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Post Office Tower, London, and the United Kingdom Network of Microwave Links

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Microwave radio links are playing an increasingly important part in the provision of additional circuits for the Post Office telephone, television and data-transmission networks. The main features of such links are reviewed and, in particular, the functions and equipment of the London Post Office Tower, which will form the terminal station for many radio-relay links, are described.

INTRODUCTION

PROVIDING a new feature on the London skyline, the Post Office Tower (Fig. 1) will be the London terminal of a nation-wide trunk network of microwave radio-relay links carrying telephone, television and data traffic.

In the period since the second world war, the Post Office has provided a national network, composed partly of underground coaxial cables and partly of microwave radio-relay links, to serve the needs of the British Broadcasting Corporation (B.B.C.) and the Independent Television Authority (I.T.A.) 405-line monochrome television services.¹ The radio component of the network provides an aggregate length of 4,000 operational video-channel miles, and its London terminal is located adjacent to, and in the shadow of, the new tower. In the same period, steady developments in microwave techniques have enabled the Post Office to introduce the microwave radio link as a practical and economic alternative to the coaxial-cable link for long-distance transmission of multi-channel telephony.²

Rapid expansion and reconstruction of the radio component of the network is now being carried out to provide extensive new trunk telephone-circuit capacity to meet the demands arising from the increasing use of the telephone in the United Kingdom, stimulated by the spread of subscriber trunk dialling, and to meet the requirements of the B.B.C.'s new 625-line television service. A prime example of the expansion now under way is the replacement by the Post Office Tower of the existing radio terminal in London, which has neither the communication capacity required for future needs nor an adequate height.

TRAFFIC TO BE CARRIED BY THE MICROWAVE NETWORK

By 1966 a trunk network of radio-relay links (Fig. 2), with aggregate route length of 2,000 miles and using



FIG. 1—THE POST OFFICE TOWER

120 stations, will join together all main centres of population in the United Kingdom. The network will by that date provide about 4,500 operational broadband-channel miles for the transmission of multi-channel telephony, of which 1,800 miles will have a capacity of 960 telephone channels per broadband channel in a frequency-division-multiplex assembly of 4 kc/s channels in the baseband* frequency spectrum 60 kc/s–4.028 Mc/s,

*The term baseband designates the band of frequencies transmitted by the radio link between its input and output terminals.

†Inland Radio Planning and Provision Branch, E.-in-C.'s Office.

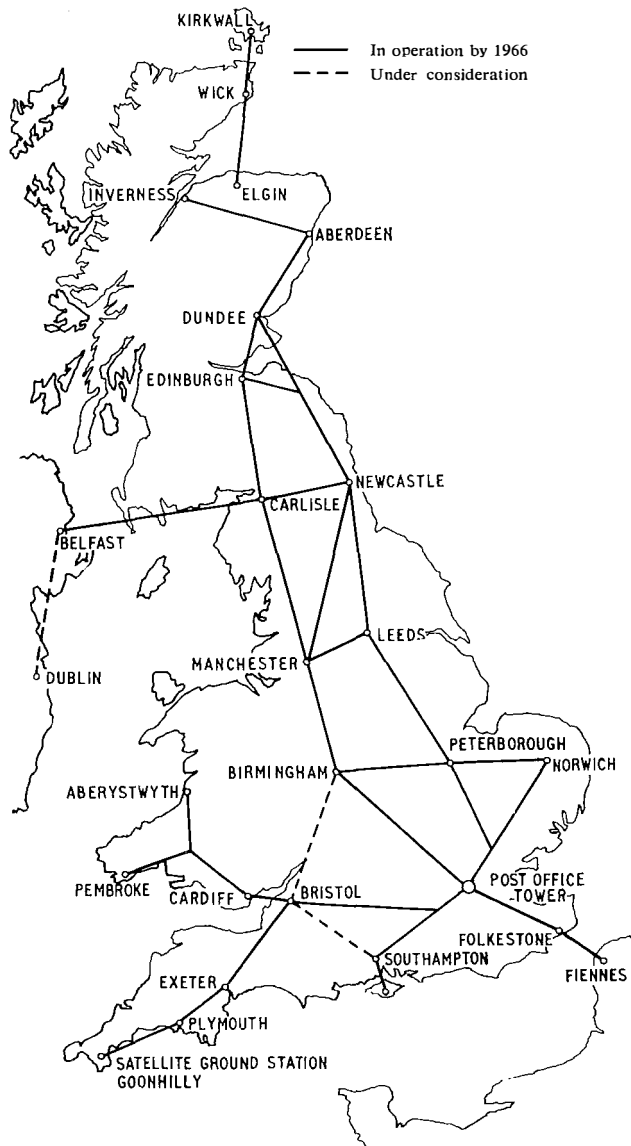
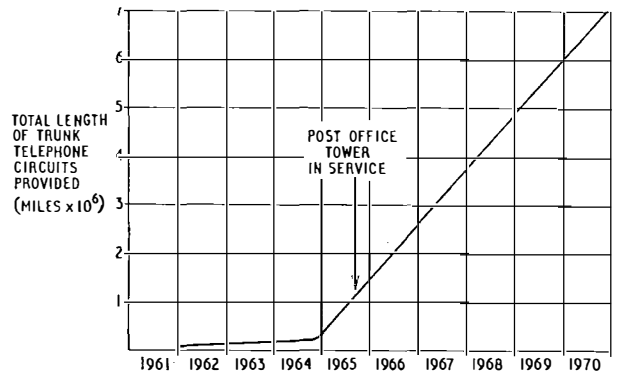


FIG. 2—POST OFFICE MICROWAVE RADIO-RELAY TRUNK NETWORK

and 1,800 miles with a capacity of 1,800 telephone channels per broadband channel (baseband frequency spectrum 312 kc/s–8.204 Mc/s). At the present time the aggregate telephone-circuit mileage carried by radio links is about 1,000,000 miles, but by the end of 1966 this will have increased to 2,500,000 and, on current estimates, should reach 7,000,000 miles by 1970 (Fig. 3).

In addition to providing for the needs of the present 405-line services, the network also provides 2,100 operational video-channel miles (vision-channel baseband frequency-spectrum 0.5–5.5 Mc/s) to serve the first 13 u.h.f. 625-line television broadcast transmitters, which are scheduled to be in operation by 1966. An important requirement has been the need to cater for the eventual transmission of colour signals; in the absence of international agreement on a colour system, the Post Office have specified transmission standards appropriate to the N.T.S.C.† system, which is com-

†N.T.S.C.—American National Television System Committee.



The curve shows the mileage already provided and the estimated future mileage.
FIG. 3—POST OFFICE MICROWAVE RADIO-RELAY NETWORK—TRUNK TELEPHONE CIRCUIT GROWTH

sidered to have the most stringent transmission requirements of any system that might reasonably be adopted.

The station which must cater for the greatest demand for circuits is that in the centre of London, at the focal point of important trunk telephone exchanges and the London network of television cables. By 1966 the Post Office Tower will be the terminal for 5,400 United Kingdom trunk telephone circuits and, in addition, for 23 television channels; by 1969 the trunk-telephone component will have increased to 30,000 circuits. The Tower will also be the terminal for telephone and television circuits to the continent of Europe, by way of the cross-channel radio link, and to North America, by way of the satellite ground station at Goonhilly Downs, Cornwall.

FEATURES OF MICROWAVE RADIO-RELAY LINKS AND STATIONS

General

Before giving details of the Post Office Tower it is necessary to consider the technical features and capabilities of microwave radio-relay links in general, so that the factors affecting the choice of site, the form of structure, and the radio equipment provided may be more clearly understood.

