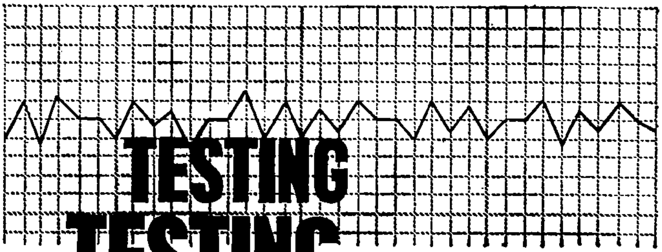
POST OFFICE

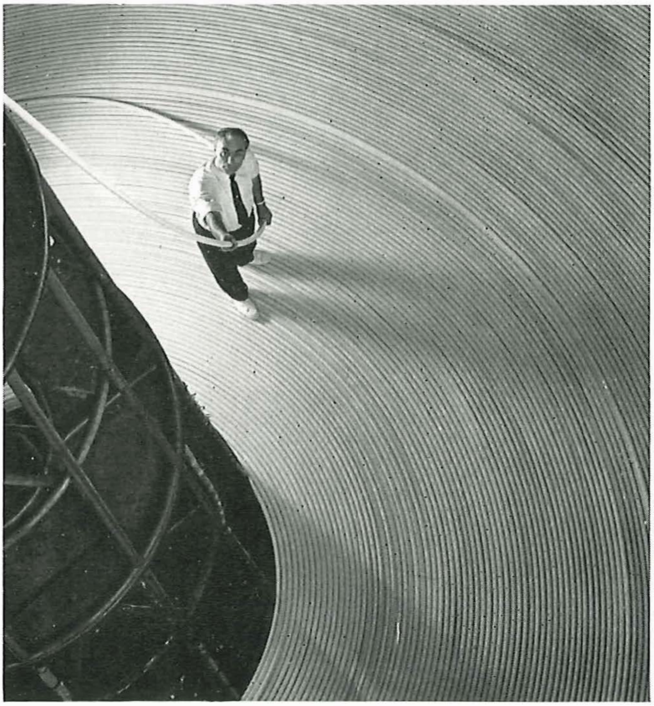
tele*communications*

JOURNAL

ONE SHILLING AND SIXPENCE

SUMMER 1964



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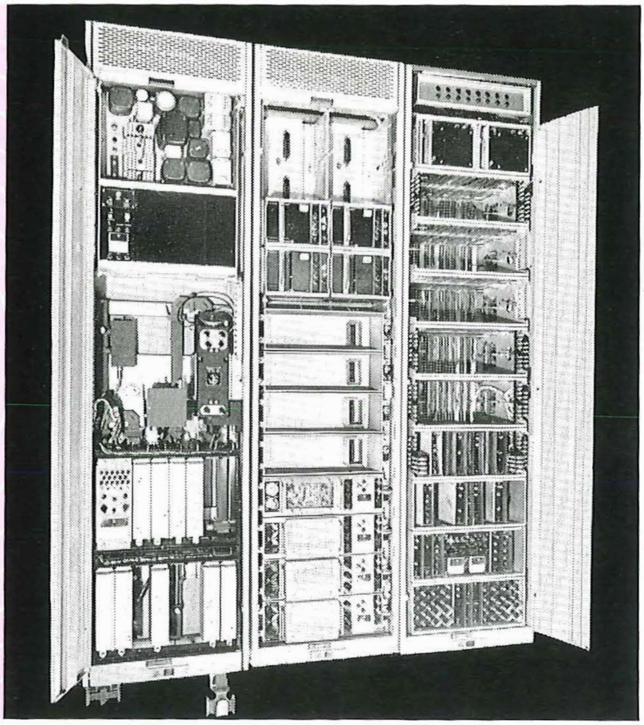

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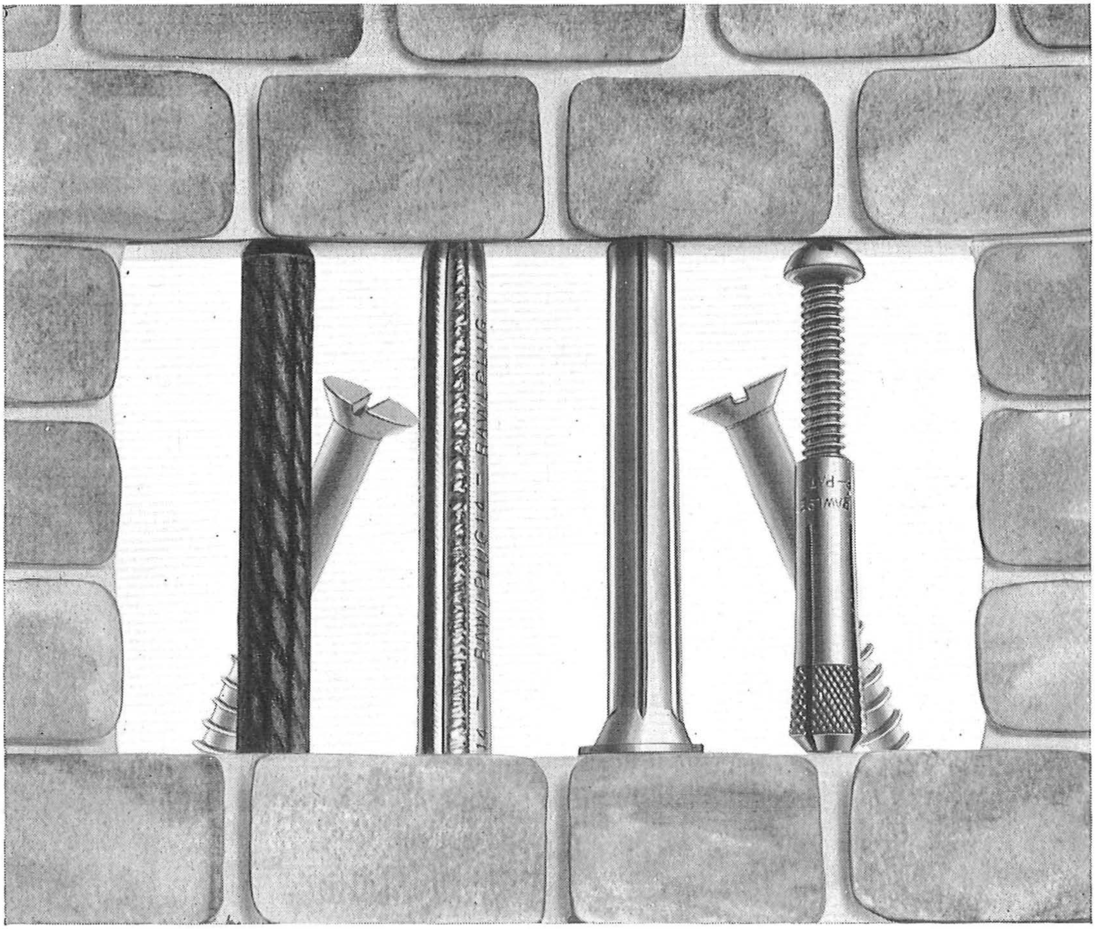
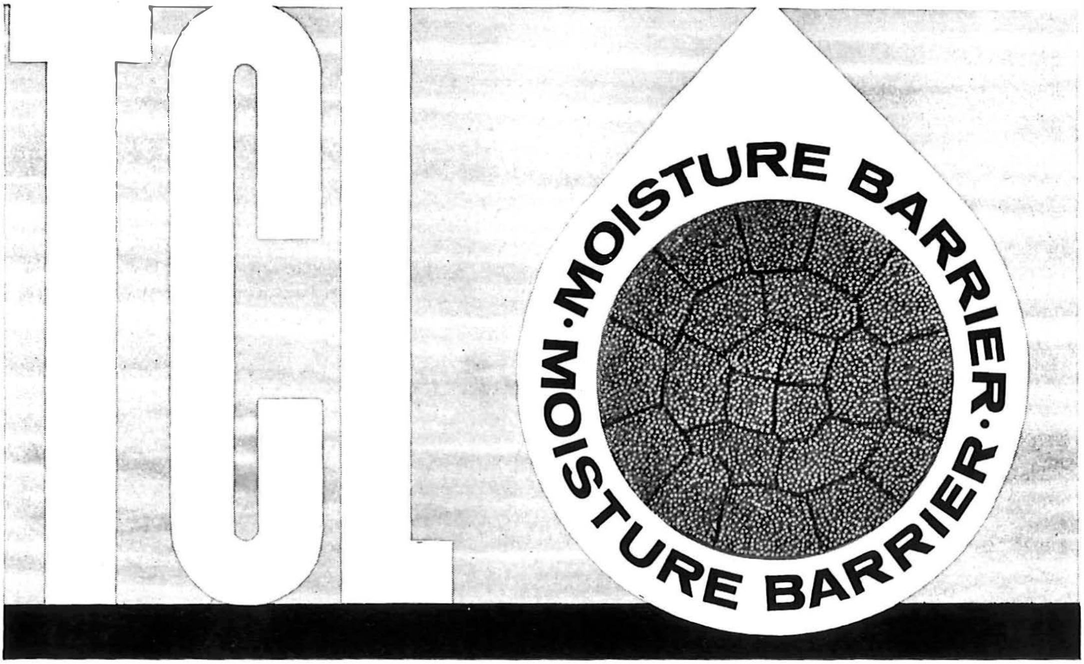


new paper-insulated plastic sheathed moisture barrier cable by



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This barrier effectively prevents the diffusion of moisture vapour through the polythene sheath which would result in a lowering of the insulation resistance.

This produces a cable having electrical characteristics equal to a lead sheathed cable and being light in weight has many economic advantages, plus freedom from sheath corrosion. Besides forming an electro-static screen, the aluminium foil can also be used to detect insulation failure due to any mechanical damage.

T.C.L. moisture barrier cable at Windsor Castle

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Post Office Telecommunications Journal

Published by the Post Office of the United Kingdom to promote and extend knowledge of the operation and management of telecommunications

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Vol. 16 *Summer* 1964 *No.* 2

An Impressive Beginning

AS the *Journal* went to press the Five Year Plan to spend £900 million on improving and expanding the Inland Telephone Service entered its second year. It did so confidently, backed by the knowledge that already, in the first year, an excellent beginning had been made.

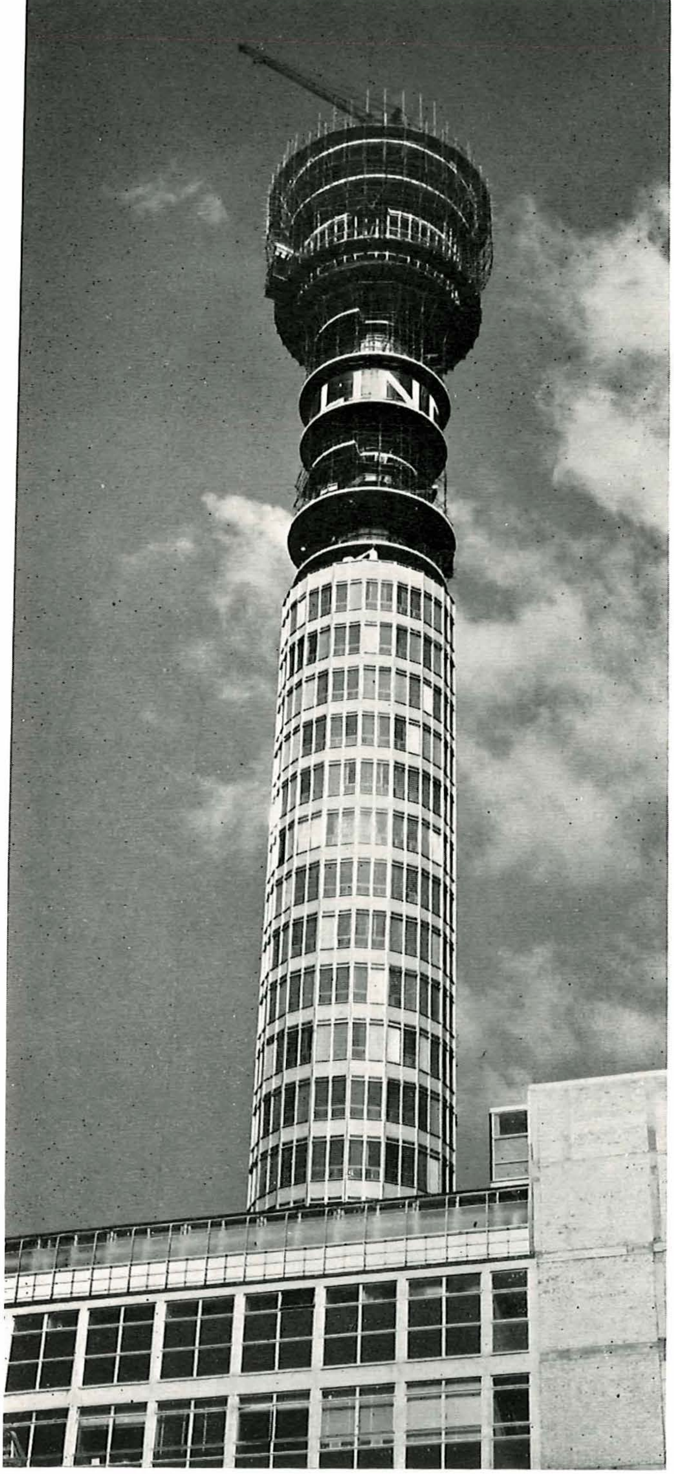
The Plan's achievements in 1963-64 are both impressive and encouraging. The number of telephones in the country, for example, increased by over 350,000 to just over nine and a quarter million. The number of local and trunk calls rose by over 400 million to more than 5,700 million. Trunk traffic went up by between 14 and 15 per cent compared with 1962-63 and local traffic by about seven per cent.

Demand for telephone service and the rate at which telephones were supplied both created new records. Demand went up by about 31 per cent over 1962-63 to some 566,000—63,000 more than the previous highest in 1960-61. Supply rose to about 555,000—an increase of more than 32 per cent over 1962-63 and about 78,000 more than the previous record in 1960-61.

In the 12 months ended in March, 1964, nearly 5,000 trunk circuits were provided to meet the growing demand for service. This was about 1,200 more than the previous best in 1961-62. Better progress than had been anticipated was also made in extending Subscriber Trunk Dialling and by the end of March, 1964, the system was available to some 43 per cent of all subscribers.

These are just a few of the past year's achievements. They show that the Five Year Plan is getting well into its stride and reflect well-deserved credit on everyone in the Inland Telephone Service. Much more remains to be done, however, if all the targets at which the Plan aims are to be reached and the next four years will call for the greatest co-operation and effort.

* *Fuller details of developments in the telecommunications field during the past year and of plans for the coming year are contained in the article* A Peep Into the Future *on page 45.*



Almost completed, the Post Office Tower rises majestically over London. It weighs 13,000 tons and will contain the second highest public restaurant in Europe.

POST OFFICE TOWER — 1

"LIKE A

"We needs must love the highest when we see it"
—Lord Tennyson.

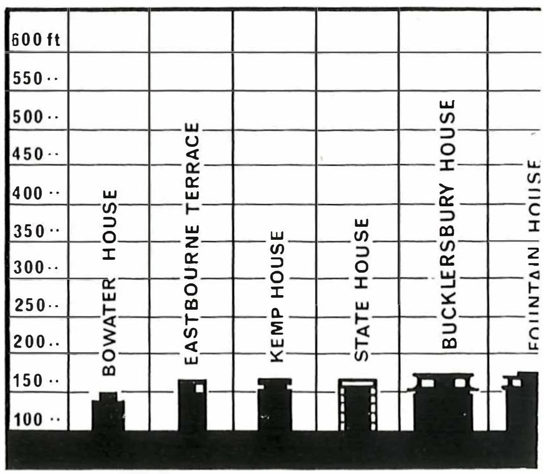
RISING like a giant minaret above London, the Post Office Tower in Howland Street, is rapidly nearing completion. The microwave equipment which will enable telephone and television signals to be beamed in and out of London from many directions has been installed and the lattice mast which tops the structure to a height of 620 feet, is now being fitted.

In November, the first test transmissions will be made, and by January, 1965, the Tower should be ready for operational use.

The Post Office Tower—the tallest building in Britain—marks a big step forward in the development of communications in this country. It is the tallest of a number of towers which will be set up as part of the new microwave radio link systems the Post Office is building throughout Britain to cater for the ever-increasing demand for trunk telephone service and television channels.

Designed to meet London's long-distance telephone circuit and television channel requirements for the next 40 years at least, the Tower will be able, if necessary and in conjunction with

Below: This drawing shows how the Post Office Tower compares with other tall London buildings, rising to over 600 ft.



GIANT MINARET..."

associated equipment in the nearby new Museum Telephone Exchange, to handle up to 150,000 simultaneous telephone conversations as well as 40 or more channels for television.

The story of the Post Office Tower goes back to 1954 when a system of broadband microwave radio links was first suggested as the best way to meet the anticipated growth of trunk telephone and television networks between London and the provinces.

There were two possible ways of achieving such a system. First, a ring of radio stations might have been built on high ground on the outskirts of London and the broadband channels brought into the city by cables.

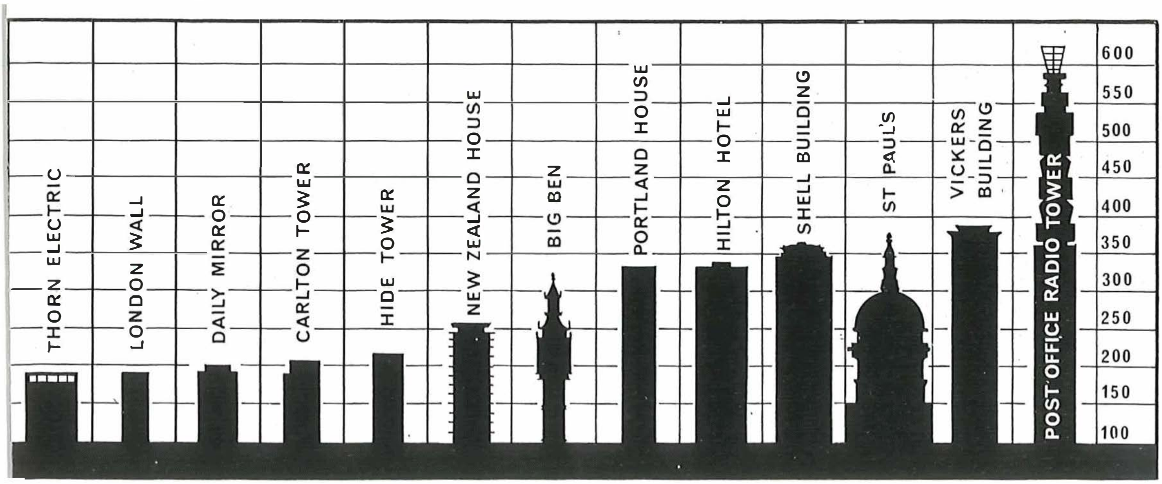
The alternative was to erect a radio tower in the centre of London which would have clear line-of-sight paths, uninterrupted by buildings or even trees, to radio relay stations in the system. The only way to ensure this was to build the tower higher than all the other very tall buildings which have shot up since the end of World War Two (at 620 feet, the Post Office Tower is 233 feet higher than the next tallest building in London, the Vickers building on Millbank). The site at the rear of the Museum Telephone Exchange, which had been bought just before World War Two to allow the exchange to be extended, was an obvious choice since the Museum Exchange, surmounted by the existing lattice mast, had long been the focal point of the telecommunications system and of the vast network of vision cables serving the London area.

Structurally, this gigantic new tower contains many unusual features, not least of which is the method adopted to achieve maximum stability and minimum movement of the aerials. The Post Office engineers stressed that aerial alignment with distant stations must be preserved at all costs since the half-power widths of some radio beams which are used are less than one degree and angular movement would court serious loss of signal power. A deviation of not more than 20 minutes of arc at the top of the tower was therefore laid down as the maximum permissible.

To achieve this degree of stability the Tower is built round a hollow shaft which varies in diameter from 22 feet at the top to some 35 feet at about 115 feet from ground level down to the base. The base section, which has a two-feet thick wall, rises from a 22 feet deep reinforced concrete truncated pyramid which, in turn, rests on a 90 feet square, 3 feet thick concrete raft sunk 24 feet below ground level on London's blue clay.

For additional stability the Tower is connected to the new Museum Exchange building 80 feet above ground level by a bridge deck strengthened to withstand a wind force load of 600 tons. By adopting these measures it is calculated that

OVER



The tallest and most nerve-shattering view in London. This picture, taken by Gerry Cranham and reproduced by courtesy of *The Observer*, was obtained with a fish-eye lens.

GIANT MINARET (*Contd.*)

deflection at the top of the Tower due to wind pressures will be as little as 15 inches and that elliptical movement produced by the sun's heat will be no more than two inches by one inch. Such small movements are insignificant in the most sensitive radio systems.

The aerials—a mixture of large and small horn and saucer-like paraboloids—are mounted in four 50 feet diameter circular galleries at a height of between 355 to 477 feet. The two galleries housing the paraboloids are 18 feet high and the other two which contain the horn aerials are 36 feet high. To ensure that there is no interference with the transmission beams the galleries are completely open to the air.

The radio equipment is accommodated immediately below the aerial galleries in 11 of 16 apparatus floors. The lower five floors house the main ventilation and refrigeration plant and the batteries and power units required for the apparatus. Except on the lowest floor, where air needed for the ventilation plant is drawn in through louvres, all the apparatus floors are fully glazed. Main mullions, clad in stainless steel and containing a bronze guide rail on which a power-operated carriage travels up and down so that the windows can be cleaned, divide the circumference of this part of the Tower into 19 sections. There are 4 feet high coloured opaque glass panels at each floor level to mask the false ceiling of the floor below and immediately below these, just over a foot high, are anodised aluminium ventilators.

All external glass is $\frac{3}{8}$ inch thick and specially made to resist penetration of the sun's rays. All internal windows are also made of anodised aluminium.

The half-dozen floors above the aerial galleries are designed to cater for the large number of visitors which the Tower is expected to attract. In ascending order they comprise the open and closed public observation platforms, tea bar, restaurant, cocktail bar and kitchens.

