84ft above the foundation level of the shaft. This link transmits a horizontal force of approximately 560 ton via floor and roof, and is hinged at each end to permit the differential settlement of the tower and the low building **1**.

Foundations

The tower is supported by a 92ft square 20ft deep ribbed raft sitting directly on the stiff London blue clay. The bridge link reduced the maximum bearing pressure (dead load and wind) from 2·7ton/sq ft to 1·7ton/sq ft—well within the acceptable limit for the clay. Restrictions on deflection of the tower require that differential settlement

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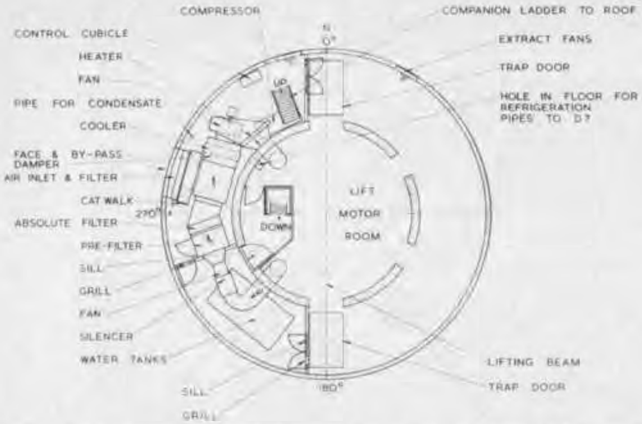


Plan at D9 showing restricted space for ventilating plant ($\frac{1}{24}$in = 1ft)

1 Lift well
2 Escape stairs
3 Public stairs
4 Lobby
5 Men's wcs
6 Women's wcs
7 Open observation
8 Service lifts
9 Window cleaning gear
10 Cloakroom
11 Cocktail bar

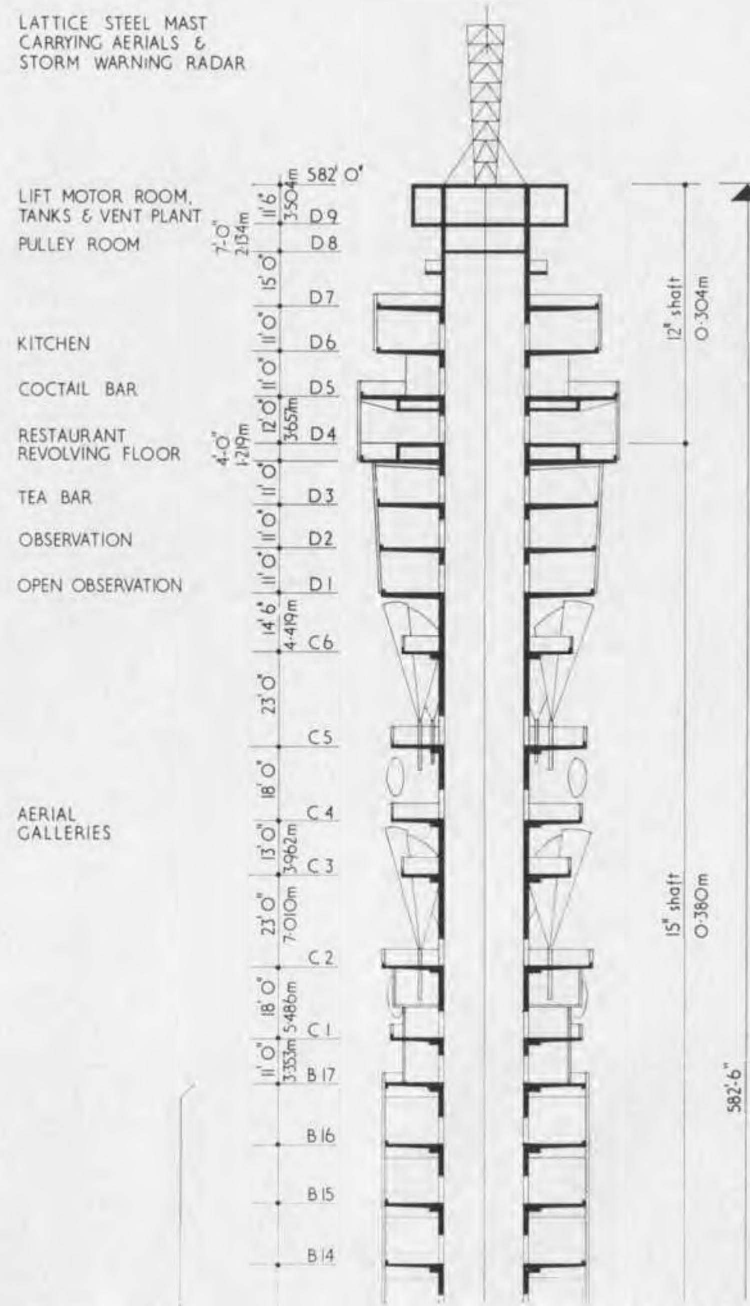
Plan at D5 (see section to right)