Microwave radio-relay links now in use operate in radio-frequency bands centred on 2,000, 4,000 and 6,175 Mc/s, and a further band centred on 6,760 Mc/s will shortly be brought into use; many individual broadband channels, each capable of carrying up to 1,800 speech channels or, as an alternative, one 625-line colour-television signal, can be accommodated in each band.

Microwaves, i.e. radio waves having a frequency greater than about 1,000 Mc/s, are suitable for point-to-point transmission because they can be concentrated into highly-directional beams by reasonably compact aerials (Fig. 4), and directed along substantially-straight line-of-sight paths between adjacent stations (Fig. 5).

To obtain the most efficient transmission of the radio waves, there must be certain minimum clearances between the direct line-of-sight transmission path of the microwave energy and the ground or other obstacles on or near the transmission path. To achieve this, microwave radio stations are usually sited on ground which is higher than the surrounding area, and the aerials are mounted on towers, usually of lattice steel but sometimes of reinforced concrete. Post Office links are normally planned so that the radio transmission path between

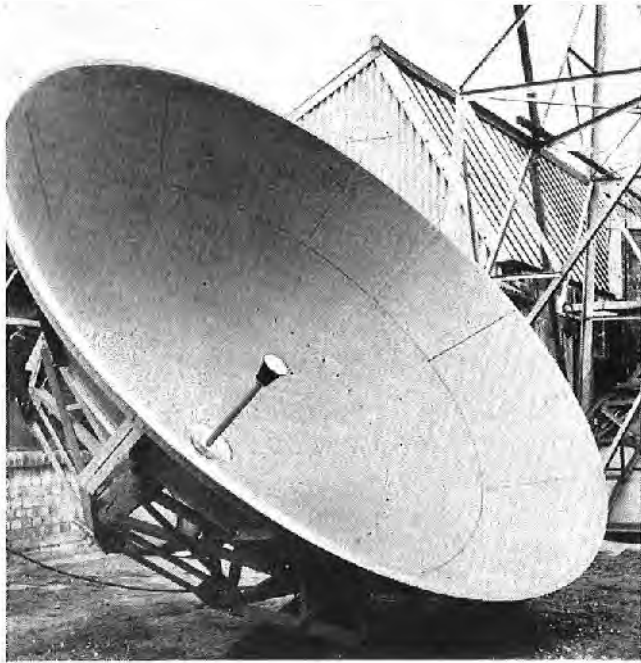
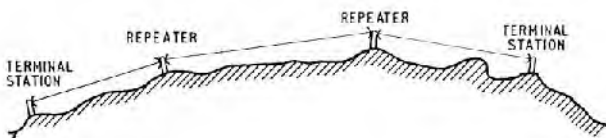


FIG. 4—PARABOLIC-DISH AERIAL



TYPICAL SPACING BETWEEN STATIONS ABOUT 30 MILES

FIG. 5—LINE-OF-SIGHT MICROWAVE SYSTEM

aerials at adjacent stations clears all features of the intervening terrain by about half the radius of the first Fresnel zone.* Moreover, as an additional precaution, this clearance is designed to occur even under adverse meteorological conditions that can occasionally arise,† making the radio path curve so that it is convex towards the earth, with a curvature one quarter of that of the earth. To provide the required quality of transmission, and in order to keep the heights of the towers within reasonable bounds, the spacing between stations is normally about 30 miles, which, in this country, leads to tower heights ranging between 50 and 300 feet, depending on the particular features of the path terrain. A typical radio station of this type, using a lattice-steel tower, is shown in Figure 6; most stations in the network have towers of this, or similar, type but reinforced-concrete towers³ are in use at seven stations.

At stations of this kind, the microwave-radio equipment is housed in a single-story building at the foot of the tower and is connected to the aerials by means of waveguide feeders located within the structure of the tower.

The average link between main centres of telecommunication traffic in the United Kingdom is about

*The first Fresnel zone is an ellipsoid enclosing the two aerials and the path, such that the sum of the distance from any point on its surface to the two aerials is half a wavelength longer than the direct distance between the two aerials.

†On occasions such as those when the normal decrease of air temperature and/or humidity with increasing height is reversed.

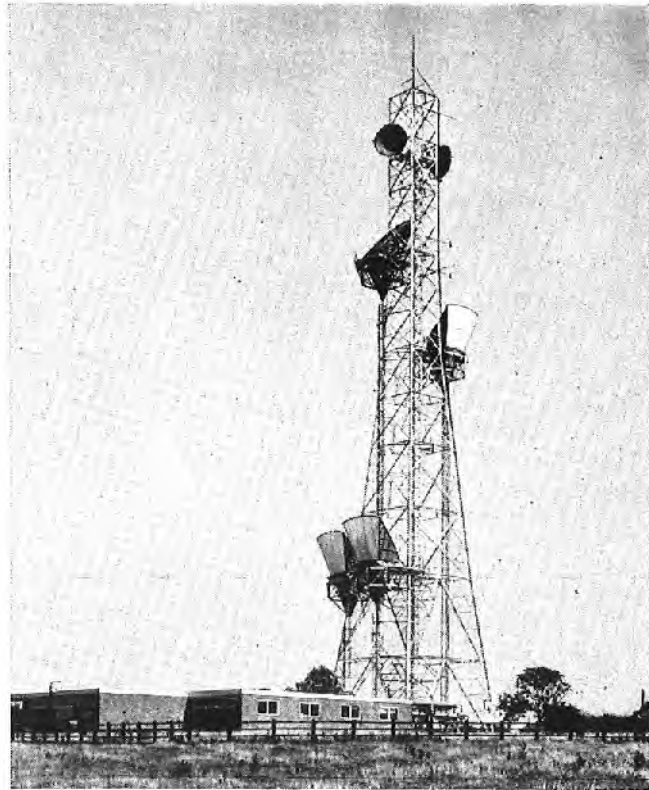


FIG. 6—TYPICAL POST OFFICE MICROWAVE RADIO STATION

100 miles long and requires up to three intermediate relay stations; greater distances are spanned by connecting individual links in tandem, either at the baseband or at the intermediate frequency.

The London Station (Post Office Tower)

The danger of obstruction of radio paths by tall buildings poses special problems in cities such as London and Birmingham, where traffic requirements and economics indicate that the radio station should be at the traffic centre itself, rather than on the outskirts with cable connexion to the centre as is the case for all other city or town stations in the United Kingdom.

The site chosen for the London station is adjacent to the Museum telephone exchange in Howland Street; here, there is no convenient hill on which to site the station and, also, there is a continuing growth in the number of high buildings in the London area as a whole. To make reasonably certain that the microwave paths to adjacent stations would not be obstructed by such buildings, it was necessary to build a tower of exceptional height that would support the aerials at up to 450 ft above ground. To keep the length of the waveguide feeders connecting the aerials to the radio equipment as short as possible, and hence the loss of microwave power to an acceptably small value, it was decided to house the microwave equipment inside the tower itself, just below the aerials. This in turn meant that lifts and welfare accommodation had to be provided for the maintenance staff, as well as emergency stairs to meet fire regulations. The tower is planned to accommodate equipment to provide up to 150,000 telephone circuits and 40 tele-

vision circuits simultaneously; this equipment imposes a considerable power-supply load and presents a difficult cabling problem. A large dissipation of energy as heat is also involved, requiring a substantial ventilation plant.

Since the tower would have a commanding view over London, a decision was taken to provide facilities for the general public at the very top. These comprise a rotating restaurant and associated kitchens, cocktail lounge, tea bar and observation galleries. A tower fulfilling these needs had to be provided to stand on the relatively small piece of land available, and the Ministry of Public Buildings and Works undertook its design and provision.⁴ The result is the now familiar reinforced-concrete tower, which is shown in schematic form in Fig. 7.