The lowest of the two observation platforms, which will be equipped with telescopes, will be completely open but guarded by protective mesh

This is one of the views of London which will be seen from the public observation platforms. Courtesy: *The Times*

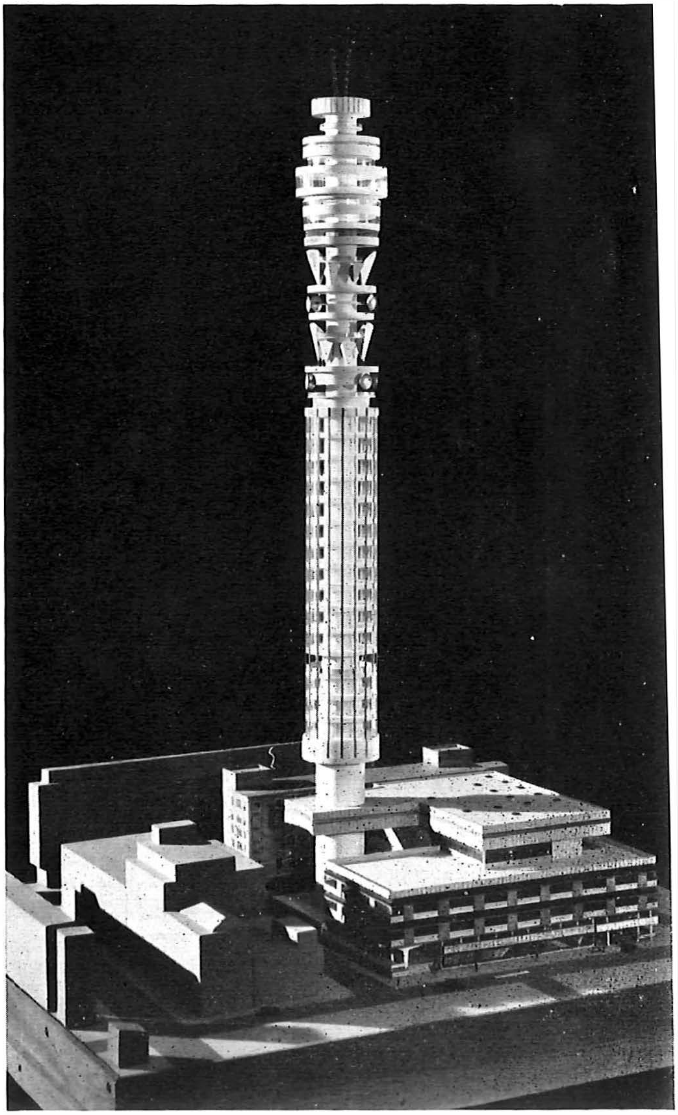
panels, while the top platform will be enclosed by double and triple glass. On the tea bar floor there will also be a Meteorological Office display window where weather charts and instruments will be on view. The restaurant floor, 65 feet in diameter and the widest part of the Tower, will seat up to 120 customers on a circular strip of floor 10 feet 6 inches wide, which will rotate once every 20 minutes so that visitors will be able to enjoy uninterrupted panoramic views of London as they eat.

Because of the height of the Tower special fire precautions are necessary. The aerial floors give little cause for concern but, because the public floors will carry several hundred people who will be isolated from the ground as effectively as if they were in an aeroplane or a ship, special arrangements have to be made. Although the Fire Brigade will be called in the event of a small fire, it is unlikely that they will arrive in time to be of much assistance. The staff will be drilled like ships' stewards and air hostesses and two hydraulic hoses and extinguishers will be provided on each public floor. Full bore hydrants are also to be installed. In addition, there will be a number of automatic and secret fire warning devices.

Above the public floors the Tower rises a further 31 feet. Immediately on top of the kitchen roof is a small gallery on which aircraft warning lights and fog beacons are mounted and above this are the lift over-run motor rooms, control gear and water storage tanks.

Finally, perched on top of the Tower, is a 40 feet high lattice mast which will carry a storm

OVER



This model shows how the Post Office Tower will look when it is completed this year.

GIANT MINARET (*Contd.*)

warning radar scanner and a Meteorological Office anemometer and provide mountings for additional microwave radio aerials if these prove to be necessary. A number of meteorological instruments, such as solarimeters, radiation recorders, thermometers and humidity and fog recorders, which will be connected to the display window at the tea bar floor, will also be installed on top of the Tower. In addition, facilities are being provided for the Building Research Station and University College, London, to carry out research from the Tower into the problems of high buildings and meteorology.

Workmen unconcernedly erecting scaffolding round the Tower high above London.

HIGHLIGHTS ON THE TOWER

∗ *The Post Office Tower, including the foundations, weighs 13,000 tons. Ninety-five tons of high tensile steel were used to reinforce the base of the Tower and a total of 685 tons of mild steel to reinforce the Tower itself.*

∗ The total cost of the Tower and the four-storey building in which the associated apparatus and the new Museum Telephone Exchange are housed, was about £2 million. Both the Tower and its associated building were designed by architects of the Ministry of Public Building and Works, under the direction of their chief architect, Mr. Eric Bedford.

∗ *At 540 feet, the Tower restaurant will be the second highest in Europe, beaten only by a similar restaurant on the television mast at Stuttgart, in Western Germany.*

∗ Running through the central shaft, two lifts, each travelling at 1,000 feet a minute, will be able to carry about 420 passengers an hour to the public observation platforms. They will serve all 29 floors.

∗ *All apparatus rooms and public floors will be air-conditioned and refrigeration plant will be installed to counteract solar heat and provide cool air for the radio apparatus staff.*

∗ Power will be derived from duplicate 11 kV main supplies in the Museum Exchange extension building and standby plant will consist of five 500 kVA diesel alternator sets, all automatically started should the mains supply fail.

∗ *Lighting in the Tower will be mainly fluorescent. Filament lighting will be installed on the staircase and other access ways within the shaft. Emergency lighting on the staircase and in public areas will be supplied from a battery which has a three hour supply.*

∗ Protection from lightning is achieved by using the steel reinforcement as the main vertical conductor, bonding this at the bottom to earth rods and, above the ground, to air terminals at level dictated by the contour of the Tower. All exposed metal, such as window frames and protective railings are also bonded back to the main earth. At each level there are four floor traps—two on the perimeter and two against the central core. In each trap is a screwed stud welded to the radial reinforcement of the floor. From these studs, which are also used to earth the electrical apparatus, copper tape is run to the air terminals and all exposed metal.

∗ *Domestic water is supplied from the mains through an automatic-pneumatic system which delivers it to storage tanks at 560 feet above ground level.*

∗ To calculate the effect of wind on the new Tower a model of the buildings was tested in a wind tunnel at the National Physical Laboratory.

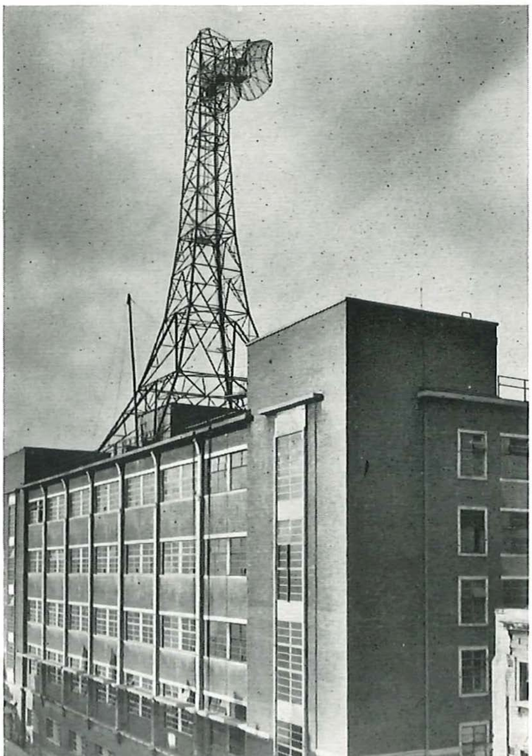
THE MICROWAVE SYSTEM AND THE TOWER EQUIPMENT

By P. J. EDWARDS

THE potentialities of microwaves for point-to-point transmission of wide-band signals (for example, television or many telephone circuits assembled in frequency-division multiplex) was well understood as long ago as the 1930s but progress was hampered by lack of adequate means to amplify such high-frequency waves.

Difficulty arose because in conventional valves electrons are in transit for longer than one oscillation of the microwave signal. It was not until such devices as the klystron and the travelling wave valve were made available by World War Two concentration on radar development that further progress was possible.

The first radio relay link in Britain to transmit wide-band television was installed in 1949 between London and Birmingham to serve the 405-line television transmitter at Sutton Coldfield. This link was not microwave by definition since it operated at the relatively low frequency of 900 Mc/s and used modified conventional valves, coaxial aerial feeders and open wire mesh type beaming reflectors. It did, however, pioneer the use of ultra high frequencies for the transmission of wideband signals.



The London terminal of the first radio-relay link mounted on the roof of the Museum Exchange close to the site of the new Tower.

The first true microwave link to be installed in Britain was brought into service between Manchester and Scotland in 1951 to provide a both-way channel for the transmission of BBC 405-line television signals. This link operated in the super-high frequency band (3,800 to 4,200 Mc/s) and, in addition to the klystron and travelling wave amplifier, used such devices as the hollow rectangular waveguide and solid parabolic reflector aerials. The use of such components now defines in part the term microwave.

The Manchester to Scotland link was the first in the world to use a travelling wave amplifier in the public service. One aerial was used for each microwave carrier wave so that each repeater station had four aerials. The radio equipment in each station was duplicated by standby equipment to which the microwave signal could be diverted by means of waveguide switches in the aerial feeders.

Although growth of the microwave links in the decade 1951-61 was slow, this period was important for the steady developments made in techniques which enabled the microwave link to become a viable alternative to the coaxial cable link for long-distance transmission of multi-channel telephony. Improvements in microwave

OVER

One of the repeater stations on the Manchester to Scotland microwave link, the first to use a travelling wave amplifier in public service anywhere in the world.

Following the Government's recent decision to introduce 625-line television and to increase the number of programmes a new network of 64 high-power television broadcast transmitters will be established in the next ten years for broadcasting in the Ultra High Frequency bands. The first 13 of these transmitters have now been approved for the inauguration of the BBC-2 programme and the network of city-to-city and spur links to serve these transmitters will be provided in the main by microwave radio.

The growing demand for city-to-city circuits further stimulated by Subscriber Trunk Dialling has given the opportunity for television and multi-channel telephone traffic to be economically integrated on the same radio routes and for the right balance to be struck between telephony provided by underground cable and that provided by radio so as to limit the effects of complete breakdown of either system. The new availability of high frequency bands and the continuing advance in microwave technique now enable the Post Office to specify certain main route links as suitable for the transmission of 1,800 telephone circuits on a single carrier wave. An extension of the technique to 2,700 circuits is now in sight.

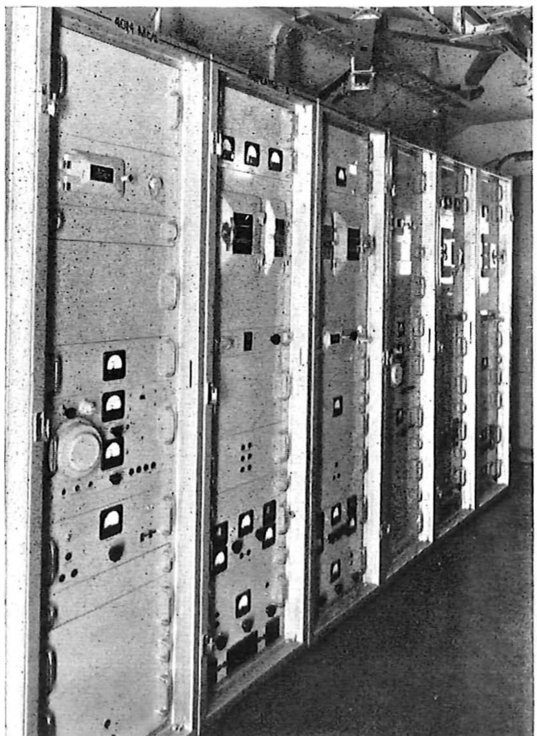
OVER

POST OFFICE TOWER (*Contd.*)

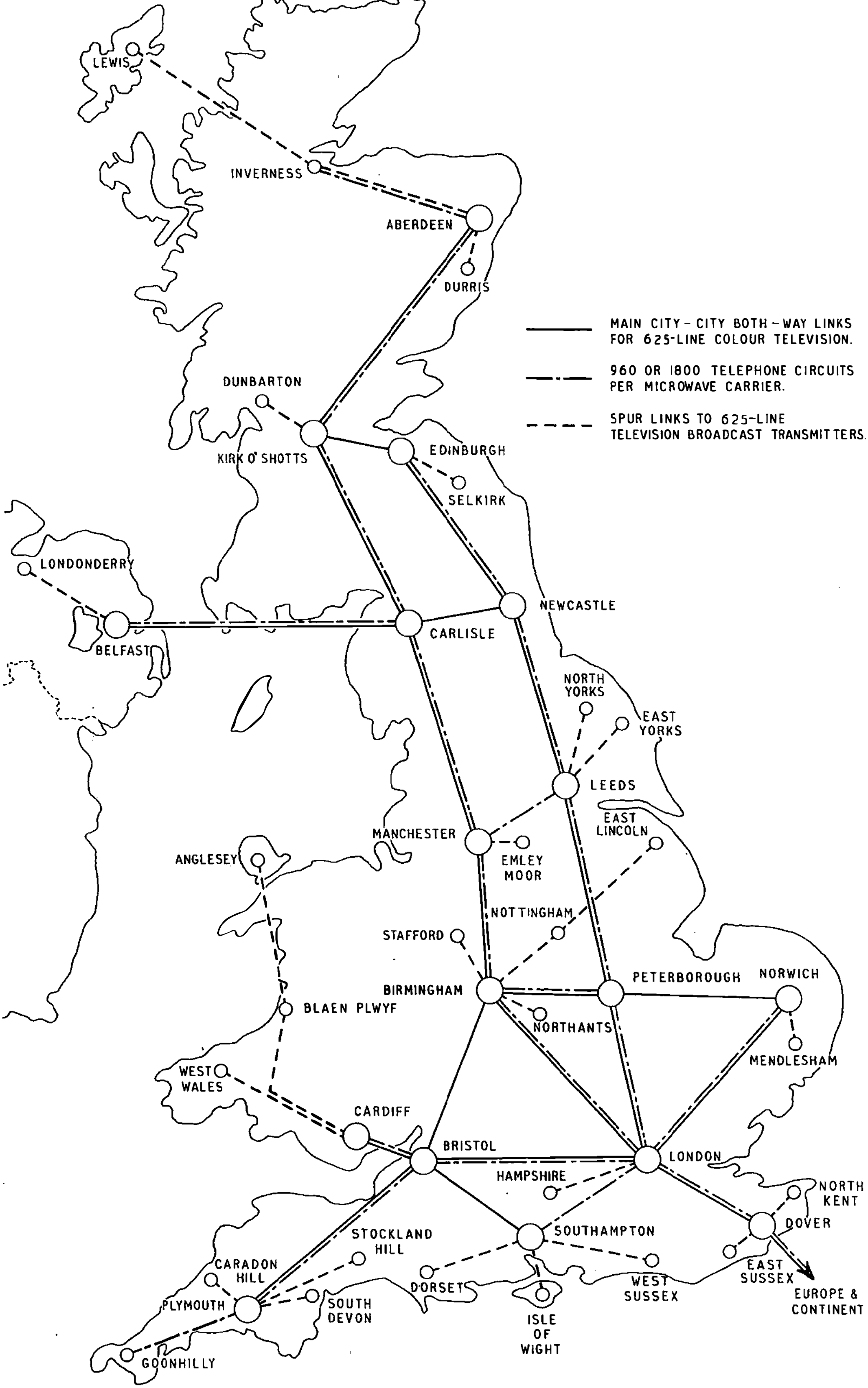
filters, for example, meant that several microwave carriers could share a microwave aerial with a resultant economy in plant provision. Further economy was achieved by the development of end-to-end standby channels which could automatically be substituted in the event of failure for either a telephony or television channel.

At the end of 1961 there were 25 microwave links in operation in Britain for the transmission of 405-line television or up to 600 telephone conversations on each microwave carrier. These links covered a distance of 3,500 miles and used internationally agreed carrier frequencies located in bands centred on 2,000 Mc/s and 4,000 Mc/s.

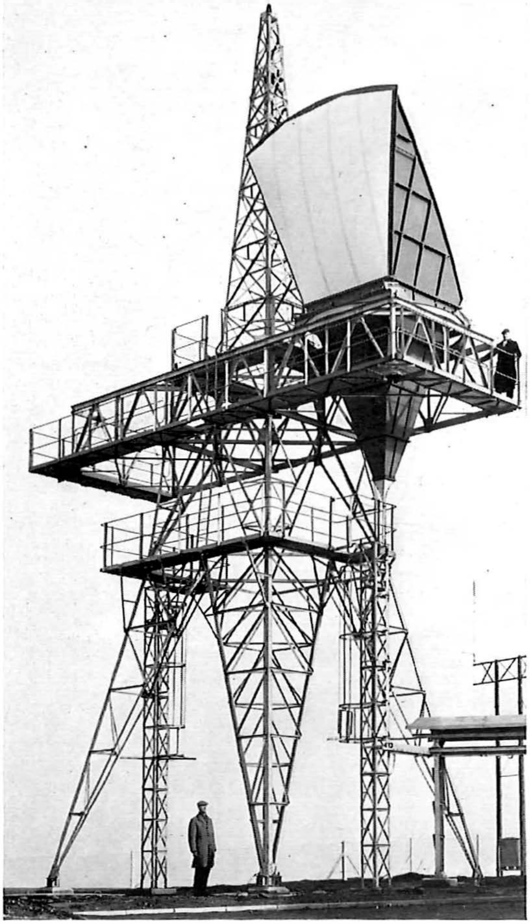
The need for all future television links to carry signals to the 625-line standard and, if necessary, to be adaptable for colour, was foreseen as early as 1958 and since 1960 all the main links have been specified for the transmission of 960 telephone circuits as an alternative to a 625-line colour television signal.



Post Office radio relay equipment showing (top right) microwave filters for combining several carriers on to a single aerial.



This map shows the network of radio links which will be needed by 1970 to meet the anticipated trunk telephone traffic and probable 625-line television requirements throughout the country.



◀ One of the large horn-paraboloid reflector aerials similar to the eight which will be used at the Post Office Tower in London.

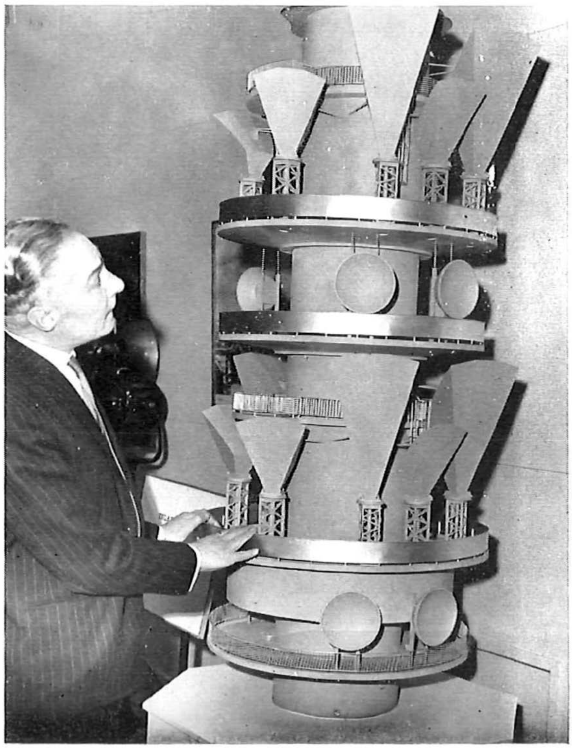
POST OFFICE TOWER (*Contd.*)

A vital part of the future main trunk microwave system carrying multi-channel telephony and a feature of the aerial gallery at the London Tower will be the horn-paraboloid reflector aerial. It has three outstanding features. First, it can transmit and receive simultaneously many carrier waves in several different bands. Second, the radio energy transmitted in and received from unwanted directions is very small, and third, the aerial is suitable for transmitting and receiving large numbers of telephone circuits on each carrier wave.

The aerial, which is 27 feet high, 14 feet wide and weighs a 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. It is made of aluminium alloy sheet highly resistant to atmospheric corrosion. The horn is truncated at the bottom and connected to a circular hollow pipe waveguide feeder. The aerial and its associated waveguide are pressurised by dry air slightly above atmospheric pressure.

The horn aerial will transmit and receive 14 carrier waves in frequency bands centred on 4,000 and 6,000 Mc/s. In future it may also be used for a further ten carriers in a frequency band centred on 11,000 Mc/s. The individual transmit and receive carriers on each frequency band will be combined in a single circular waveguide feeder by means of band combining units. The transmit and receive carrier waves appear in the circular wave guide polarised at right angles to each other and by this means it is possible to ensure that only one-ten-thousandth part of the transmitter power will be

The Postmaster General inspects a model of the aerial galleries at the Post Office Tower.



coupled into the highly sensitive receivers. The circular waveguide has a much lower power loss than the conventional rectangular waveguide. By virtue of its horn shape, the aerial transfers microwave power from the circular guide to "free space" with a loss of power due to reflection from mechanical irregularities of only 1 per cent. The concentration of microwave power in the beam of the aerial is such that the beam power density exceeds that of a theoretical omni-directional aerial by 40,000 times. The angular width of the beam is about one degree. Outside this limit the energy falls to such a low level that all carrier frequencies can be used simultaneously and without mutual interference on each of the four main routes from the Tower.

In the early years the Post Office Tower in London will use six bands of frequencies in the range 1,700 Mc/s to 11,700 Mc/s.

The full complement of carrier waves in bands 1 to 4 will probably be carried by four horn aerials for each of the four main routes while band 5 will use two dish type aerials for each route. In addition, a further 14 dish type aerials may be used for spur routes and be available for possible future requirements.

The total main route capacity of the Tower could be 150,000 simultaneous telephone conversations if the system is used entirely for telephony, or 100 both-way television channels if used entirely for television. The most likely division will be 40 both-way television channels and 100,000 telephone circuits. In addition, there will be a total capacity of 50,000 telephone circuits or 40 both-way television channels on the spur routes, but it is possible that part of this capacity will be diverted to the main routes. The London Tower will also provide facilities for *ad hoc* microwave services such as television outside broadcasts and closed circuit television.

MICROWAVE radio relay links use radio carrier waves of very short wavelength, much shorter than those used, for example, in television broadcasting. Frequencies are of the order of several thousand million cycles a second.

The stations are usually located on hilltops about 26 miles apart, and a chain of them can span hundreds of miles.

The microwave radio signals behave in much the same way as visible light, travelling in substantially straight lines and concentrated into narrow beams by dish-shaped reflectors or similar devices. The path of the beam must be clear of all obstructions such as hills, trees, buildings and so on, if adequate transmission quality is to be achieved. For this reason the aerial reflectors are generally supported on lattice steel towers at a height above ground of between 50 to 300 feet.