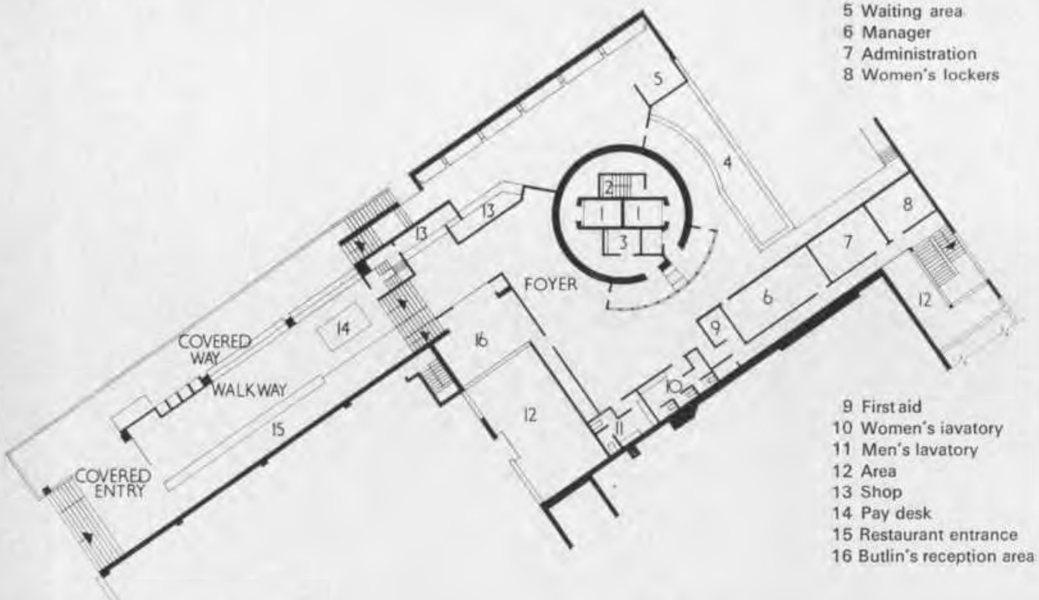
1 Lift well
2 Escape stairs
3 Cable riser
4 Holes for waveguides
5 Aerials