MICROWAVE-RADIO EQUIPMENT

Modern microwave transmission techniques and

equipment typical of those to be used in the Post Office Tower can best be illustrated by reference to the schematic diagrams of Fig. 8(a)—(d). These show a microwave link, spanning about 60 miles by means of a single intermediate repeater station, for the provision of up to eight bothway broadband channels, each for 1,800 telephone circuits or one 625-line television signal, in a frequency band centred on 6,175 Mc/s.

There are a number of bands of radio frequencies available by international and national agreement for Post Office microwave links; these bands, given in the table, have a total bandwidth of 3,200 Mc/s, and the way in which radio carrier frequencies are arranged in the 500 Mc/s-wide band centred on 6,175 Mc/s, which is typical, is shown in Fig. 8(e). The band is subdivided into two adjacent blocks of 250 Mc/s, and each block contains eight radio-frequency channels with carriers spaced about 30 Mc/s apart; at any one station all transmit channels are allocated to one block and all

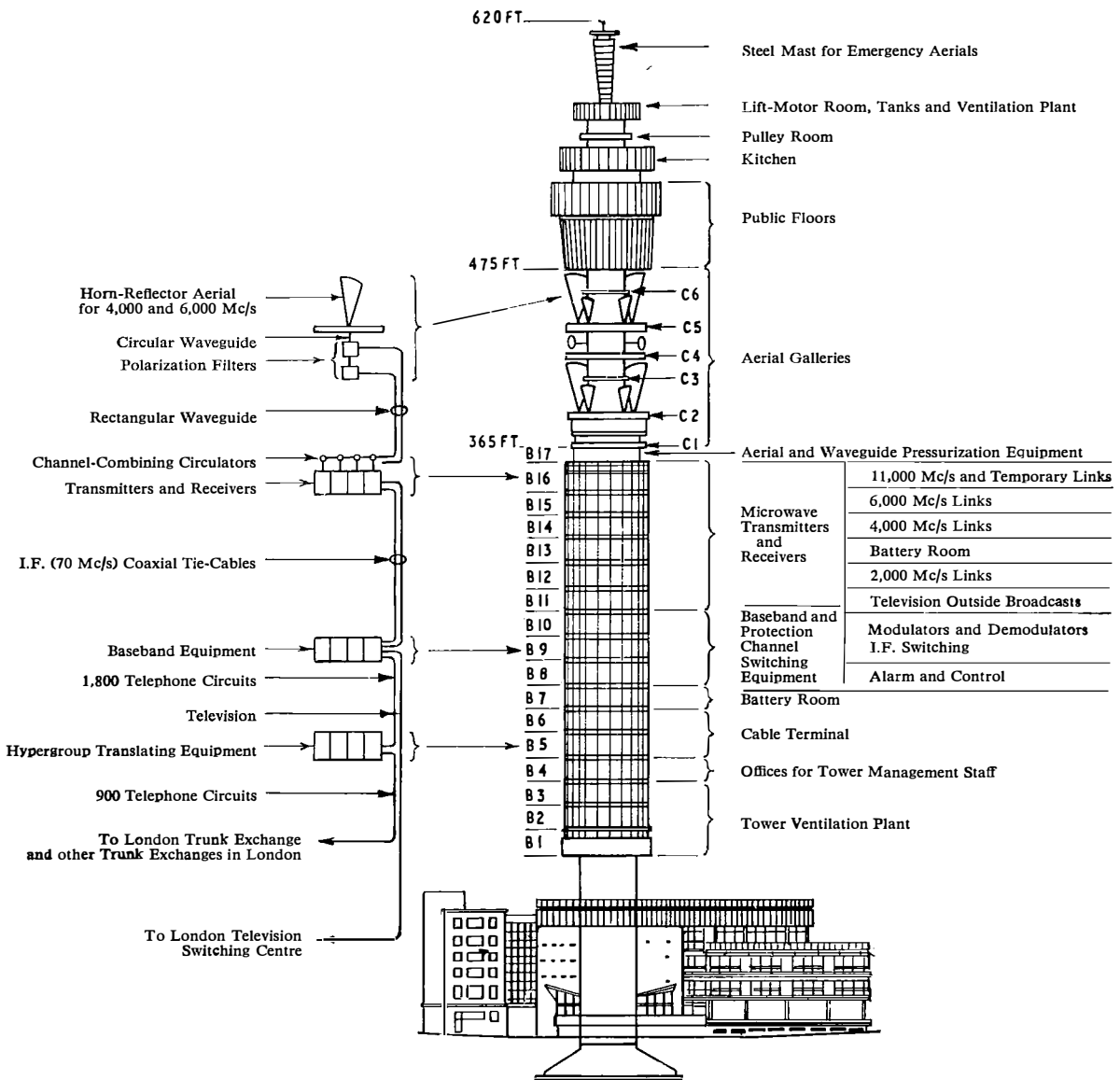
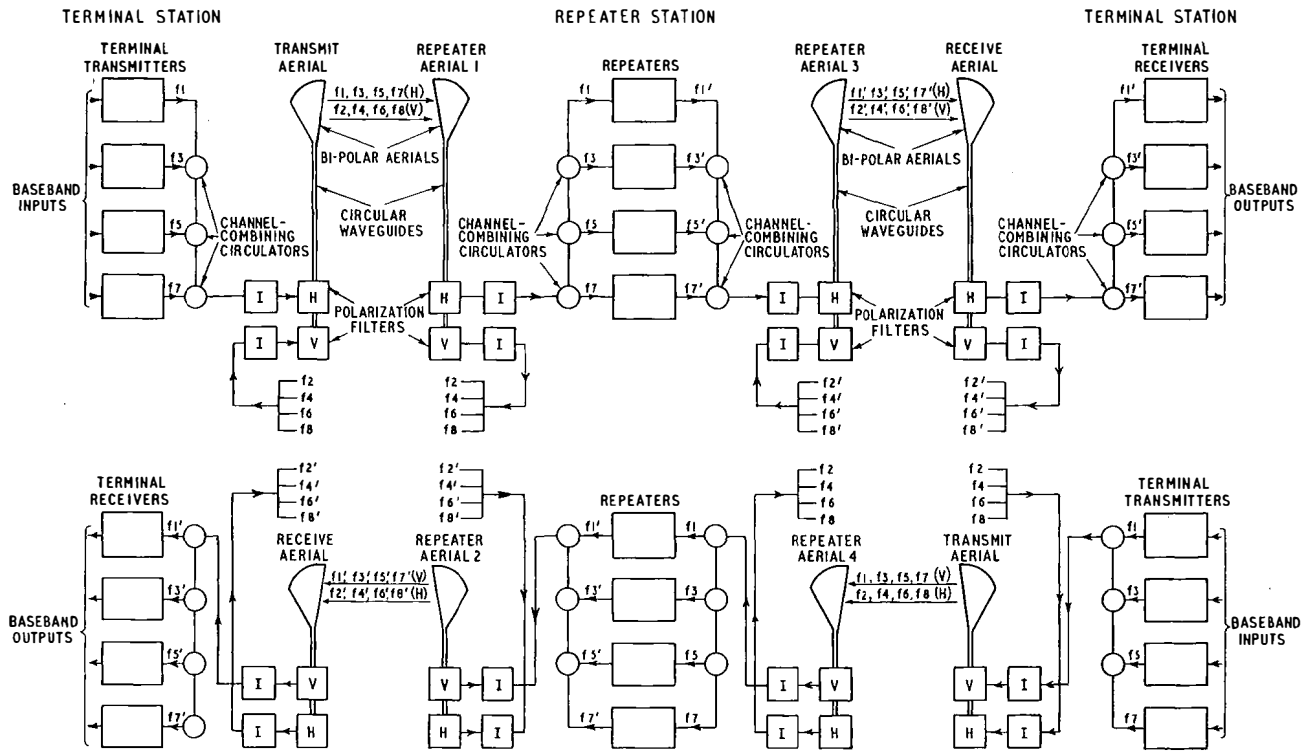
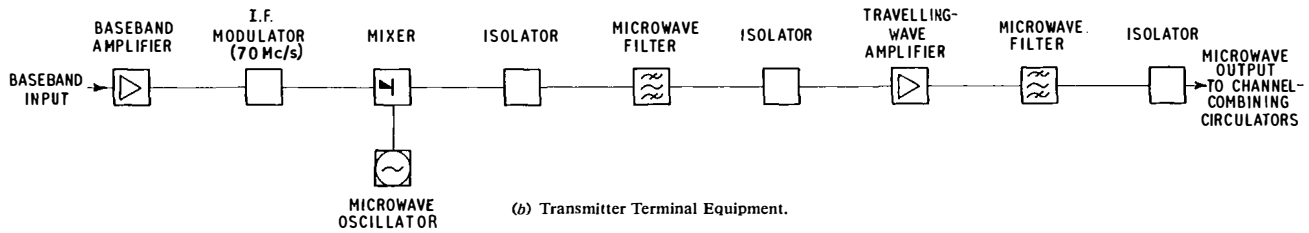