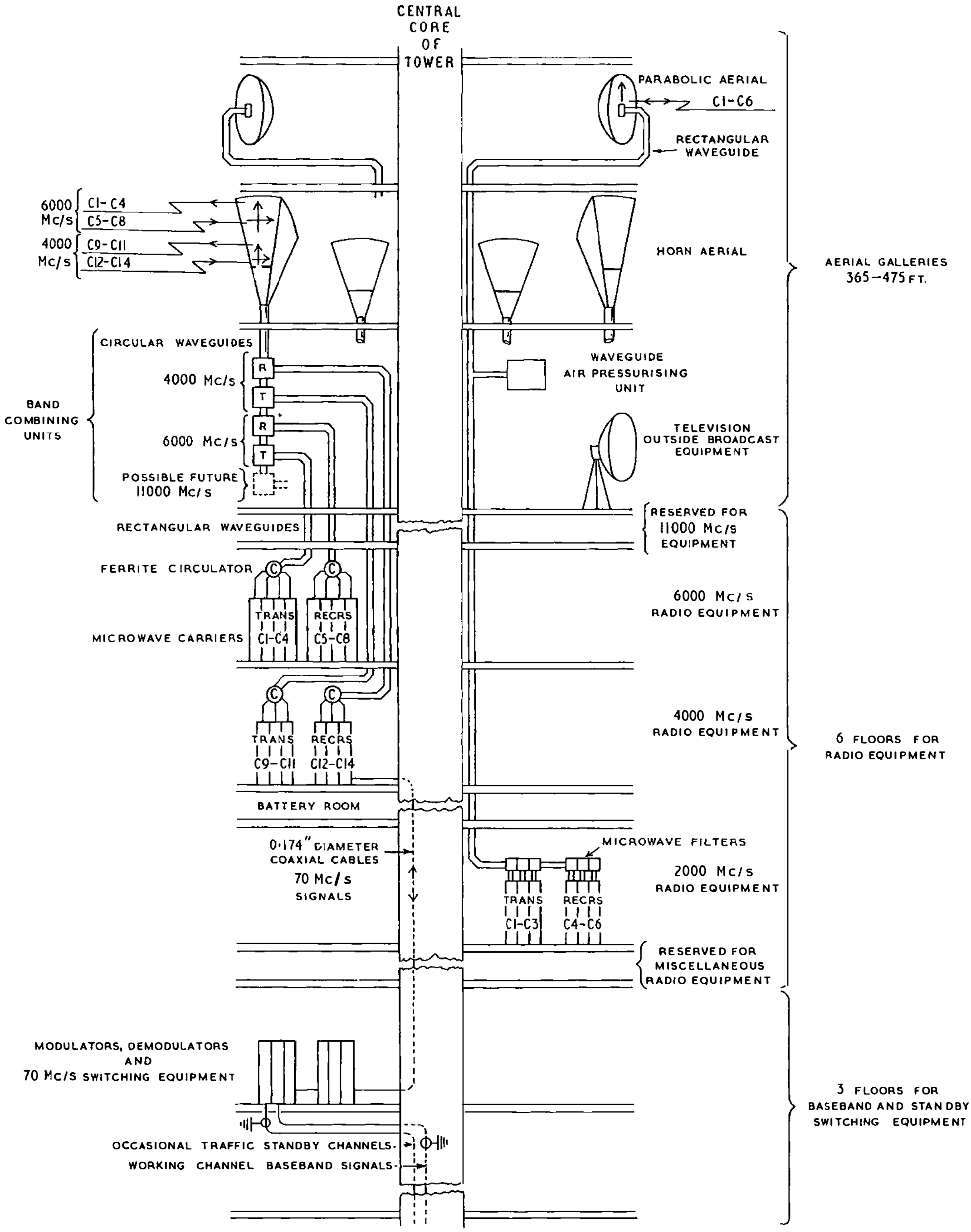
Usually, the microwave radio equipment is housed in a single-storey building at the foot of the tower and connected to the aerials by feeder lines attached to the tower members. Exceptionally, in urban areas, the aerials must be mounted at a great height so that the radio beams will not be obstructed by possible future tall buildings. In such instances, the tower structure itself must accommodate the radio equipment to minimise the transmission loss in the aerial feeder lines. So far this has been necessary only in the Post Office Tower in London and a similar tower in Birmingham.

The microwave radio equipment associated with the aerials will be housed within six floors immediately below the aerials. The floor nearest the aerial galleries has been reserved for future

OVER

No.	Frequency Band Mc/s	Probable number of aerials for each of four main routes	Number of Carrier waves for each route: Transmit	Number of Carrier waves for each route: Receive	Probable maximum number of telephone circuits per carrier wave as alternative to television	Probable use
1	3800–4200	4 Horn type	6	6	1800	Main Route
2	5925–6425	4 Horn type	8	8	1800	Main Route
3	6425–7110	4 Horn type	16 8	16 8	alternative 960 arrangement 2700	Main Route
4	10700–11700	4 Horn type	12	12	960	Main and/or Spur
5	1900–2300	2 dish paraboloids	6	6	960	Main Route
6	1700–1900	—	2 6	2 6	alternative 960 arrangement 120	"Spur" direction only

This table shows details of the six frequency bands which will be used at the Tower in the early years.



This diagram shows the arrangement of microwave radio relay equipment at the Post Office Tower. Note how many transmit and receive carrier waves will be combined on to a single aerial.

POST OFFICE TOWER (*Contd.*)

11,000 Mc/s equipment and the remaining floors are allocated on a descending height-and-frequency basis.

Microwave equipment, which will be installed during 1964-65, will provide 5,400 telephone circuits between London and Birmingham and a bothway 625-line television channel for the BBC-2 programme. It will operate in the 6,000 Mc/s frequency band (the highest for which equipment is at present available) and embody many recent advances in microwave technique to provide a capacity of 1,800 telephone circuits in each radio carrier wave.

All the microwave carriers will be derived from crystal-controlled sources and up to four transmit and four receiver carriers will be combined for connection to the band combining unit in the aerial gallery by way of a single 1.6 by 0.8 inch rectangular waveguide. The waveguides will run up the outside of the central core of the Tower through slots in the equipment floors large enough to accommodate the 100 which will ultimately be required. The maximum size of a single feeder is 5 by 1½ inches for the 2,000 Mc/s band.

A feature of the new microwave systems will be the extensive use of ferrite materials in, for example, circulators used for carrier wave combination and separation, and isolators used to minimise the effects of signal echoes.

The radio receivers will "down convert" the incoming signals (which have a power level of one-millionth of a watt) to a standard frequency range centred on 70 Mc/s (the intermediate frequency) for subsequent amplification and automatic level stabilisation to compensate for wide variations in incoming signal level when propagation conditions are disturbed.

The radio transmitters will "up convert" the outgoing signals from the intermediate frequency to microwave frequency and raise the power level to five watts for application to the microwave aerials.

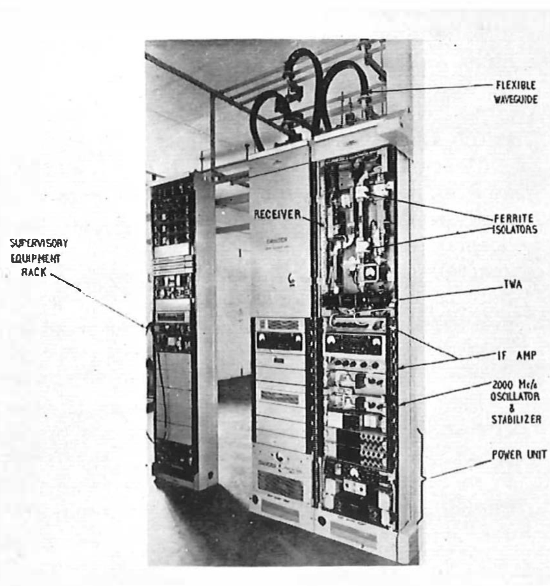
Additional equipment of the same type will be installed in 1965 and 1966 to provide three 625-line bothway television channels to the Isle of Wight; for the BBC-2 programme; and to replace existing 405-line television services.

All the microwave equipment so far referred to will be mains driven but a new version of the 6,000 Mc/s equipment to be installed later for exchanging 625-line programmes with the Continent and for the BBC-2 programme in south-east Kent will, with the exception of the travelling wave amplifier, be solid-state with power derived entirely from a 24 volt battery in an upper floor of the tower. It is anticipated that after 1966-67 even the travelling wave amplifier will be replaced by a solid-state device. Indeed, space has been reserved in the Tower for 24 and 50 volt batteries required to feed power to a large proportion of future equipment and for the low-voltage bus bars to distribute power to the various equipment floors. New 4,000 Mc/s equipment is to be installed in the Tower in 1965-66 to provide additional telephone circuits between London and Bristol; for the BBC-2 programme to Bristol and

OVER

The Post Office Tower in London will initially be used to provide four main microwave radio paths. They are from London towards Birmingham, Coventry and the north; towards Southampton, Bristol and the west and also for the Satellite Communication Ground Station at Goonhilly Downs; towards Dover, Folkestone and the Continent; and towards Norwich and the north-east of England.

New 6,000 Mc/s radio relay repeater equipment for transmitting 625-line colour television or 960 telephone circuits. Similar equipment to transmit 1,800 telephone circuits between London and Birmingham is to be installed in the Post Office Tower.



POST OFFICE TOWER *(Concluded)*

South Wales; and for broadband channels to connect London to the Post Office satellite ground station at Goonhilly.

To achieve the high standard of reliability needed for main trunk routes, groups of up to six working channels will share two standby channels which will be automatically switched into service to substitute for a failed or degraded working channel. Facilities will be provided to enable occasional traffic to be passed over the standby channels when they are not in use.

The standby switching operation will be carried out with a break of two microseconds or less at the intermediate frequency by means of equipment housed on a lower floor of the Tower. The 70 Mc/s signals will be connected between the switching and radio equipment by way of 0.174 inch diameter coaxial cables running on the inside of the Tower core. Switching will be initiated by way of pilot signals transmitted over the radio link itself in the same signal band as the working traffic, but end-to-end supervisory and control signals will be passed over special radio bearer circuits using the same aerials as the main channels but free from working traffic.

The base-band equipment,* which is mounted adjacent to the IF switching equipment, serves two purposes. First, it transfers outgoing basebands on to the 70 Mc/s carriers by a process of frequency modulation, and second, it recovers the incoming baseband from the 70 Mc/s carriers by a process of frequency demodulation.

Since the baseband equipment is outside the standby channel switching system it is fully duplicated. The traffic baseband signals are connected to the Museum repeater station by means of coaxial cables running down the inside core of the Tower.

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

THE AUTHOR

Mr. P. J. EDWARDS, AMIEE, entered the Engineering Department in 1942 as a Youth-in-Training in the Test and Inspection Branch (Birmingham). In 1948 he was transferred to the Radio Planning and Provision Branch as an Assistant Engineer and was concerned with the design and provision of Coast Radio stations. On promotion to Executive Engineer in 1950 he transferred to the Dollis Hill Research Station for work on television equipment development. Since 1960 Mr. Edwards has been responsible —as a Senior Executive Engineer in the Inland Radio Planning and Provision Branch—for planning the trunk network of microwave radio-relay links.

POST OFFICE TOWER — 3

HOW CIRCUIT FACILITIES WILL BE USED

By F. KELLY

TRUNK telephone traffic in London will be switched at a number of exchanges on different sites. The principal exchanges at Faraday and Tower will be augmented by new ones located on new sites to meet the continuing growth of trunk traffic.

Most of the trunk circuits will be derived from high frequency transmission links, cable or radio, and the channelling and translating equipment needed for circuits at each trunk exchange will generally be located within the building housing the exchange. It will be necessary, therefore, to distribute the circuits provided by the radio links terminating at the Tower to a number of transmission terminals in London.

The radio channels will provide telephone circuits in assemblies of 960; 1,800; and possibly 2,700. The larger assemblies will be broken down to units of 900 circuits for distribution to transmission terminals. The equipment to combine and break down these assemblies will be accommodated in floors immediately below the radio equipment.

The television network switching centre for London will be in the Tower building and all television channels provided by radio systems will be extended to this centre by coaxial cable. Within the limited cabling space available in the central core of the Tower multi-coaxial power cable will be needed for four reasons. First, to connect the radio equipment on different floors in the Tower; second, to extend telephony channel assemblies of 1,800 or 2,700 from the terminal radio equipment to the equipment on the lower floors of the Tower; third, to extend the telephony circuit assemblies from the Tower to the various transmission terminals in London; and fourth, to extend television circuits to the Network Switching Centre in the Tower extension. Most of this cable will be of the 0.174 inch type, in place of the previous standard .375 inch diameter cable, and so achieve a considerable saving in space and cost.

The transmission equipment terminal in the Tower extension will ultimately provide about 17,000 circuits to serve the switching units housed in the building and private wire services and will be mainly transistor-operated. The initial installation, which will provide some 10,000 circuits, will be the biggest single task of its kind ever carried out in this country.

The television Network Switching Centre will comprise a transmission equipment terminal, switching equipment and a control room, and all the inter-city, Eurovision, satellite and local television links will terminate there. The local television links will include those to the BBC and ITA centres in London and closed circuit links in the area of the Tower. Sound and music circuits used in the television and sound only programmes will also be controlled at the Network Switching Centre.

The transmission terminal will allow up to 1,800 television channels to terminate on a distribution frame. Testing facilities will be provided on console positions, which will separately cover television channels and sound circuits. Each console position for television will have access to a maximum of 300 channels and will be able to deal with either 405- or 625-line standards. The control console positions will distribute the television channels and set up monitoring facilities when required. Picture monitors for both black and white and colour programmes will be positioned in view of the console positions and a public viewing gallery is also to be provided.

THE AUTHORS

Mr. F. KELLY, AMIEE, is a Senior Executive Engineer in the Main Lines Planning and Provision Branch of the Engineering Department. He entered that Department in 1927 and until 1943 was employed on exchange maintenance, external construction and exchange construction in London and Liverpool. Since 1943 Mr. Kelly has been concerned in the planning of the trunk network.

Mr. R. T. MAYNE, BSc (Eng), AMIEE, joined the Engineering Department Telephone Development and Maintenance Branch in 1946 and moved to Sheffield Telephone Area in 1950. In 1953 he returned to the Engineering Department as a Senior Executive Engineer and is now in the Exchange Equipment and Accommodation Branch working on economic planning principles and grade of service studies. He has also been concerned recently with specific problems in exchange planning.

THE NEW SWITCHING UNITS

By R. T. MAYNE

TO utilise the long-distance circuits at the Tower it is necessary to terminate them at trunk switching units where facilities exist for selection and connection between them and the junction network to and from the local exchanges in London.

The high capacity of the Tower as a microwave system terminal will require a large proportion of the ultimate number of circuits to be distributed to other buildings in London for termination on trunk switching units. However, since it is economic to provide some switching facilities on the spot the capacity of the site for this purpose is being exploited by the installation of two large trunk switching units in the new building associated with the Tower.

One of these units will handle STD traffic originated by subscribers in London and will have the name Tower. Initially it will comprise 3,000 incoming relay sets giving access to 11 magnetic drum controlling register-translators which will provide facilities similar to those now working at the Citadel and Fortress exchanges. Calls will be routed by way of some 5,000 selectors to 1,500 outgoing trunk signalling relay sets giving access to the trunk routes available at the Tower and also to other London outgoing trunk units for access to other routes.

The second unit, to be called Mercury, will deal with trunk traffic coming in to London and occupy much of the ground and first floors. In the beginning there will be about 4,000 incoming trunk signalling relay sets and an electronic register-translator using the latest ferrite core and semi-conductor circuit techniques, to route calls through some 11,000 selectors to junction routes to the required London local exchanges. The first floor will also house a trunk test room and the new Museum junction tandem exchange which will have about 1,200 selectors switching calls between certain London local exchanges. The Museum tandem exchange will share a common outgoing junction network with Mercury trunk exchange, thus achieving a worthwhile saving in line plant costs. Later, the Tower and Mercury units will be extended to switch traffic for some 6,000 outgoing and 7,000 incoming trunk circuits.

TELEX SPEEDS THE FLOOD

The East Coast flood warning system has been speeded by a new telex system which keeps the police and river boards constantly in touch

A scene of devastation at Palling, near Norwich, during the 1953 floods.

THANKS in no small part to the Post Office a more efficient and speedier flood warning system is now in operation in the East coast counties of England from Northumberland to Kent.

The story goes back to the night of 31 January-1 February, 1953—the night of the worst natural disaster in this country for three hundred years. On that night high winds piled masses of water on the rising tide which swept through the sea defences from Scotland to the Channel coast. Three hundred people lost their lives, 24,000 homes were destroyed or damaged, nearly 47,000 animals were drowned and 163,000 acres of agricultural land were inundated. Power stations, factories and gas works were put out of action, hundreds of miles of roads and railways were damaged, fresh water supplies were cut off and sewerage services interrupted. The worst hit area was the section of coast from Holderness to the Isle of Thanet where not a mile of sea wall remained intact.

There was no general flood warning system at that time although some River Boards did exchange information on a purely local basis. Immediately after the disaster, however, a battery of teleprinters was installed in the headquarters of the Land Drainage Division of the Ministry of Agriculture

WARNINGS

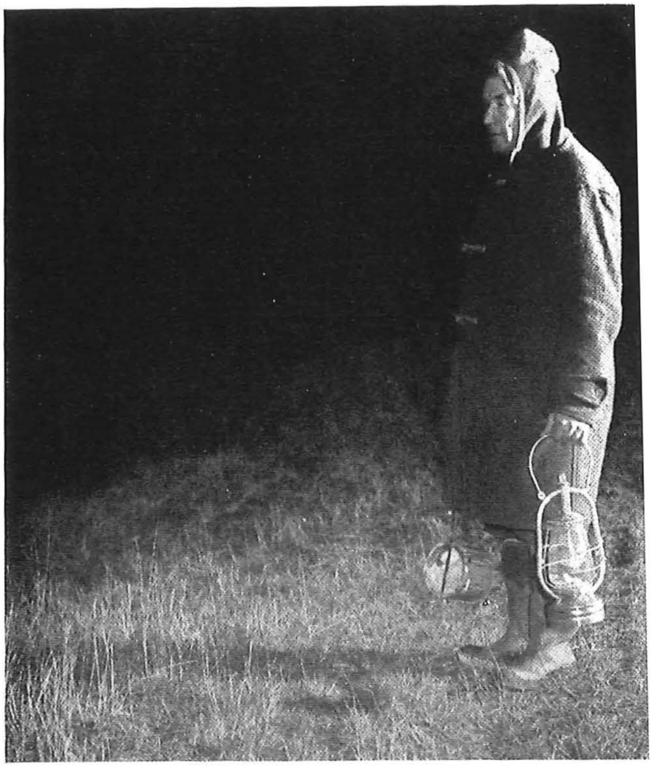
By P. F. A. FITT

at Someries House, Regents Park, London, with circuits to the various temporary East coast flood headquarters, to help control the repair programme and to collect and disseminate information on the possibility of further floods. This temporary network was operated by the Ministry of Agriculture, assisted by the Tidal Branch of the Admiralty and the Meteorological Office.

Then, in July, 1953, the Waverley Committee on Coastal Flooding recommended that a flood warning system for the East coast from Northumberland to Kent should be set up. It would be based at the Meteorological Central Forecasting Office at Dunstable and staffed by officers of the Tidal Branch of the Admiralty. The warning period would operate between 15 September and 30 April each year and the information would be passed direct to the authorities responsible for taking local action. River Boards would decide the water level at which they required information, interpret this information and consult the County Police forces. In addition, local schemes would be worked out in advance in each River Board Area in consultation with the police and Local Government authorities.

Simultaneously, a sub-committee composed of members of various Government Departments, the Post Office, the British Broadcasting Corporation and the Police made two important recommendations. One was that tidal gauges should be installed at a number of towns along the East coast, and the other was that at times of flood danger warnings would be sent by telegram to each River Board and police authority. Telegraphic addresses were allotted and arrangements made for each telegram to be prefixed: "Government priority. Flood Warning System".

This new system began on 11 April, 1953. Harbour masters read the tidal gauges and passed the information on the state of the tide and weather conditions to the Flood Warning Officer at Dunstable by way of local Royal Air Force stations which also served as Meteorological out-stations. The Flood Warning Officer decided in the light of this information whether to issue a flood warning and to which areas it would be sent.



The sea walls broken, a lonely patrol keeps watch at Wingland, Lincolnshire.

The first warning, now known as an "alert", was issued 12 hours before the expected danger peak. Four hours before this was reached the alert was either confirmed or cancelled or a danger message was sent out. These messages were passed by the Flood Warning Officer to the Meteorological Signals Officer and thence by private teleprinter circuit to the Post Office Central Telegraph Office which then sent telegrams to the River Boards and the police.

This telegram warning system was at that time the most economic and efficient available. It suffered from one big disadvantage, however. The four-hour warning period was reduced in some instances to an effective three hours because of delays arising from the number of times the messages had to be handled. A three-hour warning was considered too narrow a margin to allow all the necessary steps to be taken locally to preserve life and property.

Eventually, in August, 1962, the Ministry of Agriculture asked the Post Office to examine the entire warning system and to recommend a faster method of communication.

The task was carried out by a team from the Post Office Headquarters Telecommunications

OVER

FLOOD WARNINGS *(Contd.)*

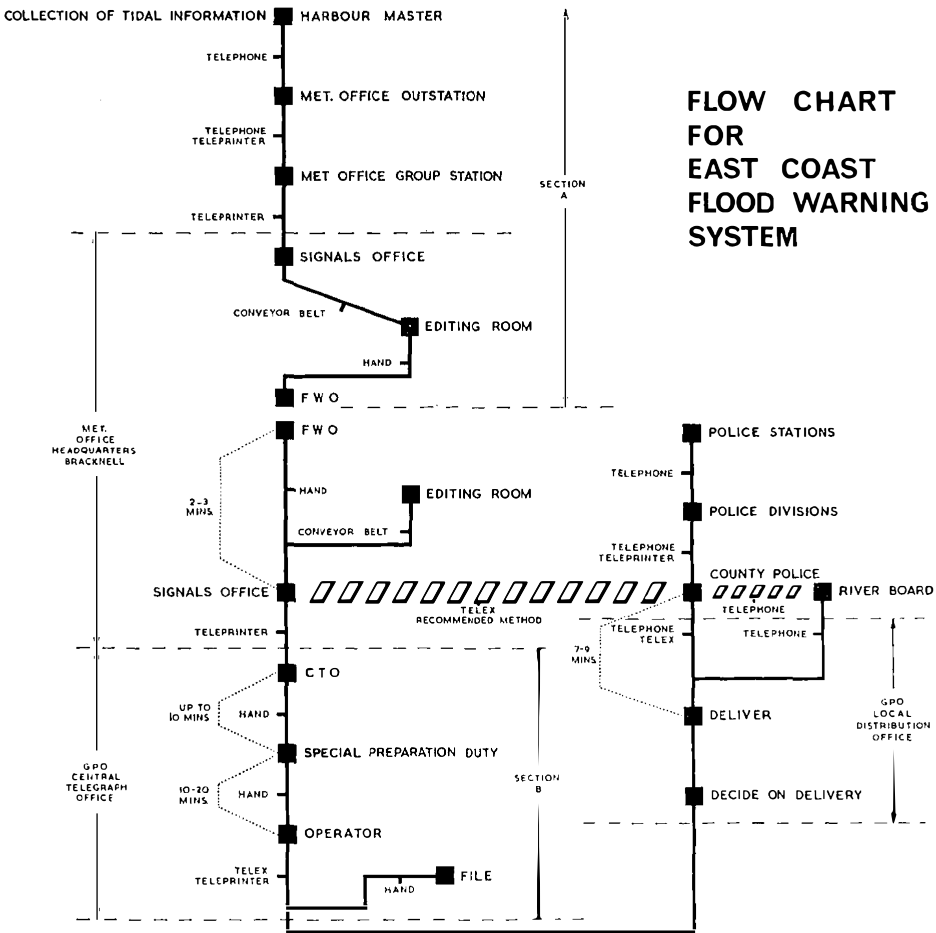
Advisory Service which, after visiting the Meteorological Central Forecasting Office and the Central Telegraph Office, decided that since every step had already been taken to reduce delays to the minimum a completely new system would have to be evolved.

