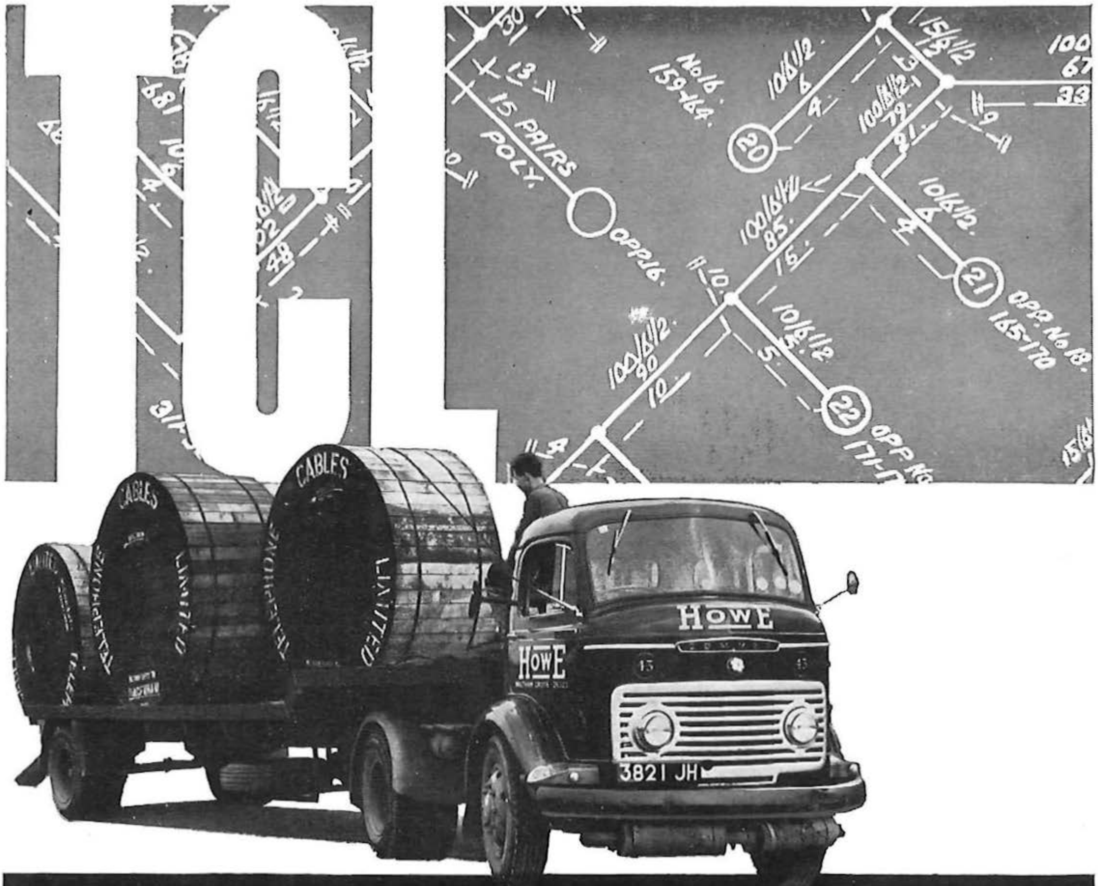
POST OFFICE

tele*communications*

JOURNAL

ONE SHILLING
AND
SIXPENCE

SPRING 1964



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Post Office Telecommunications Journal

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Contents

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Vol. 16 *Spring* 1964 *No.* 1

We Cannot Stand Aside

BRITAIN cannot afford to stand aside from the developments in satellite communications which are taking place in the United States, says the Postmaster General.

Speaking to the Telecommunications Equipment Manufacturers Association as the *Journal* went to press, Mr. Bevins pointed out that until now Britain had favoured the creation of a single global system of satellite communications, with European and Commonwealth countries taking part in the design and having a share in its management and control.

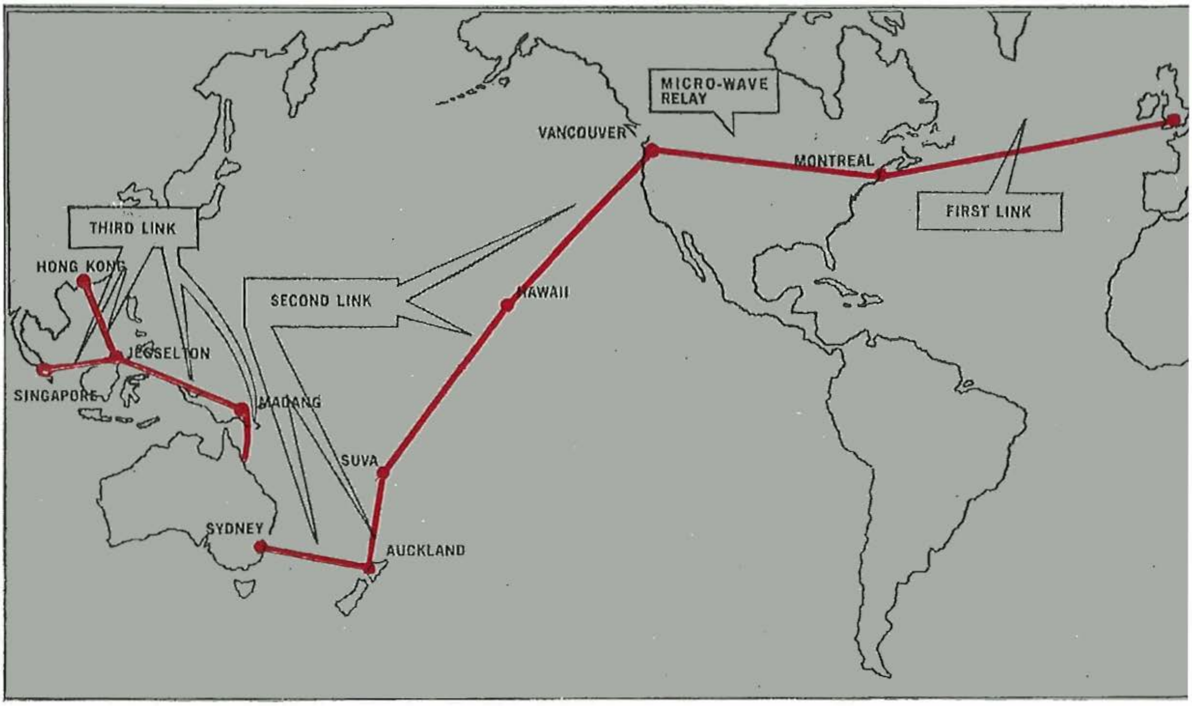
"The question now facing us," he went on, "is the application of these principles. American planning is going ahead extremely fast and time tables are being, or have been, set under which the initial phase of a commercial satellite system will come into being in 1966.

"Let us face it. This date is some years earlier than we have thought likely. Furthermore, unless things go wrong, industrial interests in the United States now look to satellites rather than to submarine telephone cables to provide the new capacity that will be needed in 1966.

"Is it practical for the United Kingdom or Europe to stand aside from these developments? I do not think it is. The Americans have a considerable lead in satellite technology, especially in regard to boosters. We need the extra capacity which satellites will give to meet the ever-increasing demands for international communications.

"Whatever form our participation takes it will obviously cost money and we should commit ourselves only if we can secure satisfactory terms which give us a real chance to influence the design and character of the developing satellite systems, a share in the ownership and opportunities to participate in development studies and, in due course, in the provision of material. Hard negotiations may lie ahead but I believe that we can succeed in these. I believe, too, that this is the only way to prevent the establishment of an effective American monopoly."

COMPAC COMPLETED



The opening of the Commonwealth Pacific Cable was an outstanding event in the history of communications said the Queen when she made the inaugural call over the second link in the Commonwealth Telephone Cable System

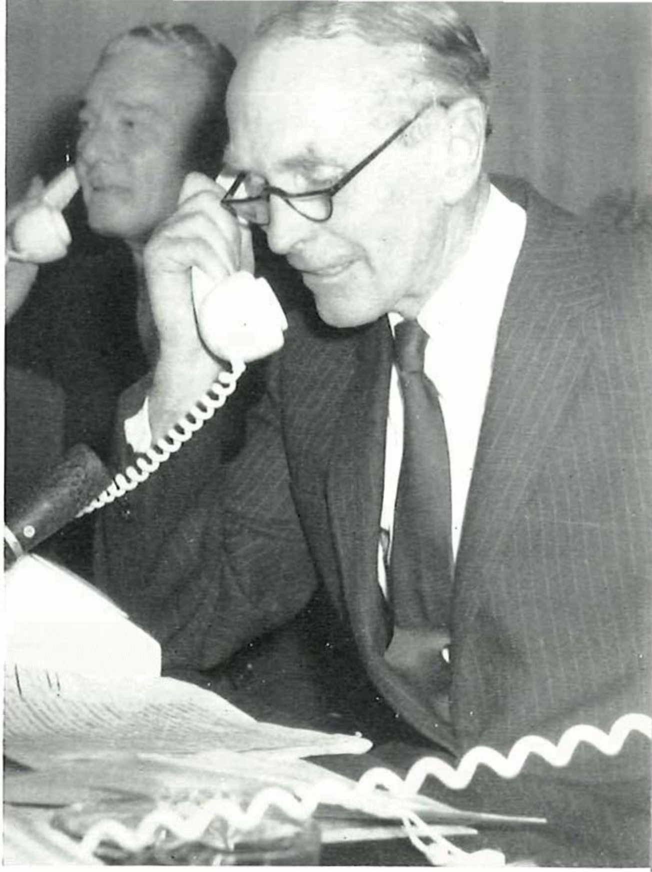
ON the night of Monday, 2 December, 1963, the recorded voice of Her Majesty the Queen travelled 16,000 miles from London to Sydney and was clearly heard simultaneously in five countries—in Britain, Canada, Fiji, New Zealand and Australia.

It was an historic moment which marked a great step forward in the expansion and improvement of the British Commonwealth's communications links. The Queen was making the inaugural call over the Commonwealth Pacific Cable (COMPAC).

COMPAC is the first telephone cable to be laid across the Pacific Ocean, joining Canada with Australia and New Zealand by way of Hawaii and Fiji. It forms the second link in the Commonwealth Telephone Cable System and together with CANTAT (the first link between Britain and Canada which was opened in 1961) and the trans-Canada microwave system, it enables people on opposite sides of the earth to speak to each other for the first time over reliable, high-quality telephone circuits which do not suffer from the fading and interference of the high-frequency radio links they replace.

COMPAC is the biggest single telecommunications project ever undertaken and has cost some £26 millions to complete. It is also the longest submarine cable ever laid and a great business venture, providing initially 76 and later 80 two-way speech channels, any of which can be used for 22 teleprinter channels. It can also provide leased circuits for airlines, shipping companies and other

Left: This map shows the route of the Commonwealth Telephone Cable System. COMPAC runs from Vancouver to Sydney.



commercial undertakings as well as high quality transmission of music, broadcasting and pictures.

From the beginning, thanks to a new automatic exchange at Sydney, operators in London will be able to dial direct to any Australian subscriber served by an automatic exchange. Operators at Sydney are also able to dial direct into the inland telephone system in Britain and similar facilities are to be provided in Montreal, Vancouver and Auckland.

Telex calls between Britain and New Zealand will also be passed directly between the two countries and operators in Wellington can now dial customers in Britain direct, without the aid of London operators.

The Sydney terminal will act as the entry point for telephone and telegraph traffic from Commonwealth places beyond Australia, particularly for Hong Kong and Singapore. Until SEACOM, the third link in the Commonwealth Telephone Cable System, is provided by the end of 1966 these extensions will be high-frequency radio links. The cable station at Hawaii will also act as a distribution point for lines between Commonwealth places and the United States and later Japan.

Differences in clock time and, therefore, in peak traffic periods between places along the route of COMPAC enable efficient use to be made of the circuit capacity. Trans-Atlantic circuits, for

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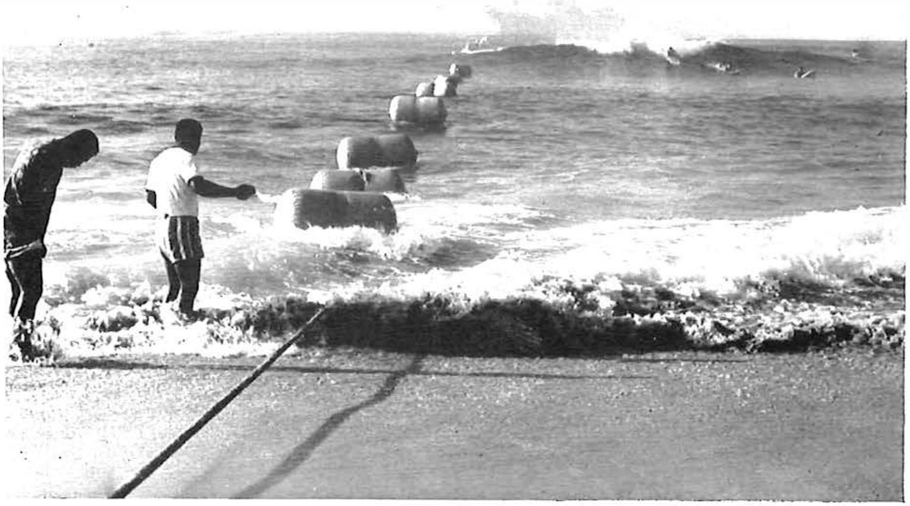
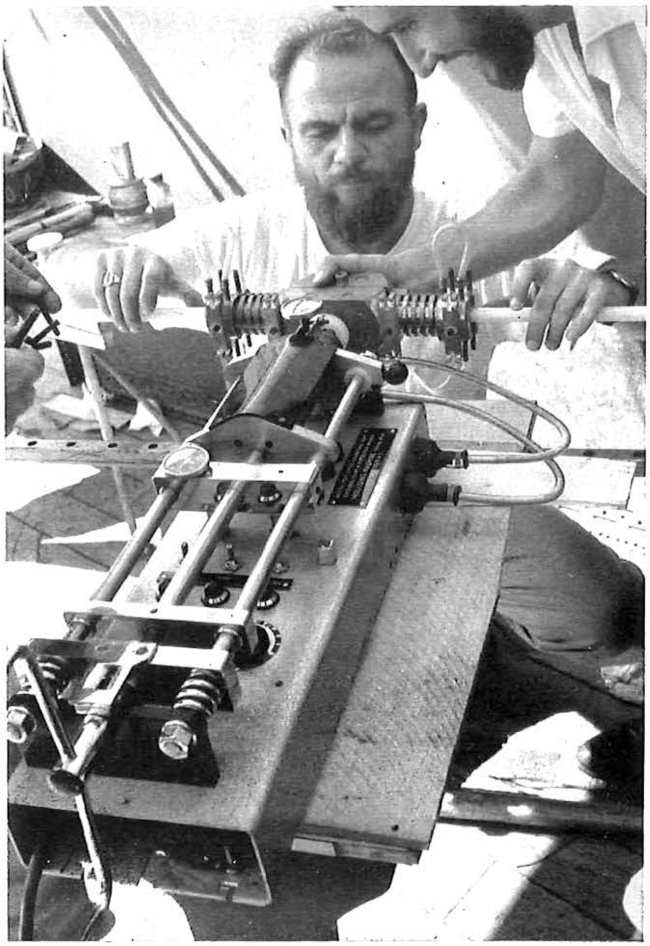
The Prime Minister (with the Postmaster General in the background) speaks over COMPAC to the Prime Ministers of Canada, Australia and New Zealand at the opening ceremony. Below: The scene in Sydney Town Hall when the Cable was opened.



The Cable and Wireless Ltd's CS *Retriever* laid the shore end cables of the Auckland to Sydney and Auckland to Suva sections of the COMPAC Cable. In this picture the shore-end cable is being floated ashore at Bondi Beach, in Sydney.



COMPAC COMPLETED (*Contd.*)

example, can be used during the morning in Britain for traffic to Australia; during Britain's afternoon when it is night time in Australia, for calls to Canada; and in Britain's evening for calls to New Zealand for which the next day has just begun.

Work on the COMPAC Cable, which is 9,500 statute miles long and includes some 320 submerged two-way repeaters laid in depths of up to 3,500 fathoms, began in 1961 when the Management Committee of the project placed £19 million worth of orders with British firms for the manufacture of the cable and repeaters. Much of the raw material for the cable was supplied by Australia (polythene) and Canada (polythene, copper and aluminium).

Early in 1962 three shore stations at Paddington (Australia), Takapuna (New Zealand) and Suva (Fiji) were completed and in June of that year the Tasman section of the cable was laid between Australia and New Zealand by the Post Office Cable ship HMTS *Monarch* along a course which had been buoyed by Cable and Wireless Ltd's CS *Retriever*. By the following November *Monarch* had completed the laying of the New Zealand to Fiji link.

Early in 1963, Cable and Wireless Ltd's new cable layer *Mercury* began to close the gap from

Cable completed! On board the cable ship CS *Mercury* in the Hawaiian Islands, the final splice is made of the first trans-Pacific cable.

Fiji northwards and *Monarch* began laying the section from Vancouver to a point north of Hawaii. The task was completed on 10 October, 1963, when the final splice was made by *Mercury*, lying off Keawaula Bay in the Hawaiian Islands. Then followed seven weeks of intensive testing before the cable was officially opened—61 years, almost to the day, after the first telegraph cable across the Pacific was opened for service in 1902.

The new lightweight cable used for COMPAC (it was first used on CANTAT) is used for all the deep water sections. It is little more than an inch in diameter and derives its strength from a central core of 43 high-grade steel strands, together little bigger than a man's little finger, which can withstand a pull of more than seven tons and which do not twist under tension. The weight of the new cable is only a third of that of armoured cable.

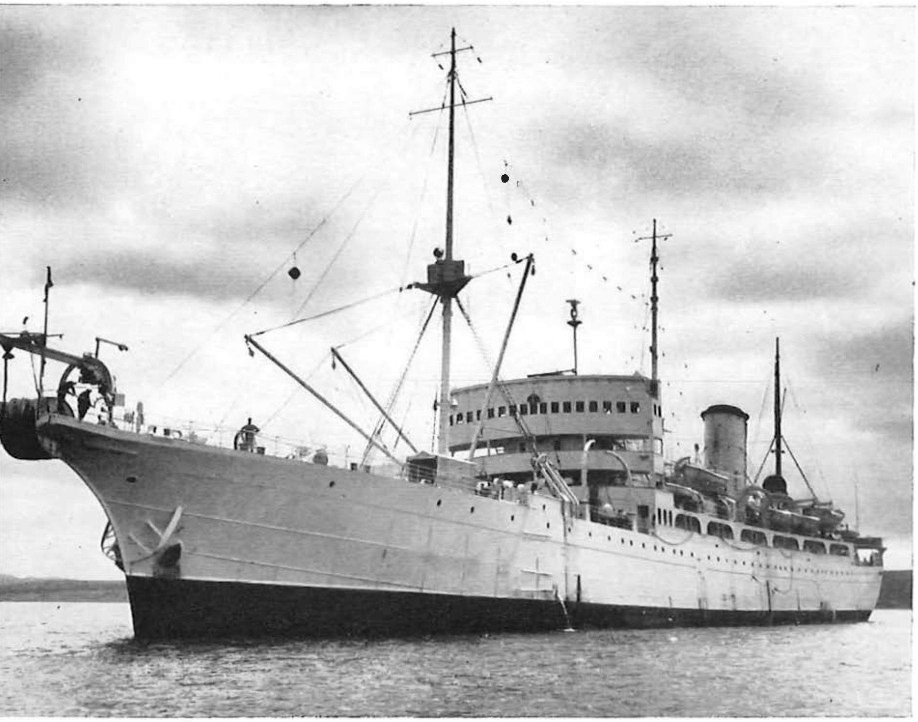
Around the central steel core of the new lightweight cable is a copper tube or inner conductor. Polythene is extruded over the inner conductor and over the polythene are wound six aluminium tapes, forming the return conductor and completing the coaxial tube which carries the electrical signals. A polythene ribbon is wound over the aluminium tapes, followed by an electrostatic screen of aluminium foil, a cotton tape impregnated with a corrosion inhibitor and finally a polythene sheath.