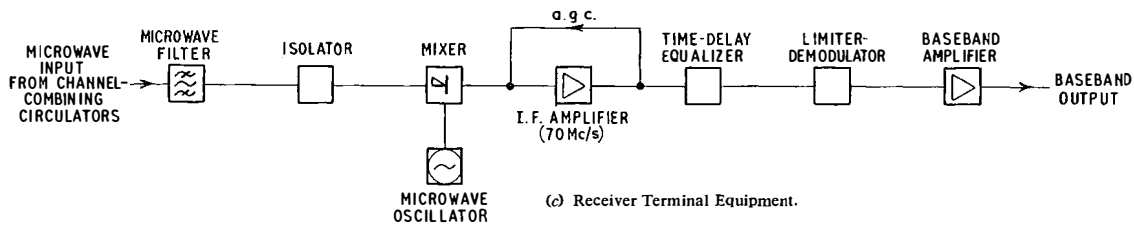
FIG. 7—UTILIZATION OF POST OFFICE TOWER



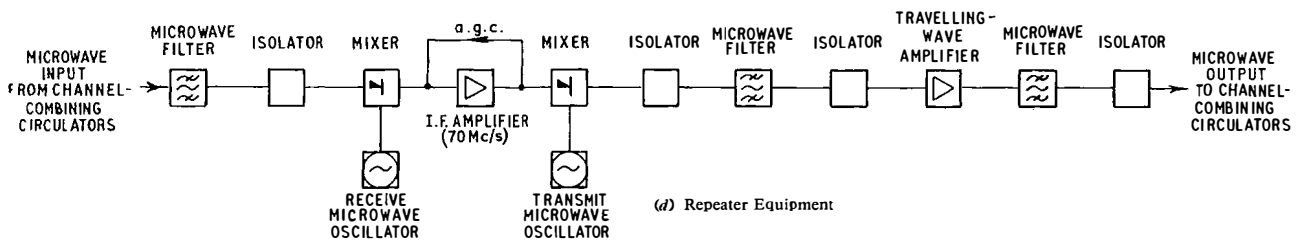
(a) Arrangement of Equipment.



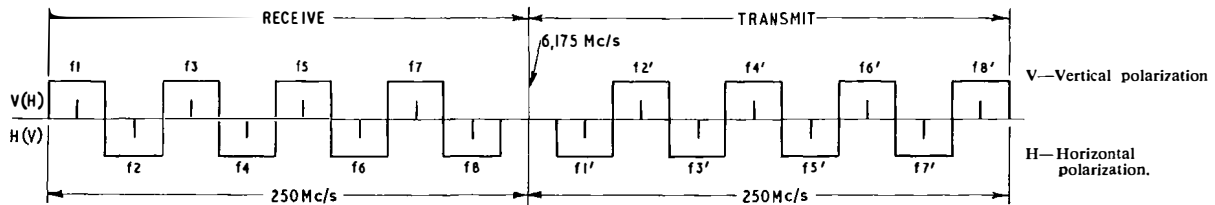
(b) Transmitter Terminal Equipment.



(c) Receiver Terminal Equipment.



(d) Repeater Equipment



(e) Ratio Channel Frequency Assignment at Repeater Station.

FIG. 8—MULTI-BROADBAND-CHANNEL MICROWAVE LINK

Radio-Frequency Bands Available for United Kingdom Microwave Links

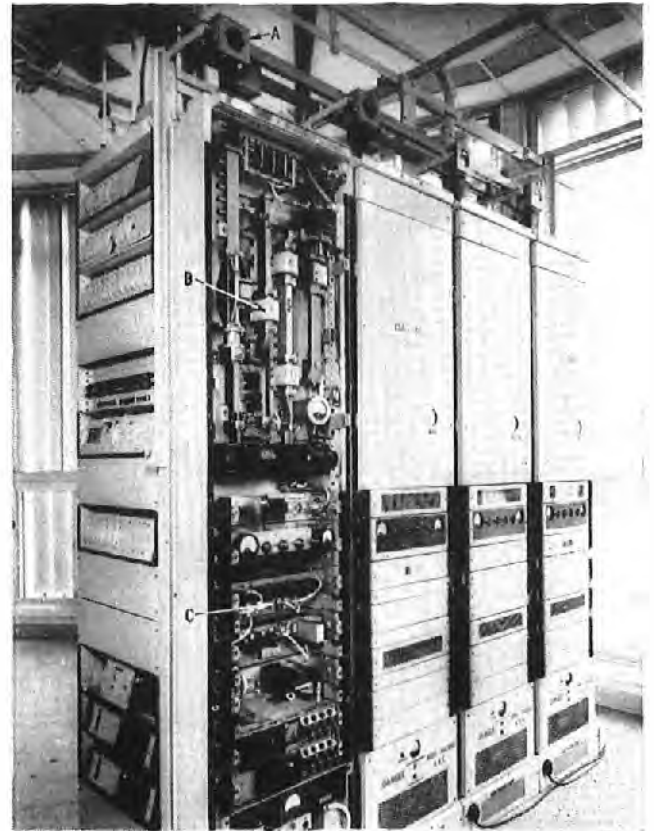
Band Centre (Mc/s)	Bandwidth (Mc/s)	Channel Spacing (Mc/s)	Number of Bothway Broadband Channels	Projected Use
1,800	200	30	2	Spur route
2,100	400	30	6	Main route
4,000	400	30	6	Main route
6,175	500	30	8	Main route
6,760	700	20	16	Main route
		40		
11,190	1,000	40	12	Spur/main route

receive channels to the other. To enable channel signals to be more easily separated, adjacent channels are given orthogonal polarization, so that the minimum spacing between the channels of the same polarization is about 60 Mc/s. Because of the highly-directional properties of the aerials used it is possible to use the same set of frequencies, independently, for transmission in four different directions from each radio-relay station.