Plan at C5 aerial gallery

1 Lift well
2 Escape stairs
3 Cable riser
4 Lobby

Plan at B13



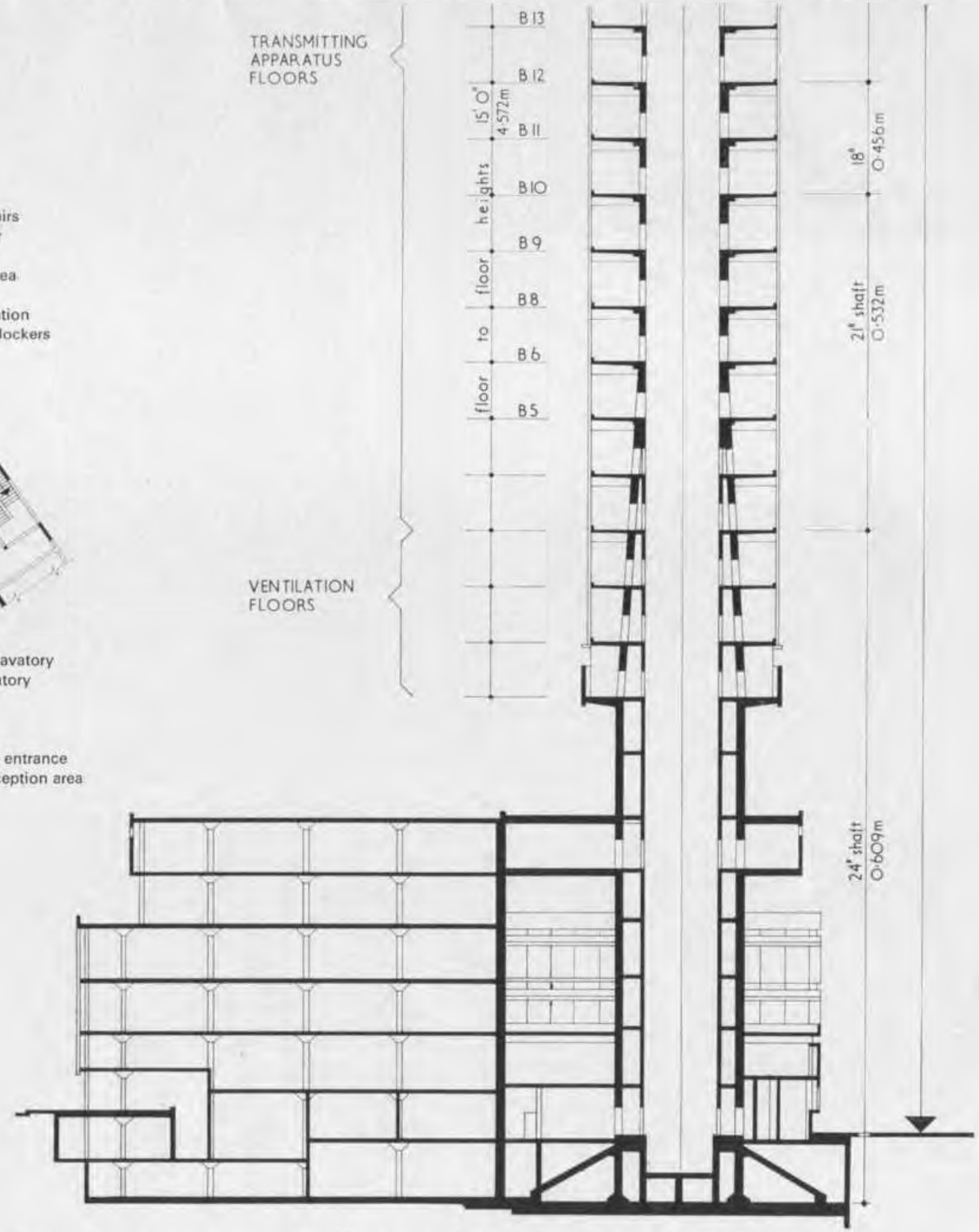


1 Lift well
2 Escape stairs
3 Cable riser
4 Pool
5 Waiting area
6 Manager
7 Administration
8 Women's lockers

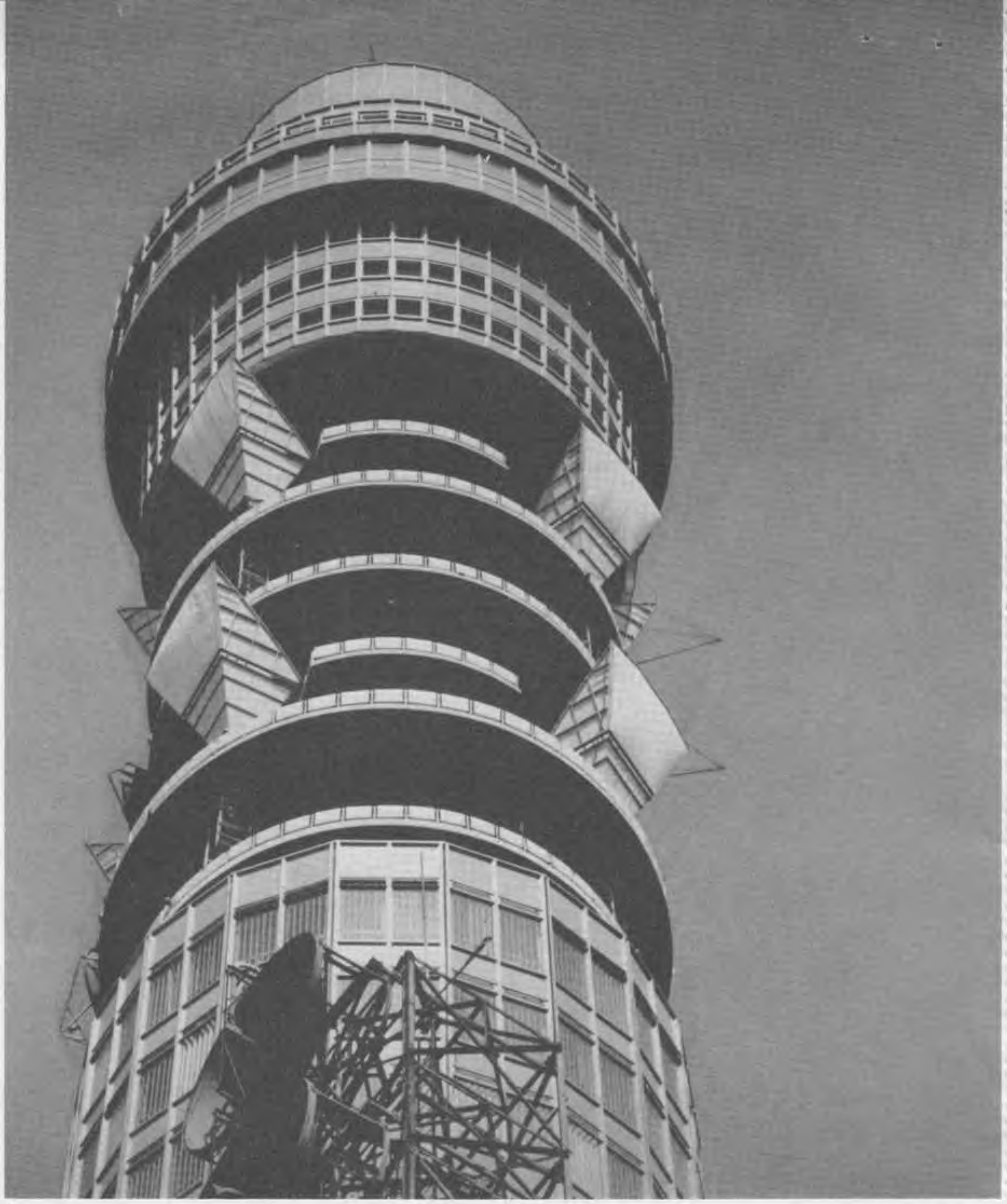
9 First aid
10 Women's lavatory
11 Men's lavatory
12 Area
13 Shop
14 Pay desk
15 Restaurant entrance
16 Butlin's reception area

Ground floor plan ($\frac{1}{48}$in = 1ft)

Foundation plan showing stiffening walls and reinforcement ($\frac{1}{48}$in = 1ft). Metric equivalents are indicated with dimensions



Section through tower ($\frac{1}{48}$in = 1ft). Metric equivalents are indicated with dimensions



5 *The slight definition of the restaurant floor is more satisfactory viewed from nearby streets, and the strong modelling of the aerial galleries can easily be appreciated*
6 *The bridge deck is arbitrarily curved, the unit being too small to be effective. Facets of the tower curtain wall are disturbing as they edge round the circle*

5

across the base of the tower shall also remain less than ½deg. This implies the maintenance of low bearing pressures.

Construction
As with most major engineering works the practical problems of construction equal those of design. Building a 600ft high tower in an urban environment calls for the use of sophisticated construction techniques and safety measures. The techniques used by the contractors, Peter Lind & Co, have the effective simplicity of all apt solutions to problems, and the firm is to be congratulated on its achievement.
The foundation excavation, immediately adjacent to heavily trafficked streets, was carried out in an ICOS walled cofferdam, similar to that used in the construction of the Hyde Park underpass. The wall reinforcement was placed in the bentonite slurry, which was then displaced by in-situ concrete, forming the finished wall **2**.
Shaft and platform were constructed separately. The shaft shuttering was of a normal braced timber panels 'leapfrogged' up the wall in approximately 3ft lifts.
The platform shuttering presented more difficult problems. Cantilevered table forms were used, which could be moved easily and rapidly in large sections. The method of raising the shutter forms is illustrated in **3** and **4**. The tower crane and hoists were raised with the shaft construction in approximately 15ft lifts. Safety nets were used during the construction of the shaft.