"A New Link has been forged"

In her inaugural message the Queen said: "The opening of the Commonwealth Pacific Telephone Cable is an outstanding event in the history of communications . . . Today a new link has been forged between the peoples of the Northern and Southern hemispheres.

"I congratulate all those whose imagination and skill have brought this enterprise to completion. We are all in their debt. This Pacific cable is more than a communication link—it is a practical expression of the faith of the Commonwealth in its own future. It is an example of what can be accomplished within our family of nations when we enter into a common venture as partners and apply to it all the skill and resources at our disposal".

OVER



The Post Office cable-layer, HMTS *Monarch*. She laid the Tasman section, the New Zealand to Fiji link and the cable from Vancouver to north of Hawaii.

COMPAC COMPLETED (*Concluded*)

The repeaters, which cost £18,000 each and are laid at intervals of about 30 miles along the COMPAC Cable, have two amplifiers working in parallel so that if one fails the other maintains service.

The successful completion of COMPAC is a tribute to the spirit of partnership between Britain, Canada, Australia and New Zealand whose telecommunications experts planned and developed it, and to the technical ability of the British Post Office research engineers who, in collaboration with British cable manufacturers, invented the revolutionary new type of lightweight coaxial cable and submerged repeaters without which the system would not have been possible.

Patricia Leamy, of St. Mary's College, Wellington, New Zealand, speaks over the COMPAC Cable at its inauguration to Ian Grierson, of Wembley Grammar School which adopted CS *Mercury* under the British Ships Adoption Society scheme.

DOWN UNDER CALLS UP

Since COMPAC was opened for service the number of telephone calls exchanged between Britain and Australia and New Zealand has risen considerably.

In the first week the number of calls exchanged between Britain and Australia went up from 538 during the week before COMPAC was brought into operation to 1,354, and those between Britain and New Zealand rose from 193 to 400.

The number of calls exchanged on Christmas Eve, Christmas Day and Boxing Day showed an even more remarkable increase, reaching a grand total of 3,501 compared with 717 during the same three days in the previous year. The number of calls exchanged between Britain and Australia was 2,577 against 505 and between Britain and New Zealand 924 against 212.

It is too early yet to say at what level of increase calls will settle down in normal periods but first indications are that they will be more than double.

A NEW STAMP FOR COMPAC

A symbolic globe crossed by a broad line representing the cable is the main feature of the 1s. 6d. special stamp issued on 3 December by the British Post Office to commemorate the opening of COMPAC.

The stamp is printed in varying colours of blue to suggest the sea, with the cable, fanning out to end in the words "Commonwealth Cable", in black. The Queen's head on the stamp is double the normal size.

The stamp was designed by Mr. Peter Gauld, FSIA who based it on the designs of stamps issued by Australia and New Zealand to mark the same occasion.

ALL-STD IN THE CITY

ON 14 January, 1964, the City of London became the first of the 56 telephone areas in Britain to be completely equipped with Subscriber Trunk Dialling when the Lord Mayor of London, Alderman C. James Harman, dialled the first trunk call from the Mansion House Exchange.

The Mansion House Exchange was the 644th exchange in the country to be converted to STD since the first STD exchange was inaugurated at Bristol in 1958 and brought the total number of subscribers served by STD to well over two million—or more than 40 per cent of all subscribers.

Speaking at the opening ceremony, the Postmaster General, Mr. Reginald Bevins, MP, said that in London telephone traffic was rising very rapidly. The number of local calls was now at the rate of 32 million a week compared with 30 million a week in 1962 and in the City Area alone the number of trunk calls had gone up from six million a week in 1961 to over seven million.

"Our London organisation handles not only London traffic, but also a great deal of through trunk traffic which passes between different parts of the country," added Mr. Bevins. "This through traffic is increasing so rapidly that the six switching centres we have in London to cope with it are becoming congested. To overcome this problem we are opening this year three new trunk switching centres around London—one at Reading, another at Cambridge and the third at Tunbridge Wells. These establishments will bring about a substantial improvement. Much of the through traffic will be diverted to these new switching centres which, as well as relieving London, will make it possible to extend STD between more STD areas."

Mr. Bevins said that the Post Office was also about to provide a number of new exchanges in London to handle both incoming and outgoing STD traffic. The first of these would be set up in Fore Street.

The Post Office Tower which was rapidly taking shape off Tottenham Court Road would play a very important part in handling the vast increase

The Lord Mayor of London dials the inaugural STD call from the Mansion House as he is watched by the Postmaster General.

in London's trunk traffic in the years to come. It was only a part of the new microwave radio link systems which the Post Office was setting up throughout the country.

The Post Office was also installing equipment which, in the near future, would almost double the number of exchanges London STD subscribers could dial direct.

- *In the City Area there are some 75,000 business lines, of which about 6,000 are served by the Mansion House Exchange, out of a total of over two million business lines throughout the country.*
- *The growth of the telephone system in London is at the rate of about 60,000 more telephone connections a year. In the next five years this rate of increase is expected to be doubled.*
- *When the Mansion House Exchange went over to STD 116 of the 323 exchanges in London had been so equipped. Within the next six months it is planned to bring STD to subscribers served by another 50 London exchanges.*

★ SPEEDING THE OVERSEAS

Two important steps have been taken to speed and increase the handling capacity of Britain's overseas telegraph service. The first is the introduction in Electra House, London, of a message relay centre equipped with a new tape relay unit. The second is the decision to set up overseas telegraph area offices in the provinces and in London. This article discusses the many difficulties and shows how these problems are being overcome

AS the *Journal* went to press six new overseas telegraph area offices were opened in the provinces—at Birmingham, Bradford, Bristol, Glasgow, Liverpool and Manchester—and two in central London. At the same time a new message relay system was brought into operation at Electra House, London—the world's biggest overseas telegraph centre—as an interim stage in the plan to mechanise the handling of telegrams.

These two events mark the beginning of a reorganisation of the Post Office's Overseas Telegraph Service which will speed the service and improve its efficiency.

Until now, all overseas telegrams originating in or destined for the provinces and outer London have circulated by way of Electra House where they have had to be reprocessed before being sent onwards. In future, much of the traffic terminating in Britain will be exchanged directly between the area offices and the distant overseas offices and a fair proportion of transit traffic (a valuable "invisible" export) will be exchanged directly between distant overseas offices. The transmission time for all these transactions will as a result be considerably reduced.

Transit traffic will make use of the new message relay system. Traffic terminating in Britain will use either the message relay system or the Gentex circuit switching system according to the overseas destination.

Further improvements can be expected when

A view of the delivery suite at the new overseas telegraph area office at Broadway, London, SW1. A multi-track conveyor belt system routes messages from overseas to the various delivery positions (telex, in foreground), phonogram and via pneumatic tubes for delivery to postmen.

TELEGRAPH SERVICE ★

By C. W. A. MITCHELL and A. T. GRAY

the Gentex network, which at present serves Western Germany, the Netherlands and Belgium, is extended and when two more area offices are opened in London—one later this year and the other when a building becomes available. Yet another provincial office may be set up later in Belfast and plans are going ahead for a bigger message relay unit to be installed within the next few years.

The Overseas Telegraph Service, which until now has been concentrated in Electra House, has 93 point-to-point routes using 115 two-way channels in the busy hour. In addition, 15 outgoing and 17 incoming teleprinters are connected to the International Telex Exchange to dispose of Gentex traffic.

Nearly two-thirds of the point-to-point circuits are provided by high-frequency radio links and these are supplemented by the old Commonwealth network of single-core telegraph cables and by a steadily-increasing number of voice-frequency telegraph channels carried in trans-oceanic submarine cables. Ten years ago this network used Morse systems of synchronous telegraphy (which were particularly suitable for single-core telegraph cables) as well as Wheatstone Morse and unprotected teleprinter working (that is, without automatic error correction) on radio links. The use of message copy prepared by typing or by gumming down printed tape was necessary as a universal transfer medium between these different transmission systems.

Recent developments, including the introduction of automatic error correction facilities (described in the Spring, 1960 and Summer, 1962 Issues of the *Journal*), have brought about considerable improvements in the reliability of radio telegraph services and today, while some routes retain Morse operation, most have been converted to teleprinter working. A growing number are

OVER

This picture shows the forwarding end of the acceptance suite at the Livonia Street area office in London, W1. In the foreground are the Gentex outgoing positions and the multi-track conveyor belts. In the background can be seen the phonogram and telex acceptance positions. The delivery suite is on the right side of the room.

Another view of the new overseas telegraph area office at Broadway, SW1, showing three-tier teleprinter stacks for Gentex traffic in the background.

OVERSEAS TELEGRAPH SERVICE *(Contd.)*
sufficiently stable for traffic to be handled automatically or semi-automatically.

At present nearly 40,000 overseas messages in each direction are handled daily by the Overseas Telegraph Service. Of these about 15,000 are transit messages between places abroad. Of the remainder about half are for central London and half for outer London and the provinces. Acceptance and delivery arrangements follow mainly conventional inland telegraph practice but a significant proportion of the central London traffic is handled at branch offices in the City and the West End. Hitherto, this traffic has been conveyed by courier services between the branch offices and Electra House.

The pattern of overseas telegraph traffic in the Midlands and North lends itself ideally to the new reorganisation. Over one half of the traffic in Scotland, North-Western, North-Eastern and Midland regions arises in or near the centres of Glasgow, Liverpool, Manchester, Bradford and Birmingham. About two-thirds of the remaining traffic in these areas is accepted and delivered by phonogram or telex. Since electrically-accepted or delivered traffic can be routed without much difficulty to and from any convenient point, the way is therefore open to the concentration of provincial traffic into area offices in those cities.

The situation is different in the South-Western Region and in Wales and Border Counties. While the former has enough traffic to justify a separate area office and Bristol itself produces the largest amount there is in no real sense a concentration at Bristol. Nevertheless, to complete the reorganisation scheme, an area office has been set up there to cater for the South-Western Region. Since there is insufficient traffic in Wales and Border Counties to justify a separate office, overseas telegraphs will in future be circulated to the Bristol, Birmingham, and Liverpool area offices through the existing telex and telephone networks.

Traffic in Northern Ireland, where the volume is small, and in the Home Counties, where the only natural centre is London, will continue, for the time being at least, to be handled at Electra House.

The bulk of traffic in central London stems from the many business organisations within half a mile of Leadenhall Street in an area served by the E.C.2 and E.C.3 postal districts while most of the rest comes from hotels, embassies and so on in the W.1 and S.W.1 districts. Since Electra House, in the W.C.2 district, is over a mile away from the city and not much less from the West End, it is in something like a telegraph vacuum. Although the distances are not very great, travelling difficulties add considerably to the overall lapse of time between acceptance and transmission in the one direction and between reception and delivery in the other. The new area offices, which will be set up in the centres of the intense concentration areas—at Broadway, S.W.1; Livonia Street, W.1; Aldersgate Street, E.C.1; and in the Tower area, E.C.3 (the first two have already been opened)—will be able to exchange many messages direct with overseas stations and so speed the service.

To overcome the problem of routing incoming traffic which is addressed simply to "London" it has been decided after consultation with the Chambers of Commerce and similar organisations, to align the area office boundaries with those of the postal districts and to ask users and overseas administrations to include the postal district in all London addresses.

The remainder of London's terminal traffic—that from the central districts for which separate area offices cannot be justified, together with that from Outer London, the Home Counties and Northern Ireland—will, for the time being, be dealt with as before. It may be possible later to segregate the Home Counties traffic into a separate section at Electra House or to a separate office elsewhere which, since it would require no delivery force, could be situated almost anywhere in the Region.

The first and most straightforward step in mechanising the Overseas Telegraph Service was taken in 1961 with the introduction of Gentex working to Belgium, Western Germany and the Netherlands (described in the Winter, 1962 issue of the *Journal*). This system will be extended to France, Italy and a number of East European countries and all the new area offices will be linked to it to dispose of traffic by direct dialling to the distant offices. However, the total amount of terminal traffic to be exchanged with these countries represents only about 20 per cent of all overseas telegraph traffic so that even allowing for the quota taken by the six new provincial and four new London area offices the reduction in terminal traffic at Electra House will amount to only some eight or ten per cent.

Gentex operation is very suitable on highly stable routes where channels are plentiful and cheap and on which automatic telex is available. There are many overseas routes, however, which do not satisfy these criteria. To cater for these and to minimise the effects of interruptions to which radio services are susceptible, it is necessary to employ a relay system in which messages are stored at the centre and offered, in the form of a queue, to the outgoing channels. In this way it is possible to achieve much higher channel loadings than with the "pure chance" access Gentex system. In addition, by using serial numbers to safeguard loss of messages no answer-back is required and the return channel can also be used for traffic. These are important advantages in a network in which channel capacity is still at a premium.

THE NEW OFFICES

UNDER the reorganisation the new Overseas Telegraph Service will take over the work previously carried out by the Post Office Cable and Wireless Service whose title disappears.

Each area office will provide a 24-hour, seven-day-a-week service and for the first time Overseas Telegraph officers will be employed outside London in the provincial offices. Training courses for OTOs I and II began in December at Manchester and by the end of February, 1964, it is expected that as many as 60 officers will be available to take up their new duties. Training for supervisors is also taking place at Electra House.

Five of the provincial area offices—at Birmingham, Bradford, Manchester, Liverpool and Glasgow—will occupy premises previously housing Cable and Wireless offices but which have been re-designed. The office in Liverpool will later move to new premises. The new area office at Bristol will be accommodated in the Head Post Office.

The first two area offices to be opened in London are in the Abbey Telephone Exchange in Broadway, in the S.W.1 district, and in a new building at 1–7, Livonia Street, W.1. The third area office will occupy a building in Aldersgate Street to cater for traffic in the E.C.1/2 area and the fourth will be in the Tower Bridge district.

The reorganisation of the Overseas Telegraph Service has been made possible by the development of message relay centre equipment which has sufficient storage capacity to handle high traffic densities and to cope with occasional interruptions to radio channels connected to the centre. Although the achievement of fully-automatic operation is already technically possible, the change from point-to-point operation to message relay working involves alterations in message format and operating procedures which require international agreement. These developments have been the subject of numerous international meetings, notably under the aegis of the Commonwealth Telecommunications Board and subsequently the International Telegraph and Telephone Consultative Committee (CCITT), and in which Great Britain has played a leading part, with a view ultimately to the adoption of automatic systems.

As an interim measure and a practical beginning, it was decided to set up at Electra House a torn-tape message relay centre with push-button selection of circuits and to replace it later with a larger and more elaborate system. This will enable operational changes to be introduced more gradually and with less risk of dislocating the service.

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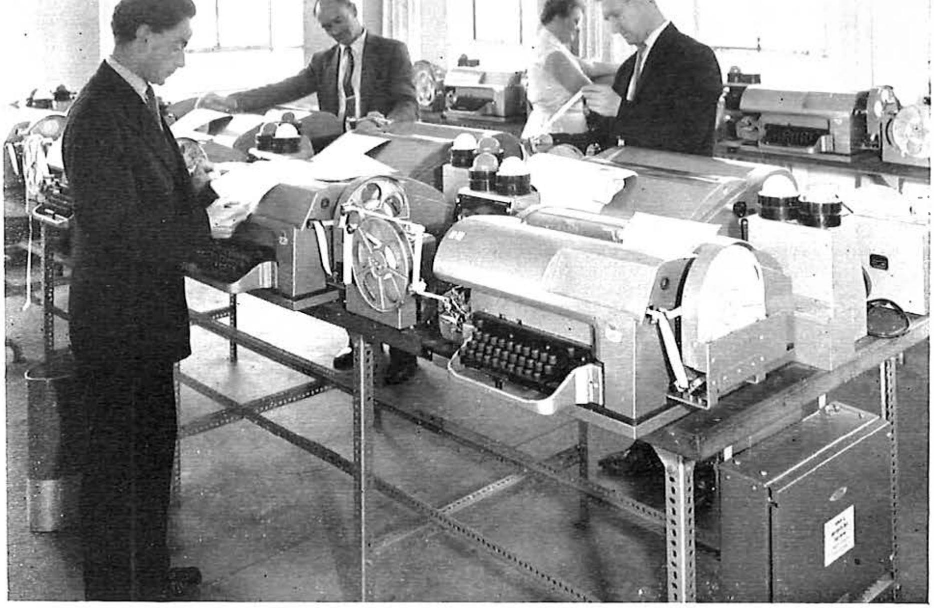
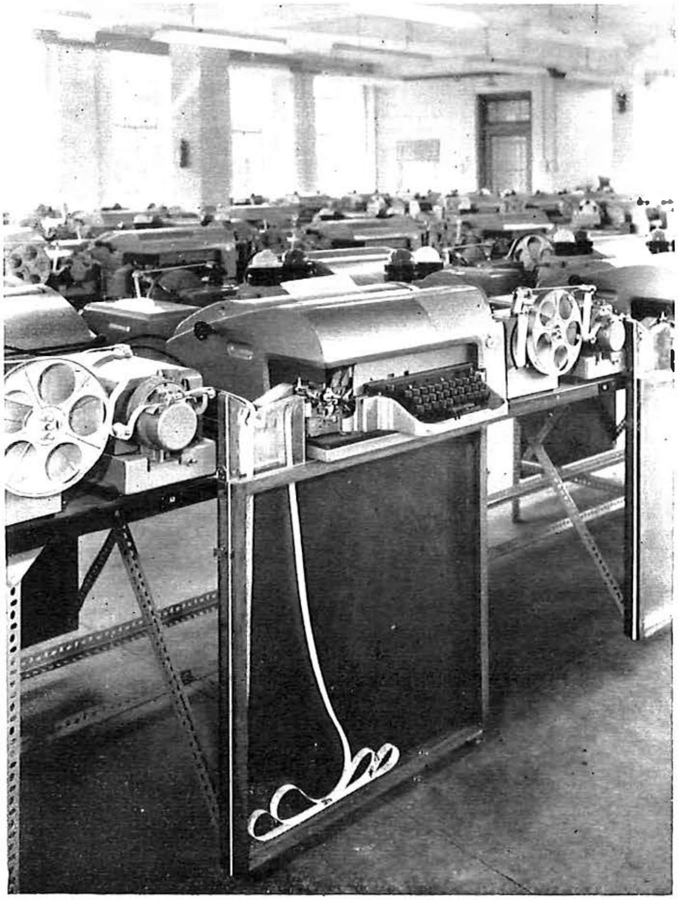


A general view of the recording machines in the Message Record room at Electra House. The machines produce page and perforated tape copies of all material leaving the unit. The operators are seen examining the copy for obvious defects.