The team first considered an arrangement in which the warning messages were passed over the public telephone network but this was rejected because of the possibility of phonetic error in telephone messages which also needed to be written down by the recipient. In addition, the Meteorological Office (by this time at Bracknell) was not on the Subscriber Trunk Dialling system which meant that calls from it would be operator controlled and possibly suffer delay.

The team then turned its attention to the possibility of a teleprinter system which would have the advantage of producing a written message. A private teleprinter system could not be justified because of the high cost of circuits in relation to the small amount of use they would receive. However, most of the police authorities involved in the flood warning system were on telex. If they could accept responsibility for delivering messages to the River Boards, a telex system would provide the best solution to the problem.

To test their reaction to the idea, the team visited a number of police authorities and River Boards in the East coast area and found they welcomed the proposal since the extra warning time the telex system gave would be invaluable in helping them to discharge their responsibilities.

Experiments were then made to check the speed of the telex system. Dialling a five-figure number and transmitting the warning message by an automatic transmitter took on average 54 seconds. All the 12 police authorities involved in the scheme could, therefore, be warned in not more than 15 minutes.



FLOW CHART FOR EAST COAST FLOOD WARNING SYSTEM

This chart shows the old flood warning system (black lines) and the new (slanted open boxes). Under the old system information went from the harbour-master to the flood-warning officer and from him to the various interested parties. The new system short-cuts that arrangement.

Left: Flood damage at Mablethorpe, Lincolnshire, in 1953; and (right) the strengthened sea wall today.

After further discussion with the Ministry of Agriculture, the Meteorological Office and Flood Warning Officers, the Telecommunications Advisory Service issued a report recommending the use of telex. The plan was accepted and the new warning system was brought into operation on 16 September last year.

Before the new system started, automatic tide gauges which continuously transmit signals showing the rise and fall of the tide, were fitted at Aberdeen and Immingham. Others are now being installed at Wick, Tyne Entrance, Lowestoft, Harwich and Southend. When completed, they will be connected by direct circuits to the Meteorological Office and the signals will be received by the Flood Warning Officer who can thus keep constant watch on the development of tidal surges. When warning messages have to be sent, the Flood Warning Officer will simply despatch a telex message to the appropriate area or areas.

THE AUTHOR

Mr. P. F. A. FITT is an Assistant Sales Investigation Officer in the Inland Telecommunications Department concerned with the organisation of advisory services at area and regional level and data transmission. He joined the Post Office as a labourer in 1946 after service with the Royal Air Force in World War Two and was promoted to Technical Officer in 1951. Mr. Fitt became a Sales Representative in Centre Area in 1955 working on Government sales and special services. He was promoted to ASIO in 1962.

About £20 million was spent on new sea defences in the first twelve months after the disastrous 1953 floods. This involved moving well over ten million cubic yards of soil (enough to cover the whole of Hyde Park to a depth of 18 feet!) and placing five million concrete blocks to strengthen earth banks.

A further £7 million has been spent on improving flood defences since 1954, and the East coast is now much better protected than at any other time.

THE WORLD'S TELEPHONES

IN 1962 the number of telephones in the world increased by 9.2 million—a record figure—to 159.2 million, according to figures issued recently by the American Telephone and Telegraph Company.

Of all the world's telephones 144.5 million were automatic and 104.9 privately operated. The largest number of telephones in any continent was 87 million in North America, followed by 49.7 million in Europe and 11.6 million in Asia. Countries outside the United States accounted for a much larger share of new telephones—61 per cent for 1962 compared with only 51 per cent ten years earlier.

Of 27 countries which have more than 500,000 telephones, Great Britain was second to the United States (80.96 million) with 8.91 million, followed closely by Japan (7.3 million), Western Germany (7.04 million) and Canada (6.3 million).

STD SHOW ON WHEELS

By J. H. I. THORBURN

To help put subscribers into the STD picture a mobile exhibition is used to stage demonstrations in Western Scotland

The author explains the STD system to the Provost of Stranraer when the latter visited the mobile STD exhibition and made a demonstration call.

A MOBILE exhibition housed in a caravan has been touring Western Scotland in the past few months demonstrating Subscriber Trunk Dialling and showing how subscribers can reap the greatest benefits from the new system.

Since May, 1963, it has been on display in 10 towns and been visited by nearly 10,000 people.

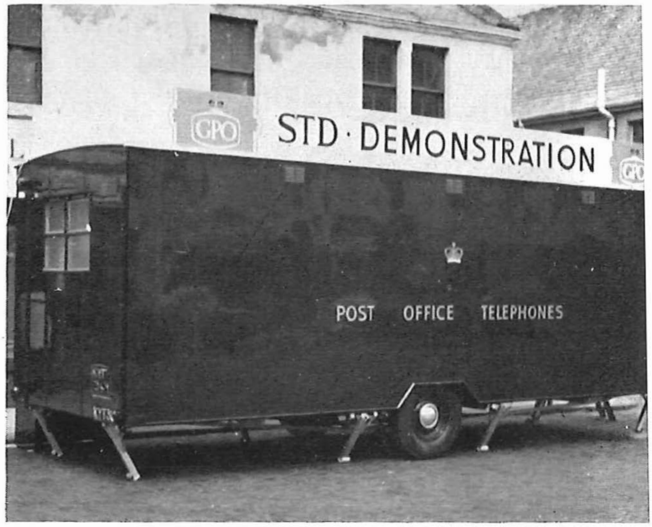
The idea for a mobile exhibition came when the Scotland West Telephone Area began to prepare for the current heavy programme of converting manual exchanges to automatic working and extending STD. Staging exhibitions in large towns where ample accommodation is available is no problem but in some parts of Western Scotland, where there are smaller towns and suitable exhibition premises are lacking, it is another matter. In addition, it is difficult for subscribers who have been used to lifting the receiver and simply asking for "Donald, the butcher" or "Hamish, the gamie" to learn how to handle automatic dialling and get used to the national codes for trunk dialling.

The caravan, which is 21ft 6ins long, 7ft wide and 6ft 6ins high, was first taken to the Glasgow Area workshops where the various display panels were fitted, electric strip lighting and tubular heating were installed and large plastic windows were let into the roof to provide the maximum amount of daylight. After being painted Post Office red, the caravan was returned and Scotland West engineers installed an automatic demonstration set and telephone equipment associated with the display panels.

The automatic demonstration set shows the progress in an exchange of a typical dialled call from one telephone to another. The switches can be seen stepping in accordance with the dialled digits until the called number answers and the subscriber's meter is operated. An illuminated display panel explains the steps. The demonstration set also shows the progress of an assistance call via 100 as well as that of a 999 emergency call. Mounted on the demonstration set are two telephones, two subscribers' uniselectors, three group selectors, one final selector and two associated subscribers' meters. Power is supplied by a rectifier unit and the tones are generated by a small ringing machine. Power points have also been installed for an electric kettle, a table lamp and a fan heater. Distributed inside the caravan are a folding table and chair, fire extinguishers, coat hooks and cupboards containing literature on STD, directories and stationery.

Inside the caravan are six display panels. One shows the Queen dialling the first STD call in Bristol in 1958 and gives details of the date and time the local exchange is to change to STD. The second panel shows a picture of a typical PBX switchboard on which are mounted a telephone and a subscriber's meter. From this telephone visitors can make trial calls to special numbers in London, Cardiff, Edinburgh and Glasgow which announce recorded messages explaining the most economical way of using STD and how metering operates.

On the third panel are shown all the pages of the local STD dialling codes booklet to help explain the national numbering code dialling and to emphasise the cheap rate charges. The main feature of the exhibition is contained in the fourth display panel entitled "Sample an STD Call". Here, visitors may make a call to any one of six numbers in different towns or cities. The fifth panel displays a map showing the area covered by the various call charges while the sixth panel contains a pay-on-answer call box from which



The 21ft 6ins long caravan housing the exhibition.

visitors can make calls to selected telephone numbers which have recordings.

In addition, the exhibition contains a shared service automatic telephone which is demonstrated to emphasise that the "call exchange" button must be pressed before the dialling tone can be received.

The mobile exhibition, which has so far given demonstrations in Annan, Bo'ness, Johnstone, Kilbarchan, Wishaw, Bellshill, Polmont, Larbert, Stranraer and Grangemouth, has already proved its worth and will be in great demand in the next few years as the conversion programme in Scotland expands. It will also be used where observation results show a need to make additional visits to a town to refresh subscribers' memories about the advantages of STD.

NOTE.—*Scotland's STD caravan unit is the second of its type in Britain. The first was pioneered by the North Western Region which helped Scotland West Area to plan its unit.*

The Scotland West Area covers about 11,500 square miles. It stretches from the old Celtic kingdom of Galloway, where St. Ninian first brought Christianity to Whithorn in about 450 AD, to the Outer Hebrides, which the Vikings colonised in the 9th century.

The Area includes such historic places as the Isle of Iona, the cradle of Celtic Christianity, and Glen Shiel, where Prince Charles Edward Stuart first raised his standard in 1745.

In Bonnie Prince Charlie's days communication among the Highland clans was by a runner bearing a fiery cross to signify that the message was of great importance. Today, the Area has 392 telephone exchanges with 96,000 connections and 2,000 call offices. These exchanges range in size from a town such as Ayr with 5,000 connections, to the island of Eigg, with four connections, one of which is "Rhum 1".

THE AUTHOR

Mr. J. H. I. THORBURN joined the Post Office in 1941 as a Youth-in-Training in Glasgow Telephone Area, subsequently becoming a Technical Officer. In 1955 he moved to the Traffic Division as Telecommunications Traffic Officer and then to Scotland West Telephone Area in 1961 on promotion to Telecommunications Traffic Superintendent. Since then he has been concerned with exchange conversion arrangements.

The new submarine cable from Winterton in Norfolk, to Leer, in Western Germany, is the first of a number of direct telephone cables to be laid across the North Sea to meet the growing demands for both telephone and telegraph service

A NEW LINK WITH GERMANY

"THE opening of this new cable marks a significant step forward in the strengthening of communications links between our two countries and in the development of the whole European submarine cable network," said Mr. Ray Mawby, the Assistant Postmaster General, on 13 February when, speaking from Post Office Headquarters, he made the inaugural call over the new Anglo-German telephone cable.

This new cable, which is 200 nautical miles long and stretches from Winterton, in Norfolk, to Borkum and thence to Leer on the German mainland, is the first direct, large capacity submarine cable ever laid between Britain and Germany.

Since 1926 telephone service between Britain and Germany has been provided on circuits routed indirectly through Belgium and the Netherlands. Now, with the opening of the new cable, which has a capacity of 120 telephone circuits, 20 direct speech circuits and about 40 direct telex circuits will be available within the next 12 months.

The new cable will also enable many of the circuits routed through Belgium and the Netherlands to be transferred and this, in turn, will allow more circuits to be provided to those two countries. In addition, several channels in the new cable will be extended to the United States by way of the TAT-3 cable, which was opened last October, to provide direct circuits between the United States and Western Germany.

Furthermore, the new Anglo-German cable will enable International Subscriber Dialling to be introduced between Britain and Germany. At first, the system will be confined to calls from London STD subscribers to subscribers in Germany but later this year the facility will be extended to include STD subscribers in Birmingham, Manchester, Edinburgh, Glasgow and Liverpool. In the near future German subscribers will also be

Mr. Ray Mawby, the Assistant Postmaster General, listens in as the German Ambassador to London speaks to his opposite number in Bonn on one of the first calls on the new cable.

STILL GOING STRONG

THE world's first working repeater was brought into service in a telephone cable which was laid for defence purposes in 1946 over much the same route as the new Anglo-German cable.

This repeater, designed and made by the Post Office Research Branch helped to increase the number of direct circuits to Germany from two to five. All five circuits now carry VF telegraph systems capable of providing 120 telegraph circuits.

Remarkably, the first submerged repeater is still operating as efficiently today as when it was laid.

able to dial their own calls direct to many subscribers in Britain.

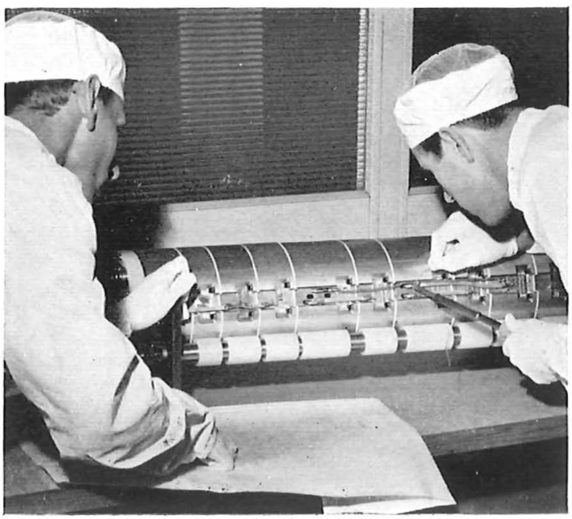
The Anglo-German cable is the first of six new submarine telephone cables which are to be laid across the North Sea in the next few years to cater for the ever-increasing demand for both telephone and telegraph services. A second Anglo-German cable and one from Britain to Denmark will be brought into service towards the end of 1964 and two new cables from Britain to the Netherlands will be completed by 1966. All these cables will have a similar capacity to that of the first Anglo-German cable. The sixth cable across the North Sea is planned between Britain and Norway.

The main cable was laid by the Post Office cable layer HMTS *Monarch* and the shore end cables at Winterton by the Danish cable ship *Peter Faber*. The cable is of the conventional armoured type, 0.62ins in diameter except for the stretch between Borkum and Leer which is 0.935ins in diameter. The 20 submerged shallow water repeaters, which, with the cable, were made by Standard Telephones and Cables Ltd, are of a new type. They have detachable housings which can be opened up for examination more readily than earlier types.

Standard Telephones and Cables Ltd have also been awarded a £2 million contract to provide the cable and repeaters for three new cables. They are for the Britain to Norway cable (385 nautical miles of cable with 52 repeaters); the Britain to the Netherlands cable (110 nautical miles and 14 repeaters); and the Norway to Denmark cable (79 nautical miles and ten repeaters).

● *The first submarine telephone cable between Britain and the mainland of Europe was laid 73 years ago in 1891. It provided two speech circuits between London and Paris.*

From that small beginning, the number of circuits has grown to well over a thousand, all routed in 18 different cables across the North Sea and the English Channel. In that time, too, telephone traffic alone between Britain and Germany has grown until today it amounts to almost two million calls a year. It is still growing at the rate of about 13 per cent a year.

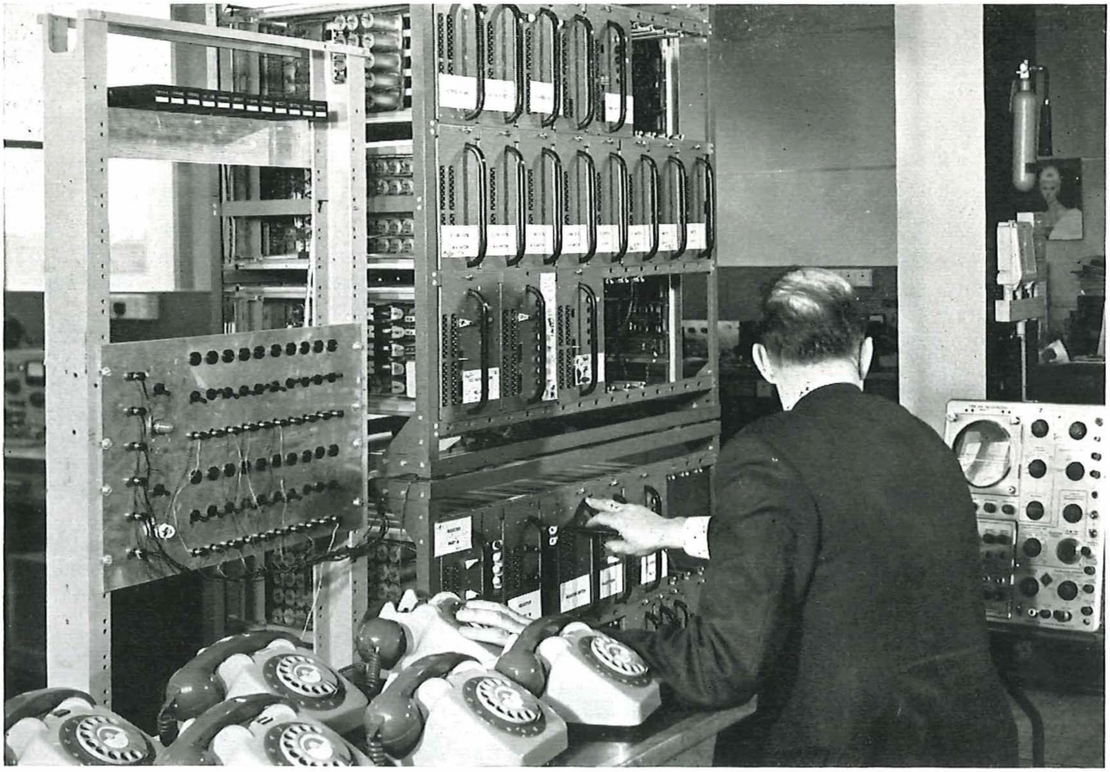


Left: The APMG describes future cable developments to the German Ambassador. Below: Engineers at Submarine Cables' Erith factory work on one of the new submerged repeaters.

ELECTRONIC EXCHANGES...

Past, Present and Future

This article tells the story of electronic switching developments, describes the problems and takes a searching look at the future possibilities



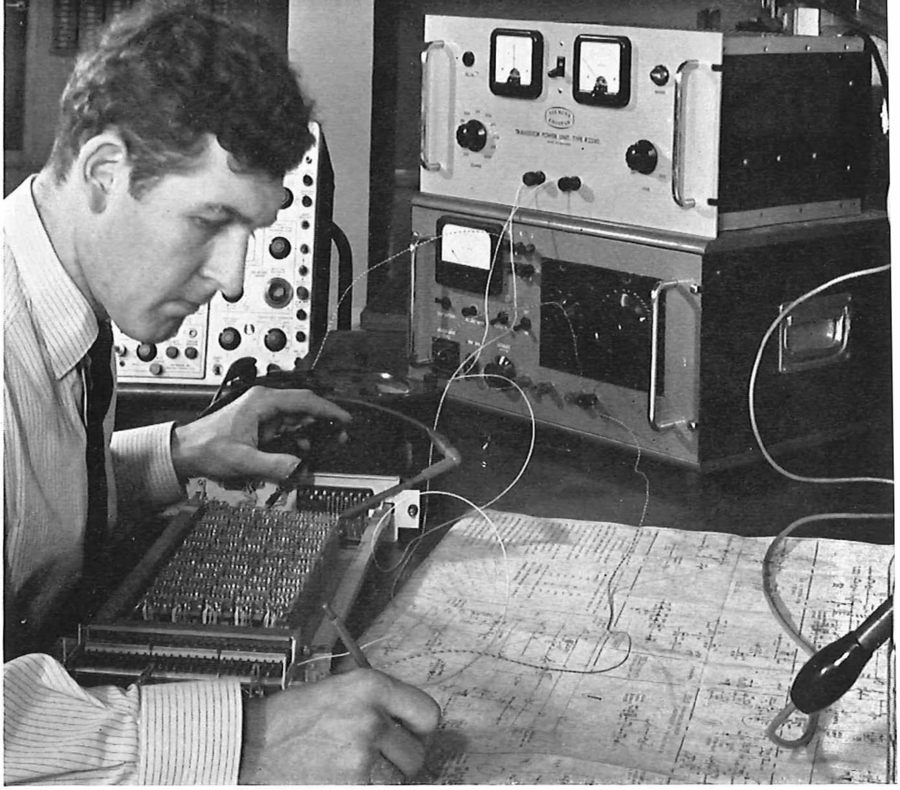
An engineer at work on a laboratory model of a space-division exchange.

WHAT is the real significance—to the subscriber and the Post Office—of electronic exchanges? What problems will they throw up? What are the prospects of a successful outcome?

These are the three main questions which Mr. H. A. Longley, Assistant Secretary, Head of the Telephone Mechanisation Branch of the Inland Telecommunications Department, asked and answered when he recently read a paper entitled "Electronic Exchanges—Some Service and Administrative Aspects"—to the Post Office Telephone and Telegraph Society.

"The electronic exchange," said Mr. Longley, was conceived about 30 years ago when proposals for forms of electronic switching were made in America and Sweden, although as early as 1919 two Britons—Eccles and Jordan—had discovered

The first three pictures illustrating this article are reproduced by courtesy of *Ericsson Telephones Ltd*, and the other four pictures by courtesy of *General Electric Company Ltd*.



Tests being carried out on a B-switch unit for the first field trial of a space-division electronic exchange model.

how to use two thermionic valves as a kind of switching relay. Their device was called a "valve trigger."

"The service given by electronic exchanges will not contrast with automatic service in the way that manual service contrasted with automatic," said Mr. Longley. "In fact, a subscriber in a non-director exchange converted to electronic will not necessarily notice any difference. Furthermore, there is today no electronic exchange in regular public service in this country and none abroad that is yet a serious competitor to electro-magnetic exchanges. But I believe that the electronic exchange will quickly confer many benefits on the telephone service in this country and, in the long term, in some ways transform it."

Apart from the potential advantages of electronic exchanges, the vital importance of exports was a compelling reason for pressing on with research and development at full speed. Research and development on electronic exchanges was very active in other exporting countries and it was vital that we should keep in the forefront of this work in maintaining and obtaining overseas markets. Since the United Kingdom telecommunications industry partly depended on the home market the Post Office was anxious to go over to electronics as soon as possible.