Conclusions
The GPO tower is a sound and straightforward solution to the problems posed. It states clearly the principles of structure called into play by the requirements of the situation, and full advantage is taken of the opportunities created by the height and stiffness of the building to provide London with a landmark in scale with its size and vitality.

ARCHITECTURAL CONSIDERATIONS

The technical prowess and matter-of-fact reasoning of this modern Tower of Babel, as the PR blurb calls it, is such that it is almost presumptuous for mere architects to comment or question.
This is also largely true of the wider town planning considerations as the tower is so powerful a marker (photo p1537) that it would be successful in most situations. Its siting depended on the land available next to the Museum telephone exchange and also to the possibility of beaming clear of any hazards. It is also in a commercial twilight zone, clear of London's popular historic buildings and

6

controversy. Ideally a tower of this type should mark a significant focal point, such as Piccadilly Circus as the centre of the West End, but obviously this was impracticable for the Museum exchange was already the centre of the telecommunications system and the vision cables network for London. Presumably the tower's existence now gives beam pathways in many directions which will severely control the heights of future buildings.

From most vantage points the bottom third of the tower is hidden from view. The glazed curtain wall shaft of the transmitting floors rises to the exposed aerial galleries with the public platforms, restaurant, bar and kitchen above, topped by the lift motor rooms, tanks, ventilation plant, pulley rooms and a 40ft lattice mast. This variety of use naturally gives a varied silhouette which is successful from a distance except for the indecisiveness of the restaurant and bar floors caused largely by the necessity to provide a protective screen enclosing the gallery outside the cocktail bar—a late decision; when a more vigorous silhouette was badly needed at this point as in Eric Bedford's original design. *The Architectural Review* (August 1965) has pointed out the affinity of the tower to Wren's steeples and the Gothic towers of the Houses of Parliament and much can be learnt from this comparison. It could be questioned whether the shaft of glazed floors should have been continuous over the three lower floors of ventilation apparatus for this would have helped to break up the silhouette. Generally however the massing is a very welcome addition to the urban landscape (see p1537).

On closer inspection the circular shaft becomes a polygonal curtain wall with the facets somewhat clumsily detracting from the general circular shape **5**, **6**. A closer rhythm of mullions would have been happier in turning the circle. This would also have served to transform the curtain wall which has almost a domestic scale, into something more noble in keeping with the grand design. The design simply has not the panache needed for a unique building.

Internally this is even more apparent. There is a grave lack of control over the number of finishes and the consistency of their use **7**, **8**. At the base of the tower, the shaft concrete is beautifully boarded and shuttered. On the observation levels it is clothed in shiny green tiles (level D3), matt grey mosaic (level D2), spotty mosaic (the ultimate in nastiness, this) **6** and plastic faced cloth on level D1. The other criticism is the domesticity of the detailing and thinking. On level D2 the entry to the marvellous view is marked by a 2ft 6in white painted flush door—it was probably hardboard faced—at the end of a 2ft 9in stub corridor. The red doorway and aluminium fluted walls of the ground floor hint at what might have been done. Two

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8

7, 8 *Two general views of open observation deck, illustrating different kinds of wall tile and ceiling treatment*

9 *Junction between transom top frame member and louvre frame above illustrates one of the problems associated with a*

impressions stand out; first the utilitarian approach resulting, presumably, from a low budget, and second the attention to what seems an unnecessary degree to the requirements of the fire officer.

Garnett Cloughley Blakemore & Associates was commissioned for the interior design of the upper floors by Butlin's who have leased the restaurant. This firm has taken the main elements of what are very small spaces and applied an overall theme of royal blue and pillar box red, which at night is probably very successful, to the top of the tower restaurant, the bar and the staircase between. In daylight the blue paint does not sufficiently soften the standard tower details such as ceiling ventilators and fire equipment fittings but the quality is set by the details—strong lettering, moulded light surrounds, simple chrome stick table lamps, and a specially designed carpet.

The core wall in the restaurant is sheathed in smoke mirror which successfully reflects the panoramic skyline **11** and expands a space which is only 10ft 6in wide. This is the floor which revolves. Cash and cloakroom counters and other fitments are sculpturally designed in red plastic sheet **12**, the forms continuing the circular theme. The bar space is less cramped while the kitchens and their associated service rooms are surprisingly spacious.

An exciting oval staircase joins bar, restaurant and top public viewing platform. Here the architects have painted the mosaic walls dark blue to show what they thought of the spottiness, and filled the well with a coarsely detailed hardwood screen.

At ground level the entrances for the public and restaurant customers are covered by a wide simple ceiling dotted with lights which is very welcoming. The entrance to the restaurant is excellent in its simplicity and quality **13**, quite superior to the detailing of the entrance to the public platforms.

This inconsistency extends to the four-storey base building which broadly follows the massing of surrounding terraces. The modelling and treatment of the main building has been carefully considered (although the validity of the solid panels 'floating' in the general wall surface can be questioned) **14**, while links to the existing building and other subsidiary buildings are banal and fussily detailed to the point of being overworked **15**. An exception to this is a large stone extension in Cleveland Mews, finely designed in a good factory tradition **16** and probably the best part of the lower building complex, its nobility being very suitable for the uniqueness and size of the tower above.

MECHANICAL SERVICES

The GPO tower is divided into two separate sections—the public rooms and the apparatus section. Plant serving the public rooms is located in a roof level plant room.