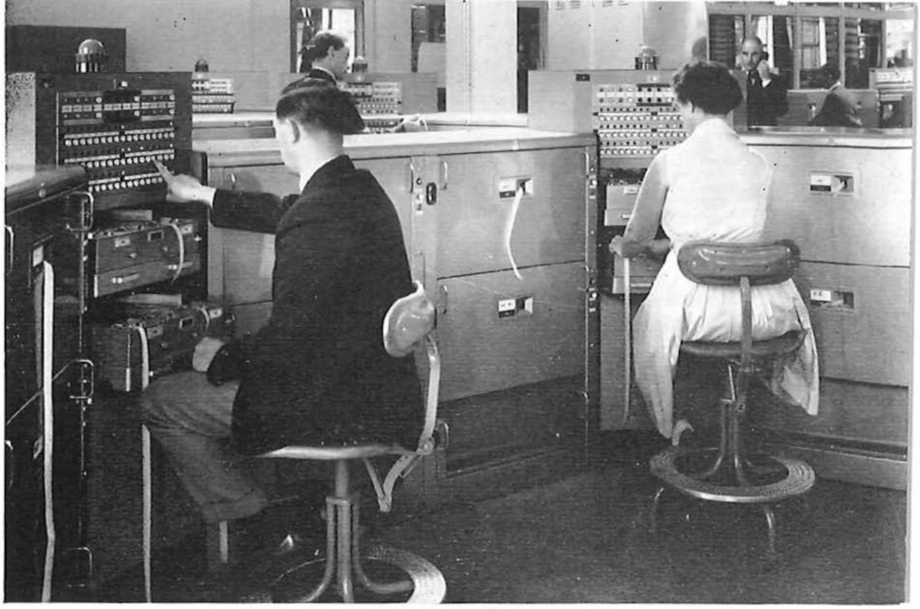
OVERSEAS TELEGRAPH SERVICE (*Contd.*)

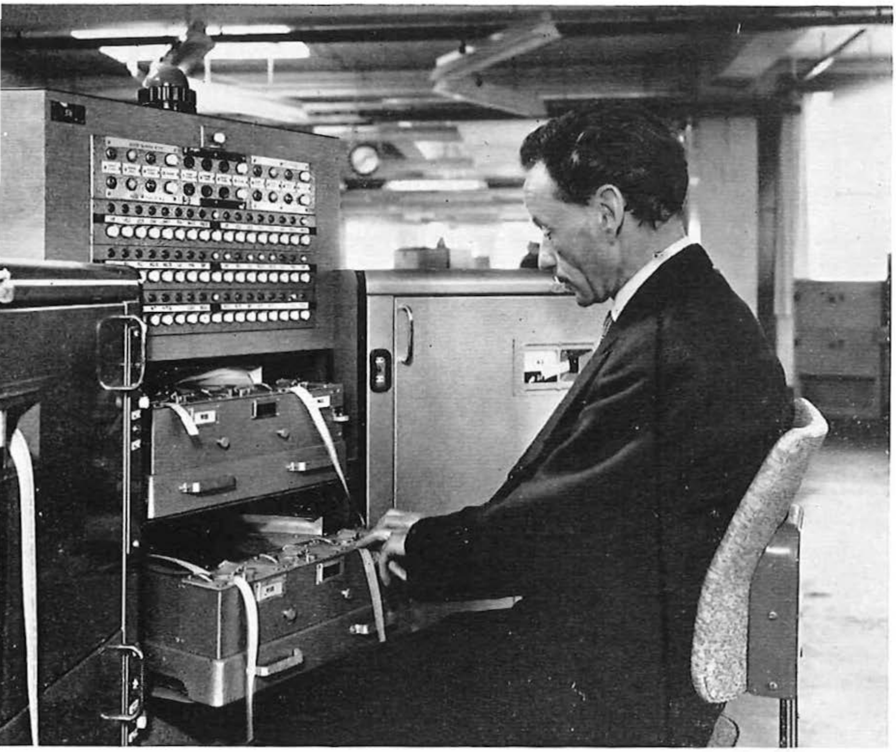
Designed by Post Office engineers and installed by staff of the External Telecommunications Executive, the equipment (very similar to that described in the Summer, 1958, issue of the *Journal* but designed for a much higher peak traffic load) uses printed perforated tape as the storage and relaying medium. Each operator accepts messages from up to four incoming circuits terminating on printing reperforators in two cabinets. Between the cabinets is a panel containing rows of push buttons providing a selection of up to 50 outgoing channels and below the panel are six auto-transmitters in two banks of three.

After an incoming message is torn off and scrutinised for the forwarding information an operator inserts it into a free transmitter head and assigns it to the correct outgoing route by pressing the appropriate button. The switching equipment then associates the transmitter with the selected channel and the message is transmitted as soon as the circuit is free. Several transmitters on the same or different positions can be associated with any outgoing circuit in this way and the messages which are temporarily stored at the auto trans-

A view of the Buffer Store at Electra House showing some of the 40 special tape storage units, designed by Post Office engineers, which enable traffic to be accumulated for routes which may become congested or completely stopped. Each unit holds some 90 minutes traffic.

Tape emerges from the reperforators of the tape relay unit consul, ready to be fed into the auto-transmitters. The OTO I in the picture is routing a message which has been inserted in an auto transmitter.





A close-up showing an OTO I pushing a tape into an auto transmitter. The tape is made up of a stream of messages and each has to be carefully torn off before being placed in the transmitter.

mitters are transmitted one after the other. The number of queue places (that is, auto transmitters) required increases exponentially with the load to be carried by the outgoing channels and a limiting factor of the equipment design has been the provision of sufficient auto transmitters to satisfy the busy hour load.

The safe transit of messages through the unit is secured by the provision of page monitor machines

OVER

on all outgoing channels, the message copies so obtained being re-sorted manually into received order number. Monitor tapes are also taken so that traffic lost because of the failure of the forwarding channel or the distant machines can be re-run quickly.

A special feature of the message relay centre is the high proportion of overseas radio channels connected to it. Forty special tape storage units are provided to enable traffic to accumulate on routes which may be congested or stopped and for use as buffer storage units on error corrected radio channels. These units, which were designed and constructed by the Post Office, achieve maximum economy and each can hold about one-and-a-half hour's traffic.

The new interim equipment has been designed to accommodate about 35 overseas circuits with an average busy hour loading of about 0.65 Erlang (an Erlang is one hour of traffic on one channel). It is expected to handle between 35-40 per cent of the station's total traffic which, with about 20 per cent to be handled by Gentex, is sufficient to enable the decentralisation plan to be carried out. Nevertheless, the full benefits of mechanisation cannot be realised until a larger number of overseas circuits can be converted to message relay working.

The present equipment, however, will pave the way for future development of message relay working. Plans are well advanced for first augmenting and later replacing the present message relay unit with a much larger semi-automatic equipment to which automatic routing facilities can also be added. When this is accomplished it will be possible to mechanise over 90 per cent of the total terminal and transit traffic, although a residue of routes which technically are suitable neither for Gentex nor for message relay operation, will probably remain for many years to come.

THE AUTHORS

Mr. C. W. A. Mitchell, AMIEE, entered the Post Office in 1926. In 1933 he joined the Engineer-in-Chief's Office, Telegraph Branch where he was concerned initially with the establishment of voice frequency telegraph networks for domestic and defence purposes and later with the development of telegraph switching systems. In 1950 he transferred to Telephone Branch as Senior Executive Engineer responsible for telephone switchboard and relay development. On the establishment of the External Telecommunications Executive he transferred to the Engineering Branch to take charge of telegraph planning and, as Assistant Staff Engineer, has been engaged since 1958 in the mechanisation of overseas telegraph services.

Mr. A. T. Gray is a Principal Telecommunications Superintendent in the Overseas Telegraph Mechanisation Division of the External Telecommunications Executive. He was a marine wireless operator with the Marconi Company before joining the Post Office as an Assistant Traffic Superintendent in 1932. Most of his career was spent on telephone work in Regions and in Headquarters until, late in 1960, he was given his present appointment with the task of piloting in the plan described in this article.

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HANDLING THE OVERSEAS PHONOGRAMS

By A. B. WHERRY

PLANS for routing and automatically switching overseas phonograms (telegrams dictated by subscribers over the telephone) in the provincial overseas area offices envisage that in those cities served by director exchanges ordinary subscribers and pay-on-answer coin boxes will be given automatic access by dialling the standard code 193.

The code 557, which has been used in some places to give access to the Cable and Wireless offices, will no longer be used. On calls from pay-on-answer coin boxes the exchange equipment will be arranged to give to the overseas telegraph operator a coin box identification signal, control of the coin slots and audit facilities.

Telephone operators who will also require access to the area office in the director area will dial an arbitrary three-digit code, the exchange equipment being arranged to give standard supervisory facilities.

Where a significant amount of overseas phonogram traffic originates from a non-director group switching centre (GSC) on the fringe of director

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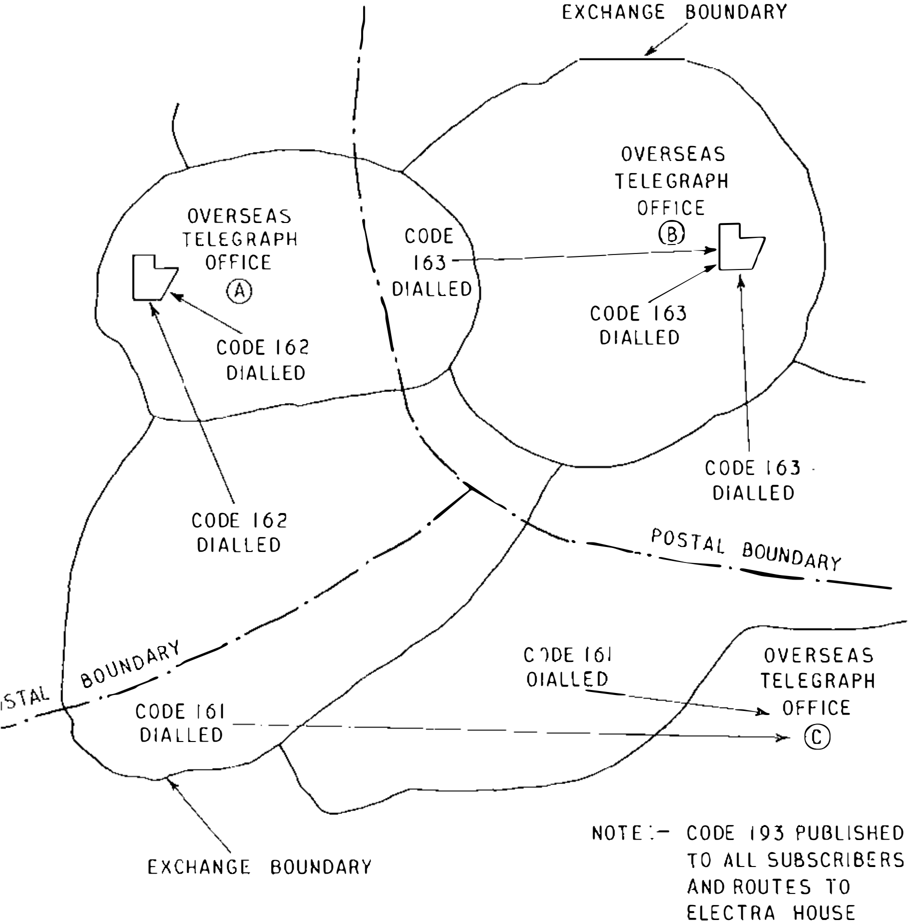


This diagram shows the method to be adopted for allocating the codes in London. Where a telephone exchange area is divided by a postal boundary, separate codes are used to route to the appropriate overseas office.

areas it may be economical to provide direct junctions from the automatic equipment at the GSC to the overseas office. Subscribers in these fringe areas will gain access to these junctions by dialling 193. Assistance telephone operators for exchanges in the fringe area will obtain the overseas office by dialling a director exchange multiple number.

At Bristol and Bradford the code 193 will be used by ordinary subscribers and pay-on-answer coin boxes and the exchange equipment will give the same facilities as in the director areas. Telephone operators will use code 093 and receive standard supervisory conditions. An exchange multiple number will also be needed for access to the overseas phonogram office but if calls from ordinary subscribers are routed over these circuits they will be metered and the overseas phonogram operator will have to arrange the appropriate rebate. Direct 193 and 093 junctions may be justified to carry overseas phonogram calls originating in adjacent GSC areas.

In London, overseas phonogram calls originating in the central area will be handled on a decentralised basis at the area offices, which will serve geographical areas based on London postal districts. Since the postal district boundaries do not line up with those of telephone exchange areas special engineering measures are needed to ensure that overseas phonogram calls are routed, as far as possible, to the area office serving the particular postal district. Special problems arise where one or more postal boundaries divide an exchange area.

The code 193, which will be published generally to subscribers, will give access to the overseas telegraph office at Electra House but in those exchange areas within, or partly within, one postal district a code in the "16X" range will be published on an individual basis to ordinary subscribers who make regular use of the overseas phonogram service. Exchange equipment will be arranged to route calls to the area office serving that particular postal area. The existing code "557" will no longer be used.

The External Telecommunications Executive will notify individual subscribers about how to gain access to the area office serving their postal area by dialling, say, 161, or 162. But, subscribers who have not been informed of the special code will dial 193 and may not, therefore, be routed to

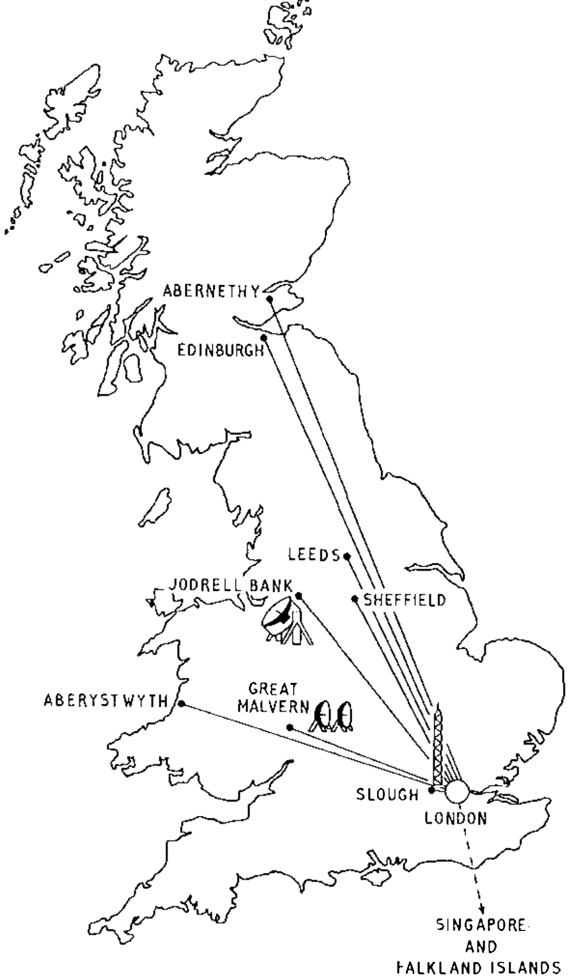
OVER

THE IQYs OF THE SUN

DURING the International Quiet Years of the Sun in 1964 and 1965, the Post Office will be repeating the part it played during the International Geophysical Year (1957-58) when it co-operated with scientists throughout the world in passing on messages alerting observers to solar activity.

In the International Years of the Quiet Sun, when solar activity will be at its lowest for many years, the alerts will be transmitted over the World Meteorological Organisation's network, received by the Meteorological Office at Dunstable and from there passed to the Post Office for distribution by telegram to observers in Britain, Singapore and the Falkland Islands (for Antarctica). Special instructions are held at delivery offices to ensure that the messages, which will carry the prefix "Geophysical," are dealt with immediately.

Teams of scientists from more than 60 countries are taking part in the mass observations which are aimed at adding to the knowledge gained of many branches of geophysics (the physics of the earth and its surrounding atmosphere) during International Geophysical Year.



This map shows the destinations to which the Post Office will send the IQSY alerts.

OVERSEAS PHONOGRAMS *(Concluded)*

the area office serving that postal district.

Ordinary subscribers and pay-on-answer coin box users will be permitted dialling access to the area office and the facilities given by the exchange equipment on these calls will be the same as in the provincial director areas.

A departure from traditional practice is that some subscribers in an exchange area will dial one particular code to gain access to the area office while others in the same exchange area dial a different code for the same service.

To cater for the early opening of the Broadway and Livonia area offices traffic is being temporarily routed via a nearby automatic exchange. Later when some relief is given to the London tandem traffic switching units, a more economic arrangement will be adopted.

Some calls destined for overseas telegraph offices, for example, those from subscribers who have difficulty after dialling 193 and from prepayment coin box users, will be received in the first instance by the assistance operator. To enable these calls to be completed, junctions may be justified from the automanual boards direct to the overseas phonogram board or use will be made of junctions from the automatic equipment to the overseas phonogram board. These junctions will be reached by the operator dialling an arbitrary three-digit code, the exchange equipment giving standard supervisory conditions. An exchange multiple number will also be needed to give access to the overseas telegraph office and since metering will be given to subscribers who dial this number, the overseas phonogram operator will have to arrange for the appropriate rebate to be made. Telephone operators from non-director GSCs on the fringe of the director area will obtain access through the exchange multiple number serving the overseas office.

This article describes the plans for setting up and extending the BBC's new television programme and tells of the important part which the Post Office will play in planning and providing the new network and the many other facilities

By B. F. DOWDEN

Right: BBC engineers hoisting one section of the new UHF (Channel 33) transmitting aerial at Crystal Palace into position. *Courtesy: BBC.*

The Post Office and BBC-2

THE Post Office is playing an important part in heping to establish and extend to much of the country by the end of 1966 the BBC's new second television programme—known as BBC-2—which comes into operation in a few weeks' time with the introduction of regular programme transmissions from the new 500 kW Ultra High Frequency station at Crystal Palace.

The BBC has placed orders with the Post Office to supply most of the main, transmitter and studio links required for networking the new programme to 13 of the first 18 UHF stations which will provide the new service to areas containing about 75 per cent of the country's population.

The Post Office will also provide about 90 studio and outside broadcast vision links for the main centres of population, such as London, Birmingham and Manchester.

To complete these tasks in just over two years, Post Office engineers will have to provide some 2,200 channel miles on microwave radio systems and install new coaxial cables containing about 850 coaxial-pair miles. By contrast, the Post Office network of vision links for BBC-1 and ITA-1 total about 7,000 channel miles (half on radio and half on cable), most of which was built up over the past 14 years.