The baseband input signal, after suitable pre-emphasis, frequency-modulates an oscillator having a mean centre-frequency of 70 Mc/s—the intermediate frequency (i.f.)—producing an intermediate signal having a spectral range of 55–85 Mc/s. The modulator has a voltage/frequency transfer function which is highly linear so as to avoid production of intermodulation noise in telephony systems and distortion of television signals. After amplification the i.f. signal is applied, together with a signal from a microwave oscillator, to a balanced crystal-diode mixer; one microwave sideband of the mixer output is selected by the r.f. filter shown and amplified by a travelling-wave amplifier (t.w.a.) to a power level of 5 watts. In the arrangement shown for the terminal stations in Fig. 8, the individual broadband outputs of eight t.w.a.s are combined into two groups (radio-frequency channels f1, f3, f5, f7 and f2, f4, f6, f8) by means of ferrite circulators (Fig. 9) and connected to a bi-polar aerial by way of a polarization filter and a circular waveguide capable of supporting orthogonally-polarized signals. Another aerial, and a similar arrangement of polarization filter and ferrite circulators, is used to receive eight individual broadband signals (radio-frequency channels f1'–f8') from the distant repeater station. The received microwave signal in each radio-frequency channel is converted to i.f. by means of a low-noise crystal-diode mixer, amplified and translated to the baseband frequency by a highly-linear frequency-demodulator.

A typical repeater, as shown in Fig. 8(d), consists in essence of a terminal receiver and transmitter connected together at the intermediate frequency, the microwave oscillators being displaced in frequency from each other to produce an input-output carrier-frequency shift of 252 Mc/s.

The total transmission loss between hypothetical aerials that radiate power uniformly in all directions (isotropic aerials), 30 miles apart in free space, is 140 db. Practical microwave aerials are highly directional ($\pm 1^\circ$ to 3 db power points) and have a gain of 45 db



A.—Three-port ferrite circulator. B.—Ferrite isolator.
C.—Mop-up equalizer.

FIG. 9—MICROWAVE TRANSMITTERS AND RECEIVERS ON FLOOR B15

relative to isotropic aerials. The use of such aerials results in an overall transmission loss (including losses in waveguide feeders) of about 60 db under normal propagation conditions. For all practical purposes this loss is constant over the r.f. channel bandwidth of 30 Mc/s.

The normal radio-frequency (r.f.) signal level at the input crystal-diode mixer is 10^6 watt, and this may fall to 10^9 watt during occasional periods of severe fading. It has been found convenient, in the majority of links installed in the United Kingdom, to provide most of the fixed gain and all the reserve gain to overcome the inter-station transmission loss at the intermediate frequency, although one link in operation from the Post Office Tower has repeaters in which all the amplification is carried out at radio frequency.

For satisfactory transmission of multi-channel telephony or colour television, linear distortions in those sections of the radio system carrying frequency-modulation signals must be minimized. As an example of this problem, the variation of transmission time over a 30 Mc/s channel must not exceed a few nanoseconds,* and ferrite isolators (Fig. 9) are, therefore, extensively used to reduce the level of echo signals arising from mismatches between the various microwave elements, and "mop-up" time-delay equalizers (Fig. 9) are fitted in terminal receivers.

LAYOUT OF RADIO EQUIPMENT IN THE TOWER

The Tower consists of a hollow shaft of reinforced

*nanosecond = 1×10^{-9} second.

concrete from which all the floors are cantilevered. The main structure is topped by a short steel tower which, at present, carries a storm-warning radar and meteorological instruments but is available for microwave aerials should the need arise; below this are the lift-motor and water-tank rooms and the public floors.

Aerial Galleries

The aerial galleries occupy the height range of 365–475 ft and consist of four main circular galleries (C1, C2, C4 and C5) for principal aerials, with two smaller butterfly-wing mezzanine galleries (C3 and C6) for spur-route aerials. The most striking feature of the galleries is the large horn-reflector-type aerials, two of which are used for each of the four principal routes from the Tower. While more conventional parabolic-type aerials allow for connexion to a single aerial of a number of transmitters and receivers using channel frequency assignments within a single common-carrier frequency band, the wide transmission bandwidth of the horn-type aerial allows for simultaneous use of channel-frequency assignments in two common-carrier frequency bands centred on 4,000 and 6,175 Mc/s; in this way a pair of such aerials will carry 20,000 telephone conversations. The directivity pattern of the horn aerial is such that this can be achieved on each of the four principal routes from the Tower, without significant crosstalk interference between routes.

A horn aerial (Fig. 10), 27 ft high, 14 ft wide and

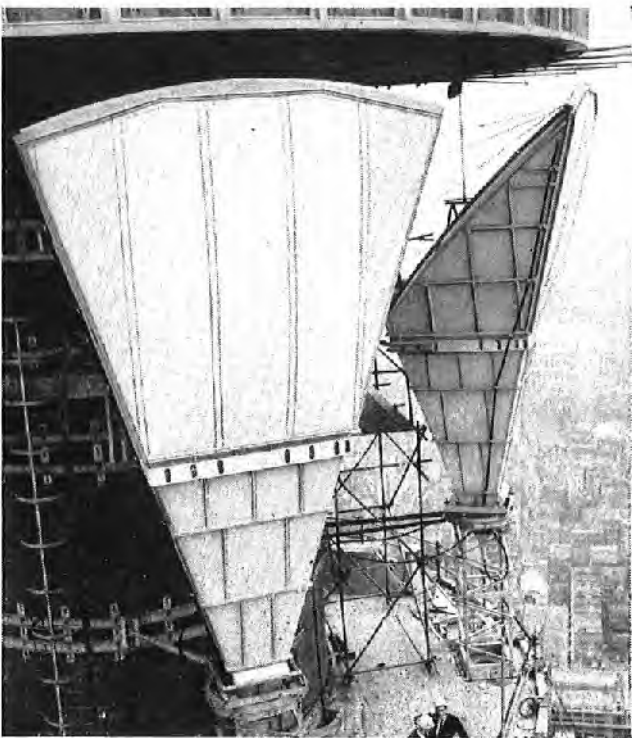


FIG. 10—HORN-REFLECTOR AERIAL BEING INSTALLED ON GALLERY C5

weighing 1 ton, consists of a parabolic reflector fed by a pyramidal horn with its axis vertical and its apex coincident with the focal point of the reflector; the radiating aperture is 140 ft² (gain 45 db relative to an isotropic aerial), and is closed by a Hypalon-coated

terylene sheet, thus allowing the aerial and its associated waveguide to be pressurized slightly above atmospheric pressure by dry air to prevent the ingress of moisture. The pressurizing equipment is shown in Fig. 11. Because

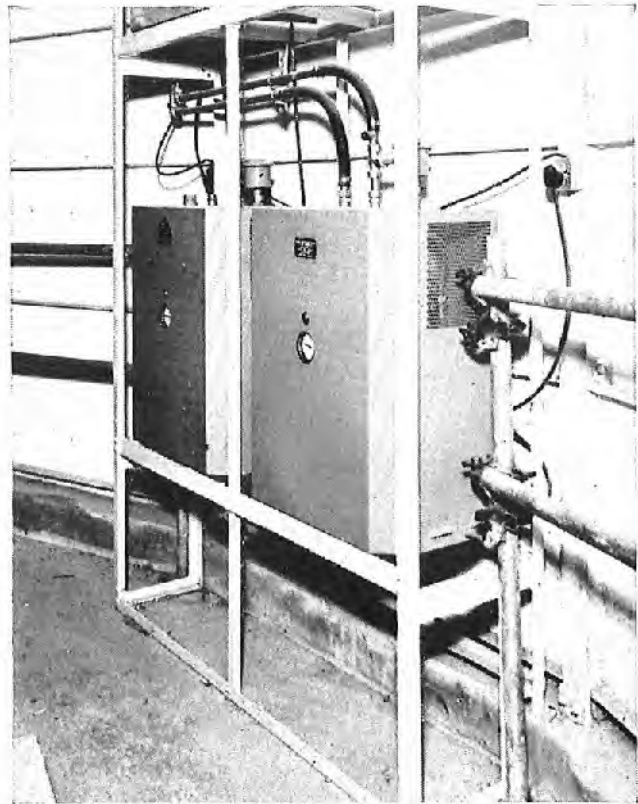


FIG. 11—AIR-PRESSURIZING EQUIPMENT ON FLOOR B17 FOR AERIAL AND WAVEGUIDES

of its gradually-tapering feed, the horn provides a superior match to the waveguide feeders and reduces echoes and losses; it has been designed to transmit and receive two signals of dominant TE₁₁ mode, orthogonally polarized, when used in conjunction with low-loss circular waveguide of 3 in. diameter.