More than a tenth of the total capital investment in telecommunications went on providing accommodation for the equipment. The rapid increase in telephone lines and traffic, the high and increasing cost of sites and the difficulties of acquiring new sites presented a serious problem. However, electronic switching equipment was expected from the outset to take up less space than the present electro-magnetic equipment, and miniaturisation held out great promise for future savings in space, and, therefore, costs. Electronics was expected to enable many existing exchanges to be replaced within existing buildings and with greatly increased capacity.

Experience confirmed that electronics would also set the stage for reliability on a scale quite impossible with electro-magnetic equipment.

The incidence of individual faults would be greatly diminished but, because of the closely-knit character of electronic switching equipment, some individual faults could cause partial or total breakdown unless precautions were taken. Providing a maintenance organisation to cope with a liability to total breakdown could eat into savings in maintenance costs resulting from a reduction in the number of faults. And to avoid this by duplicating essential items in an exchange would

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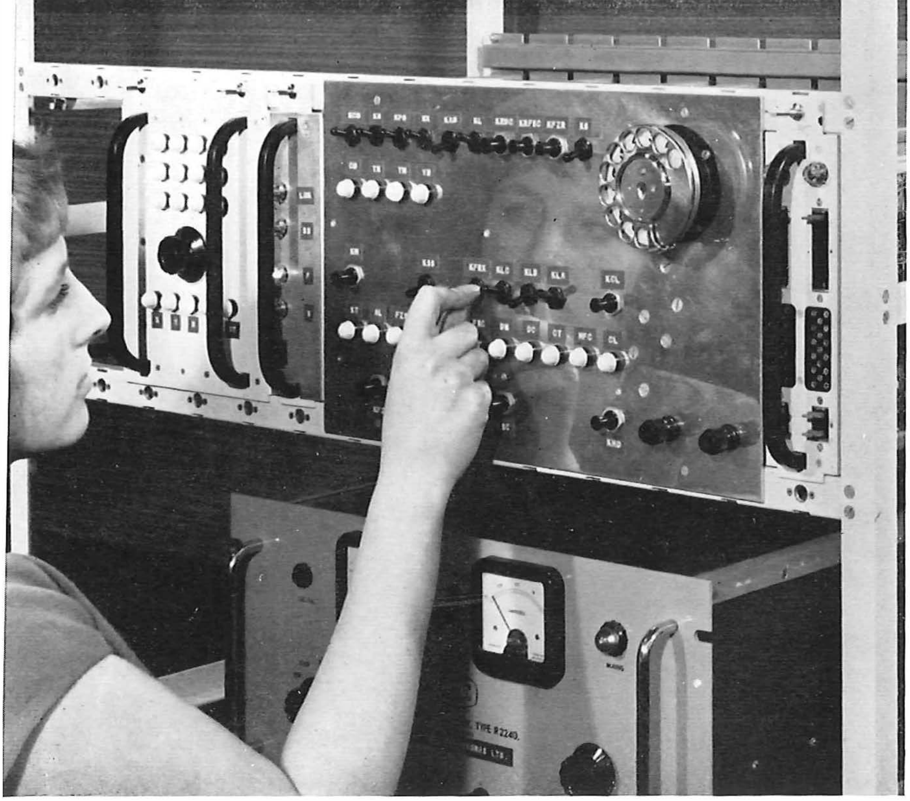

This girl is putting a completed unit of a model of a space-division electronic exchange through its production tests.

ELECTRONIC EXCHANGES *(Contd.)*

increase the capital cost. The Post Office had, therefore, studied very closely exactly what would be tolerable and had prescribed standards, similar to grades of service, as a basis of design of electronic exchanges.

"We may look for marked improvements in service quality resulting from increased reliability," added Mr. Longley. "In addition, electronic exchanges will be designed to make a second attempt automatically and instantaneously over an alternative route if a first attempt fails. Call failures due to exchange equipment faults may ultimately reduce to negligible proportions . . . and exchange maintenance costs may be put on an entirely new plane."

Mr. Longley went on to speak about speed of service and said that a wholly electronic switching system would eliminate ringing-tone pauses, although while the electronic and electro-magnetic systems were working side by side they would be reduced rather than cut out altogether.

With the expansion of STD and International Subscriber Dialling, subscribers sometimes had to dial ten digits for an inland call and 14 or 15 for an ISD call and they would be greatly assisted in this by the use of faster-moving dials, or better still, key-sending. A key-sending telephone had, in fact, been developed and some were on trial on the Headquarters exchange. Keying a number into a Strowger exchange was, however, followed by a still longer pause before the ringing tone was heard, but with an electronic system there would be immediate ringing tone on all types of call.

Another important improvement offered by electronic exchanges would be a reduction in dialling codes. STD exchanges were arranged in 700 numbering groups, each reached by dialling a one-, two- or three-digit code after the initial O. Every exchange had a different code so that ultimately there would be some 6,000 different codes, but the set of dialling codes shown in each booklet would differ if, as seemed likely, the size of the booklets was limited to reasonable proportions. In addition, every exchange had its own individual set of dialling codes for local calls. There could, therefore, ultimately be a separate version of the booklet for every one of the 6,000 exchanges in the country. When the national numbering scheme for STD was drawn up it was realised that these difficulties would be almost entirely removed if each number group had a separate linked-numbering scheme. Such an arrangement would be uneconomic with the existing step-by-step system but since electronic exchanges are register-controlled, we could look forward to the general introduction of linked-numbering schemes. There would then be only 700 trunk call codes, uniform for the whole country, and the local codes list could be reduced to an average of six codes.

There would then be an opportunity to abolish the issue of separate dialling code booklets by incorporating the information in directories, but this would not be fully effective until all exchanges were electronic, or at least electronically controlled.

An interesting feature inherent in electronic exchanges and likely to be a boon to business subscribers, was that PBX auxiliary lines were always outside the normal numbering range so that any directory number could become the first line of a PBX group. Reservation of multiple numbers as PBX reserves would cease and no subscriber would need to change his primary number no matter how many lines he needed. This facility would also increase the capacity of national and local numbering schemes.

The capability of any electronic system to provide special facilities might be particularly important in the export field. Because of its centralised control system there was theoretically no limit to what could be done, although the costs might be different on different types of electronic exchange.

The design of a new switching system in any case provided a welcome opportunity for the Post Office to review its facilities and a great deal of work has been carried out. Well over 100 suggestions for facilities of various kinds had been examined and costed and nearly 50 of them had been selected for more detailed study. Many considerations had to be taken into account when assessing the value of the proposed facilities: the advantages to the subscriber and to the Post Office, the possible demand and the level of charge to be made and the cost of providing the service and so on.

Among the suggestions being considered was that temporary withdrawal of service and restoration should be centred on the parent automanual exchange, thus eliminating the labour of TOS under the present practice. The idea was that the operator would be able to signal over a junction to the remote unattended exchange and so put a line temporarily out of service or restore it back to service.

Electronic registration and storage of call charge units in place of conventional meters would eliminate meter readings, added Mr. Longley, and it was possible to visualise arrangements by which exchange equipment would signal direct into a computer centre for the account to be prepared. "It is also conceivable that an individual subscriber's call unit total could be read from a remote point. We would also hope that an electronic coinbox, besides possibly simplifying the apparatus at the coinbox end of the line, would facilitate the faster insertion of coins and eliminate the interruption in conversation when the coins are inserted. The possibility of dispensing with the press button on shared service lines,

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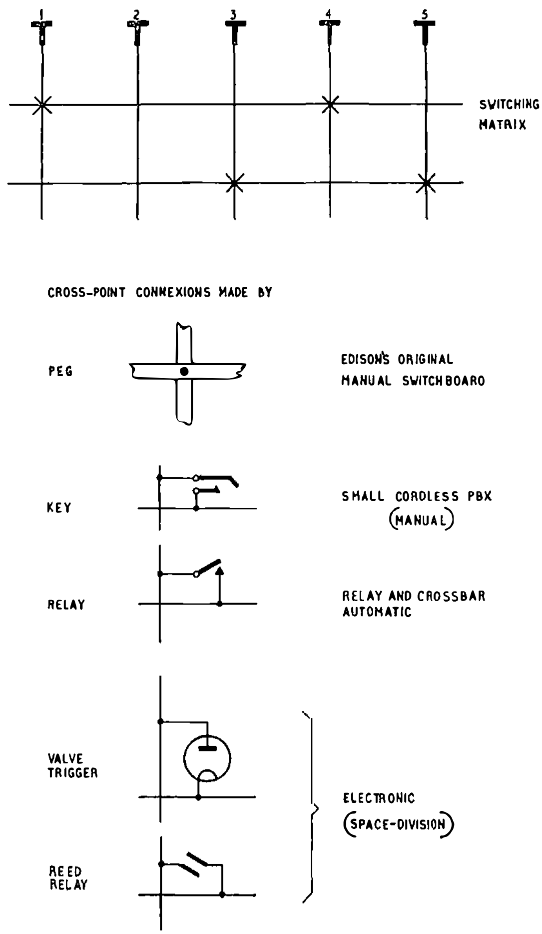
This diagram shows Edison's switching principle on manual, automatic and space-division exchanges, subscribers No. 1 and 4 and 3 and 5 being connected.

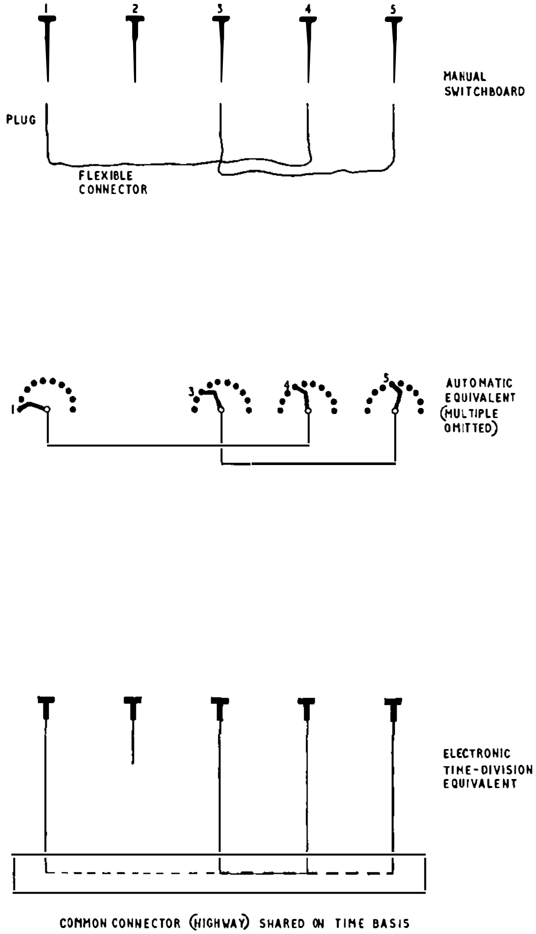


ELECTRONIC EXCHANGES (*Contd.*)

still retaining separate metering for each party, is being examined."

Ways of arranging for the automatic completion of calls which meet the engaged condition, after the calling party had finished his conversation, were also being examined. The Post Office was also studying the possibility of replacing the telephone bell by apparatus giving a tone. Such a system was now on trial on telephones connected to Strowger exchanges. This technical development would prepare the way for economies in local line plant when electronic exchanges were introduced.

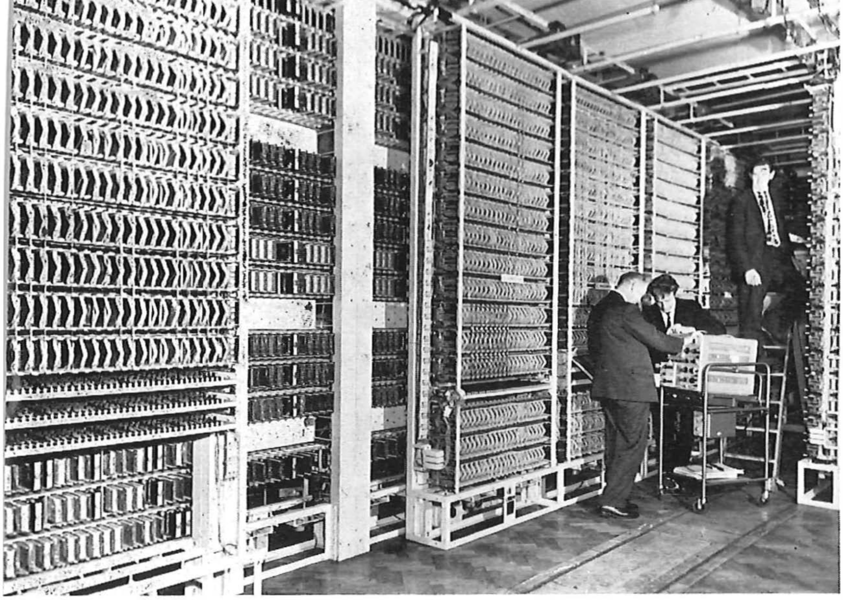
This shows Graham Bell's switching principle, subscribers 1 and 4 and 3 and 5 connected by manual, automatic and electronic systems.



"There is a variety of principles on which electronic exchanges could be operated," Mr. Longley continued. "In this country, study has been mainly on two broad principles: 'space-division' and 'time-division'. There have been two streams of telephone switching development and both had their origins in the very early days of telephony, 80 years or more ago. Graham Bell invented the first telephone switchboard which comprised simple jack terminations for subscribers' lines and flexible double-ended cords to establish connection. This principle was the father of the Strowger system and many others. Edison, who had invented a telephone working on different principles from that of Graham Bell's, produced another kind of switchboard in order to get round Bell's switchboard patent. This consisted of a matrix of vertical bars, one for each subscriber, and horizontal bars for connecting circuits. Brass pegs were inserted at the cross-points of these bars in order to set up calls. This concept is the father of a series of very interesting switching systems. The small cordless PBX switchboard was based on this principle, using keys instead of the brass pegs of Edison. The relay switching system, invented in 1911, by Betulandar, a Swede, had ordinary electro-magnetic relays at the cross points. This was an attractive system in many ways but since the number of cross-points and, therefore, of relays increased with the number of subscribers according to a square law, it was economic only for small exchanges and PABXs. To overcome this difficulty Betulandar introduced in 1919 the so-called co-ordinate selector which, by using only 20 electro-magnets where the original relay system needed 100, avoided the adverse cost ratio of large relay exchanges.

"In electronic space-division systems the switching element at each end cross-point could be a valve trigger. An exchange on these lines is a true electronic exchange and trial exchanges on this basis have been made. Recently, however, an electro-magnetic device known as a reed relay* has been invented which fulfills the function of the valve trigger and has the great merit that, given mass production, it ought to be very cheap. Exchanges using these reed relays, but otherwise electronically controlled are what we call space-division electronic exchanges. This system should be successful for large exchanges, where the old

*The reed relay was described and illustrated in *Telephone Exchange Relays* by G. F. MACHEN in the Summer, 1962, issue of the Journal.



Engineers prepare to carry out tests on a completed model of a time-division electronic exchange.

relay systems failed, largely because of the potential cheapness of the reed relay and because it is small and extremely reliable.

"In the time-division system subscribers' line terminations all have access to a common connecting path—known as a highway. Each conversation uses the highway for, say, one-millionth of a second at intervals of one-ten-thousandth of a second so that a hundred conversations can take place simultaneously on the same highway. Just as with television a single moving spot appears as a complete picture so the aggregate of these minute pulses is heard as perfect speech.

"There is scope for great diversity by the combination of space-division, time-division and other principles and we could have a period in which there is a considerable variety of design before it becomes possible to achieve standardisation. The dilemma is that if electronics is to be a serious competitor to the Strowger and crossbar systems there must be mass production and, therefore, very early efforts to achieve a degree of standardisation so that competitive prices can be reached as soon as possible.

"The Post Office is, therefore, preparing to change over completely to electronics, when the right conditions have been created, both for the new exchanges and extensions.

"Over half of Post Office capital expenditure on equipment goes on extensions of existing exchanges, and this means that we shall have widespread electronic extensions of Strowger exchanges. This will pose some new problems because the service quality and facilities will differ on two halves of an exchange extended in this way. The difference will depend to some extent on whether or not the arrangements provide for the Strowger half to be electronically-controlled. Such an arrangement may be more appropriate in some cases than others."

Mr. Longley then went on to talk about standards of provision of electronic exchanges. The trunking of an electronic exchange was very complex and the specification of grade of service in terms of individual links within the exchange would not have the same significance as for the step-by-step system. It was necessary, therefore, to specify grades of service differently and this had been done for certain classes of call, such as those between subscribers on the same exchange; calls from a subscriber to an outgoing junction; calls from an incoming junction to a subscriber; and calls from an incoming junction to an outgoing junction. For the time being the standards would be those to give the equivalent grades of service now expected from Strowger exchanges. These standards were expressed in terms of limiting values to be met with a 10 per cent increase of traffic above the specified level and made special provision for electronic exchanges employing large full availability group by specifying limiting values in the event of a 20 per cent variation above the design figures.

To keep down the number of cross-points, subscribers on space-division exchanges would have only four outlets, which would be used for both incoming and outgoing calls. This would require very careful adjustment of the loading and distribution of subscribers' lines over the lines

OVER

ELECTRONIC EXCHANGES *(Contd.)*

terminations. The standards worked out would result in broadly the same incidence of delay in receipt of a dialling tone as for Strowger exchanges, but when delay occurred it would usually tend to be longer.

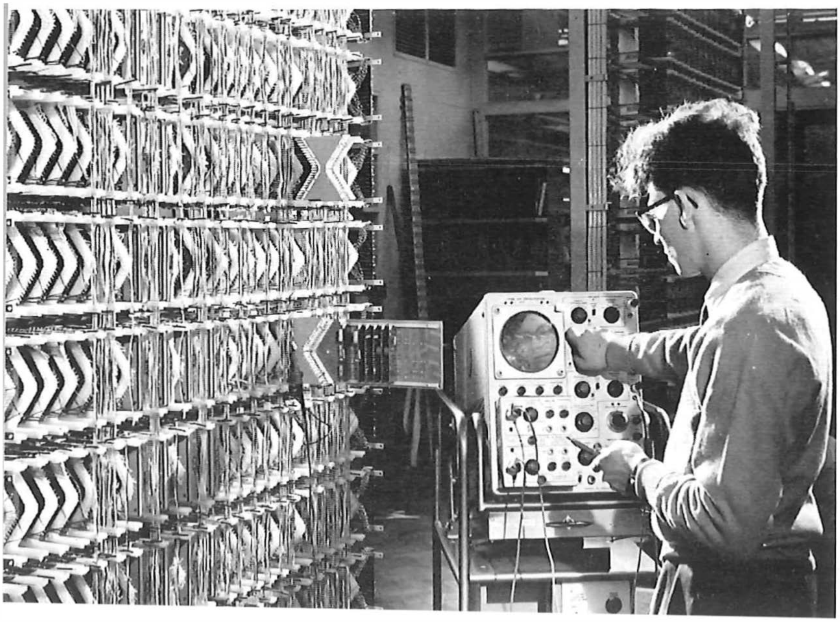
Under present practice a calling subscriber, who on lifting his receiver, finds all outlets engaged, is greeted by silence while he waits for the dialling tone. With electronic exchanges a much cheaper arrangement would be to give a busy tone immediately if all outlets were engaged. The subscriber would then have to replace the receiver and call again. The Post Office had decided that this was a logical and acceptable alternative to the present arrangement and had agreed to its adoption at small electronic exchanges.

"How and when is all this going to be achieved?" continued Mr. Longley. "In normal times there is a high degree of co-operation between the Post Office and the telecommunications industry, but in the electronic exchange field collaboration is on a very exceptional scale. In 1956 a Joint Electronic Research Agreement was signed between the Post Office and the equipment contractors to set the pattern for joint research into and development of electronic exchanges. The driving force behind this is the Joint Electronic Research Committee which is presided over by the Engineer-in-Chief of the Post Office. Other groups on both the engineering and administrative sides of the Post Office deal with individual projects and special aspects, such as the study of facilities. At the top, the Director General of the Post Office meets the managing directors of the equipment contractors to review progress and deal with broader issues.

"An important stage was reached when the first electronic exchange of its kind was opened at Highgate Wood* in December, 1962. This trial exchange, which worked on the time-division principle, was installed in parallel with the Strowger exchange and could be switched in and out of service for experimental purposes.

"Until recently research and development had proceeded on three types of electronic exchange: one using space division and two time division. Although the potential of the time-division system was considered to be very high and research on this type of equipment was actively continuing, it had been decided at the end of 1963 that the space-division system offered the best prospect for very early progress. It had, therefore, been decided to concentrate immediate development on the space-division system with a view to production in quantity. This step had been accompanied by a new look at the organisation as a result of which a Reed Electronics Systems Project Executive Board had been established under the chairmanship of Mr. D. A. Barron, CBE, the Deputy Engineer-in-Chief, with a project team under the management of Mr. J. A. Lawrence, staff engineer.

"Space-division development will run along several lines. One application is to be tried at a new exchange of about 3,000 lines at Leighton Buzzard which opens next year. A different but successful application to small exchanges, up to perhaps 2,000 lines, has been developed and trials of small units of this system are to be made at



A development engineer carries out initial tests on an element of a time-division electronic exchange.

*Described in *The Highgate Wood Story*, Spring, 1963.

Leamington and Peterborough exchanges later in 1964. Work is also proceeding on the application of a space division system to large exchanges, including director exchanges.

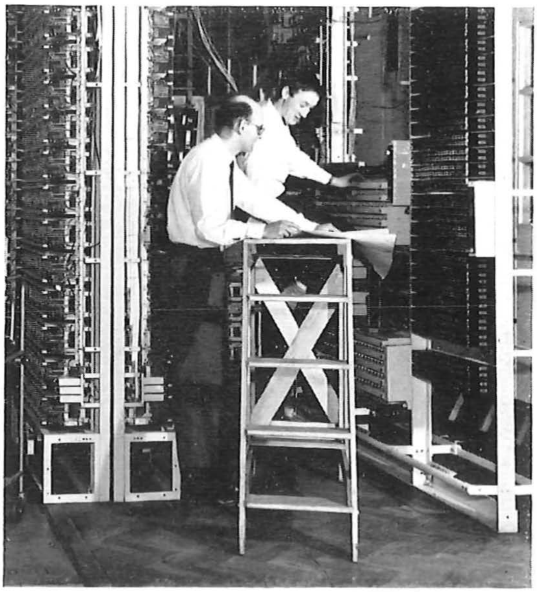
"Hanging over all this," continued Mr. Longley, "is the question of cost. There is the overriding issue of capital costs which ought to be comparable with the existing system to be acceptable, but which depend heavily on the economies resulting eventually from mass production and which can, therefore, only be estimated. There is the question of provision periods and extensibility of equipment performing different functions in an electronic exchange and the effect this might have on the burden of spare plant and therefore on costs. There is the possibility of lower running costs which cannot be measured without practical experience, and the other expected advantages which are mostly imponderable financially. They will have to be weighed in the balance before the firm decision to switch to electronic exchanges is taken.