Under the Government's plans for the future of broadcasting in the light of the Pilkington Committee's Report, the BBC have been authorised to radiate a second national television programme. This will start on 20 April in the London area and

OVER

THE POST OFFICE AND BBC-2 (*Contd.*)

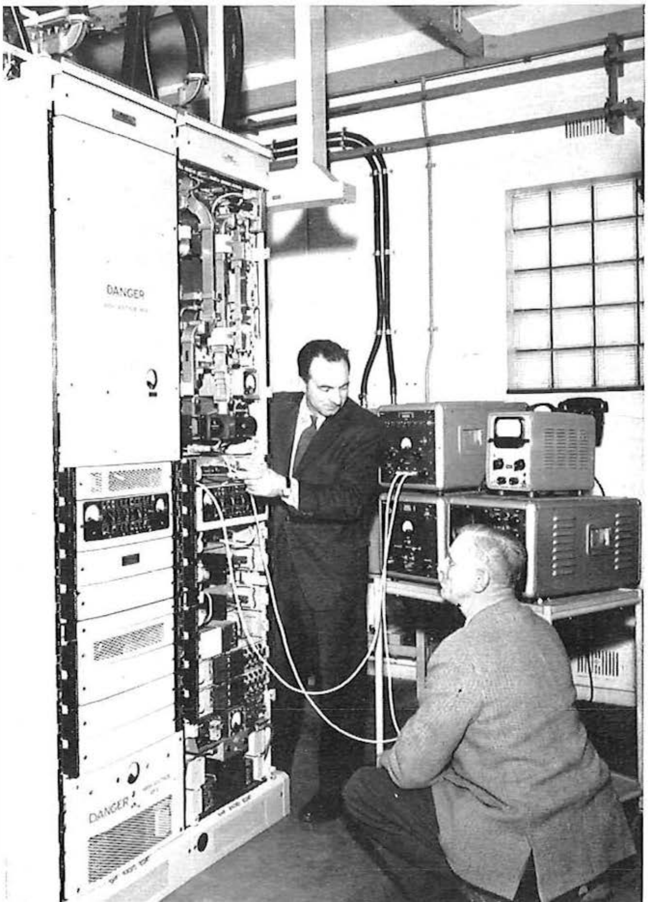
will be extended to the rest of the country as rapidly as possible. The new service will be in the Ultra High Frequency Bands IV and V and use 625-line transmission. The Government has also agreed in principle that colour programmes may be included in it once the choice of a colour transmission system has been made. In deciding to adopt a higher line standard of 625 lines, the Government recognises that the two existing television services on 405 lines should in due course be changed over to 625 lines. The Government has also decided that all UHF programmes for the same area will be transmitted from the same site and mast.

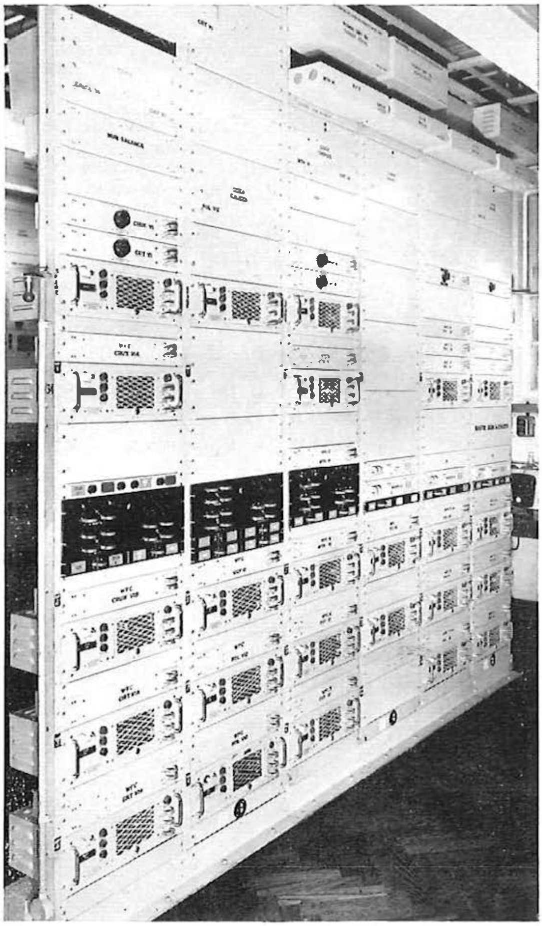
It is estimated that to achieve the near-100 per cent coverage of the population now obtained by some 25 high and medium power VHF stations it will be necessary to establish 64 high-power UHF transmitters, with about 250 major "fill-in" low-powered stations and about 1,000 unattended translator stations to serve the "shadow areas" and those areas falling between the nominal service areas of the high-powered transmitters. To feed the main UHF transmitters for BBC-2 about twice as many transmitter links as were needed for BBC-1 may have to be provided. Most of the low-powered translator stations are likely to operate by direct pick-up of the radiated signals from adjacent main transmitters.

The system of colour which will be used on BBC-2 has yet to be decided, but the Pilkington Committee recommended that the transmitted colour signals should also be capable of giving an acceptable monochrome picture on standard black and white receivers.

To assist the *Comité Consultative International des Radio communications* (*CCIR*) in deciding

Below (left): This is the new 6,000 Mc/s radio equipment which is to be used on the link between Carlisle and Kirk o' Shotts. Below (right): Racks of valve-type video amplifiers of the type which are expected to be used on single-section links.



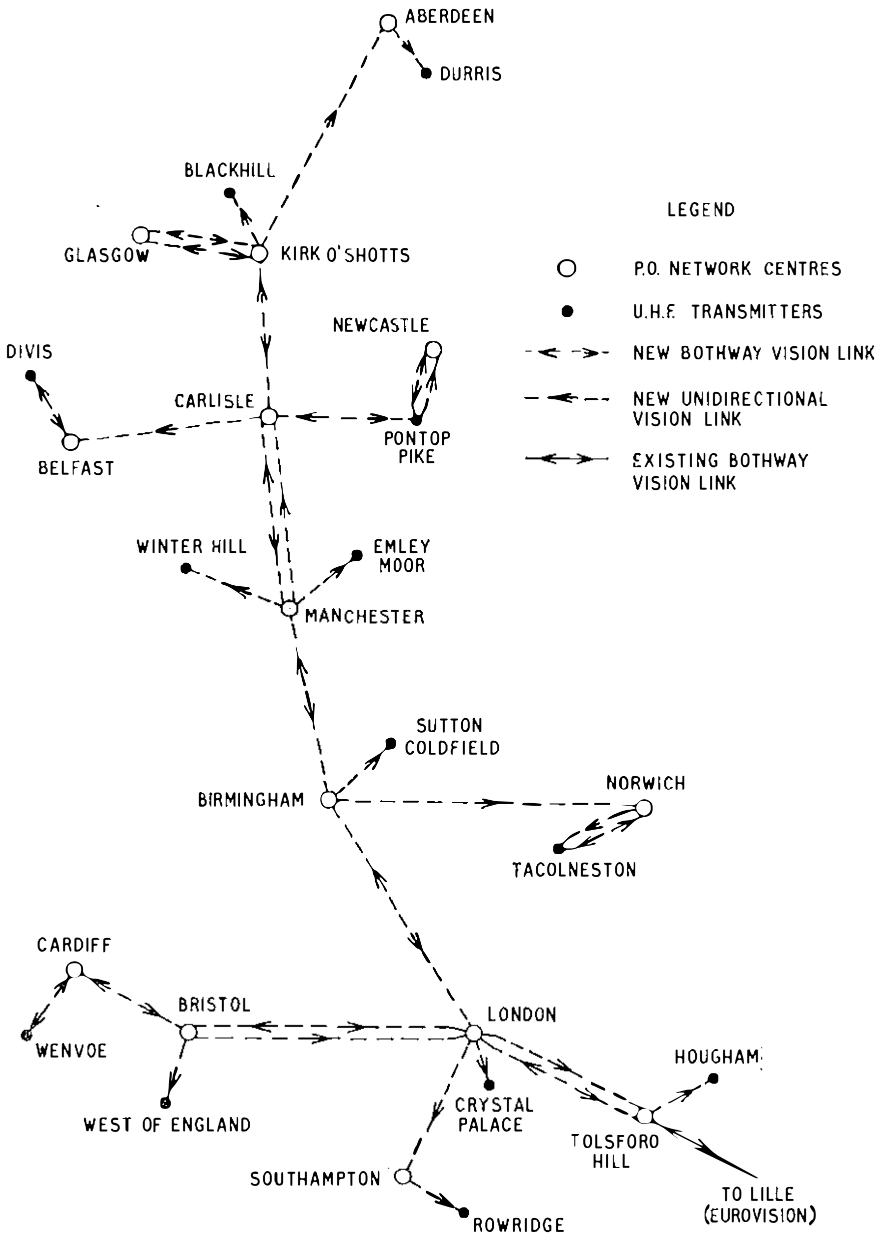


which colour system to recommend for use in Europe, a working party of the European Broadcasting Union has been investigating three compatible systems which differ mainly in the manner in which the "chrominance" (hue and saturation) information is transmitted.

The first of these systems—known as NTSC, from the initial letters of the American National Television System Committee which developed it—has been in regular public service in the United States for some years. In this system the signals are sensitive to small phase and gain changes in the transmission path, especially if these vary with the picture content. To maintain these effects within acceptable limits the transmission path must give

OVER

This diagram shows the main and transmitter links for 13 of the first 18 UHF stations which will be established to transmit the new BBC-2 programme.



A tower at Riddings Hill Radio Station showing the new horn reflectors which enable aerials to be shared by several frequency bands.

THE POST OFFICE AND BBC-2 (*Concluded*)

a very high standard of performance but such requirements have been assumed in planning and designing the new Post Office vision network.

The other two systems are SECAM (from the French System en couleur avec memoire) and PAL (for Phase Alternation Line) which has recently been developed in Western Germany. Both these systems make less stringent demands on the performance of the transmission path.

The Post Office links for networking the existing 405-line television services have been provided by several methods, including carrier systems on coaxial cables, unbalanced video on coaxial cables and microwave radio systems. A frequency bandwidth of 3 Mc/s is needed for the transmission of 405-line video signals but for 625-line standards a bandwidth of about 5.5 Mc/s is required. For various reasons it has been decided to use microwave radio systems during the next few years for providing all 625-line, colour main vision links and unbalanced video techniques for all short and medium distance vision links up to about 25 miles.

Unbalanced video signals are transmitted over the coaxial cable pairs, without change of mode or frequency, by using video amplifiers at a maximum distance of about six miles for 405-line monochrome standards. Since almost all the spectrum below 3 Mc/s is utilised, it is impossible to power feed over the coaxial pairs and special techniques are required to limit the induced hum from adjacent systems.

It is also possible to use unbalanced video amplifiers to provide 625-line, colour links, but, to achieve the required linearity of performance for the transmission of NTSC-type colour signals the output level has to be reduced. Because of this restriction and the greater attenuation of coaxial cable at 5.5 Mc/s the spacing of amplifiers has been reduced to about 3.2 miles and this in turn has led to the provision of additional coaxial intermediate stations.

A new unbalanced video line system, using transistors instead of valves, has been developed and is likely to be used on most of the multi-section video links for BBC-2 but valve-type amplifiers may continue to be used on single-section links.

The transistor amplifiers will take their power from 24 volt enclosed-type batteries, floated across the mains and backed up with long-break engine-sets in stations where the load is likely to exceed the five-day capacity of the battery. These arrangements for supplying power at coaxial intermediate stations are expected to prove much cheaper than conventional no-break power plants which are used to maintain continuous power supplies to valve-type equipment.

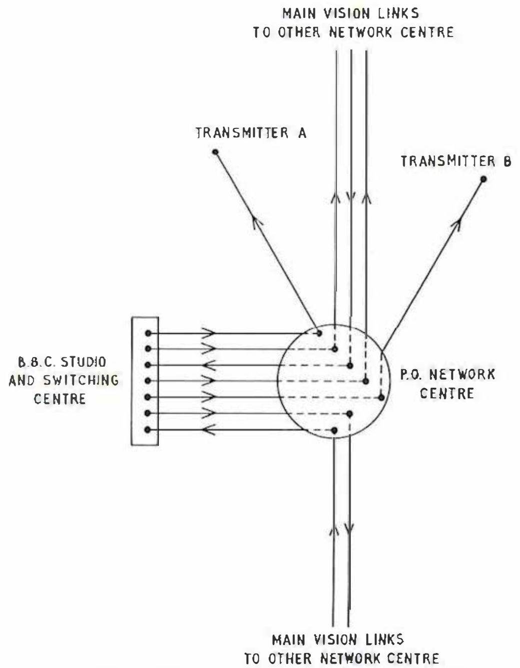
In the past, long distance links have been provided by radio in the 2,000 Mc/s and the 4,000 Mc/s bands, with radio relay stations spaced at intervals of 25-30 miles. When the working radio channels develop faults, additional channels (known as "protection" channels) are automatically switched in. On integrated routes, each protection channel serves a number of working channels.

In recent years radio-relay systems have been developed to the stage where today they can be used for the transmission of 960 telephony channels or alternatively 625-line,colour television signals on each broad-band channel. These modern systems are now being provided in the 6,000 Mc/s band as well as the 2,000 and 4,000 Mc/s bands. Most of the gain is provided at an intermediate frequency centred on 70 Mc/s. A new type of horn-reflector is also available for use on main routes which allows aerials to be shared by several frequency bands. On spur routes, paraboloid aerials will continue to be used.

The Post Office will also provide a number of portable outside broadcast repeaters to 625-line, colour standards (a suitable portable video repeater, using transistors, has already been designed by Post Office engineers for use on either coaxial-pair or telephone-pair cables); portable outside broadcast injection equipment for use at any intermediate radio station to translate the outside broadcast video signals to a band centred on 70 Mc/s for injection at intermediate frequency into the radio channels; and sound and control circuits associated with the vision links. These latter will be provided by conventional means as standard 'music' and speech circuits. Exceptionally, when transmitter vision links are to be provided on microwave radio systems—for example, Manchester-Emley Moor and Southampton-Rowridge—the sound circuits will be derived by using a frequency modulated sub-carrier in the baseband above the video signal.

Network switching (not to be confused with programme presentation or continuity switching) is needed in any television network if programmes originate from more than one point in the vision links and associated sound circuits. For the Independent Television Authority and the programme contractors, network switching is carried out by the Post Office by means of specially-designed equipment installed at each main television centre. Switching of the BBC-1 network is usually done by the BBC on its own premises and for this reason most main, transmitter and local links are extended from each of the Post Office main television centres to the appropriate BBC switching points. Exceptionally, at Bristol and Cardiff, switching equipment in the Post Office network centres is remotely operated by the BBC from its studios at Whiteladies Road, Bristol, and Broadway, Cardiff. Switching of the BBC-2 network will be similarly performed by the BBC but there are likely to be additional remote switching facilities at Carlisle and Southampton.

In planning the new Post Office links for BBC-2 it has been necessary to allow for the possible addition of further links at a later stage for the duplication of BBC-1 and for a second ITA programme.



This diagram illustrates typical connection arrangements at the network centres.

STATION SITES

The BBC, ITA and the Post Office have agreed on the sites of 13 of the first 18 UHF stations which will be set up to transmit the new BBC-2 programme.

Five will be at or adjacent to the existing ITA Band III stations at Winter Hill, Emley Moor, Black Hill, Durris and Dover and eight will be at existing BBC Band I stations at Crystal Palace, Sutton Coldfield, Wenvoe, Rowridge, Pontop Pike, Divis, Tacolneston and Llanddona.

The remaining five stations will be erected on entirely new sites.

THE AUTHOR

Mr. B. F. Dowden, a Senior Executive Engineer in the Engineering Department (LMP Branch), has been concerned with the planning of the Post Office network of television links since 1953. He joined the Post Office in 1927 as a Youth-in-Training in the South-West Section, London Engineering District (now the South-West Area, London Telecommunications Region) and transferred to the Engineer-in-Chief's Office in 1944.

A close-up of one of the new winches as it is made ready to erect a radio mast at Leafield. The winch drum can carry up to 1,100 feet of steelwire rope.

A NEW AID TO EFFICIENCY

By A. A. MACKEMSON and M. HART

NEW powered winches—more efficient and safer than the hand-operated winches they replace—are now in service at the main ETE-controlled radio stations at Rugby, Dorchester, Criggion, Ongar, Leafield, Portishead and Bodmin where they are being used for external construction and maintenance work.

The introduction of these new winches, which were built to Post Office specification and comply with the regulations of the Factories Act, enables work to be carried out more quickly and is a further step in the Post Office plan to make greater use of mechanical aids to improve efficiency. At present they are being employed mainly in erecting partly or wholly assembled structures, such as radio masts of various types, and for hoisting ancillary equipment into position.

The new winch, which is mounted on a trailer and towed by a Land-Rover or similar vehicle, is powered by a five horse-power diesel engine and, using an in-line pulley, can lift direct loads of up to two tons. The winch drum normally carries some 800 ft of 7/16th-inch diameter steel wire rope (the maximum capacity is 1,100 ft) and a special gear box gives rope speeds of 15 and 30 feet a minute in both forward and reverse directions. A dog clutch, which is padlocked for safety when the winch is working, allows the winch drum to be freed from the engine so that the rope can be spooled on and off by hand.

The winch operator has positive control over the movement of a load, lifting it initially at maximum speed and then accurately positioning it by "inching" in either direction by applying light hand pressure on a special engine clutch lever.

In addition to the normal hand-operated friction band type brake on the winch drum, two further features ensure the maximum degree of safety in the event of an emergency. The first is that power transmission is effected through a worm gear so that if there is a power failure (caused, for example, by a broken driving chain) the direction of load movement cannot be reversed by the weight of the load itself. The second feature is that the winch is driven continuously against a drum-type brake associated with the worm gear so that any continued movement of the load after a power failure is inhibited. The engine throttle control is pre-set to ensure that the engine stalls if the maximum load for the winch is exceeded. If the engine or associated gear fails, the winch can be operated by hand to bring a suspended load to the ground.

Above: A 150-ft high steel latice mast at Leafield is hauled into place by the winch.
Below: Task completed, the winch is attached to its Land-Rover and driven away.

GOING UP and UP and UP

THE pictures on these pages show how the Post Office Tower in the centre of London —now the tallest building in Britain—is rapidly taking shape. As the Journal *went to press it had topped* 515 *feet on the way to its eventual height of* 620 *feet.*

The Tower, which should be ready for operation by the Post Office by early 1965 *and will cost* £1,700,000, *is part of the microwave radio link systems which the Post Office is building throughout the country to complement the trunk network underground cable system. It will eventually, if necessary, be able to handle up to* 150,000 *simultaneous telephone conversations and* 40 *or more channels for television, relaying programmes between the studios, control centres and transmitters of the broadcasting authorities and serving as a centre for outside broadcast hook-ups in the Greater London area.*

When complete, the Tower will comprise 16 *circular cantilevered floors of telephonic equipment surmounted by about* 100 *ft of platforms containing aerials. Above these will be public observation galleries, a public restaurant and finally a* 40-*ft high steel mast for future aerials, topped by a storm-warning radar scanner. The public restaurant will revolve once every* 30 *minutes.*

Left: A rooftop view of the Post Office Tower taken from Mullard House and looking westwards over London.