Plant equipment serving the apparatus section of the tower is located in the low level plant rooms comprising three levels below the apparatus floors.

Public section

The restaurant and cocktail bar are fully air-conditioned by the circulation of ducted air. The system incorporates a direct expansion air cooling plant having a loading of 20 ton refrigeration. The associated air heaters are electrically operated.

Conditioned air is recirculated from restaurant and cocktail bar. The fresh air intake represents 30 per cent of the total fan capacity of 6,000 cu ft/min. Extraction of a corresponding quantity of vitiated air takes place via the servery.

The fresh air serving the plant is cleaned by passage through a high efficiency filter, preceded by a disposable fabric

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circular building. The high quality of detailing and finish of door and window frames contrasts with that of the ceiling finish

10 *Tiling at observation level produces an unpleasant spotty effect. Timber balusters fill the oval staircase shaft and rise through to restaurant and bar levels*

11 *Magnificent views are reflected in the mirror walls of the core and visually expand the small spaces: all other hard surfaces are dark blue, as are table cloths and carpet, the latter having a line pattern of post office red*

11

12

13

15

12 *All fitments, such as cloakroom counter, are moulded in red plastic sheet and many angles are curved to give, quite successfully, interest to the small spaces*

13 *Detailing of restaurant entrance at ground level reflects an appropriate gaiety, mainly through the character of the lettering and the continually revolving red star motif*

14 *The mezzanine, as seen from Howland Street, is well handled and the base building fits in well with surrounding buildings. The solid wall panels strike the one superficial note in an otherwise straightforward treatment*

15 *Link (right) to existing Museum exchange is quite out of character with rest of building: the differing scales and various external treatments are distressingly obvious*

16 *The finely detailed base building has a simple treatment in scale with tower above*

14

16

filter.

Public areas other than the restaurant and cocktail bar are ventilated by plenum plant without air cooling facility. Background heating to the public rooms is by direct electric heating wall panels.

Hot water supply to the kitchen and lavatories is obtained from local electric water heaters connected to the GPO main electric supply.

A comprehensive layout of cooking equipment is provided and all heat requirements for this are met by electricity. The kitchen is ventilated by means of an axial flow extract fan of 8,000 cu ft/min rating in a store next the kitchen, drawing air from extract hoods fitted over the cooking equipment. The extract discharges through the side of the structure above the kitchen in a position adjacent to the extract serving the public areas. Baffle plates are located external to the discharge, and spaced a short distance from it, to guard against wind conditions adversely affecting the air discharge. Air inlet to the kitchen is drawn through a high level hinged window; it is unheated.

Apparatus section

The apparatus section of the tower is without a central system of heating, as enough heat is generated from the electrical apparatus to maintain the required minimum temperatures; these are about 10degF above ambient in the unattended automatic sections—local electric heaters are provided to boost the temperature to 60°F–65°F when plant is being installed or maintained.

The tower was planned to allow for forty years' growth in use, which is likely to result eventually in a heat dissipation within the apparatus section of about 250kW. However a heat loss of up to 45kW may occur at times on a single one of the thirteen apparatus floors. In addition, the solar heat gain per floor is estimated at 10·5kW.

Solar heat gain is being reduced by the provision of double glazing on the south, south-east and south-west walls of the tower; the outer leaf is a heat absorbing glass. Between the glazing is located an arrangement of vertical adjustable aluminium sun visors of aerofoil section.

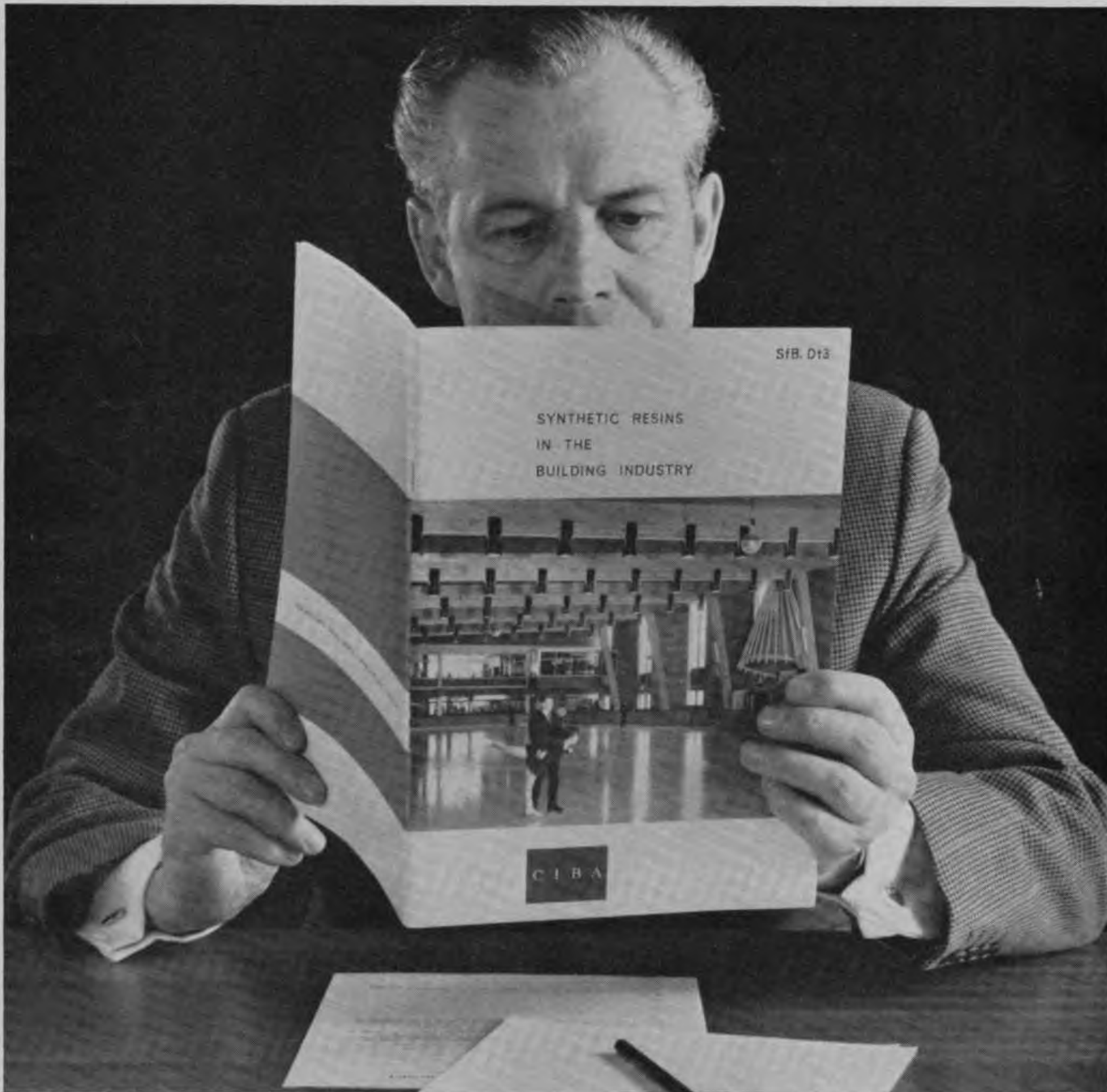
The apparatus section is ventilated by means of a plenum ventilation system embodying inlet and extract. The air supply is unheated, the heat gains from the apparatus within the tower being adequate to compensate for winter heat losses.