"With the potential advantages which electronic exchanges offer, the possibility of an ultimate reduction in costs and the vital importance in the export field, one cannot help feeling that the sooner we get into this business the better," concluded Mr. Longley. "Other countries think the same. When the Highgate Wood electronic exchange was opened there were two experimental electronic exchanges abroad—one in the United States, the other in Munich. Since then an electronic exchange has been opened in Stuttgart, Germany. We also know of a handful of other experimental projccts in the United States, Germany, France, Japan, Holland and Sweden. Two of these use the time-division principle and the rest the space-division in a variety of forms. All these applications seem to be experimental so far and little or nothing is known about their costs.

"With this sort of background it is clear that a maximum effort is called for. This is just what is being put into the project in this country in a joint enterprise of unique proportions. The current effort compares favourably with the pace of previous major changes in the telephone system. The Strowger system was invented in 1889; the first public exchange of this type opened in this country in 1914; and the first standard exchange in 1927—a spread of 38 years. Although the relay system was invented in 1911, the first standard crossbar exchange was installed in the United States in 1948, although Sweden had some earlier than this. If, as we expect, we have some electronic exchanges in public service within ten years of the signing of the Joint Electronic Research Agreement it will be a creditable performance and will mark the beginning of a new and exciting era in telephone progress."

A view of one of the units of a time-division electronic exchange being wired.

Engineers make the initial tests on a rack of equipment for a time-division exchange.



A PABX WITHOUT A SWITCHBOARD!

By H. F. EDWARDS

A SMALL private automatic branch exchange has recently been introduced which is different from anything else in the Post Office range of private branch exchanges. It has no switchboard.

This may sound like Hamlet without the Prince of Denmark, but the answer is quite simple. All that has been done is to designate some of the extension telephones (that is, to provide the facility of answering incoming calls and breaking in on engaged extensions) so that their users do the work which an operator would normally carry out.

When automatic working came into use, it took a lot of work away from the operator and enabled extension users to dial one another; to dial public exchange numbers direct; and, on a PABX 1 (or PABX 4), to transfer exchange line calls from one to another. Apart from giving occasional assistance, the operator's sole remaining function is to answer incoming calls and connect callers to extensions. At a small installation of up to 20 extension telephones, the number of incoming calls is not enough to keep an operator busy but enough to interrupt her so frequently that she cannot do another job efficiently.

On the new PABX 5 the normal enquiry and transfer facility is so exploited that the last remaining function of the operator is performed by extension users. This has been done by eliminating the switchboard and, in place, making one or more specially fitted telephone bells ring on incoming exchange calls only; and by introducing an arrangement on those extensions that have been "designated" so that when the bells ring the incoming call is automatically connected to the first "designated" extension to have its receiver lifted in reply. Whoever answers the call can then transfer it to any other extension in the usual way. The new PABX enjoys one unusual facility which is normally available only to a switchboard operator. If the designated extension user receives engaged tone from an extension and if the incoming call is urgent, she can intrude into the conversation by dialling the digit 1, to say that there is a call waiting.

One advantage of having two or more telephones at which incoming exchange calls can be answered is that if Miss A is already answering one call when another comes along, or if she is adding up a column of figures, or otherwise occupied, she can afford to go on with that job knowing she is not the only one able to answer the call.

This is the new PABX 5 which has a capacity of 20 extensions and five outside lines. Another version caters for only ten extensions and three outside lines.

An incoming call has been answered on this designated extension and is being transferred to the required extension by pressing the button and then dialling.

The capacity of the new PABX is 20 extensions and 5 outside lines (exchange lines or lines to other PBXs). A smaller version caters for only 10 extensions and 3 outside lines. Any or all of the extensions can be "designated" but most subscribers will probably want to restrict the number to two or three. It is quite easy for the maintenance engineer to alter the arrangements whenever desired.

Although new to the Post Office, this new type of PABX, sometimes known as an "unattended" or "subscriber-attended" PABX, has been supplied by Ericsson Telephones Ltd. to the overseas market and for private communications in this country for some years. The PABX 5, which is modified to satisfy Post Office requirements, is only an interim model, however, and a PABX 6 incorporating improved facilities will later be introduced in its place.

ISD EXTENDED

INTERNATIONAL Subscriber Dialling, which was introduced in 1963 to enable London STD subscribers to dial their own calls to most subscribers in Paris, was extended on 23 April to subscribers in most towns throughout France and also to subscribers on most exchanges in Belgium and Switzerland.

Making the inaugural call to the Belgian Minister of Posts, Telegraphs and Telephones, Mr. Ray Mawby, the Assistant Postmaster General, said that the event was an important step forward in the Post Office's plan to provide facilities so that all subscribers in Britain could dial their own calls to subscribers in as many other countries as possible. The International Subscriber Dialling system had many advantages, the most important of which were that calls were connected more quickly and most calls were cheaper since subscribers paid only for the time they actually used.

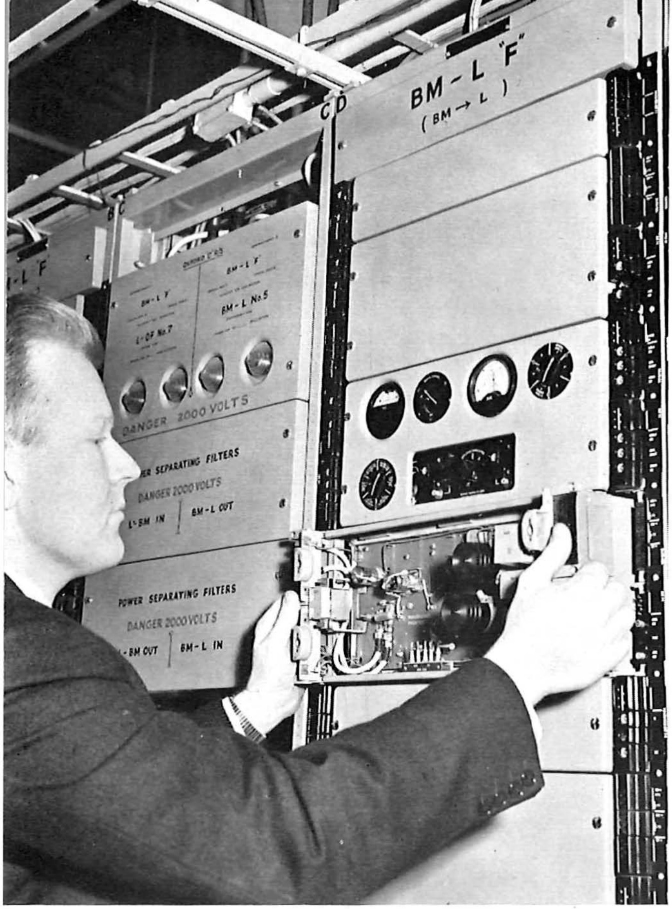
Mr. Mawby also announced that early in May this year the ISD system was due to be extended for London STD subscribers to subscribers on most exchanges in Western Germany and the Netherlands. When that stage was completed London's STD subscribers would be able to dial about nine-tenths of their calls themselves to the Continent of Europe.

By the end of 1964 it is hoped to bring STD subscribers in Birmingham, Edinburgh, Glasgow, Liverpool and Manchester into the system and early in 1965 to extend ISD to Sweden, Denmark, Austria and Italy, and possibly, later, to Norway and Finland.

CONGRATULATIONS

The *Journal* congratulates Mr. P. T. F. Kelly, Senior Executive Engineer in the Main Lines Development and Maintenance Branch of the Engineering Department, on winning a Nuffield Travelling Fellowship—the first member of the Post Office to do so and one of only two Civil Servants to receive the award this year.

Mr. Kelly, who will be producing a paper entitled *The Organisation of Long Distance Telecommunications Services and Related Problems: Sweden and Canada*, will spend about three months in Canada and four months in Sweden, travelling extensively in both countries. He is no stranger to either, however, having visited both before on official business.



All photographs illustrating this article were taken at the Oxford main repeater station.

◀ **Mr. M. D. Allsworth, an Oxford Area engineer, changes over one of the amplifiers.**

A new system has been brought into use on the London-Birmingham-Manchester trunk routes which now enables them to carry three times the normal number of speech channels. The Post Office plans to extend the system to other routes

By L. P. LAFOSSE

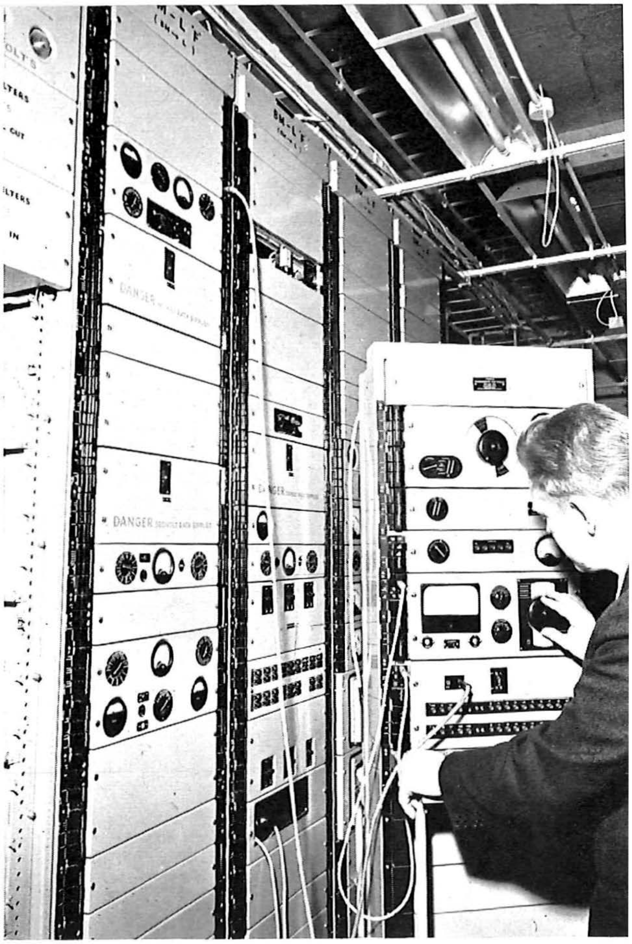
NEW EQUIPMENT TREBLES THE SPEECH CHANNELS

NEW equipment has been brought into service on the London to Birmingham and Birmingham to Manchester trunk telephony routes which, at one step, trebles the number of speech channels these systems can carry.

Until recently, coaxial systems on these routes have had a capacity of only 960 speech channels. Now, with the new equipment, they can accommodate up to 2,700 channels.

The new system got under way in 1960, when, to cater for the expected growth of trunk traffic, the Post Office decided to equip the last remaining pair of 3/8th-inch diameter coaxial tubes between London, Birmingham and Manchester with new 12 megacycle line and terminal translating equipment to provide—for the first time in this country—a system of three 4 Mc/s broadbands.

A speech channel normally occupies a 4,000 cycle bandwidth and 960 of them can be contained in a 4 Mc/s bandwidth. A 4 Mc/s line bandwidth capable of transmitting 960 speech channels has been standardised internationally for some years and many such systems have long been in operation in Britain. The method of assembly is to combine 12 speech circuits to form a group, five such groups making up a supergroup of 60 circuits and 16 supergroups forming a



The level of the system is measured with the aid of trolley-mounted equipment.

hypergroup of 960 circuits.

Under the new 12 Mc/s system the number of supergroups in a hypergroup is, for technical reasons, reduced to 15. Three hypergroups are combined to fill the 12 Mc/s spectrum. The first hypergroup becomes Band I and is transmitted direct to line in the 0-4 Mc/s range. The second and third hypergroups are translated into the 4-8 Mc/s portion of the spectrum (Band II) and the 8-12 Mc/s portion (Band III) respectively.

Similar equipment which reverses the assembly process is installed at the distant end of the line so that 2,700 speech channels are available between the terminal stations. In practice, many channels are retained in the form of a group, a supergroup or even a hypergroup and extended over other line links before regaining their identity as speech channels.

The new 12 Mc/s line links between London and Birmingham and Birmingham and Manchester were completed before fully engineered equipment for translating hypergroups into Bands II and III was available. However, by means of special equipment made by Standard Telephones & Cables Ltd. and capable of transmitting the 0-4 Mc/s band and of translating one hypergroup only into the 6-10 Mc/s band, two thirds of the line capacity, that is about 1,800 circuits, is now available to meet the urgent demands for more circuits.

Terminal equipment needed to exploit the whole of the bandwidth is expected to be ready for service in the late summer of 1964. This will entail the use of higher frequencies than those previously required and careful testing of the equipment since, at these frequencies, cross-talk is more difficult to avoid. This third broadband will also include the new translating equipment required to re-arrange the second broadband into its correct location in the frequency spectrum.

This new line system, known as Coaxial Equipment Line No. 8A uses the frequency range 300 kc/s to 12.5 Mc/s and special amplifying equipment is provided in small buildings at three-mile intervals along the whole route. On the London to Birmingham system there are 53 amplifying points and on the Birmingham to Manchester route 34.

Power is fed over the cable at 2,000 volts ac between the centre conductor of the two coaxial tubes which form the line system. Up to 13 amplifying stations can be fed from each terminal station and a similar number on each side from each intermediate power feeding station. If the cable power fails, each dependent station reverts automatically to local power supply, or reverse power feeding can be brought into operation by remote control.

Like other modern coaxial line systems, the new CEL 8A system automatically compensates the effects of cable and repeater temperature changes and ageing of the repeater equipment. Line temperature changes are detected by changes in the level of a pilot frequency of 4,287 kc/s, the power of which increases or decreases the temperature of a sensitive resistor (called a thermistor). The resistor controls the output of the repeater.

Two other line pilots—one of 308 kc/s, the other of 12,435 kc/s—are employed, which determine the auxiliary equalisation required to

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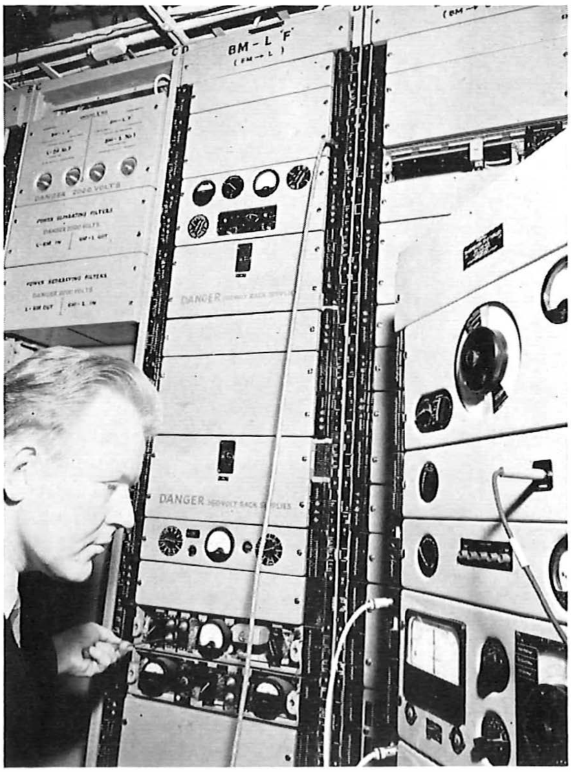
SPEECH CHANNELS (*Contd.*)

compensate for valve ageing, and the effects of changes in temperature in the repeater stations. These temperature changes have an important effect on the response of amplifiers used on the 12 Mc/s system.

Before the new system was installed a central depot was set up at the manufacturer's works in Woolwich where racks of equipment were assembled, adjusted and then tested under the supervision of Post Office engineers. The racks were then dismantled, packed and transported to the trunk route where they were re-assembled and installed at each individual station and re-tested.

A four-wire telephone circuit, amplified at 12-mile intervals, is installed between the terminal repeater stations, using interstitial pairs in the coaxial cable. All intermediate repeater stations thus have access to the circuit and are able to speak in either direction. Alarms from each station are also extended over interstitial pairs in the coaxial cable to the terminal stations so that faults in power supplies or transmission equipment may be indicated.



THE new 12 Mc/s line system will play a vital part in the Post Office plan to cater for the ever-increasing demand for trunk service.

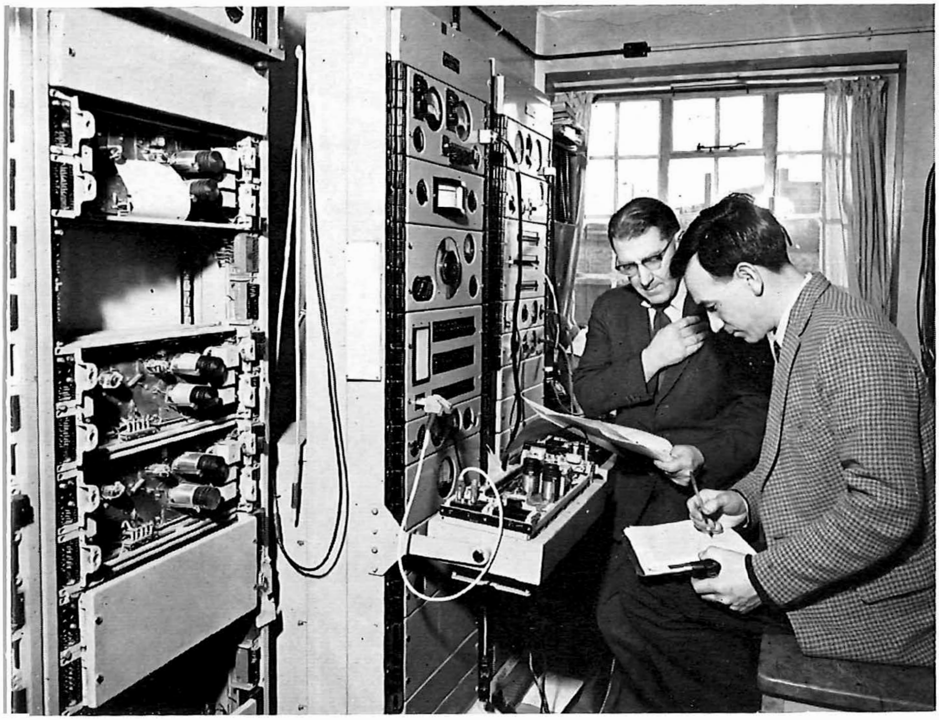
Its obvious advantages lie in the fact that many more trunk circuits can now be provided without laying additional long-distance underground cables since only the line terminal equipment need be changed and new repeater stations and line equipment installed along the route of existing coaxial cables.

New radio links are also being brought into service as quickly as possible, each capable of carrying many more circuits than earlier systems.

The line up of the system is achieved by measuring the pilot levels. The cable temperature of the first repeater section to be installed is calculated from the measured resistance of the looped centre conductors of a spare pair of tubes or a calibrated spare interstitial pair if spare tubes are not available. The estimated section loss at each of the three pilot frequencies is then calculated from the cable temperature, section mileage and nominal cable loss at 10 degrees Centigrade.

The system is then energised, the levels at the terminal transmit bay are set to a pre-determined figure and the levels of the three pilots at the first intermediate station are measured. From the calculated loss of the first section, the levels measured at the amplifier output of the transmit bay, and the intermediate station bay gain, the expected level is determined for each pilot frequency at the amplifier output of the first intermediate station. The difference between the measured and calculated levels is investigated if it exceeds 0.5 db. This process continues until all the repeater sections have been tested. The variation of cable attenuation with frequency is equalised by using line amplifiers with a gain shaped to compensate for the cable loss at all frequencies. Inevitably, however, small discrepancies accumulate in the overall gain frequency response and these are corrected by adding small line equalisers, individually designed and constructed to suit the system, at the terminal and power feeding stations.

Mr. Allsworth adjusts the pilot regulator.



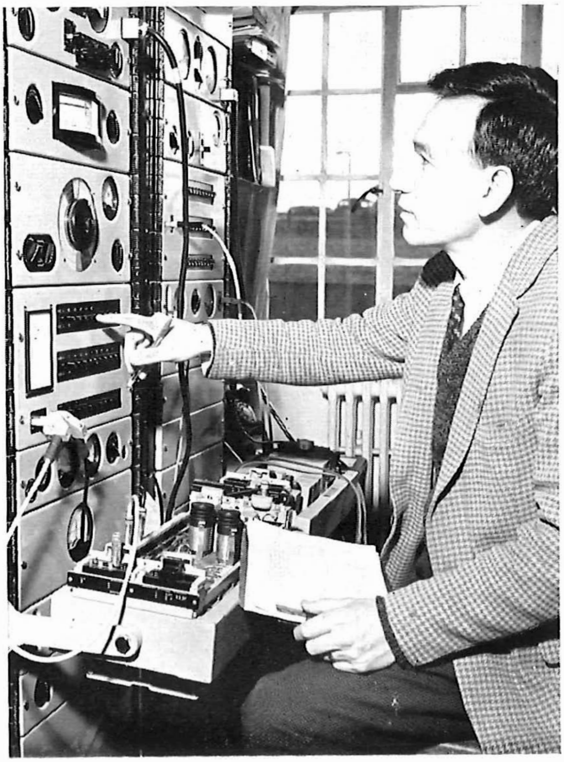
Two Oxford Area engineers discuss the results after testing the amplifiers. In the bay on the left the amplifiers undergo a "warming up" period.

Later, crosstalk, harmonics, inter-modulation, interference, basic noise, power modulation and overload are measured under minimum and maximum load conditions.

Finally, the gain stability of the system is checked in each direction of transmission by pilot recorders which are an integral part of the terminal equipment. The system is not put into service until the recorder traces have shown no changes in insertion gain exceeding 0.25 db in any period of 24 hours for 14 days or more than 0.5 db over the whole period.

While the line system and associated terminal equipment is being tested and installed the standard equipment which translates the 4 Mc/s broadbands to the required supergroups, groups, or individual channels is also being installed and tested.

Mr. L. A. Kingsley is seen measuring the characteristics of the high frequency amplifier. ▶



THE AUTHOR

Mr. L. P. LAFOSSE is a Senior Executive Engineer in the Main Lines Planning and Provision Branch of the Engineering Department. He has been concerned with the planning of the Post Office network of trunk cables and equipment for many years. Mr. Lafosse joined the Engineering Department in 1921 as a Youth-in-Training in the Test and Inspection Branch and transferred to the Engineer-in-Chief's Office (Lines Branch) in 1934.

This article, the first of a series on interesting telephone areas and exchanges, tells the story of the oldest automatic exchange in the country which is soon to be replaced by a modern STD exchange

BLACKBURN:

THE OLDEST AUTOMATIC EXCHANGE

By J. H. BONNARD

The Blackburn Head Post Office which houses the 48-year-old automatic exchange and plant.

MOST people know of Blackburn's early associations with the cotton industry and some that it was the birthplace of James Hargreaves, who invented the Spinning Jenny.