Pictures by
ROY ARGENT

Right: A worm's eye view of the tower taken from Cleveland Mews which runs alongside the Museum Exchange.

LOUD-SPEAKING TELEPHONES

By H. THWAITE

The Post Office is developing a new loudspeaking telephone which will be the most advanced in the world. This article tells the story of loudspeaking telephones and discusses the problems involved in producing effective instruments

An engineer at Dollis Hill at work on the design of the new LST No. 4 which will be constructed as a single unit.

ENGINEERS at the Post Office Research Station at Dollis Hill have designed a new loudspeaking telephone which will operate successfully under all conditions likely to be met on the public network in this country.

This new apparatus—called the Post Office Loudspeaking Telephone No. 4—is believed to be the most advanced of its type in the world. It is now being styled and will become available to customers within the next 18 months.

There are many types of loudspeaking telephone—some voice-switched, some partly switched and others not switched at all—and many forms of layout and individual styling. Each can offer a satisfactory performance under certain conditions but very few indeed are suitable for general use on a public telephone network. The voice-switched LST No. 4 will give this type of service for the first time under conditions where formerly only conventional hand sets could be used.

The LST No. 4 will be a desk-mounted, single unit apparatus, possibly enclosing the entire amplifier and switching equipment. It will be operated from the mains supply and provide all the usual facilities, such as a microphone cut off, handset working and volume control, and will be able to be used with most subscribers' extension plan arrangements.

The concept of a loudspeaking, or hands-free, telephone is not new. Such devices, in one form or another have been advertised by telephone apparatus manufacturers since the mid 1930s and

The author (left) and a colleague take part in a "group" conversation using the American A.E. Company's Speaker-phone. This set is partly voice-switched and will operate from line current. A flashing neon lamp in the press button provides a novel way of indicating when the set is in use.

over a quarter of a century ago the British Post Office—believed to be the first administration in the world to do so—designed and offered to subscribers its first loudspeaking telephone for general use over the public network.

Although the first Post Office loudspeaking telephone was well in advance of its competitors, its performance was not considered good enough to warrant more than limited use by a small section of subscribers. It was complicated, bulky and relatively expensive and by the end of World War Two most of the sets had been recovered.

For some years after World War Two there was neither enthusiasm nor official encouragement for design work on loudspeaking telephones. Commercial sets continued to be offered for intercommunication systems but they were generally of the "press-to-speak" type and not, therefore, truly hands-free. It was not until the late 1950s that development was continued seriously and as time went on advances in electronics and miniaturisation and improvements in components enabled more efficient devices to be produced.

Today, several types of loudspeaking telephone sets are available in this country, elsewhere in Europe and in the United States which give acceptable performances under the working conditions for which they are designed.

The purpose of a loudspeaking telephone is to enable a subscriber to take part in a telephone conversation without having to use a handset. Speaking and listening to the distant subscriber is carried on by means of a microphone and loudspeaker placed on a desk or table in front of the user and, ideally, conversations are conducted as if the distant speaker is present in the same room. Apart from switching on the set, the user is completely free to write or refer to documents and does not have to touch the instrument except, perhaps, to adjust the volume control. The device also allows a number of people in a room to take part in a conversation, extra microphones being fitted if necessary.

The big problem with a loudspeaking telephone is that it repeats or attempts to repeat everything it

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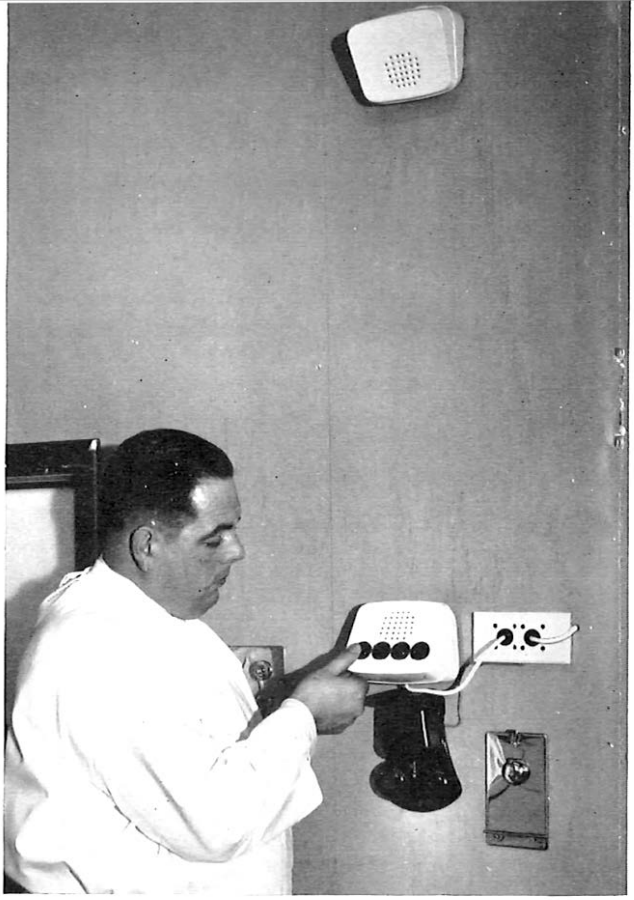


A medical orderly at Dorchester Hospital switches on the LST No. 3—a Post Office instrument designed for use where handling an ordinary telephone may spread infection. In this picture the loudspeaker is seen above the speaker unit.

LOUDSPEAKING TELEPHONES (*Contd.*)

hears—direct speech, background noise and room reverberation, street noises and even the speech output from the instrument's own loudspeaker. With a handset the transmitter is held so close to the lips that the voice level is relatively high. But when the transmitter is removed some distance away, as with a loudspeaking telephone, sounds reach it from several paths and the level of direct speech is considerably reduced. The drop in level caused by acoustic loss of the air path could be compensated by inserting amplifiers in the device in each direction of transmission but the result would be a very noticeable decrease in signal-to-noise ratio and a lowering of quality due to reverberation. This arises because reflected sounds in travelling round a room arrive later at the transmitters and produce a "cathedral" or "echo" effect.

In conversation between people in the same room the reflected sounds are much less noticeable since the listener uses binaural, or two-ear, reception which allows him to listen selectively. On a telephone circuit the distant listener effectively employs only one ear located, as it were, at the loudspeaking set microphone position and he cannot, therefore, exclude the effects of the delayed reflections.

Room acoustics also influence the degree of acoustical coupling between the microphone and loudspeaker and set up a feed-back condition between the loudspeaker, microphone and the telephone instrument loop. On simple loudspeaking telephone sets this produces the effect that the distant party hears his own voice as an echo or, at high levels, the set itself begins to "howl". On more sophisticated systems in which the transmission path is amplified and automatically switched or blocked by voice operation in either the send or receive direction, acoustical coupling causes mutual interference by mis-operating the switching circuits.

Room noise may also bias a loudspeaking telephone to the send direction and thus interfere with incoming speech by causing the initial syllables of a word to be clipped. A high local noise level may even prevent a weak signal from a distant party getting through.

It is obvious, therefore, that to achieve the best performance with the minimum echo and the least possible mutual interference the room in which a loudspeaking telephone is used must be made as non-reverberant as possible, that the person speaking should be close to the microphone—not more than 15 to 18 inches away—and that the loudspeaker should be sited well away from the microphone.

Unfortunately, these conditions are rarely met since users prefer to have their loudspeaking telephone instruments as a single unit with both the loudspeaker and the microphone mounted in it and the entire unit placed well to the back of the desk. This may be an attractive arrangement but the performance may not always be satisfactory. The customer may prefer such an arrangement but this does not alter the laws of physics.

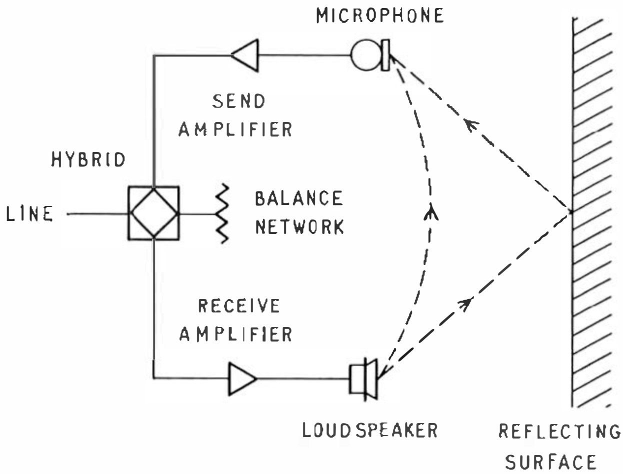
Although there are many different forms of loudspeaking telephone in styling and layout of components there are basically only two methods of circuit operation. One—simple and uncomplicated—is known as non-switched. The other employs switching of speech paths by means of voice operation to overcome the problem of acoustic feedback or "howl" and is known as voice-switched.

In non-switched devices, which are cheap and easy to maintain, both sending and receiving paths are amplified and operate simultaneously and independently without complex switching networks or control. A hybrid transformer, a form of Wheatstone bridge, connects the line to the output of the microphone amplifier and couples the line to the input of the receiver amplifier and loudspeaker. Each amplifier has a gain of about 50 db.

The Post Office non-switched set—the Loudspeaking Telephone No. 1—consists of two units: a telephone No. 706 but with a loudspeaker in place of the dial and has a separate control instrument housing the microphone, an indicating lamp, a dial, ON/OFF key and a three-position volume control key. The transistor amplifiers, hybrid and automatic balance network are contained separately in a small unit normally fitted off the desk. A practical design of a suitable balancing network which can automatically match all line conditions is virtually impossible to achieve, but the hybrid and balance network of the LST No. 1 does match the line over a wide range.

All the units of the LST No. 1 are interconnected by plug-in cords and where extension working is required the telephone instrument is fitted with press buttons. The set is operated from the exchange line current.

The gain of the sending amplifier in the LST No. 1 is adjusted during manufacture and gives an



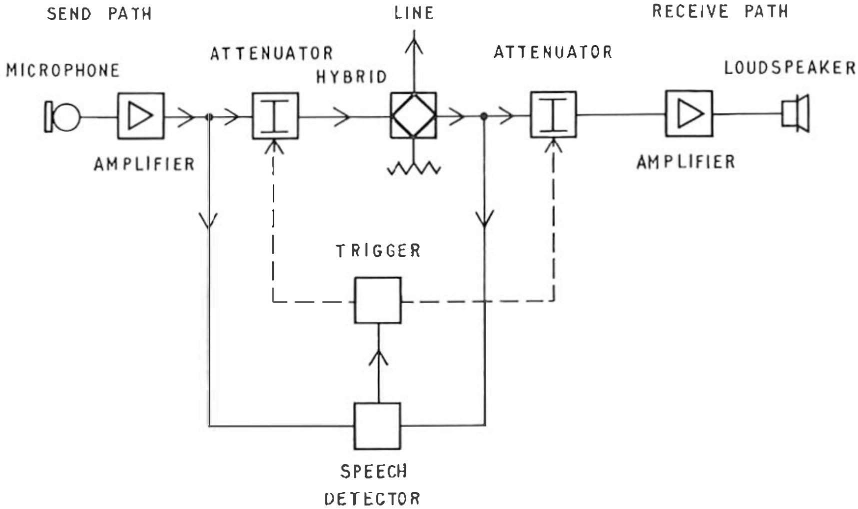
This diagram shows the arrangement of a typical non-switched loudspeaking telephone. The direct air path coupling between loudspeaker and microphone forms a closed loop circuit through the hybrid.

output to line at a talking distance of 18 inches almost equivalent to that from a normal handset. The microphone is electro-magnetic and gives a much better reproduction than the usual handset carbon transmitter which means that it is possible to operate the set at lower transmission levels. The volume control can be adjusted by the user to regulate the receive gain. The amount of gain which can be used before howling occurs is determined by the balance of the hybrid and the acoustical coupling.

A number of other countries have non-switched loudspeaking telephone sets, among them the United States Bell Telephone Laboratories' *Speakerphone* and the German *Silafon*. The

OVER

Below (left): The Post Office LST No. 1. It employs a balance network which automatically adjusts itself with the line current. Below (right): The Bell Company Speakerphone which is a non-switched set.



This diagram shows a simple arrangement of a voice-switched set. Each path is amplified and includes an attenuator which is switched in or out by the trigger under the control of a speech detector.

LOUDSPEAKING TELEPHONES (*Contd.*)

Silafon, which is operated from the line current, has press-buttons for re-connecting the loud-speaker for third party listening while the handset is in use or to connect the receiver amplifier to boost the handset receiver on faint calls. There is also a microphone cut-off key.

Because they are unstable and suffer from echo and side-tone effects, non-switched loudspeaking telephones cannot be used successfully on all calls and are satisfactory only where the overall line loss does not exceed 15 db. They are also unsuitable for loud-to-loud working over short distances because of their tendency to howl.

These problems are overcome in the voice-switched system in which there is full transmission in only one direction at a time, the other direction being attenuated or blocked by switches operated automatically by the send and receive speech signals.

In a voice-switched set the subscriber's line terminates on the usual hybrid arrangement at the instrument where it divides into receive and transmit paths. Each path is amplified and includes an attenuator switched in or out by a trigger under the control of a speech detector. When the circuit is in the listening condition the detector responds in favour of the incoming signal and causes the trigger to free the receive path and block the send path. Since the incoming speech signal from line would otherwise produce about equal levels at both inputs of the detector and thus seriously interfere with the correct sequence of the voice switching operation, some loss (say 10 db) must be intro-duced between the send amplifier and the detector

Below (left): The German Siemens *Halske* non-switched LST and (right) the Danish TFA set which has a separate cabinet for the loudspeaker and amplifier. With the Danish set, switching can take place only during the pauses in conversation.

whenever the set is switched to receive. Similarly a loss must be introduced in the path between the receive amplifier and the detector when the circuit is in the sending condition.

Although it reduces the likelihood of singing, voice switching has its own problems. The most common is the necessity to achieve effortless and clickless switching so that the initial syllables of words are not clipped. Other difficulties which occur are mis-operation to the loudspeaker output (which imposes a serious limitation on the proximity of mounting the microphone and loudspeaker within the same unit); variations in the balance of signal levels due to differences in components; and the feeling of isolation which distant handset users experience due to the absence of all echo and side tone.

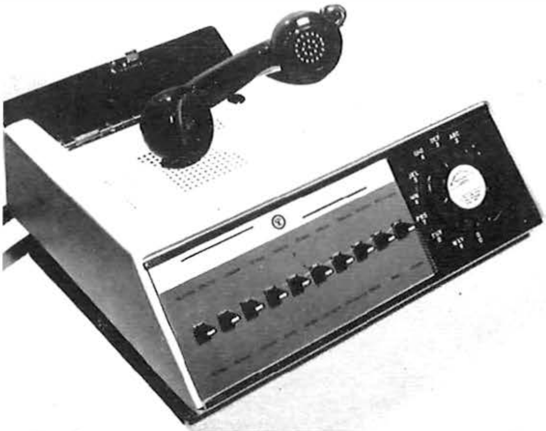
Attempts to overcome these problems have produced all kinds of circuit additions and other modifications which, in some instances, have resulted in the production of complex loudspeaking telephones which are extremely expensive and difficult to maintain and often of little value on a telephone system where the apparatus and line conditions may vary from connection to connection.

Unlike the non-switched set, however, the voice switched loudspeaking telephone can be designed to operate as loud as a subscriber requires.

Most loudspeaking telephones manufactured today employ voice switching techniques in some

OVER

This Automatic Telephone and Electric Company model is similar to the Post Office LST No. 2. The set is fully transistorised and amplifiers and electronic switching circuits are housed inside the case. Power for operating is derived from line current.



Above (top): The GEC single-cabinet type of LST, completely self-contained. A version of this model was adapted for use as the Post Office LST No. 2. (Centre): The ST and C voice-switched instrument; and (below): The Swedish *WeGe* voice-switched set. In a more recent model the loudspeaker is incorporated in the front of the instrument.

LOUDSPEAKING TELEPHONES (*Concld.*)

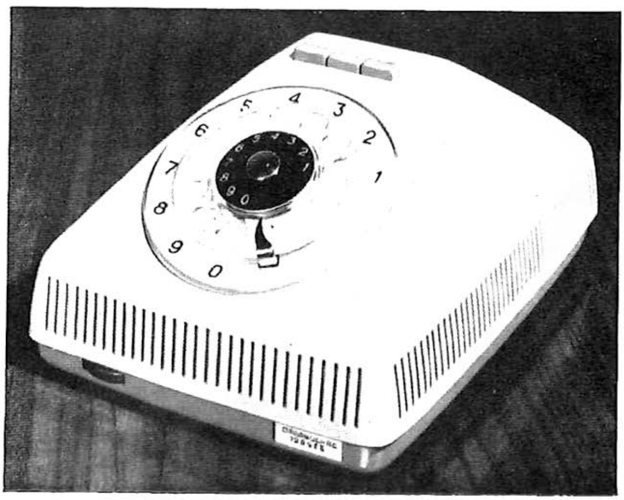
form or another and almost all make use of transistors, which means that the complete assembly can be mounted in a single desk unit. One such set is a version of the GEC model which has been adopted by the Post Office as the Loud Speaking Telephone No. 2.

The Post Office also provides the Loudspeaking Telephone No. 5 for use by disabled or paralysed people who cannot hold a handset (see article "The Post Office Aids the Handicapped" in the Winter, 1963, Journal) and the LST No. 3 for use in places such as laboratories, mortuaries and hospital operating theatres where handling an ordinary telephone instrument could spread infection.

The LST 3, which is non-switched, is made in three units, each enclosed in a waterproof case, with all cables and entries sealed to withstand washing by high pressure hose. The units are mounted on a wall, the speaker unit at shoulder height and the loudspeaker above it. Three levels of volume can be selected by press buttons which are covered in plastic bellows and are the only parts to be touched by hand. Since there is no handset, the third volume level selects the maximum gain of the amplifier and cuts off the microphone to prevent howling. The first of the LST No. 3 instruments was brought into use recently at a hospital in Dorchester.

Loudspeaking telephones present very complex problems but the new LST No. 4, which embodies the most advanced techniques, is expected to resolve most if not all of them. Its appearance will mark a very big step forward.

This is the Swedish *Ericavox*, fully voice-switched and operated from line current. The microphone (behind the three buttons) faces upwards and is sensitive in all directions horizontally so that the set can be used from any position round a desk.