The superior qualities of the horn aerial have been an essential factor in the provision of broadband radio channels, each capable of carrying 1,800 speech channels, to the high standard of performance required. The conventional parabolic aerials of the type at present in use in the Tower galleries have so far been restricted to links carrying television or a maximum of 960 speech channels per broadband, but an improved version (e.g. as shown in Fig. 4) for single-band operation, with a performance approaching that of the horn aerial, is becoming available and will be in use by mid-1966.

The aerial galleries have capacity for about 30 aerials to serve the main routes from the Tower; in addition, a further 14 aerials may be used for spur routes and, temporary services, and be available for possible future requirements. Facilities are also available for temporary radio links for television outside broadcasts to be installed on the lowest of the aerial galleries, C1 (Fig. 12).

Aerial Feeders

Because of the importance of keeping the length of



FIG. 12—TELEVISION OUTSIDE BROADCAST EQUIPMENT IN USE ON AERIAL GALLERY C1

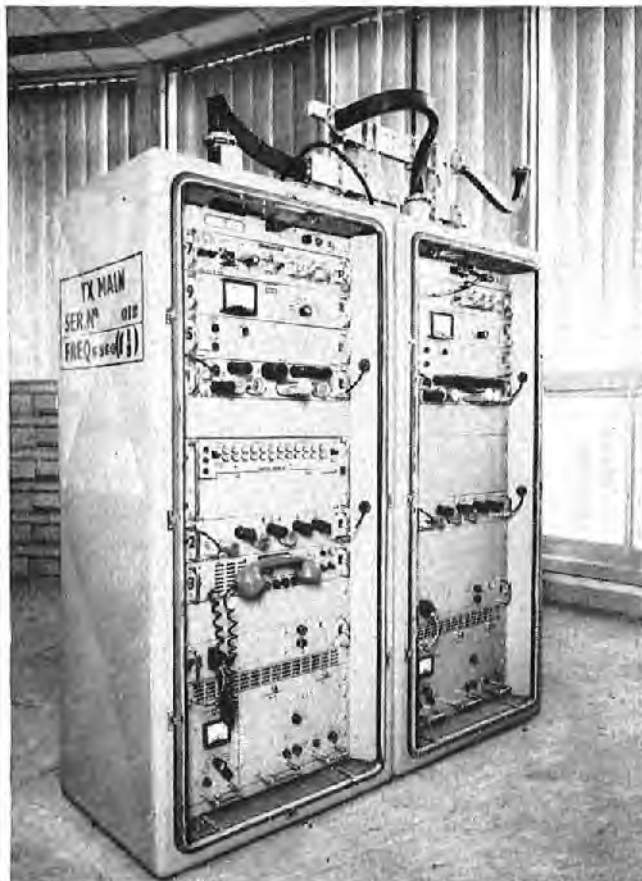


FIG. 13—TEMPORARY RADIO EQUIPMENT IN USE FOR TELEVISION LINKS TO SOUTH WALES AND ISLE OF WIGHT ON FLOOR B16

aerial waveguide-feeders as short as possible, and hence the loss of microwave power to an acceptably-low value, a special arrangement has been adopted for radio

equipment in the Tower. Microwave transmitters and receivers will be separated from the associated baseband and ancillary equipment, and will be housed as near as possible to the aerials, i.e. in the top six floors of the Tower (B11–B16). Further, because the waveguide to be used for the higher-frequency bands has a higher loss per unit length than that used for the lower-frequency bands, the equipment floor nearest to the aerial galleries (B16) has been reserved for 11,000 Mc/s equipment, and the remaining floors have been allocated on a descending height and frequency basis. Space on floor B16 will also be used for radio equipment associated with temporary radio links (Fig. 13). The aerial waveguide-feeders run vertically down the outside surface of the hollow shaft that forms the central core of the Tower, and for this purpose slots large enough for the 100 or so feeders which will eventually be required are provided in the equipment floors.

For parabolic aerials, single-polarization rectangular feeders are run from the aerial illuminators by way of two right-angle bends to the vertical runs, as shown in Fig. 14. For the horn aerials (Fig. 15), the twin-

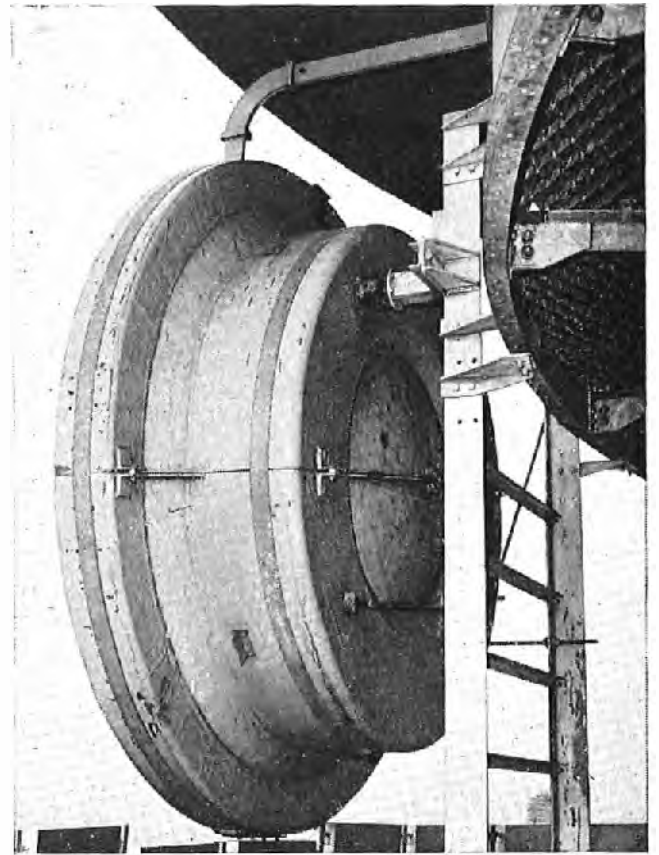
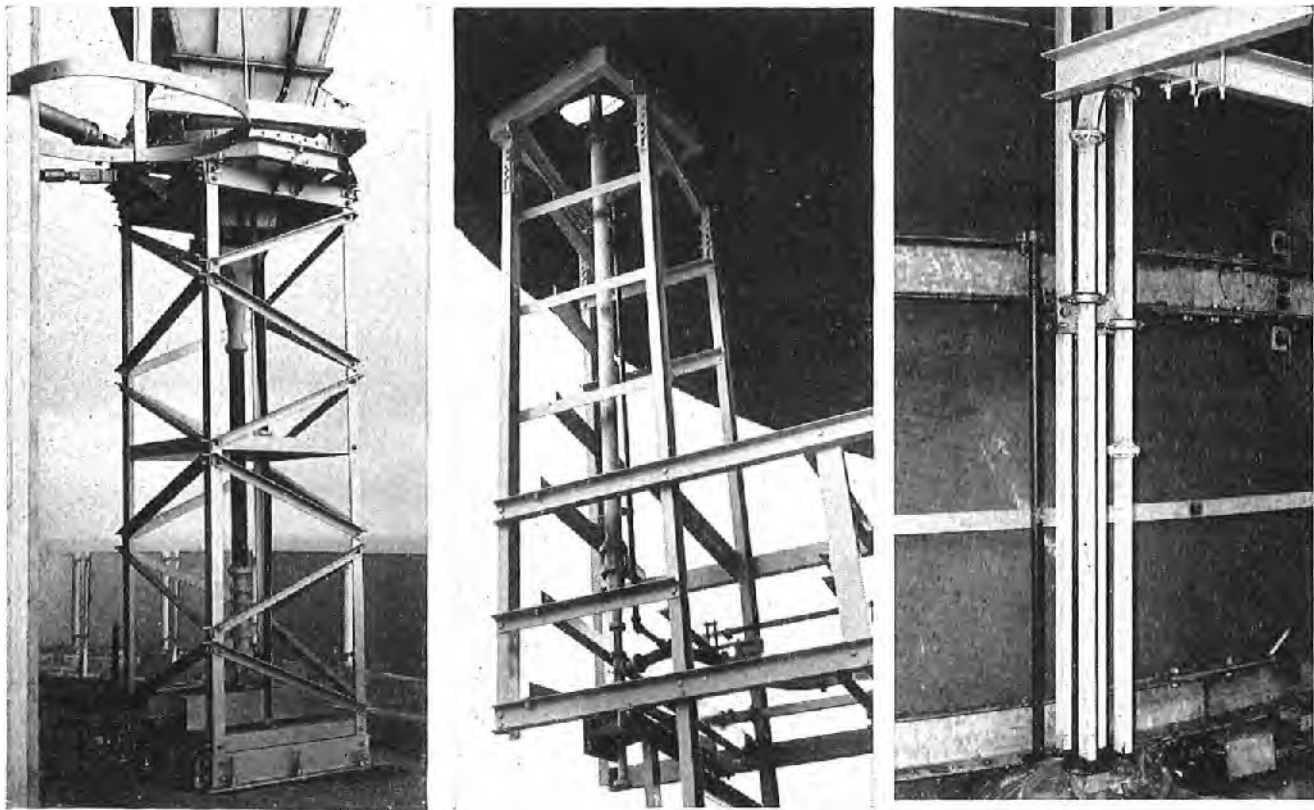