Electrostatic air filters are provided at the air inlet—preceded by disposable fabric pre-filters. An unusual feature of the filtration is an arrangement whereby automatic washing of the electrostatic filters is carried out from a remote control cubicle.

It is anticipated that the eventual increase in heat gains from further electrical apparatus which remains to be added will so increase heat gains that cooling provision must then be added to the plenum system now installed. To this end, provision has been made within the low level plant rooms and ventilation ducting for the future installation of compressor plant of 130 ton capacity refrigeration, direct expansion type air coolers and condensers.

The plenum plant is divided into two separate units of equal duty, each rated at 31,000 cu ft/min and operating at high velocity. The two plants are interlinked, so that in the event of failure of one unit, a reduced supply of ventilation can be maintained to both sections. A proportion of the air is recirculated.

The space available for ventilation trunking is limited, and therefore the main air flow moves at the high velocity of 3,000ft/min. Attenuator junction boxes lower the air velocity to about 1,000ft/min at the horizontal floor



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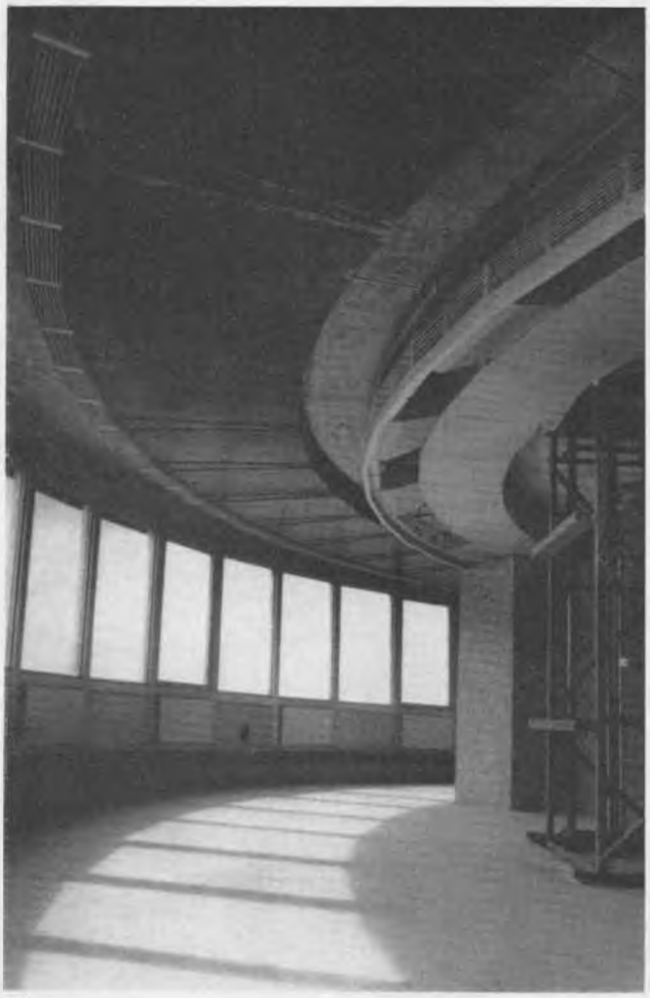

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17 *Enclosed public viewing gallery showing ducting and grilles for plenum ventilation system. Photo taken during construction*

18 *Typical apparatus floor showing cramped conditions for equipment*

ventilation off-takes.

Particular attention was paid to reducing the sound level of the system to within acceptable limits, as the fans themselves are operating at a high noise level. To this end, silencers are fitted to all axial flow fans; centrifugal fans are mounted on frames supported on anti-vibration mountings.

The design noise criteria for the restaurant and cocktail bar are NC40* and in sundry apparatus sections NC45. The noise emanating from the building has been suppressed to limit it at the pavement level to NC25.