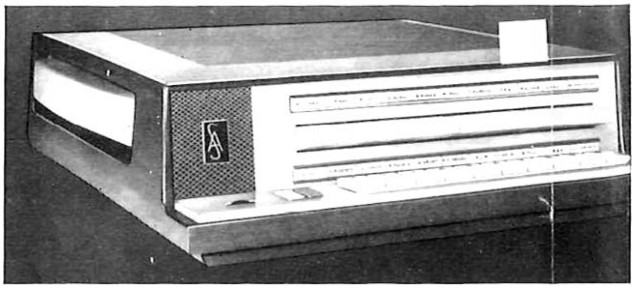


THE AUTHOR

Mr. H. Thwaite, BSc(Eng), AMIEE, is Senior Executive Engineer in the Subscribers Apparatus & Miscellaneous Services Branch who joined the Engineering Department in 1933 as Youth-in-Training in the North Eastern Region. He was promoted Inspector in 1937 to the Telephone Branch, Engineer-in-Chief's Office and was engaged on development and maintenance of exchange equipment and power plant.

In S Branch since 1951, he has been responsible for design and provision of communications equipment to the Services, and latterly for the design of subscribers' special telephone equipment and the Medresco hearing aids for the Ministry of Health.

In World War Two Mr. Thwaite served in the Fleet Air Arm, Royal Navy.



(Above): The American *Shipton* LST, which is designed for a loudspeaker intercommunication system. (Below): The Post Office LST No. 5 which is designed for use by the disabled and paralysed.

HELPING THE HANDICAPPED - 1

By G. W. LEWIS

A disabled patient at the Cheshire Foundation Hospital using the modified telephone. Note the extension levers for buttons A and B and the "lazy tong" arm to hold the telephone.

AN article in the Winter, 1963, issue of the *Journal* told of the many ways in which the Post Office helps the handicapped to use the telephone.

Now comes news from the Guildford Area of an experiment which is being carried out to help partially paralysed patients at the Cheshire Foundation Hospital, Blackmoor, to operate a coinbox.

The experiment has involved making additions and alterations to the equipment so that most of the patients can now make their own calls.

When Post Office engineers from Guildford investigated the problem they found that an extension arm had already been placed on the coinbox to help patients lift the receiver to their ear and this has been left. They also discovered that the patients themselves preferred the returned coin chute to remain in its original form.

Three problems remained. The first was how to help those patients who suffered from uncertain or delayed movement and became distressed and flustered when asked to insert coins. The answer was provided by a tray on which coins are placed before making a call and guided to their respective slots by sliding them between guide plates. When the coins arrive at the end of the guide plates they drop through into suspension, the coin bar having been removed so that no pressure has to be applied to insert the money.

Removing the coin bar produced its own difficulties because the associated spring sets no longer operated automatically when coins were inserted. To overcome this problem an external lever was fitted to operate the spring sets manually. It was then discovered that under these conditions it was possible to obtain free local calls simply by restoring the lever after dialling so that the coins remained in suspension until the end of the call and could be recovered by pressing button "B". This difficulty has been overcome by using the spare contacts associated with the balance arm to short out the transmitter so long as the coins are suspended so that button "A" must be pressed before the call can begin.

Although many patients have the strength to do so many lack the precision of action to find and

OVER

press a small button. For this reason extension levers, each ending in a flat plate have been provided on buttons "A" and "B" so that only a light pressure is needed on this large area to operate the buttons. To help those who cannot dial, a Sender No. 1 is shortly to be installed.

Since some of the patients must lie permanently prone, others can move about only in wheelchairs and others can walk, it has been impossible to give every patient complete ease of operation. This could have been achieved by using a motor-driven apparatus to raise and lower the whole call office backboard over a distance of some 18 inches but the moveable parts would be a source of danger to disabled users and the equipment would be expensive to make.

HELPING THE HANDICAPPED - 2

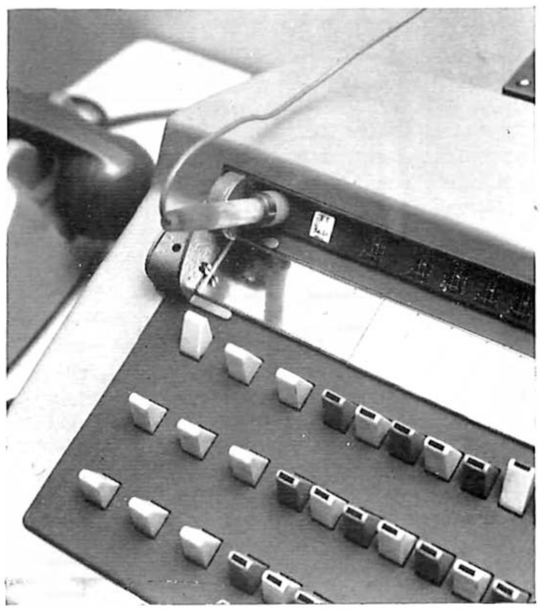
"IN his most interesting article (*The Post Office Aids the Handicapped*) in the Winter, 1963 issue, Mr. R. G. Fidler mentioned an electronic probe for detecting light signals on cordless switchboards.

"Your readers may like to know that such a probe is available for use in conjunction with the small new-style lamp calling PMBXs 2/2A (2+4), 2/3A (3+9), 2/4A (5+20), and the PABX1. When used with the PABX1, the doll's eye plinth is not necessary since the lamp signals can be read directly.

"In its present form the device, which has been developed in conjunction with the Royal National Institute for the Blind, consists of a bracket located at the left hand end of the row of calling and supervisory lamps and held in position by an internal permanent magnet. The probe, when not in use, is held by magnetism against the bracket over the first exchange line lamp. No adaptation to the switchboard is required, other than the connection of four additional wires, and no batteries are used, the small power requirements of the transistor being met by the PMBX power supply.

"The operator knows from the night alarm buzzer, that a lamp is illuminated. She moves the probe along the row of lamps and hears a tone in her earphone when the probe is over the illuminated lamp. There is no difficulty in distinguishing between adjacent lamps, and the probe is not affected by daylight or artificial light in the room".—Major J. A. SHEPPARD, LTR.

Above: A PMBX 2/4A for use at the Jewish Blind Society, fitted with a converter to give an audible signal in the earphone when the probe is over the illuminated lamp. Below: A view of the magnetic bracket and probe when in the resting position.



Technical Officer L. H. Fenwick checks the number of subscribers' lines and the size of the multiple cable at a distribution pole in Waller Road, New Cross, London.

A NEW SCHEME FOR EXCHANGE LINE COSTING

By A. J. LEVELL

A new system for assessing the cost of line plant used for local exchange lines has been introduced recently. This article describes the problems and the advantages of the new techniques

IN the White Paper *Telephone Policy—The Next Steps* of May, 1958, the Post Office said that "the rental paid for the possession of the telephone must cover at least the full cost of the equipment individual to the subscriber." This equipment consists essentially of three main parts—that portion at the exchange which is individual to the subscriber; the line plant from the exchange to the subscriber's premises; and the instrument and wiring at the subscriber's premises.

How is the cost of the line plant used for the average exchange line to be assessed? In the Post Office ledger today, the gross value of local line plant stands at nearly £400 million. This immense amount of plant, of all different kinds and ages, is shared by five-and-a-half million exchange connections, nearly 140,000 private circuits and over 700,000 external extensions. Furthermore, because plant cannot possibly be fitted precisely to needs in every location and at every point in time, and because the Post Office requires plant flexibility to enable it to meet demand for telephone service and to cater for removing subscribers, there must be idle plant, or spare capacity, in the local line network. How then, from this welter of factors, can the cost of the average residence or business line be assessed?

OVER

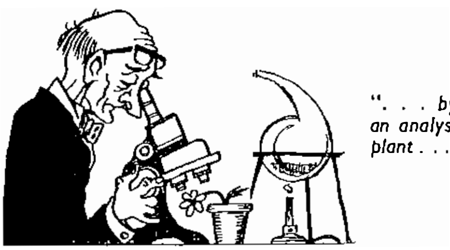
"This immense amount of plant . . ."

Illustrations: E. A. OLDMAN

EXCHANGE LINE COSTING *(Contd.)*

The Post Office accounting system and the engineering cost system do not help a lot. It might be thought that the Accountant General's Department ought so to develop its plant accounts that an answer to the question would be more or less "on tap" from each year's accounts. This would necessitate splitting the present ledger covering the whole of local line plant into separate ledgers for at least three categories—exchange connections, external extensions and the private circuits. A moment's thought will show how impracticable this would be. The engineering classes of work CS and CL would each have to be split into three and fitters and linemen would have to analyse their time accordingly. Every time a pair changed its use from, say, external extension to exchange connection, some document would have to be prepared to give effect to this transfer in the plant ledgers! Clearly this sort of paper empire is just not possible.

It has always been the case, therefore, that assessments of the cost of exchange lines have rested on *ad hoc* studies, using some kind of sampling techniques. The last of these studies took place in 1946-48 and comprised a thorough analysis and costing of the plant in 22 exchange areas. These 22 areas were regarded as representative of



". . . by making an analysis of the plant . . ."

the United Kingdom as a whole but this, of course, was not necessarily a valid statistical assumption. For want of any better basis, however, the 1946-48 analysis has had to be used in costings of exchange lines, adjustments being made from time to time by means of price factors.

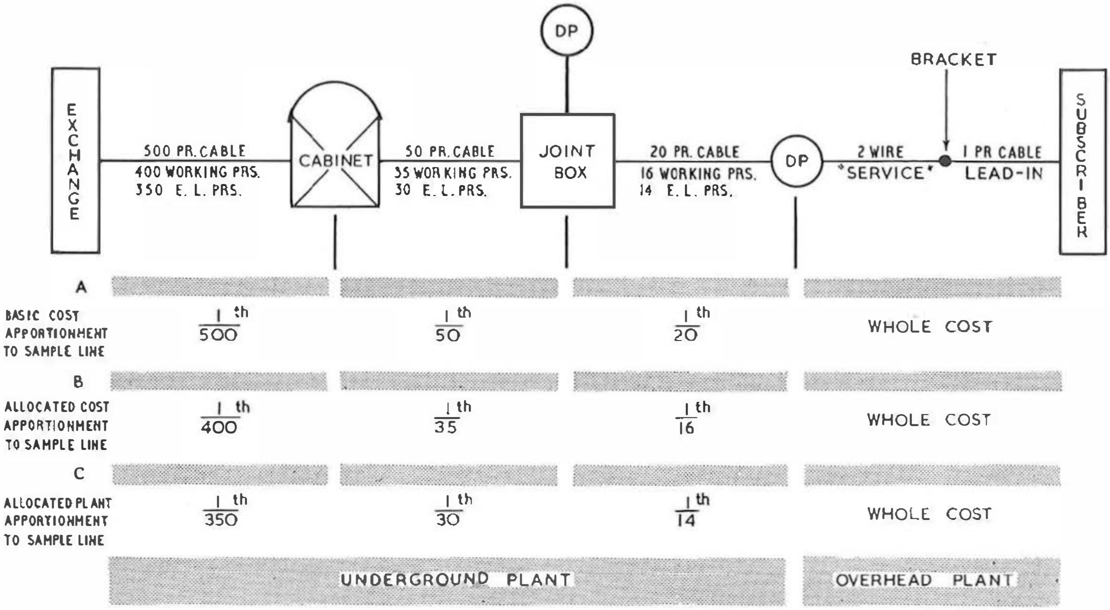
By 1956 it was realised that with the passage of years and developing techniques—such as the use of cabinets and pillars and lighter gauge conductors—a new plant analysis had to be obtained if financial policy were to continue to be soundly based and adequate cost and plant information was to be available for AGD and Engineering Department needs. The method used previously of costing all the line plant existing in a number of exchange areas would not only be statistically unreliable but would also give rise to a large amount of work concentrated in comparatively few areas over a period of, say, two or three years.

The alternative of making a catalogue of all local line cables and then costing a sample of these was considered but this would have meant a good deal of concentrated work and a catalogue of cables had little foreseeable other use. Furthermore, the statistical angle did not seem to be so satisfactory as for the method that was eventually chosen—that is, to cost a sample of individual exchange connections chosen by random sampling methods.

It so happened that the Chief Statistician's Division of AGD were at that time thinking about setting up on punched cards a "sampling frame" of exchange connections. This sampling frame is a central record of exchange numbering ranges (covering both working and spare multiple) and from it could be obtained random samples of exchange connections. By costing individual exchange connections errors due to sampling could be defined and the work of plant analysis spread over the whole country and over a greater period of time, thus causing less upheaval and also holding out some prospect of a continuous sampling scheme that could reflect changes in techniques as the years went by. In addition, the scheme offered an ultimate prospect that, as the size of the cumulative sample increased, between regions variations of cost could be assessed reasonably accurately.

The basic principle of the exchange line costing study, as finally conceived, is that each exchange connection sampled should carry its share of the quantity, and hence of the cost, of common plant used to provide that connection. This is done by making an analysis of the plant used for each sample connection and apportioning to the particular connection its due share of each type of plant—duct, cable, joint boxes, and so on. This apportionment has to be done in three ways in order to give the basic cost of the sample connection; the total cost allocated to the sample connection, including its appropriate share of spare plant; and the total quantity of plant attributable to the sample connection. (This latter is an engineering requirement and includes a weighting not only for spare plant, but also for plant used for miscellaneous purposes—for example, for private circuits.)

This principle of apportionment must be applied to each section of the sample line separately, to



This simplified diagram illustrates apportionment of cable cost. Apportionments on similar principles are carried out separately for duct, cabinets, pillars, joint boxes, poles and so on.

cater for the changes in plant and variations in the number of working circuits along the route of the sample line.

Both AGD and ED felt that before instructions for Telephone Managers' offices could be written about a complex and novel scheme like this, some kind of pilot run was essential. It was decided, therefore, to carry out such an exercise on 100 exchange connections selected by random sampling methods. A few Areas could have been asked to undertake this but it was eventually decided that it would be better for the Headquarters officers concerned to undertake the pilot studies themselves with facilities afforded by four Areas—Exeter, Leicester, Oxford and London/West. Two-men AGD/ED teams were formed who obtained, both from a study of office records and diagrams and from physical surveys, line plant data for 25 lines in each of the four Areas. The work involved in collecting and interpreting the data and in subsequent costing was greater than had at first been thought and the apportionment of costs to sample lines presented formidable numbers of sums to be done. In costing the 100 lines some 70,000 calculations had to be made and checked. The spread of cost even for this small sample was enormous, the capital cost of the cheapest line being £13 and of the dearest about £1,000.

The value of the pilot run was not in yielding any usable results but in testing procedures, indicating what would be involved by the main costing and in disclosing the potentialities of the scheme. With the benefit of this experience, four main conclusions about the future course of the study were drawn.

The first conclusion was that all sample lines would have to be physically surveyed if the information was to be accurate enough for the various applications in mind. It was found that the survey produced significant variations in duct costs compared with assessing such costs from office records.

Second, punched cards or some form of automatic data processing would have to be used for the masses of calculation work involved by the apportionment processes.

Third, something like 4,000-5,000 sample lines would be needed to provide answers within acceptable confidence limits. The collection and processing of data even for this relatively small sample would be a huge task and it was considered that it would not be reasonable to ask Area planning teams, of which there are about 700 in the whole country, to do more than an average of two lines per team per year. Hence it was decided to programme the exercise at a rate of about 1,400 lines a year.

The fourth and final conclusion was that the scheme was practicable and flexible and that it constituted the best means available of providing

OVER

EXCHANGE LINE COSTING (*Contd.*)

the information necessary for future telephone costings to be within acceptable limits of accuracy and for sound technical planning.

Start of the costing

Authority was given for the exercise to go ahead and planning began in earnest. An important improvement—to employ the technique of double sampling and thus somewhat reduce the amount of detailed survey, recording and costing work—was suggested by the Chief Statistician. This involved dividing the exercise into two phases.

In the first phase a large random sample of connections—about 10,000—was selected and Areas were asked to give elementary details of each line (for example, whether business or residence) and to measure and record its radial length.

In Phase Two a fairly small sample—the 1,400 lines mentioned above—of the Phase One connections was selected by random methods for detailed costing, using the radial length ascertained under Phase One as a stratifying factor. In other words, relatively fewer circuits were selected from the more popular distance steps, because their costs are less variable than those in the less popular steps. Thus the desired standard of sampling accuracy was achieved but the overall amount of survey work and detailed recording was reduced.

To date, two Phase One samples have been arranged and completed. Four Phase Two samples have been selected and of these three have been completely finished by Areas. The fourth is currently being dealt with in the field.

Radial length (miles) rounded to nearest tenth of a mile above	NUMBER OF CONNECTIONS IN EACH RADIAL DISTANCE STEP							
	BUSINESS				RESIDENTIAL			
	EXCLUSIVE		SHARED		EXCLUSIVE		SHARE	
	Phase I First S'ple	Phase I Sec'd S'ple	Phase I First S'ple	Phase I Sec'd S'ple	Phase I First S'ple	Phase I Sec'd S'ple	Phase I First S'ple	Phase I Sec'd S'ple
0.0 – 0.2	701	621	20	16	278	300	119	85
0.2 0.4	765	745	21	17	566	567	288	271
0.4 – 0.6	521	494	21	20	612	673	307	289
0.6 – 0.8	352	336	21	23	564	595	304	265
0.8 – 1.0	256	243	24	11	368	483	257	234
1.0 – 1.5	347	396	56	34	537	599	410	387
1.5 – 2.0	151	166	37	33	171	193	178	141
2.0 – 2.5	77	78	15	22	49	50	39	47
2.5 – 3.0	29	35	9	9	9	12	8	10
Over 3.0	23	16	10	4	7	6	10	8
TOTAL	3,222	3,130	234	189	3,161	3,478	1,920	1,737
Mean rad'l len. (miles)	0.636	0.663	1.211	1.229	0.736	0.751	0.855	0.864
Stan. error of mean	0.010	0.011	0.046	0.063	0.008	0.008	0.012	0.013

"... within acceptable limits of accuracy ..."

The Phase One sample not only acted as a stepping stone to Phase Two but also provided useful information about the average radial length of different types of exchange connection—for example, that the average residence exclusive connection is about one-tenth of a mile longer than its business counterpart. This is something, of course, that many telephone people had suspected for a long time, since much residential development occurs on the outskirts of towns. But nobody had been able before this exercise was done to quantify the difference. In rentals costings AGD now allows for the greater amount of line plant used for residence lines.

Mechanics of the Scheme

Three main problems had to be overcome. The first was to decide on a method of processing the data and then arranging so far as possible for field work to be done in such a way as to facilitate this processing. The second was how to calculate formulae to be used for apportioning costs and plant used to an individual circuit, and, the third, how to obtain cost data so that plant can be costed at present-day prices.

On the first problem the initial inclination was to turn to punched cards. But CMBD/COMB later advised that, with so much calculation work to do, the use of a computer would be a better proposition. Further, since this job would not have a week-to-week urgency, it might prove to be useful "fill-in" work for the AGD/LEAPS computers (National-Elliott 405), which had at that time just been installed for payroll work. It was decided therefore to adopt computer methods and to arrange for the data provided by Areas to be recorded in such a way as to make the subsequent punching of paper tape as straightforward as possible. This entailed designing what must have been to Area staff rather strange-looking forms. It was also necessary to code every item of local line plant—about 900 items—and to issue these coding lists to Areas. It was felt to be more reliable, as well as saving time in the long run, for the Area engineering staff who provided the data to encode it, rather than to leave this as a separate operation to be done by LEAPS punching staff, who would not be familiar with engineering descriptions. Briefly, the plan has been to have a facing sheet and a general sheet for each line, giving the main particulars, and then subsidiary sheets for each section of the line, overhead and underground plant being dealt with on different types of sheet.