FIG. 14—PARABOLIC-DISH AERIAL SHOWING RECTANGULAR WAVEGUIDE FEED ON AERIAL GALLERY C4

polarization circular waveguide drops vertically by way of ellipticity compensators to polarization filters housed in the aerial gallery immediately below. At the polarization filter, transition is made to two single-polarization rectangular feeders, and these join the vertical waveguide runs in the slots around the central core of the Tower by way of single right-angle bends. A more desirable



(a) Square-to-Circular Transition and Ellipticity Compensator.

(b) Polarization Filter with Circular-to-Rectangular Waveguide Transition.

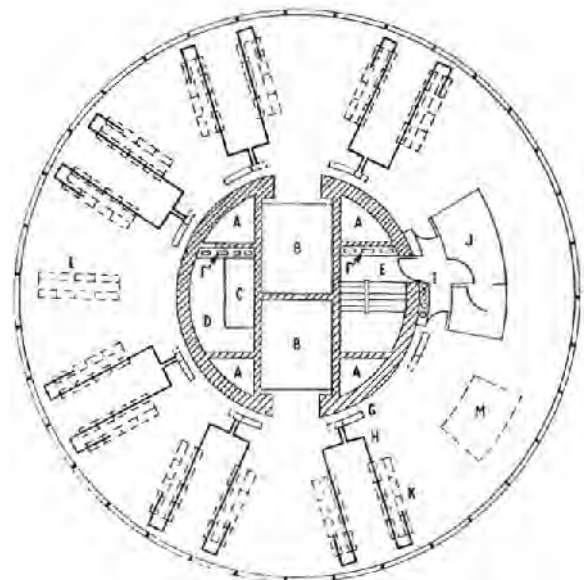
(c) Rectangular Waveguides on Outside Surface of Central Core of Tower.

FIG. 15—HORN-REFLECTOR AERIAL WAVEGUIDE-FEEDER ARRANGEMENT

arrangement, and the one adopted in conventional stations, would be to limit the length of higher-loss rectangular waveguide used by continuing the circular waveguide to a point as close to the microwave equipment as possible. This arrangement has been precluded in this instance by the fact that circular waveguide used for multi-frequency band working must not be bent if adequate signal quality is to be achieved, and for the physical dispositions and number of horn aerials involved this could result in up to 16 vertical waveguides running through the annular equipment space and thus be a serious limitation on the amount of equipment that could be housed on each floor.

Microwave Transmitters and Receivers

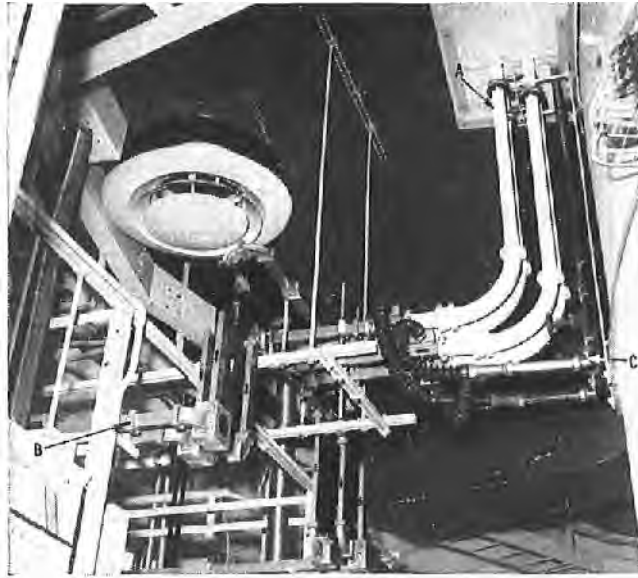
The use of rectangular waveguide, which can include a number of bends without exceeding an acceptable amount of signal distortion, facilitates the optimum arrangement of the radio equipment within the space available. The equipment is arranged in suites of 20 in. wide and 7 ft 6 in. high racks arranged radially, as shown in Fig. 16. Rectangular waveguides, each carrying up to four broadband radio signals, emerge from the slots (Fig. 17) abutting the inner core and are distributed radially to connect individual channels to the appropriate transmitters or receivers by way of ferrite circulators (Fig. 9). Fig. 17 also shows the arrangement for connecting the pressurizing equipment to the aerial waveguide feeders at the boundary point



A—Ventilation ducts. B—Lifts. C—Coaxial-cable duct. D—Working platform. E—Staircase. F—Power busbars. G—Waveguide slots. H—Waveguides. I—Service pipes. J—Toilets. K—Radio-equipment racks. L—Line-termination racks. M—Test trolleys and spares.

FIG. 16—TYPICAL LAYOUT OF APPARATUS FLOOR AND CENTRAL SHAFT

between pressurized and unpressurized waveguide. Dry air (from the pressurizing equipment on floor B17)



A—Waveguide feeders from aerial galleries. B—Distribution of waveguides to microwave equipment. C—Air pipes.