Not so many know, however, that Blackburn and its neighbouring town of Accrington, are closely linked with the early introduction of automatic telephony in Britain. Indeed, the town has some very early connections with the development of the service under the National Telephone Company. Mr. W. E. L. Gaine, Town Clerk of Blackburn from 1875 to 1892, left his municipal post to become General Manager of the company, and another leading townsman, Eli Heyworth, became Chairman of the Executive.

The original automatic exchange at nearby Accrington, which shares a linked numbering scheme with Blackburn, was opened in 1914. After a working life of 46 years, it was replaced in 1960. The present Blackburn automatic exchange was installed in 1916, and the original Keith Line Switch equipment is still in use. It will remain in service until the late summer of 1964, when it will be replaced after a life of 48 years. This exchange, one of the most "off-loaded" in the country, is now the oldest public automatic exchange in Britain and the last survivor of the Keith Line Switch system.

Blackburn exchange was opened on 14 October, 1916, with a capacity of 2,200 multiple. The Clerk of Works at the time, Mr. H. G. Thornley, who retired from the Post Office in 1953 and still lives in Blackburn, recollects having consultations with Mr. B. O. Anson, the then Assistant Engineer-in-Chief, during the latter's many visits to Blackburn when installation work was in progress.

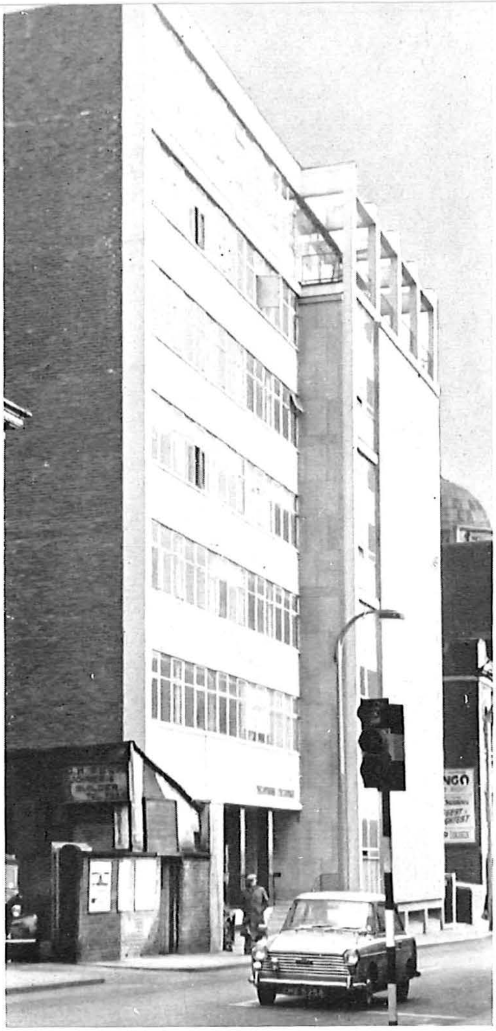
The exchange and associated automanual switchboard are housed in the Head Post Office building. The first point of interest which strikes a visitor is the topsy-turvy use of the floors in the three-storey building compared with modern practice. The Post Office counter is on the ground floor, the automanual switchroom on the first floor and the heavy automatic plant, generators, batteries and the main distribution frame are on the top floor. The underground cables have to rise to the top floor and they do this in a 50ft high column, through a shaft in the centre of the building, to feed into the tops of the MDF verticals.

The cables convert from paper to silk and wool insulation in the cable chamber and then rise to the top storey as a densely-packed group of about 40 lead covered cables, ranging in size up to 1,400 pr/ 6½ lb. The column represents a dead weight of over six tons, but the problems of weight distribution and, to some extent, creepage, are alleviated by the incorporation of a supported "S" bend at the halfway mark. Since these cables were added to over the years the strain proved too much for the cables and the prefabricated steel racking upon which they stood at the "S" bend. It became necessary, therefore, in 1957, to erect a massive new 8ins by 6ins "H" section girder construction at the halfway mark to prevent the cables from stretching and creeping any farther. A huge block of solder measuring 24ins by 15ins by 12ins was sweated on to the cables at this point so that the column became one solid whole which was clamped to the girders. Since then, the downward creepage has been restricted to about an inch in six years. The attenuation of years, however, has done some damage to the cables and a few conductors have broken and been abandoned. An emergency plan involving the running of interruption cables from the basement to the top storey up the main staircase has been prepared in case the cables suffer further serious damage.

Every usable area of floor space in the automatic plant room has been utilised to maximum advantage. Parts of racks have been pressed into use for odd pieces of equipment, such as 25 coin-box uniselectors tucked neatly away at the bottom of some shelves of final selectors. Gangways between racks of equipment are only 22ins wide in some places, which makes maintenance and adjustment a difficult and uncomfortable undertaking. Most of the equipment in the room has no individual covers, since the Keith Line switches and vertical relay selectors are mounted in glass cabinets with sliding doors.

The KLS equipment is unique in design and

OVER

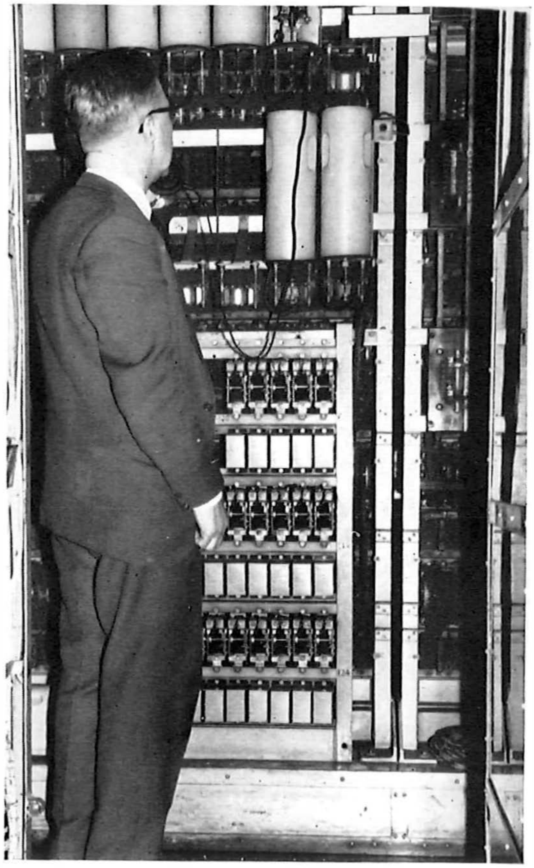


THE NEW EXCHANGE

When the old Blackburn Exchange connects its last call and closes down on 30 July this year it will be replaced by a modern 9,600 multiple STD exchange which is now being installed.

The new exchange building (*see photograph above*) close by the Head Post Office, is a handsome five-storey structure built in contemporary style. It is of brick and concrete construction, decorated with blue panels, and has a superstructure clad in blue tiles to match. A wing built on the mezzanine principle provides office accommodation on seven floors. The side of the new building nearest Blackburn Cathedral has been faced with stone slabs to harmonise with the stone of the Cathedral.

Young engineers examine the overhead feed of the underground cables into the main distribution frame verticals. These cables rise to a height of 50 feet.



No wasted space here. In the bottom of a final selector rack are 25 coin-box uniselectors.

BLACKBURN *(Contd.)*

operation. Each primary unit functions as a giant, ten-outlet, common-user uniselector for 50 calling equipments. These outlets give access to secondary KLS equipment which, in turn, gives access to vertical relay group selectors. On the primary KLSs, the calling equipments are mounted in pairs, one above the other. Viewing the line switch unit from top to bottom, there are 25 calling equipments in pairs (except for the odd one, of course), the master switch or drive mechanism and then 25 more calling equipments. All this equipment occupies a space only 4ft 6ins high by 1ft wide.

The KLS is also unique in operation, selecting the next free outlet as soon as it has routed the previous call so that it is always standing on a free outlet, except when there is congestion. Under congestion conditions it will continue to search after the last call until a free outlet is found for the next, even though the next call it handles may not have been originated.

Each calling equipment consists of a line relay, a battery cut-off relay with inner and outer armatures, fantail and plunger, and a ten-outlet bank. The normal "at rest" position of each fantail and plunger is in engagement, by means of a keyhole slot, with the vertical drive shaft of each unit of 50 calling equipments. The drive shaft, which is nearly 4ft 6ins long, is driven by the master switch so that when hunting takes place it weaves to and fro in a horizontal plane at the rate of two double sweeps a second. All disengaged fantails and plungers in contact with the shaft move to and fro in front of the banks, but not in contact with

Technical Officer C. S. Thornton adjusts the vertical relay selectors which are accommodated in a large glass-fronted cabinet in the plant room.

them, until a free outlet is found.

When a call is made, both armatures of the subscriber's battery cut-off relay operate, thereby driving the fantail and plunger forward into the bank. At the end of the plunger are two small vulcanite rollers which operate a pair of very fine contacts in the bank and these, in turn, connect the subscriber to the chosen outlet. This particular fantail is now disengaged from the drive shaft and is not interfered with when the KLS moves on to the next free outlet.

On incoming calls, only the inner armature of the battery cut-off relay operates, cutting off the line relay so that the incoming call can be received. The inner armature does not move the fantail and plunger, since these are connected to the outer armature only.

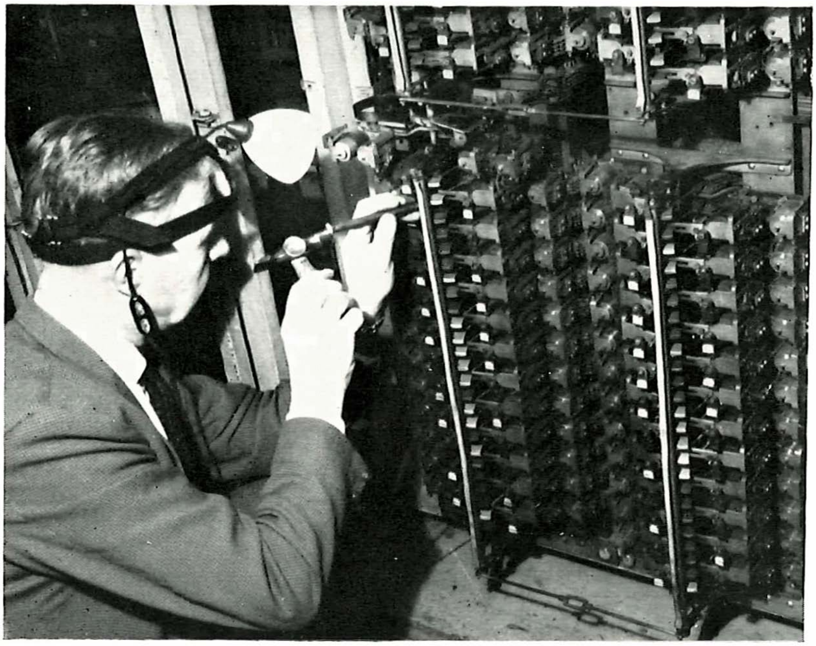
The master switch employs an interesting form of electro-mechanical drive which is supplied by interaction between an $\frac{11}{16}$ins-bore solenoid and a large horseshoe spring. The exact positioning of the fantails and plungers when they plunge into the bank is achieved by the operation of a spring-loaded arm moving into a toothed quadrant when a free outlet is found. This locks the position of the switch and further refined positioning of the plunger is carried out by guiding teeth in the banks which steer the pointed tip of the plunger. A master switch normally serves two groups of 25 calling equipments. Where there is a low calling rate, however, four groups of 25 calling equipments can be twinned together under one master switch drive by means of adjustable connecting rods.

The KLS system is prone to double trunking and conditions can arise where two or more plungers enter the same choice when two or more receivers are taken off at the same time. Since the system involves considerable mechanical movement many adjustments have to be carried out, some in an unusual way. For example, when individual line switches and banks have to be adjusted the approved method is to do it with a hammer and drift, colloquially called the " 'ammer and 'ickey". On rare occasions when serious and prolonged congestion occurs, the blower end of the exchange vacuum cleaner is directed on to the drive mechanism solenoid to prevent piston seizure which might result from overheating. If piston seizure occurred 50 subscribers would become locked on to one outlet which could be an engaged one.

Another legacy from a bygone age is the vertical relay two-motion selectors which occupy considerable shelf space with the overhanging relays. It is difficult to understand why this method of mounting relays commended itself in the first place. One old switch equipped with a side switch is retained in the exchange as a curiosity. This is virtually a small selector within a selector and consists of mechanically-driven wipers which pass over a three-contact bank. Its function was to transfer the battery feed from vertical to rotary to release the magnet.

About 70 per cent of the equipment in the Blackburn exchange is of the types which have been described. The remainder is a mixture of equipment from various periods which has been installed over the years.

OVER



Leading Technical Officer H. C. Webb adjusts the position of a Keith Line Switch calling equipment in relation to its bank by the method known as the " 'ammer and 'ickey." The master switch, on the right of the headlamp, serves two units of 50 calling equipments by means of adjustable twinning connecting rods.

BLACKBURN *(Concluded)*

Maintenance is difficult since no KLS equipment has been manufactured in Britain for many years. Metal fatigue and wear take their toll and Blackburn has had to be kept going by cannibalisation from recovered equipment. Pieces of equipment from old exchanges in many other areas, including Leeds, Newport, Chepstow, Portsmouth and Accrington, are still working at Blackburn. Some of the equipment has even come from the United States. To have kept a busy exchange working under these conditions reflects enormous credit upon the local maintenance engineers.

The present number of connections on Blackburn is about 4,200. There is a bar against connecting any more lines on traffic-carrying capacity grounds. There is also a bar against installing any more equipment because of building congestion and for safety reasons. How then are the rest of Blackburn's 7,200 customers served?

In 1950, when it became apparent that some form of relief would have to be provided, a relief exchange was opened about 400 yards from the main exchange. This is Blakewater, named after a local stream, and it consists of 30 sleeve-control trunk subscriber positions modified to include a manual type of multiple and answering field. Connected to it are the original 1,400 manual relief subscribers' equipments installed in 1950. In 1956, the capacity of Blakewater was increased by providing 2,000 multiple, comprising semi-auto equipments. Besides saving space on the manual switchboard, the semi-auto equipment obviated the considerable cost of providing 2,000 manual multiple and calling equipments. Under the semi-auto system, subscribers make outgoing calls to the switchboard by way of group and final selectors.

The Blakewater exchange shares the same underground network with Blackburn, so that it is possible to have Blackburn subscribers working on KLS or uniselectors in the same street as Blakewater subscribers working on manual or semi-auto equipments. According to the type of equipment in use, Blakewater subscribers receive either manual style ringing or auto ringing. There are no coin-box connections on Blakewater and PBXs, doctors and taxi firms lines are, as far as possible, kept on the Blackburn automatic exchange.

Until fairly recently, Blakewater exchange functioned as the trunk control centre for the Blackburn Group and Blackburn acted as the toll exchange. Very roughly, Blackburn automatic switchboard controlled all calls up to 50 miles radial distance, and Blakewater controlled all calls over that distance. Shortage of positions has necessitated heavy off loading arrangements, however, and the control of most trunk calls has now been switched to Manchester/Cathedral. Blackburn Area directories still carry a list of exchanges up to 50 miles distance for which "100" should be dialled and all other trunk calls are made via level "98".

The Blackburn automatic switchboard which was installed in the early 1930s for the introduction of trunk demand working, consists of 36 6ft 4½ins positions located in a glazed brick switchroom. There is no room to install any more positions but a small contribution to off loading the main switchboard has been made by transferring the service PBX onto spare EQ positions.

It has been apparent for some time that the combined positions of the Blackburn and Blakewater exchanges would be insufficient to last until the introduction of a new exchange this summer. Meanwhile, the control of all traffic which it is possible to move out of Blackburn town has been transferred to Manchester/Cathedral, 25 miles away, where there is spare position capacity. The remaining operator-controlled traffic has been shared as equally as possible between Blackburn and Blakewater exchanges.

The late Kathleen Ferrier, the world-famous singer, worked at the Blackburn exchange as a telephonist. The Blackburn exchange also produced Pamela Walker, the 17-year-old telephonist who was voted the 1962 Interflora Personality Girl.

THE AUTHOR

Mr. J. H. BONNARD is a Senior Telecommunications Superintendent in the Traffic Division of the Blackburn Telephone Area where he has been particularly concerned with the design and staffing problems associated with the new Blackburn ATE. He joined the Post Office in 1934 as a Youth-in-Training in the York Area and was promoted to Assistant Traffic Superintendent in 1940. During World War Two he was Landlines Officer to Royal Air Force Transport Command. Mr. Bonnard has also served in the Lincoln and Belfast Telephone Areas.

A NEW TV NETWORK FOR MALAYA

Microwave radio equipment made in Britain is being used to link television studios and transmitters in Singapore, Kuala Lumpur and Ipoh over a route of 300 miles.

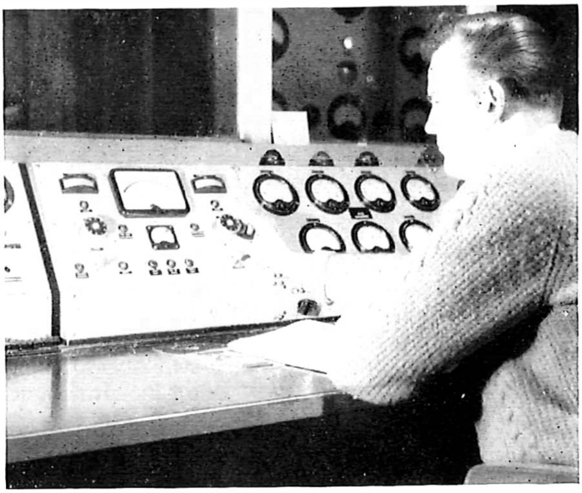
When the route is completed the new system will extend the television service, which is at present limited to the Singapore and Kuala Lumpur local areas, to form a complete network along Malaya's western coast.

Big savings in the cost of the new links have been made possible by the use of aerial towers and buildings along the route of the £1 million microwave long-distance telephone network which was built by Standard Telephones and Cables Ltd. in 1958–60.

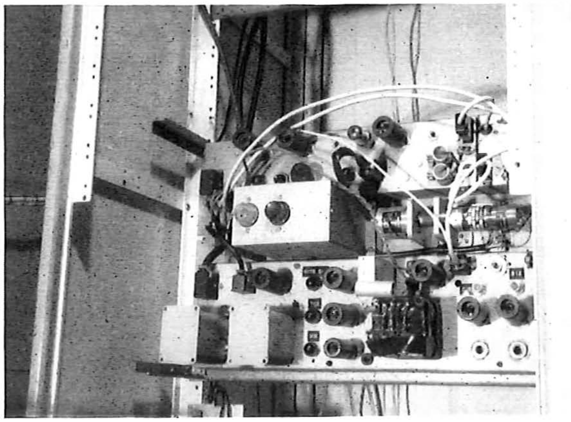
The new equipment, which is being provided by ST and C, will operate in the 4,000 Mc/s band and is designed to handle standard 625-line picture signals in black and white or in colour. It is being manufactured mainly at the Company's North Woolwich and St. Mary Cray plants. A number of the key microwave components and waveguides are being made at ST and C's new factory at East Kilbride, Scotland.

Some of the telephonists at Blackburn. Left to right: Mrs. Dilys Vallett, Miss Vivien Green and Miss Sheila Abbott at work on the switchboard.

A NEW AUTOMATIC TUNER AT RUGBY



Above: The automatic tuner control panel and (below) the new phase control unit.



A NEW tuning system has been installed at Rugby Radio Station which automatically keeps the main aerial coils on tune and transmissions at a constantly satisfactory level even during the worst weather.

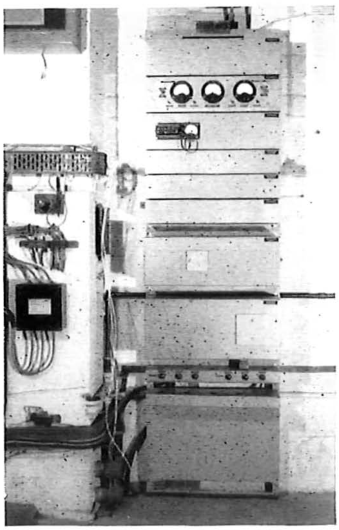
For nearly 40 years Rugby Radio Station has been carrying morse telegraph traffic to all parts of the world and four times every day it transmits the precise time signals which are used to compare the international frequency standards.

Since a station with this kind of world coverage must have extensive aerial systems the Very Low Frequency transmitter at Rugby has twelve 820ft high masts spaced at quarter-mile intervals. This means that the electrical characteristics of the aerial system are easily adversely affected by bad weather, high winds, humidity and temperature changes causing detuning of the aerial circuit.

In the past, a manually-operated tuner has had to be used to correct the effects of the weather but this has been entirely satisfactory only for fairly long-term adjustments. The immediate adjustment necessary to compensate for squalls, for example, could not readily be made by this method and in any case it was difficult to make adjustments while the aerials were carrying traffic.

The new system uses a servo-driven tuner and is controlled by the strength of the transmitted signal. As the signal varies during bad weather the automatic tuner makes the necessary adjustment very quickly.

This development will be of great value to scientists all over the world who use crystal controlled time signals and will greatly simplify the operation of the transmitter.



The automatic and remote control equipment for the variometers.

A PEEP INTO THE FUTURE

IN the coming year the number of trunk telephone circuits will be substantially increased; another 380,000 lines will be added to the local cable network; the waiting list will be reduced and virtually abolished by March, 1966; a start is planned on buildings for 150 new automatic telephone exchanges and repeater stations and for 20 engineering centres and workshops; international subscriber dialling will be extended to include a number of provincial cities in Britain and more European countries; the telecommunications services are expected to show a profit of £36 million in 1964-65.

These are the highlights recorded in the White Paper "Post Office Prospects, 1964-65" which was presented to Parliament on 13 March.

"Telephone and telex traffic, both inland and overseas, continues to grow rapidly", says the White Paper. "In the inland service, telephone trunk calls are growing at more than 14 per cent a year and telex traffic by about 25 per cent . . . These rates of growth are expected to continue in 1964-65".

The number of local calls, the White Paper goes on, has increased by about 7 per cent above the level of the previous year and a similar growth is expected in the coming year. In the overseas service, telephone and telex traffic is growing at more than 15 per cent a year.

Continuing automation of the telecommunications services which produced a reduction in 1963-64 of about 1,000 in the number of exchange operating staff, is expected to result in a further reduction in 1964-65. The very large new construction programme and the growing maintenance requirements, however, needed an increase in engineering staff of over 6,000 in 1963-64 and this figure would be increased by at least another 5,000 in the coming year.

Telephone service would be brought to about 660,000 applicants in 1964-65—210,000 of them business subscribers and 450,000 residential subscribers. By March, 1965, the total number of connections is expected to be 5,834,000 and the total number of telephones, including extensions, over nine and three-quarter millions.

Another 100 manual exchanges are expected to be converted to automatic working in the coming year at the end of which automatic service should be available to 92 per cent of subscribers. By March, 1965, more than half the country's subscribers will have STD facilities.