On the second problem, it was imperative to reduce every apportionment to a formula so that the calculation could be programmed for the computer. An apportionment has to be done separately for cable and duct and for overhead plant, for every section of line through which a sample circuit passes (a section is a stretch of plant, for example, between joint-boxes, with no change in its characteristics. On average there are over 40 underground and overhead sections per exchange line). The sample circuit also has to take its share of items, such as cabinets, pillars and joint-boxes. Some of these apportionments can be expressed by a very simple formula, for example:

Apportionment co-efficient for basic cost—Cable

$\frac{1}{p}$ where p is the total pairs in the cables.

but others are more complex, for example:

Apportionment co-efficient for allocated cost—Joint-Boxes

$$\left(\frac{q}{Q} \times \frac{p}{P} \times \frac{1}{p^1}\right)$$

Where q = number of ways in sample duct group

Q = number of duct mouths accommodated by the jointing point

p = total pairs in sample cable

p^1 = total pairs working in sample cable

P = total pairs in all cables in the sample duct group

In the end satisfactory formulae were devised to meet all conditions and these have been incorporated in the computer programme.

The final problem of obtaining cost data was, on the whole, the easiest to solve. Information was fairly readily available for pricing most stores and labour, but duct, jointing point and buried cable costs presented a real difficulty. Eventually, however, it was found possible to classify duct and so on under 29 footway and carriageway surfaces and to get annual information from Finance branches on the average let prices for contract work. In fact, this information was combined with an existing Regional return which minimised the additional work. All the pricing information is now coded in a table (called a "look-up" table) for use in the computer. This table is changed annually to keep the pricing up to date.

When the first Phase Two sample of lines was sent to Areas the precaution was taken to print only a small supply of the necessary forms so that useful amendments based on field comments and practical experience from the first few hundred lines were able to be incorporated in the main supply.

Present state of the costing

The field work of the scheme has now settled down fairly well into a routine. Areas are advised in June and November of their allocation of the lines to be surveyed during the year. Ceased and removed lines are withdrawn from the sample and the rest are surveyed by Area planning officers. About 4,000 lines have so far been done. The relative forms are sent to the Engineering Department (LLB) for scrutiny from the engineering point of view, and then to AGD where further checks are applied in TCB II before the forms are passed to LEAPS staff who prepare paper tapes from the data.

LEAPS programming staff have devised a programme which enables the computer to transfer all the information to magnetic film, certain checks being applied in the process. Data for over 3,000 lines is now on magnetic film, each line taking about one-and-a-half minutes to be processed in this way. A further programme has been arranged by the LEAPS staff for calculating capital costs under the groupings required by AGD and at the time of writing, the results for just over 2,000 lines—the first two years' work in the field—have been produced by the computer at a rate equivalent to about 50 lines an hour. These results show the inclusive capital costs for different types of lines divided into various categories of plant, for example, poles, wires, cable, duct and so on. From these capital costs the AGD will evaluate annual costs.

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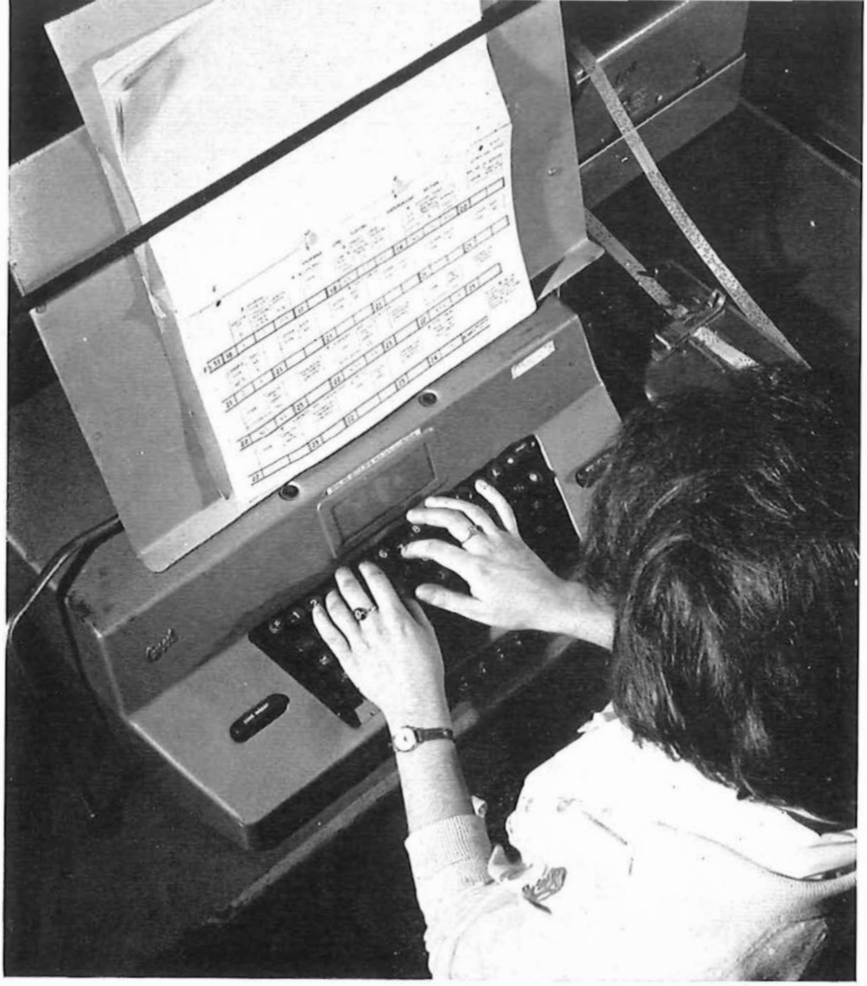

A LEAPS operator prepares a paper tape from encoded information on an exchange line costing survey form for an underground section of plant. The information on the paper tape is processed by a computer which transfers it on to magnetic film.

EXCHANGE LINE COSTING *(Concluded)*

It is too early yet to comment on these first results, which are still being analysed, but there are some indications that the capital cost of some types of line may prove to be somewhat lower than has hitherto been estimated. Shared service lines are costed first as exclusive and then as shared service. This procedure has the advantage of giving a result for exclusive lines more quickly, and the difference, of course, represents line plant savings from shared service. These savings appear to be slightly larger than has hitherto been thought. These points are merely indications however. Studies are not yet complete and the Chief Statistician has also to examine the results to decide what is the likely degree of sampling error.

Further programmes will be devised in due course to give the Engineering Department the plant information it requires. Generally ED's requirements will be met by less frequent use of the computer than will AGD's but perhaps in longer runs. The kind of information ED expect to obtain will include, for example, the total amount of "in situ" plant (this will be presented in plant groups and the information given in total and for various sizes of exchanges); the composition of an average mile of plant for the various types of construction; and the average route length of an exchange connection in various parts of the network, for example, exchange to cabinet. In addition, the programmes should provide information about the percentage of exchange connections served by each type of construction, for instance, open wires from ring type DPs; the percentage distribution of exchange connections served from the Main Distribution Frame to the subscriber (direct, via cabinet and pillar, via cabinet only, and via pillar only); and the average transmission equivalent resistance and signalling resistance in radial mileage steps.

It is intended to keep exchange line costing going at its present rate until sufficient information is available to give results within reasonable confidence limits for both AGD and ED requirements. It is then expected that the study will continue at a reduced rate as a permanent feature so that information may be kept up to date with a minimum of effort.

Conclusions

A study of this character and size has called for the closest co-operation between staff at Headquarters, Regional Headquarters and in Area offices and this has been willingly forthcoming. At Headquarters the exercise has been run by an informal committee composed of officers from the AGD (Chief Statistician's Division, Inland Telecommunications Division and LEAPS) and from ED (Local Lines Branch). The engineering aspect of the scheme has been described rather more fully in an article in the IPOEE Journal, October, 1963, by J. R. Goldsmith and H. D. Hewstone, and the author wishes to acknowledge his debt to them for some of the material in this article.

What do we expect to get from this expenditure of time and effort? Financially, the exchange line costing will provide an up-to-date means of assessing the profitability of the different types of exchange connection and also give local line plant costs for general use in the AGD (for example, for costing private circuits and external extensions). From the engineering point of view the study will give average costs of local line plant for estimating purposes, will help to indicate the effect of changes in engineering methods and procedure in the local line network and will give "in situ" plant values for use in assessing the average lives of plant groups. In short, although the exercise may seem to Area people to be very much of a form-filling one, the processing of all this data will provide valuable information on both costs and plant quantities and should be of great assistance to Headquarters in formulating financial and engineering policy. It is a tool of management that we can ill afford to do without.

THE AUTHOR

Mr. A. J. Levell entered the Post Office as an Executive Officer in 1935. For some years, apart from Forces service, he was on the postal side of the AGD, being promoted HEO in 1945. In 1949 he became a Senior Executive Officer in the Central Organisation and Methods Branch at Headquarters and in 1953 a Chief Executive Officer. Most of his assignments in that Branch were connected with Telephone Area offices' work. Returning to the AGD, he took up duty as CEO in the Inland Telecommunications Division in 1956 and became head of that Division on promotion to Assistant Accountant General in January, 1959.

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NEW YEAR'S HONOURS

Nine members of the Post Office telecommunications staffs received awards in the New Year's Honours List.

Mr. R. W. White, Assistant Staff Engineer at the Post Office Research Station, Dollis Hill, received the OBE and Mr. J. W. Hotham, Executive Engineer, Telephone Manager's Office, Tunbridge Wells, the MBE.

Seven received the BEM. They were: Miss H. Dibble, Chief Supervisor, Peterloo Exchange, Manchester; Miss E. N. Keith, Chief Supervisor, LTR Flexocopy Unit; Miss D. F. Berwick, Chief Supervisor, Southend-on-Sea; Mr. H. T. Trigg, Technical Officer, Atherstone; Mr. J. M. Riva, Leading Technical Officer, Edinburgh; Mr. A. Lee, Technical Officer, Post Office Research Station, Dollis Hill; and Miss D. J. M. Knight, Supervisor, Evesham.

Miss E. N. Keith, who received the BEM, has been in charge of the London Flexocopy Unit since its inception in 1954.

A NEW RELAY IN ORBIT

ANOTHER space communications satellite is orbiting the earth. It is *Relay II*, a space switchboard with a long life expectancy, which was launched from Cape Kennedy, Florida, on 21 January, and it is circling the earth every three hours and 15 minutes along a path inclined at 47 degrees to the equator.

Relay II's mission is to continue the work of its successful sister satellite *Relay I* and to test the improvements built into the new spacecraft. Its communications experiments, including television, will help to determine the possibility of this type of spacecraft in future operational space communications networks.

At the same time, space engineers will be able to obtain more information on a spacecraft's lifetime. The new *Relay* will send back to earth data about the radiation it encounters and the damage which radiation may cause to its components.

Relay II is identical to *Relay I* in most respects but, since scientists wish to know how long the transmitting equipment will last, it has no automatic cut-off device. It also has different solar cells which provide greater resistance to radiation, different transistors for the voltage regulator, and electrically-operated mechanical switches. It can transmit one-way wide-band communications (television, 300 one-way voice channels or high speed data) or two-way narrow-band communications (12 two-way telephone conversations or Teletype, photo-facsimile and data).

During its first orbits of the earth the new satellite will be in a position to transmit television programmes lasting for up to one hour between Europe and the United States. By April periods of mutual visibility will last as long as 70 minutes, falling to as little as ten minutes in the autumn as the satellite apogee moves south.

During the early months of the satellite's life wide-band experiments and demonstrations will be conducted between the Post Office satellite ground station at Goonhilly Downs, Cornwall, and stations in the United States, France and Japan. Narrow-band experiments will be carried out between the United States and Brazil.

The new *Relay* weighs 172 lb and is an eight-side prism tapering at one end. It is 33 inches high and 29 inches in diameter at its broad end. The exterior is composed of eight honeycomb aluminium panels studded with 8,215 solar cells.

***Relay II* is examined by a technician at Cape Kennedy, Florida, before being launched. *Relay II* has over 8,000 solar cells.**

A PEAR-SHAPED EARTH

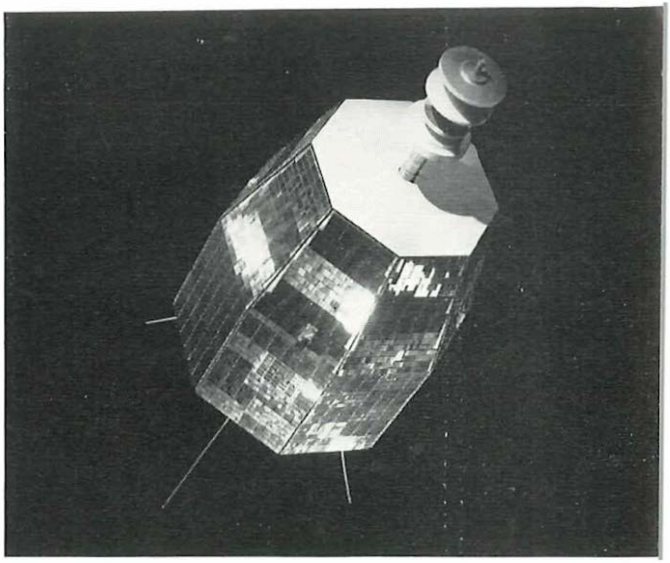
The earth is pear shaped. This discovery has been made by scientists who have been examining those telemetry tapes which record data obtained from a number of satellites which have orbited the earth since 1957. In addition, the scientists believe that hitherto unsuspected layers of helium, hydrogen and cosmic dust surround the earth far beyond the oxygen-nitrogen atmosphere which people can breathe.

THE SATELLITE THAT WON'T GIVE UP

RELAY I, the United States communications satellite which was intended to commit suicide by the end of 1963, was still very much alive and transmitting messages when the *Journal* went to press at the end of January.

The apparent reason for the failure of the destruction device to operate was that the satellite was colder than scientists had predicted, thus slowing up the chemical reaction which eats through a vital wire.

Since *Relay I* was launched in December, 1962, it has been used in about 2,000 communications experiments.



This is *Relay I*, the American satellite which was supposed to commit suicide but which is still transmitting messages.

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SOON A NEW SYNCOM

A new Syncom *satellite which will orbit the Pacific Ocean to relay communications between the United States and Asia from a height of 22,300 miles above the earth, will be put into orbit from Cape Kennedy within the next few months.*

The new Syncom *will orbit above the equator at a point precisely above 180 degrees longitude in mid-Pacific. Two Pacific terminals—one a land station at Camp Roberts, California, the other the communications ship* Kingsport *now anchored at Guam—will send and receive communications by way of the satellite. The new satellite is an experimental forerunner for a permanent three-satellite system which is planned to provide a continuous global coverage.*

A Manned Space Laboratory

The United States is to launch a semi-military manned space laboratory into orbit in late 1967 or early 1968. The space laboratory will consist of a modified two-man *Gemini* space craft and a cylinder the size of a small caravan which will house the laboratory equipment.

The whole vehicle will orbit the earth at a height of about 350 miles and stay in orbit from two to four weeks at a time. The cylinder may be left in orbit when the first crew returns to earth.

OCEANOGRAPHY BY SATELLITE

For the first time recently, oceanographic data was transmitted by way of a communications satellite.

It happened during an eight-nation oceanographic survey of the tropical Atlantic Ocean. The data was collected to depths of about 3,000 feet between Pointe Noire, the Republic of Congo, and Freetown, Sierra Leone, and processed on board the US Bureau of Commercial Fisheries research vessel *Geronimo* before being encoded and transmitted to Kingsport, the *Syncom II* surface station anchored in Lagos Harbour, Nigeria. From Kingsport, the data was transmitted to the *Syncom II* satellite—some 22,300 miles above the earth—which relayed it to Lakehurst, New Jersey. From there the information went by conventional ground lines to the National Oceanographic Data Center in Washington.

FIRST TRANS-PACIFIC TV

The first television programme across the Pacific was carried out on 22 November, 1963, when a telecast demonstration was transmitted from California, to a receiving station in Japan, by way of the communications satellite *Relay I*, orbiting the earth at a height of 4,000 miles.

A second satellite communications ground station is to be opened in Japan next summer. **OVER**

SATELLITE ROUND-UP

(Concluded)

Technicians at work on Western Germany's new mobile satellite ground station.

AND NOW A *MOBILE* GROUND STATION

WESTERN Germany's first transportable satellite ground station has been opened at Raisting, in Bavaria.

The terminal, which is completely self-contained and can travel by road and be shipped by sea, air or rail to any remote destination, can work with communications satellites of the *Relay* and *Telstar* type, providing 12 two-way voice channels.

The equipment can handle facsimile, multi-channel teleprinter circuits and high speed data transmissions.

The station was designed and built by the International Telephone and Telegraph Corporation and installed by Standard Elecktrik Lorenz and engineers of the ITT and the German Postal, Telegraph and Telephone administration.

THE PROBLEMS POSED BY PAINT

By Dr. P. E. TAYLOR

Complaints from staff in telephone exchanges started off an Engineering Department investigation into the possible effects which paint may have on people and apparatus. This article tells the story

THE Engineering Department's Test and Inspection Branch has been carrying out an investigation into an unusual problem.

It all began when people who work in apparatus rooms at telephone exchanges complained about the unpleasant—and, some claimed, unhealthy—smells given off by paints when the rooms are redecorated. It was also reported that the paint fumes were responsible for an increased number of faults caused by the sticking of the selector mechanisms. Since a survey showed that trouble of this sort was fairly common the Subscribers Apparatus and Miscellaneous Services Branch asked the Test and Inspection Branch to investigate the problem and if possible to suggest a remedy.

The paint used for redecorating apparatus rooms is bought by the Ministry of Public Building and Works and has to comply with a Government specification. It is the same as that used in office buildings generally—the ordinary hard gloss paint normally used by decorators—and consists of a drying oil modified synthetic resin of the alkyd type, thinned with a mixture of solvents and containing pigments, extenders, driers, anti-skinning agents, anti-settling agents, dispersing agents and so on. The ingredients responsible for the smell are the drying oil and the solvents.

With the aid of an odourometer which uses the human nose to detect the intensity of unpleasant smells, several members of the investigating team carried out experiments and found that the solvents were comparatively innocuous and that the drying oil was responsible for most of the unpleasantness.

The sticking of selector mechanisms was a more puzzling problem. It was first suggested that the paint "fumes" were condensing on the bearing surfaces as the temperature fell in the evening, but this did not stand up to investigation since it was possible to calculate that the concentration of vapours did not rise to even a tenth of the saturation value.