In view of the extreme limitation of plant space, fans and motors are not generally provided in duplicate and the fabric air filters are not of the automatically actuated type. However the electric supply to the fan plants is safeguarded by a stand-by electric supply.

A separate ventilation plant serves the lavatories, all of which are mechanically ventilated.

Independent extract ventilation plants are fitted to the battery room floors. Air supply for these is drawn from the central supply plant, but all extract from the battery rooms is discharged to atmosphere, as the air tends to be laden with sulphuric acid fumes which must not be recirculated through the building.

Two separate fan plants are installed to ventilate the low level plant rooms.

Water is obtained from the Metropolitan Water Board and a fully autopneumatic system including pumps in duplicate, pneumatic tank and compressor takes water from the main and delivers all domestic water through a pumping main to storage tanks at 560ft above ground level.

To protect the board's main against back pressure that would occur were reflux valves to stick in the open position a dead weight pressure relief valve and additional reflux valves have been inserted between the main and boosted supplies.

Mains water for kitchen, restaurant, tea bar and drinking water points on other floors is taken direct from this pressurised main and, where necessary, pressure reducing valves are installed.

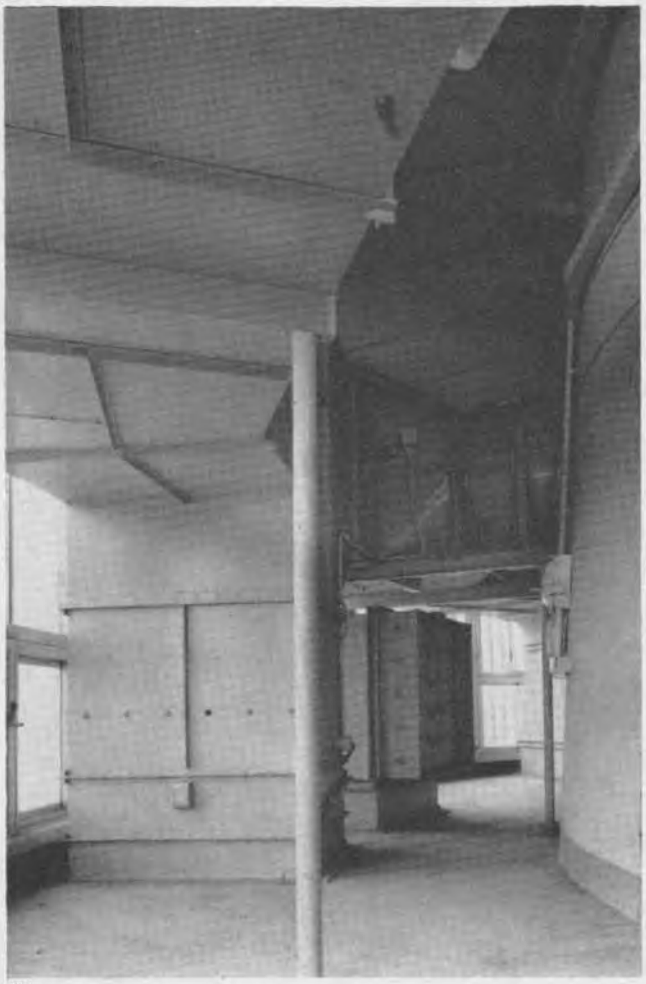
Domestic water for all other purposes is supplied by the main high level storage tanks and two other intermediate break-pressure tanks each of 50gal capacity situated at the 190ft and 320ft levels. These tanks ensure that the maximum pressure on the fittings does not exceed 100ft.

Fire protection arrangements have been provided to the standards of the GLC. Two systems of smoke detection are provided, one to each plenum plant. In the event of a smoke condition, an alarm sounds, the recirculating dampers are closed, fresh air inlet is fully opened and extract is fully opened.

A fire damper is provided in the vertical trunk duct between each floor, the damper being actuated by a fusible link device.

The GPO tower is independent as regards services from the boiler plant and other services provided for the Museum telephone exchange next to it.

* The noise criteria valve derives from NC curves which are drawn on axes of sound-pressure level against frequency band.



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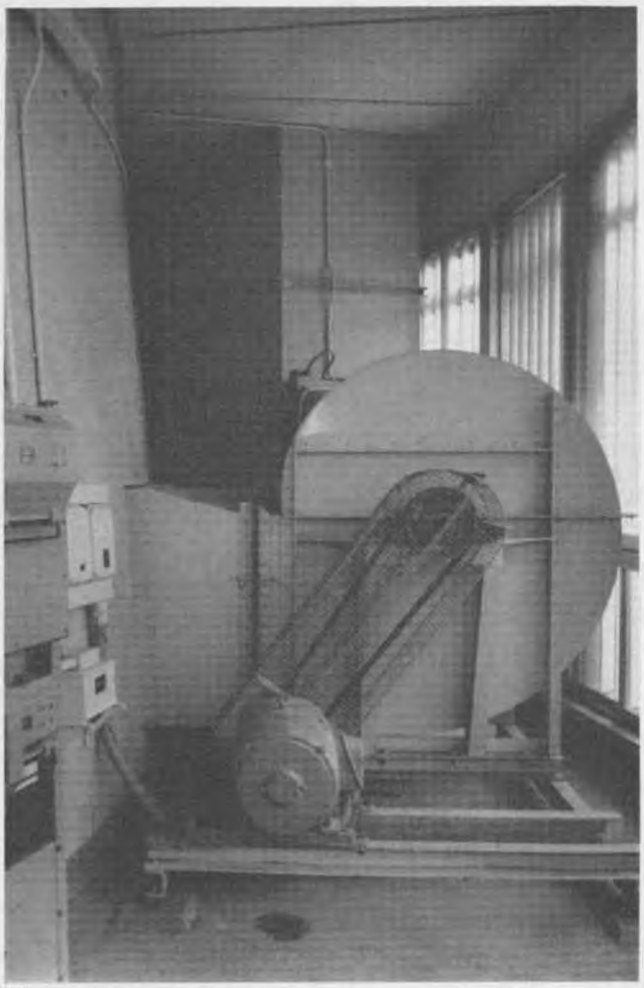