Development work on electronic exchanges will continue and the Post Office and the telecommunications industry will concentrate most of their immediate efforts on the development and engineering of what is known as the space-division principle. Equipment of this type will be tried out in public service at Leamington and Peterborough exchanges later in 1964.

International Subscriber Dialling, introduced between London and Paris in 1963, and since extended to almost the whole of France to Belgium and Switzerland will soon be further extended to Western Germany and the Netherlands. Later in 1964 similar dialling service to these countries will be given to subscribers in Birmingham, Edinburgh, Glasgow, Liverpool and Manchester.

The overseas telegraph service will be further mechanised and the telex service will be extended to Gibraltar, Jamaica, Paraguay, Ecuador, Uruguay, Bolivia, Egypt and Burma. Subscriber dialling to correspondents in the United States will also be introduced.

The first direct cable between Britain and Denmark will be brought into service in October, 1964, and a second direct cable to Germany and another to the Netherlands will be laid. The sections of the Commonwealth South-East Asia cable (SEACOM), which will link Singapore with Sabah, and Sabah with Hong Kong will be completed before the end of 1964.

"Research and development work on the electronic equipment required for satellite communications is proceeding and there will be further development of the ground station at Goonhilly Downs", concludes the White Paper. "The Post Office is taking part in the international discussions now in progress which, it is hoped, will lead to the establishment of a global system of satellite communications".

★

Remote Control

Monitoring centres are being installed on the 3,000-mile trans-Canada microwave system which will enable all the 127 relay stations to be operated by remote control.

Automatic interrogation signals will be sent to each relay station in turn over telephone cable or radio circuits. Each station will then reply, giving its general state of efficiency and detailed information on 12 operating conditions. If the station is faulty in any respect a red warning light will glow at the monitoring centre. Most faults will be automatically corrected, the monitoring station sending signals to switch in duplicate equipment. Emergency standby units will be available to take over automatically if there is a power failure.

The new microwave network, which was described in the Winter, 1963, issue, is due to become operational in May.

OVER

HELPING THE HANDICAPPED

IN the Winter, 1963, issue of the *Journal* Mr. R. G. Fidler told how the Post Office is helping handicapped people to dial and receive their own telephone calls and, in particular, described an instrument known as the Patient Operated Selector Mechanism (POSM).

We are now informed that a device similar to POSM was designed and built by Mr. F. M. Holmes, of the Post Office Headquarters Staff in Scotland, as long ago as 1960, entirely independent of the work then being carried out at the Stoke Mandeville Hospital.

The device was provided for ex-RAF pilot Ian Anderson, of Durham Avenue, Portobello, who is almost totally paralysed and completely blind. In addition to the telephone facility, Mr. Holmes' equipment enables Mr. Anderson to switch on and off a call bell, the radio, a radiogram (including record changing), and an electric fire. An audible signal indicates whether the fire has been switched on or off. The equipment could provide a total of 12 separate facilities and at present a loudspeaking inter-communication system to the front door and an electrically-operated door lock are being installed.

A similar installation was also provided for Miss Elma Alexander, of Pitkierie Nurseries, Anstruther in April, 1963, which, in addition, allows her to use facilities for lighting and television. A feature of its design is the extreme simplicity and reliability. Both installations have given faultless service.

The Royal Institute of Chemistry and Fife County Council respectively paid for the components for Mr. Anderson and Miss Alexander and the equipment was installed free by a number of individuals in their spare time.

Constructional details and diagrams of the equipment have been supplied to a number of other regions and it is understood that similar installations are in use throughout the country.

Mr. F. M. Holmes, who designed and built the device, helps Mr. Anderson to operate it.

How "Telecommunications" Was Born

THE word "telecommunications" is in common usage today. But very few people know from where it came and when it was first used.

According to the Peruvian Post Office magazine *Postelec*, the man who invented the word was Louis Marie Edouard Estaunié, novelist and one-time Inspector General of the French Posts, Telegraphs and Telephones.

In the preface to his book *Practical Treatise on Electrical Telecommunications* which was first published in 1904, M. Estaunié says of his invention of the word telecommunications: "*Because of the need to put an end to generalisation, I have been obliged to add a new word to a vocabulary already rich enough for the taste of many scholars. I trust I will be forgiven. New words burgeon in the new scheme of things rather like flowers in Spring. We must resign ourselves to this, taking comfort in the fact that when the summer comes poor shoots will perish.*"

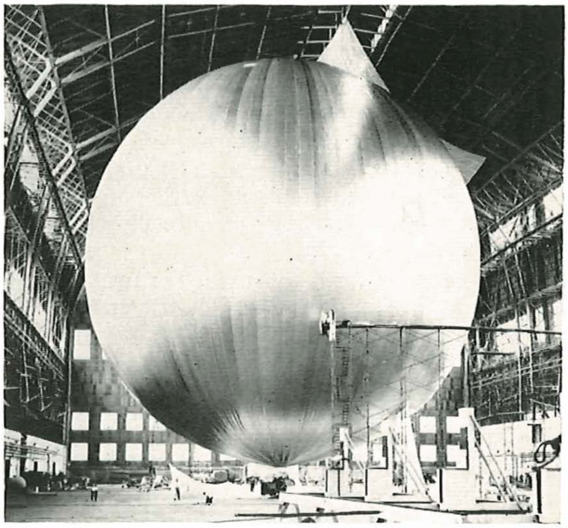
M. Estaunié's new word was no poor shoot. It flourished and in 1932 received official blessing when a conference in Madrid re-named the Telegraph Union the International Telecommunication Union.

UK - 2 and ECHO II

BRITAIN'S second scientific satellite—the 150lb UK-2—which was launched from the United States on 3 April has sent back to earth a mass of information on its observations in space. The data signals are being sent from a number of receiving stations throughout the world to a collection centre at Slough, in Buckinghamshire, where they are fed into data translating equipment and subsequently into a computer at Aldermaston's atomic weapon research establishment.

*

The first live television pictures from Japan were relayed by way of the satellite Telstar II *and transmitted over the Eurovision network on* 16 *April.*



Echo II, the passive communications satellite, undergoes inflation tests before being launched from California at the end of January. Echo II is 135 feet in diameter.

Telecommunications Statistics

	Quarter ended 31 *Dec,* 1962	*Quarter ended* 30 *Sept,* 1963	**Quarter ended 31 Dec, 1963**
Telegraph Service			
Inland telegrams (excluding Press and Railway)	2,883,000	2,695,000	**2,347,000**
Greetings telegrams	741,000	757,000	**628,000**
Overseas telegrams:			
Originating UK messages	1,606,000	1,646,000	**1,663,000**
Terminating UK messages	1,620,000	1,669,000	**1,665,000**
Transit messages	1,342,000	1,264,000	**1,346,000**
Telephone Service			
Inland			
Gross demand	125,000	155,000	**165,000**
Connections supplied	108,000	129,000	**150,000**
Outstanding applications	149,000	174,000	**167,000**
Total working connections	5,311,000	5,457,000	**5,532,000**
Shared service connections	1,101,000	1,097,000	**1,102,000**
Total inland trunk calls	138,730,000	155,864,000	**158,261,000**
Cheap rate trunk calls	30,529,000	37,295,000	**33,638,000**
Overseas			
European: Outward	991,000	1,161,000	**1,178,000**
Inward	*944,000	*1,034,000	***1,124,000**
Transit	*10,000	*11,000	***13,000**
Extra-European: Outward	94,000	92,000	**108,000**
Inward	*117,000	*115,000	***135,000**
Transit	*16,000	*17,000	***8,000**
Telex Service			
Inland			
Total working lines	10,000	11,000	**12,000**
Metered units	26,494,000	27,637,000	**31,555,000**
Manual calls from automatic exchanges (Assistance and Multelex)	3,000	3,000	**3,000**
Calls to Irish Republic	22,000	27,000	**26,000**
Overseas			
Originating (UK and Irish Republic) ...	1,439,000	1,692,000	**1,854,000**

Figures to nearest thousand. * Includes estimated element.

A NEW CABLE SHIP

A NEW cable repair ship owned by Cable and Wireless Ltd was launched at Birkenhead on 28 February.

She is the *Cable Enterprise* (4,300 tons), which is designed to operate in all weathers from Arctic cold to tropical heat and will normally carry up to 100 officers and men.

Cable Enterprise is constructed of steel throughout and is driven by diesel-electric engines. She will be able to handle cable over bows or stern and is fully equipped to carry out repairs to all types of deep-sea cable, including coaxial cable with submerged repeaters. She will be able to stay at sea for six weeks at a time and steam 6,000 miles at up to 15 knots without entering port for fuel or stores. All accommodation spaces, including cabins, the hospital, officers' dining saloon and lounge, mess rooms and recreation rooms, are fully air-conditioned.

The new ship, which will be commissioned this summer and operate in the Far East, will join Cable and Wireless Ltd's fleet of seven ships—the cable layer *Mercury* and six other repair ships. It is expected that she will be based at Singapore.

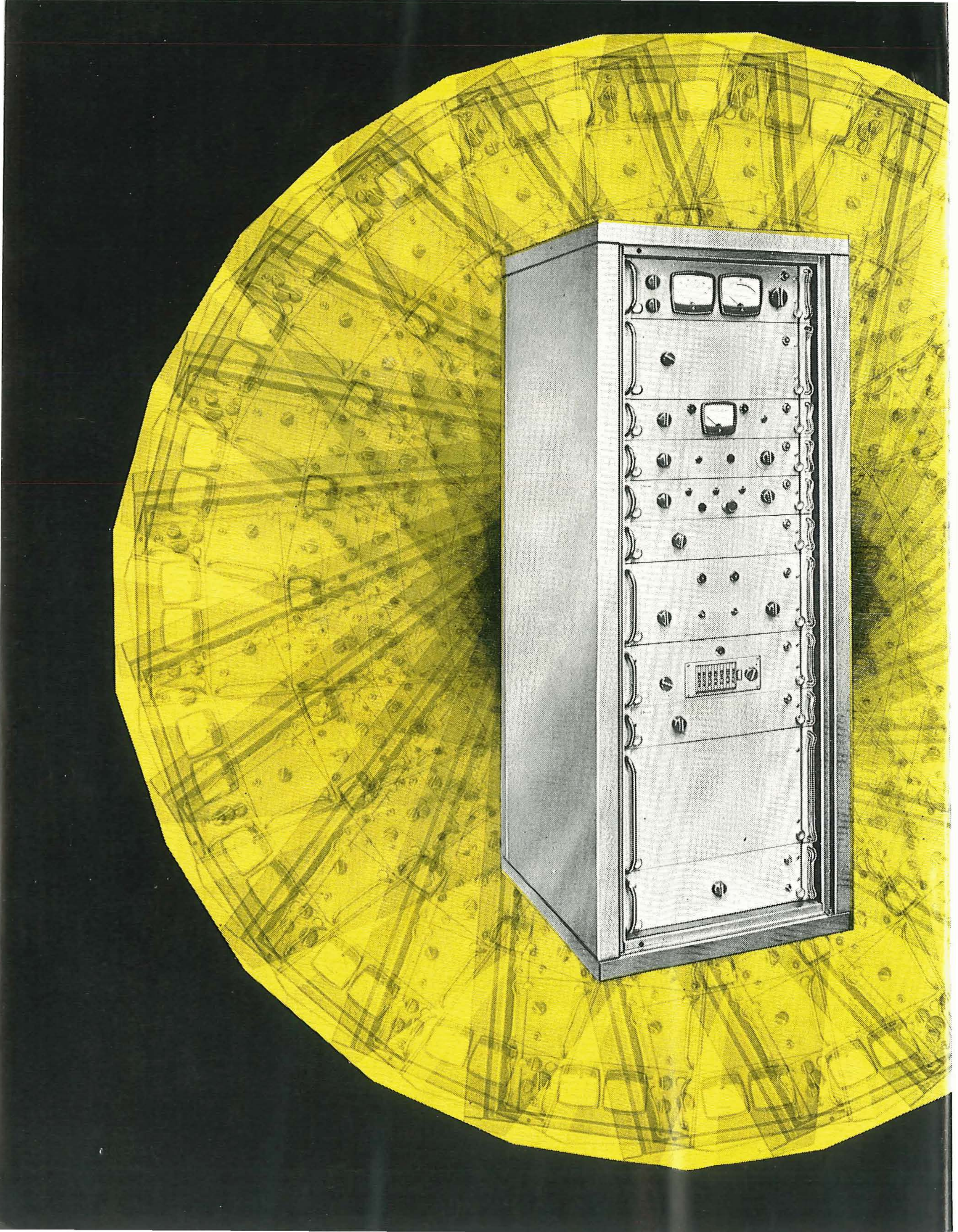
The scene at Birkenhead a few months before the *Cable Enterprise* was launched.

Publication and Price. The *Journal* is published in February, May, August and November, price 1/6. The annual postal subscription rate is 6/6 to any address at home or overseas.

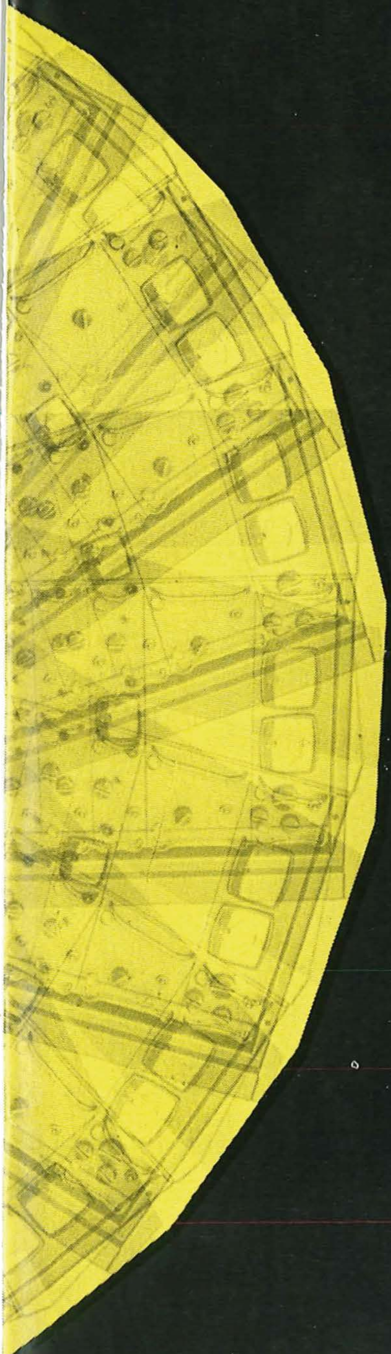
Contributions. The Editorial Board will be glad to consider articles of general interest within the telecommunications field. No guarantee of publication can be given. The ideal length of such articles would be 750, 1,500 or 2,000 words. The views of contributors are not necessarily those of the Board or of the Post Office.

Communications. Communications should be addressed to the Editor, Post Office Telecommunications Journal, Public Relations Department, GPO Headquarters, St. Martin's-le-Grand, LONDON, E.C.1. Telephone: HEAdquarters 4345. Remittances should be made payable to "The Postmaster General" and should be crossed "& Co."

GPO



Plessey UK



PVR 800 receiving system

A RANGE OF SIX BASIC RECEIVERS COVERING ALL TYPES OF RECEPTION OVER THE RANGE 3-27.5 Mc/s.

This all-transistor equipment provides a choice of six basic terminals which are arranged for the reception of Multitone telegraph, FSK, SSB, ISB, DSB.

1. Single path FSK reception
2. Dual diversity FSK reception
3. Single path SSB reception for speech or telegraphy
4. Dual diversity SSB reception for telegraphy
5. Single path ISB reception for speech or telegraphy
6. Dual diversity or twin path ISB reception for speech or telegraphy.

All the receivers have six pre-set crystal controlled channels in the frequency range 3 to 27.5 Mc/s. A synthesiser is also available.

MODULAR CONSTRUCTION Each receiver comprises units built up from transistor modules, standard modules being used throughout where practical.

ANCILLARY UNITS Optional ancillary units are available for all receivers. These include PG 331 Frequency Synthesiser, PV 419 Six-channel Synthesiser Memory, PV 332 Automatic Frequency Control. For multi-channel SSB or ISB Telegraph Service, the PV 182 Telegraph Demodulator and the PV 117 Synchronous Regenerative Repeaters are available either as separate units or built into the PVR 800.

STABLE PERFORMANCE The units in PVR 800 receivers are designed so that their performance is virtually independent of variations in component characteristics. Extensive use of negative feedback reduces spurious signal components, improves linearity, and ensures specified performance over a wide temperature range.

INTERCHANGEABLE UNITS In stations where more than one receiver is in use the modular construction of the PVR 800 brings valuable economies in maintenance, servicing and spare parts holding. Modules can be interchanged between units and equipments, and fault finding can be carried out on a substitution basis – by relatively unskilled personnel – cutting overheads and reducing 'off the air' time to a minimum.

For more details of this series of versatile HF Receiving Systems, write to:—

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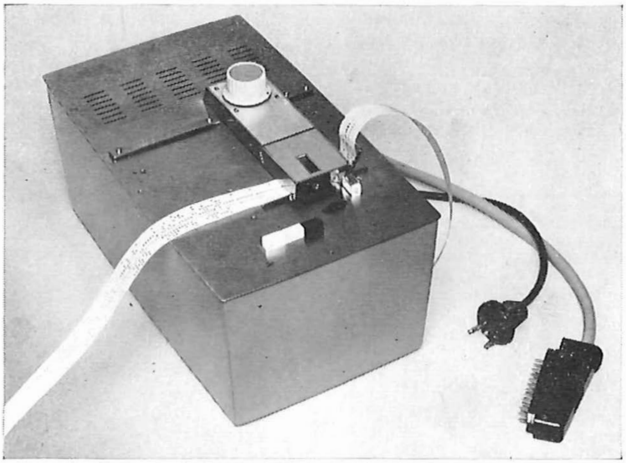
TD18a

Combined Tape and Edge Card Reader



MODEL 23

5, 6, 7, 8 unit reading of tape and edge card.

Tight tape, tape out, tape latch alarms.

Unlimited manual forward and back-spacing of tape and card.

Free standing or flush mounting in a desk unit.

Signal Contacts made for 95% of each reading cycle.

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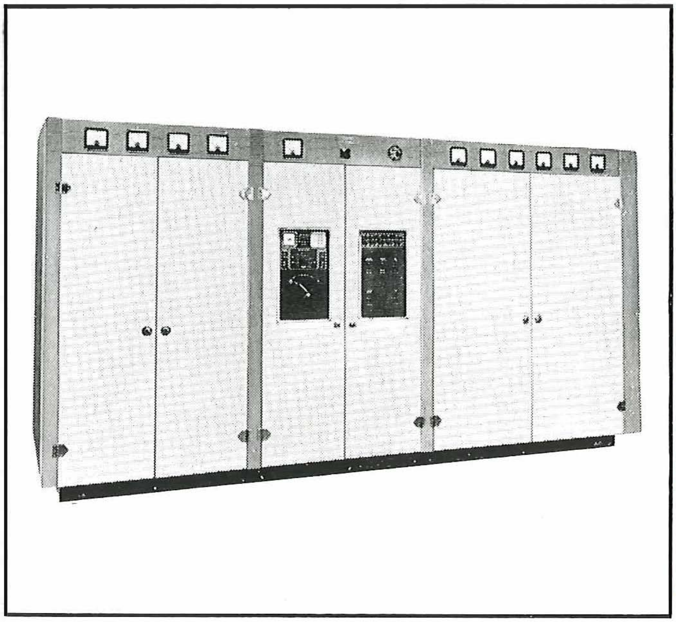

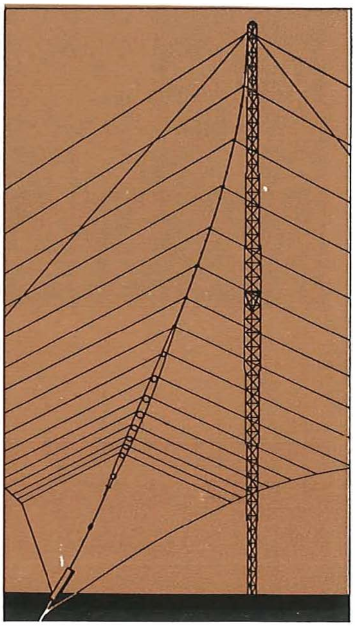

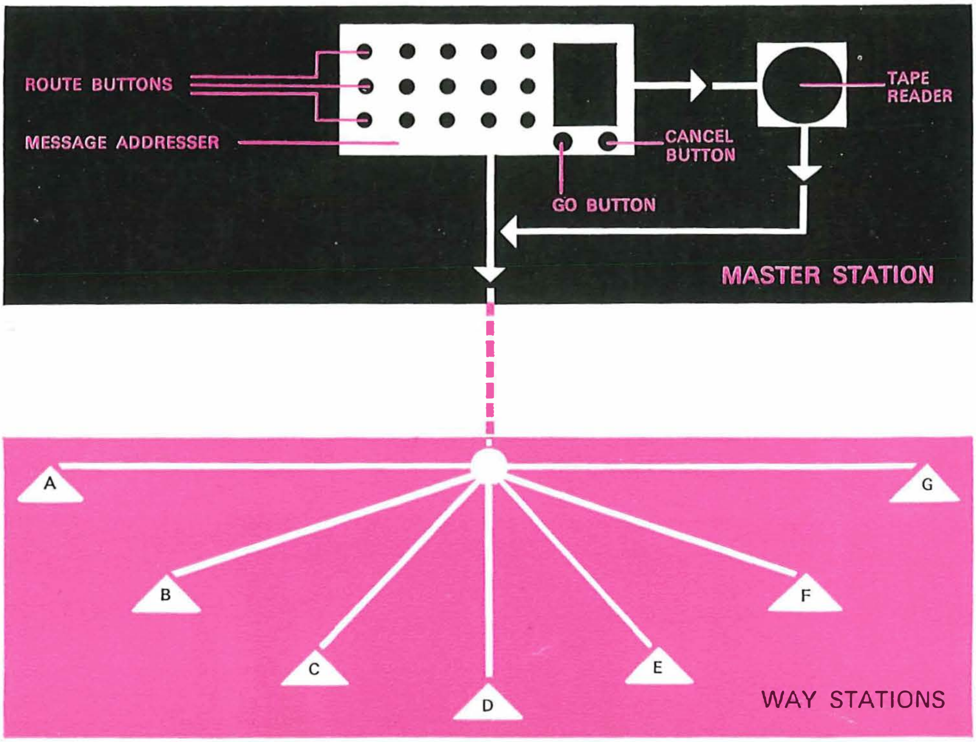

ROUTE BUTTONS
MESSAGE ADDRESSER
TAPE READER
CANCEL BUTTON
GO BUTTON
MASTER STATION
A
G
B
F
C
E
D
WAY STATIONS

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