FIG. 17—AERIAL WAVEGUIDE FEEDER ENTRY TO MICROWAVE EQUIPMENT, FLOOR B15, SHOWING ATTACHMENT FOR INJECTING DRY AIR

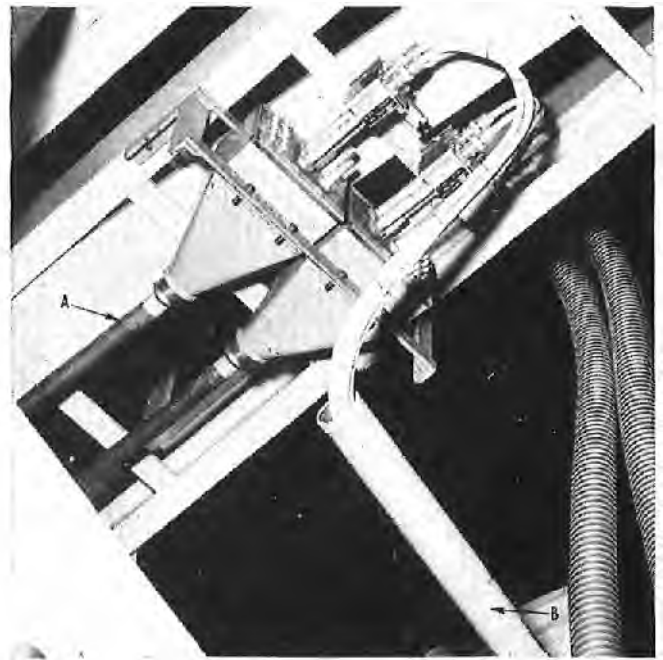
passes through the waveguide aerial feeders and polarization filter to the associated horn aerial and, thence, by way of an air connecting pipe to another horn aerial and its waveguide feeders, back to the pressurizing equipment.

Each suite contains four racks, and the layout provides a corridor for test equipment between the ends of the racks and the inner core of the tower. The space on each floor is limited to a ring of arc 320° (floor area $1,200 \text{ ft}^2$) by the presence of smoke barriers and access areas. Each floor will accommodate about 48 two-way transmitters and receivers of current size. The radial position of a given equipment is determined primarily by the radial position of the aerial it serves on the aerial galleries, and two waveguide slots are provided per useful quadrant of annular space; the size of slot provided is reduced for the lower floors to take account of the decreasing numbers of feeders. The equipment is laid out in pairs of parallel suites of four racks each, with a back-to-back spacing of 12 in. to allow circulation of air for convection cooling and to facilitate the waveguide connexions between back-to-back suites. A parallel, rather than a truly radial, arrangement has been chosen to enable standard right-angle waveguide bends to be used.

Baseband and Protection-Channel Switching Equipment

For reasons which have been stated, baseband modulators and demodulators are housed on floors B8–B10, and the i.f. (70 Mc/s) signal connexion to microwave transmitters and receivers is by way of composite coaxial cables, each containing four tubes of 0.174 in. outside diameter (Fig. 18), which are located in a cable space inside the central core of the Tower. A typical cable length is 100 ft and, in order to maintain the required level and quality of signal, amplifiers and time-delay equalizers are fitted to each tube, and these are mounted on the racks adjoining the microwave transmitter and receiver suites.

To achieve the high standard of reliability required for



A—To baseband equipment (Floors B8–10). B—To microwave transmitters and receivers.

FIG. 18—I.F. (70 Mc/s) TIE CABLES

the trunk broadband microwave systems radiating from the Tower, standby or so-called “protection” broadband channels are provided that automatically switch to replace faulty working channels so that a break in transmission of only a few microseconds occurs. The protection channels will be shared between several working channels, with a consequent economy in cost of provision of circuits and in the use of the frequency spectrum. Switching is carried out at the intermediate frequency (70 Mc/s) by high-speed diode switches located at the terminal stations.

Each channel carries a continuity pilot signal located above the traffic-signal frequency spectrum in the baseband; should this pilot signal fall in level by 6 db, or the noise in a narrow band about the pilot frequency increase beyond a predetermined amount, immediate change-over to a protection channel is automatically carried out. A standard arrangement is to provide switching equipment which will accommodate up to six operational channels and one or two protection channels, as required. The i.f. switching equipment will be mounted on racks adjacent to those carrying the modulating and demodulating equipment, on floors B8–B10.

It is now usual to employ an auxiliary radio link, a narrow-band low-power system, sharing aerials and waveguides with the main system, for the transmission of alarms from repeaters and terminals, and for the transmission of end-to-end signals associated with automatic switching, control and supervision. In the Post Office Tower all switching and alarm indications, together with facilities for manual control of channel switching, will be concentrated on floor B8 (Fig. 19) which will be continuously staffed.

Baseband-Signal Distribution

From floors B8–B10 the basic television and frequency-



FIG. 19.—ALARM AND CONTROL EQUIPMENT. FLOOR B8

division-multiplex telephony signals, which occupy a baseband frequency range up to about 8 Mc/s, are taken by further coaxial cables down the central shaft either to the adjacent building, which houses the new London Television Switching Centre and trunk telephone exchange, or to floors B5 and B6 of the Tower, which have been allocated as a cable terminal. Here, the larger assemblies of telephony channels from the radio broadbands will be broken down by hypergroup-translating equipment into units of 900 circuits for distribution to transmission terminals associated with the various London trunk-switching centres. Conversely, units of 900 incoming telephone channels will be combined into the larger units required for transmission over the radio links. Floor B4 is also allocated for this purpose, but initially will provide office accommodation for management staff.

ANCILLARY SERVICES

Floors B1-B3 house the comprehensive ventilation plant for the Tower; air is delivered at the rate of 6,000 ft³/min to the ducts in the centre shaft at an air velocity of 3,000 ft/min and passed, via expansion chambers and silencers, to annular ceiling ducts on the

equipment floors. Extraction is either direct from the equipment racks or via a second annular extraction-duct around the outside of the rooms, feeding similar large ducts in the centre shaft. The extracted hot air can be re-circulated in cold weather to maintain a reasonable temperature.

Power supplies⁵ for the Tower project are provided from duplicate and independent mains connexions at 11 kV which feed a power room in the basement of the adjoining building, providing a 2,500 kVA medium voltage (415/250 volts) supply via dry-type transformers. Five automatically-started 500 kVA diesel alternators provide against failure of both mains supplies and can provide power within 30 seconds of mains failure. The equipment in the Tower requires approximately 900 kW, and this is distributed in three separate three-phase systems, two of which are regulated and provided with short-break automatic change-over between the duplicate mains sources and feed the telecommunications plant; the third is fitted with manual change-over and feeds domestic services.

In a few years it is likely that, for telecommunications equipment, including radio apparatus, valves will have been completely superseded by solid-state devices; indeed, some of the radio equipment now on order for the Tower will contain only a few valves and one travelling-wave tube. Such equipments will operate from a 24-volt d.c. supply, and floors B7 and B13 of the Tower have been allocated for batteries and associated rectifiers.

Because of the public restaurant and viewing gallery at the top of the Tower, lifts provided in the centre shaft must, apart from their use by staff and for equipment, give a rapid passenger service. Two lifts are provided, separately motored and controlled, and limited by the size of the shaft to a cage size of 6 ft 3 in. by 4 ft 6 in. This allows 15 passengers to be carried, and, to permit some of the larger units of equipment and aerial components to be hoisted, a false ceiling is fitted to each cage which, when removed, provides an internal height of 12 ft. The lifts are the fastest of their kind in Britain, with a speed of 1,000 ft/min, giving a journey time to the top of 34 seconds. Automatic control causes the car to answer all calls in the direction of travel, but this control can be over-ridden by an attendant to provide an express service to the public galleries.

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