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19 *Plant room, level* B3, *showing one of the main extract fans and ductwork*

20 *Main supply fan, level* B2, *supported on frame on anti-vibration mountings*

CONTRACTORS

General: Peter Lind & Co Ltd. *Subcontractors and suppliers: Reinforcing rods for tower:* Stanton & Staveley Sales Ltd. *Reinforcement to Museum telephone exchange extension:* The Square Grip Reinforcement Co Ltd. *Concrete aggregates:* Hall & Co Ltd. *Fletton bricks:* Erith & Co Ltd. *Sundry steelwork:* A. A. Thornton (Teddington) Ltd. *Cement:* Tunnel Portland Cement Co Ltd. *Lightning conductors:* R. C. Cutting & Co Ltd. *Polystyrene:* Jablo Plastics Industries Ltd. *Laying asphalt:* General Asphalte Co Ltd. *Fixings:* Rawlplug Co Ltd. *Granite sills and coping:* Nine Elms Stone Masonry Works Ltd. *Exposed aggregate cladding panels and concrete blocks:* Cooper Wettern & Co Ltd. *Safety helmets:* Malcolm Campbell (Plastics) Ltd. *Non-ferrous fixings:* Harris & Edgar Ltd. *Aluminium and stainless steel windows and curtain walling to tower:* Henry Hope & Sons Ltd. *Heating, hot water, gas and ventilation services:* C. J. Jefferies Ltd. *v-form concrete shuttering, safety helmets:* Acrow (Engineers) Ltd. *Cast iron pipework and plumbing:* Smeaton & Sons Ltd. *Steel stairway:* Frederick Braby & Co Ltd. *Steel scaffolding:* London & Midland Steel Scaffolding Co Ltd. *Sprinkler system:* Atlas Sprinkler Co Ltd. *Tower crane for building telephone exchange extension:* Liebherr (Ireland) Ltd. *Windows and rooflights:* J. A. King & Co Ltd. *Ironmongery:* Alfred G. Roberts Ltd. *Safety nets to tower:* London Spinning Co Ltd. *Ruberoid roofing:* The Ruberoid Co Ltd. *Painting:* Arnold Sharrocks Ltd. *Joinery:* J. C. Richards (Woodworkers) Ltd. *Lightweight concrete screeding:* Isocrete Co Ltd. *Plastering:* Humphris & Bailey Ltd. *Cable trunking and boxes:* Salamandre Metal Works Ltd. *Mosaic work:* Marriott & Price Ltd. *Window cleaning gear to telephone exchange:* Palmers Travelling Cradle & Scaffold Co Ltd. *Quarry tiling:* Corrosion Technical Services Ltd. *Sanitary fittings:* W. N. Froy & Sons Ltd. *Sundry glazing and domelights:* James Clark & Eaton Ltd. *Balustrading and steel ladders:* Clark Hunt & Co Ltd. *Timber doors, joinery:* Walter Lawrence & Son Ltd. *Steel fire resisting doors:* Durasteel Ltd. *Elevated flooring:* Archibald Low & Sons Ltd. *Steel partitioning:* Roneo Ltd. *Plastic covered sliding/folding doors:* Horsley, Smith & Co (Hayes) Ltd. *Steel rolling shutters:* Dennison Kett & Co Ltd. *Cemglaze:* Cement Glaze Ltd. *Terrazzo tiling:* St James Terrazzo Tile Co. *Composition block flooring:* Granwood Stonewood Ltd. *Restaurant revolving floor:* Ransomes & Rapier Ltd. *Aluminium false ceilings:* Gardiner Sons & Co Ltd. *Timber shuttering fixings:* John Lynn & Co Ltd. *Climbing Crane to tower:* Climbing Cranes Ltd. *Passenger hoist to tower during construction:* Wickham Engineering Co Ltd. *Ceilings:* Anderson Construction Co Ltd. *Fireproof partitions:* Unilock Partitions Ltd. *Basement walling:* Impresa di Costruzione Opave Specializzate (ICOS). *Reinforcement for basement:* The Rom River Co Ltd. *Concrete joint waterstops:* Tretol-Servicised Ltd. *Prestressing wire for base of tower reinforcement:* British Ropes Ltd. *Anchorages for prestressing wire reinforcement to tower base:* P. S. C. Equipment Ltd. *Tricosal admixture to concrete:* A. A. Byrd & Co Ltd. *Timber shuttering for concrete:* John Lenanton & Son Ltd, George E. Gray Ltd. *Insulating:* Newalls Insulation Co Ltd. *Flooring:* Semtex Ltd, Lionweld Ltd. *Fire extinguishers:* Nu-Swift Ltd. *Steelwork:* T. W. Palmer & Co (Merton Abbey) Ltd, Wm Jones Ltd. *Hoisting blocks:* Fellows Bros Ltd. *Tiling:* Harradene Rouse & Co Ltd. *Shuttering:* Shutter Contractors Ltd. *Lifts:* A. C. E. Machinery Ltd. *Partitioning:* Sankey-Sheldon Ltd. *Protective clothing:* Downham Supplies (Contractors Tools) Ltd.