Later, it was suggested that the aldehydes and acids from the drying oil were polymerising on the bearing surfaces but this too was disproved when the sticky deposits were shown to be oxidised lubricating oil which could not have come from the paint. Another possibility was that the solvent vapours were causing the lubricating oil to creep away from the bearings. It was possible to show in the laboratory that oil will creep over a metal surface more rapidly in the presence of solvent vapours but so far it has been impossible to demonstrate this effect in selectors.

Enough evidence has been collected to show that both the unpleasant smells and the increased fault rate are likely to continue so long as oil-based paints are used for redecorating. An obvious remedy is to use an emulsion paint which evolves only water vapour during drying. Paints of this type have other advantages, such as freedom from tendency to discolour with age, and it is hoped soon to arrange a field trial so that their suitability for apparatus rooms can be studied.

The problems of smell and vapours apart, the periodic repainting of apparatus rooms remains a nuisance and it may not be too fanciful to suggest that the apparatus rooms of the future will have surfaces which do not need re-painting within the normal life of the building in perhaps plastic surfaced hardboard or laminates.

OVER

The decoration of exchange apparatus rooms is only part of a general problem of providing a suitable environment for exchange apparatus. The Engineering Department is also studying the methods of forced ventilation used at exchanges in "dirty" areas. Even in "clean" areas sulphur compounds in the atmosphere tarnish silver contacts and this is the subject of another investigation being carried out at Research Branch. It has been known for at least ten years that make and break contacts operated in an atmosphere containing certain organic vapours will show a progressive rise in contact resistance. Recently an investigation carried out by an equipment manufacturer at the request of the Post Office showed that this could even occur in the contacts of the 706 telephone when exposed to the vapours from domestic floor polish. Obviously, there is a possibility that vapours evolved during painting could affect the contacts of exchange apparatus in the same manner, although this has not yet been shown to occur.

This instrument—an odourometer—is used to measure the intensity of unpleasant smells. In the Engineering Department's test it found that the drying oil caused the greatest amount of unpleasantness.

The Author

Dr. P. E. TAYLOR is a Chief Experimental Officer controlling the London Materials Section of the Engineering Department's Test and Inspection Branch. He holds a PhD for post graduate work as an external student of London University and is an Associate by election of the Royal Institute of Chemistry. He is also a member of the Oil and Colour Chemists Association. Dr. Taylor says that much of his real education has been due to the stimulus of working in the Materials Section where he has been, man and boy, for over 30 years. He thinks that the benefits of the application of science in general and chemistry in particular have as yet scarcely been tapped and finds that discussion with the "man on the spot" and personal inspection of problems is often more fruitful than discussion in committee or lengthy correspondence.

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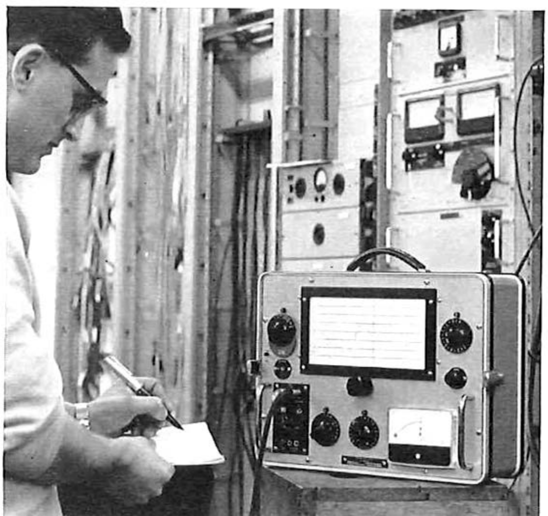
A NEW TRANSISTORISED OSCILLATOR



A new portable, general-purpose transistorised oscillator—known as the 74306-A and operated from dry cells housed in the oscillator case or from an external direct current supply—has been introduced by Standard Telephones and Cables Ltd.

The new oscillator, which covers the frequency range 10 kc/s to 20 Mc/s in eight bands, uses printed circuit techniques, delivers output levels of 0 to —50 dbm (continuously variable) into 75 ohm unbalanced circuits. By means of a built-in transformer and a U-link, the output can be fed into 140 ohm and 600 ohm balanced circuits at frequencies of up to 600 kc/s.

Apart from its use as a general-purpose instrument, the new oscillator can be applied in testing and maintaining multi-circuit open-wire or cable systems, including coaxial cable telephone systems. Its frequency range includes the line, pilot and carrier frequencies of the latest 12 Mc/s coaxial cable systems.

This is the 74306-A oscillator seen in use at a Post Office trunk switching centre.

EIGHT AREAS FOR PAY-TV

LICENCES are to be offered to five companies, entirely independent of each other in control and finance, to operate experimental pay-television services in eight areas of England and Scotland.

The experiment, which was envisaged in the second White Paper on Broadcasting, is aimed to provide information on public reaction to pay-television, and the eight areas have been chosen to cover as wide a cross-section of the community as possible.

The companies and the areas in which they will operate are as follows:

1. *Caledonian Television Ltd: Penicuik (near Edinburgh) with possible extension elsewhere in Scotland.*
2. *Choiceview: Leicester, with an option later of an extension in the London area.*
3. *Pay-TV Ltd: Sheffield and certain London boroughs, initially Westminster and Southwark.*
4. *Telemeter Programmes Ltd: an area in the north of England and a London area comprising Merton, Morden, Mitcham and Wimbledon.*
5. *Television Ltd: an area including Luton and Bedford and probably some towns in Hertfordshire and a London area.*

The pay-television experiment will operate over relay networks and the service can be taken as an additional programme either by relay subscribers or by viewers using their own sets which pick up BBC and ITV programmes direct.

Programmes will be the responsibility of the Pay-TV licensees and payment for them will be made either by fitting a slot meter to viewers' sets or by a device which will record the programmes viewed so that they can be billed later. In some instances there will also be an installation charge and a rental for the meter.

The licences will operate for three years and the operators are expected to start their services by late 1964.

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THE POST OFFICE AIDS THE PRESS

TO assist the Press in covering the Great Train Robbery trial at Aylesbury the Post Office have provided a mobile van containing ten telephone call offices and a telex call office.

The telephone call offices, of the modern pay-on-answer type, are housed in a specially-designed vehicle. Each has its own booth complete with a seat. These call-offices are so designed that they will work to any kind of system—manual, STD or ordinary automatic. Because of the pressman's habit of making transfer charge calls, seven of the offices are connected direct to the automanual switchboard at Aylesbury so that calls can be made on demand. The other three call offices have STD facilities.

The telex call office is equipped with four teleprinters in a long caravan which, with the telephone call offices, has been placed just outside the building in which the trial is taking place.

Commenting on these special communications arrangements, Mr. Alan Lofts, Thomson Newspapers' Crime Reporter said: "*They are extremely good. I would like to see these facilities extended and used for all big news stories.*"

Mr. Arnold Latcham, of the Daily Express, said: "*They are the best facilities I have encountered in 17 years' experience.*"

Radio System for Public Transport

To speed traffic and reduce rush hour delays in the centre of Stockholm, the city's 900 buses and trams have been fitted with radio telephones which are in communication with a central control station manned night and day. Under the scheme a reserve fleet of some 30 buses is held in constant readiness to be used when required, being directed by the control centre with the help of continuous reports from the public road transport drivers.

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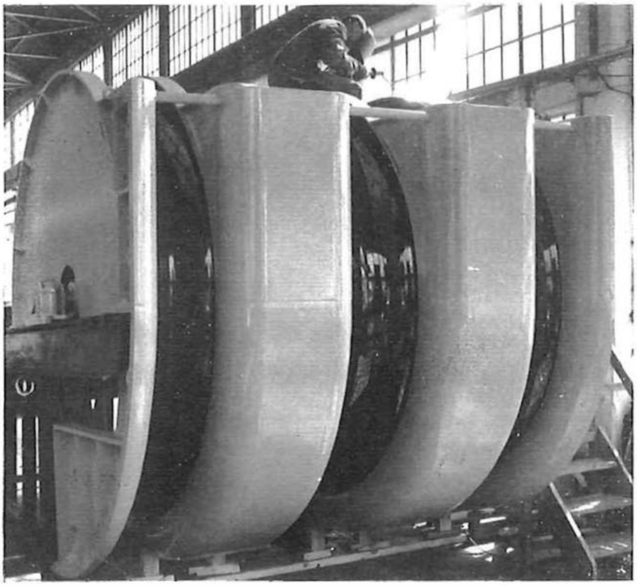
In the article *The Ray Supervision and Training Scheme* by J. E. D. Stark and C. Hall in the Winter, 1963, issue of the *Journal*, a caption on page 13 said that the two diagrams illustrated the proportion of a recruit's time spent on training. They showed, in fact, the proportion of her time spent by a supervisor on training.

OVER



THE FIRST DUAL-PURPOSE CABLE SHIP

A welder at work on the 15-ton bow sheave assembly of the new 6,000 ton Canadian icebreaker-cum-cableship, the first dual-purpose vessel of its kind, which is now being built for the Canadian Department of Transport by Canadian Vickers Ltd., of Montreal.

This picture was taken at the Greenwich Works of Submarine Cables Ltd, which is supplying the whole of the cable-laying machinery—valued at some £200,000—for the new ship.

Photograph: Courtesy British Insulated Callender's Cables Ltd.

TWO NEW REGIONAL DIRECTORS

THE *Journal* offers congratulations to Mr. E. E. Neal and Mr. E. T. Vallance who have been appointed Director of the Post Office, Wales and Border Counties and Director of the Post Office, Scotland, respectively.

Mr. Neal, who succeeds Mr. K. H. Cadbury, joined the Post Office in 1929 as an Assistant Traffic Superintendent (Telephones). In 1944 he was promoted Inspector in the Inland Telecommunications Department at Headquarters in London to plan, open and control a special training school for all Post Office telecommunications staff in Britain. In 1947 he became Assistant Controller of Telecommunications in Home Counties Region and in 1951 Telephone Manager in London North Area. Later, Mr. Neal was Staff Controller at Cardiff before being appointed Deputy Regional Director, North Western Region in 1961.

Mr. Vallance succeeds Mr. W. H. Penny, the present Director, Scotland, who retires on 31 March. Mr. Vallance, who began his Post Office career as an Assistant Traffic Superintendent, was appointed Assistant Postal Controller at Scottish Headquarters in 1936. Subsequently he held the posts of Senior Assistant Postal Controller and Head Postmaster at Glasgow before being appointed Deputy Regional Director, Scotland, in July, 1962.

PITHY PARAGRAPHS

* *A further link in the trans-America telephone cable link was opened between Boston and Missouri in November, 1963. The cable, which cost £70 million to complete, is dug four-feet deep into the ground and, says the American Telephone and Telegraph Company which laid it, "will resist nuclear blasts, hurricanes, earthquakes and floods."*

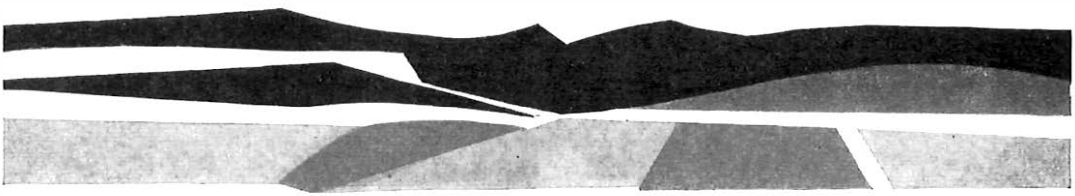
* The "999" emergency telephone service in London last year dealt with 451,333 calls, nearly 81,000 more than in 1960. Of this number, 296,926 calls were made to New Scotland Yard, 29,200 to the London Fire Brigade and 125,207 to the London Ambulance Service.

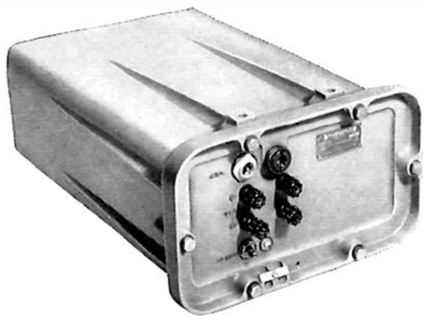
* *There are now 65,000 telephone kiosks in the United Kingdom. The average cost of a kiosk and its associated equipment is nearly £300. An additional £60 a year is spent to cover the cost of maintenance and replacing stolen and damaged equipment.*

* By the end of November, 1963, the number of combined television and sound radio licences in Great Britain and Northern Ireland was 12,777,635. Sound only licences totalled 3,128,433, including 567,331 issued for sets fitted in cars.

* *Following an agreement between the Governments of Pakistan and Japan a Telecommunication Research Centre is to be set up at Haripur, in Pakistan, to conduct theoretical and practical research, to train Pakistani staff in the methods of conducting telecommunication research and to promote the development of systems and equipment. Japan will provide the equipment and technical staff.*

New improved reliability with the A T & E 'Country Set'





The 'Country Set' VHF frequency modulated radio-telephone has been specially designed to operate efficiently and with field-proven reliability in an extremely wide range of different environmental conditions. It provides isolated subscribers with a complete telephone service and by means of an in-built out-of-band tone relay set, it can work directly into an automatic or manual exchange with full signalling and supervisory facilities including dialling. Other versions provide for junction operation (auto or manual) between exchanges. The improved 'Country Set' with its transistorized receiver is designed to run continuously from a 12 volt source (either primary or secondary batteries). Two versions of the equipment are available operating in the frequency range of 54-88 Mc/s and 156-184 Mc/s; units are also supplied to provide a variety of selective calling and party line facilities. The 'Country Set' Rural Telephone is just one of a wide range of commercial equipments built by A T & E, who also offer a comprehensive planning, surveying and installation service. If you would like more details, please write to:

AT&E (Bridgnorth) Ltd. Bridgnorth, Shropshire, England
Automatic Telephone & Electric Co. Ltd.
A Principal Operating Company of the Plessey Group

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Telecommunications Statistics

	Quarter ended 30 *Sept*, 1962	*Quarter ended* 30 *June*, 1963	**Quarter ended 30 Sept, 1963**
Telegraph Service			
Inland telegrams (excluding Press and Railway)	3,253,000	2,435,000	**2,695,000**
Greetings telegrams	895,000	615,000	**757,000**
Overseas telegrams:			
Originating UK messages	1,610,000	1,560,000	**1,646,000**
Terminating UK messages	1,619,000	1,573,000	**1,669,000**
Transit messages	1,245,000	1,239,000	**1,264,000**
Telephone Service			
Inland			
Gross demand	122,000	140,000	**155,000**
Connections supplied	100,000	117,000	**129,000**
Outstanding applications	150,000	167,000	**174,000**
Total working connections	5,272,000	5,402,000	**5,457,000**
Shared service connections	1,107,000	1,097,000	**1,097,000**
Total inland trunk calls	†135,567,000	147,978,000	**155,864,000**
Cheap rate trunk calls	†33,775,000	33,909,000	**37,295,000**
Overseas			
European: Outward	981,000	1,140,000	**1,161,000**
Inward	980,000	1,010,000	***1,034,000**
Transit	10,000	11,000	***11,000**
Extra-European: Outward	84,000	94,000	**92,000**
Inward	105,000	115,000	***115,000**
Transit	†14,000	17,000	***17,000**
Telex Service			
Inland			
Total working lines	10,000	11,000	**11,000**
Metered units	22,333,000	29,777,000	**27,637,000**
Manual calls from automatic exchanges (Assistance and Multelex)	2,000	4,000	**3,000**
Calls to Irish Republic	19,000	26,000	**27,000**
Overseas			
Originating (UK and Irish Republic) ...	1,302,000	1,641,000	**1,692,000**

Figures to nearest thousand. † Amended figures. * Includes estimated element.

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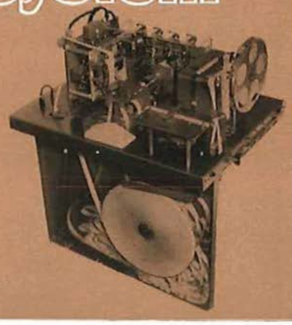
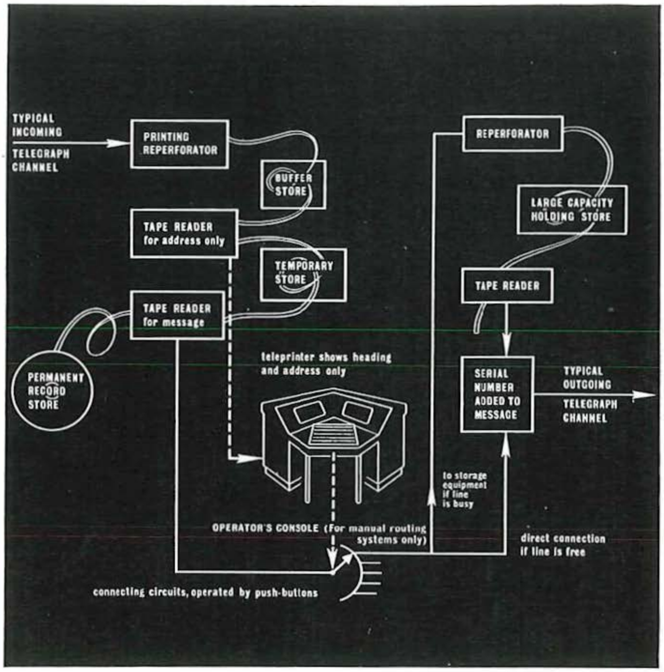
Contributions. The Editorial Board will be glad to consider articles of general interest within the telecommunications field. No guarantee of publication can be given. The ideal length of such articles would be 750, 1,500 or 2,000 words. The views of contributors are not necessarily those of the Board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

Communications. Communications should be addressed to the Editor, Post Office Telecommunications Journal, Public Relations Department, Headquarters, G.P.O., London, E.C.1. Telephone: HEAdquarters 4345. Remittances should be made payable to "The Postmaster General" and should be crossed "& Co."

GPO

tape relay telegraph system





AMATI — Advanced Manual Automatic Tape Interconnector, the new STC/Creed Tape Relay Telegraph System, compatible with all-electronic systems, is designed for use in locations where the expense of more sophisticated telegraph systems cannot be justified. STC Switching Techniques and Creed Telegraph Machines combine to give efficient and high-speed routing of telegraph messages. Facilities offered include: High-Speed Cross-Office Transfer □ Universal Operation (mixed if required) i.e. **(a)** Torn tape—semi-automatic routing. **(b)** Continuous tape—semi-automatic routing. **(c)** Continuous tape—automatic routing □ Centralized Operating Position for Manual Routing Systems resulting in high operating efficiency □ Mixed Receiving and Transmission Speeds—depending on the speeds of the particular circuits concerned □ Electronic Circuitry combined with simple electro-mechanical switching □ Automatic Checking of incoming serial number □ Automatic Generation of message heading e.g. serial numbering, date and time transmission □ Permanent Record of messages □ Individual Storage of Incoming Duplex Lines on continuous tape systems □ Common Pool Outgoing Storage (each store catering for at least 3 6000 characters) □ Write, 'phone or Telex, Standard Telephones and Cables Limited, Telephone Switching Division, Oakleigh Road, New Southgate, N.11. Telephone ENTerprise 1234. Telex 21612.

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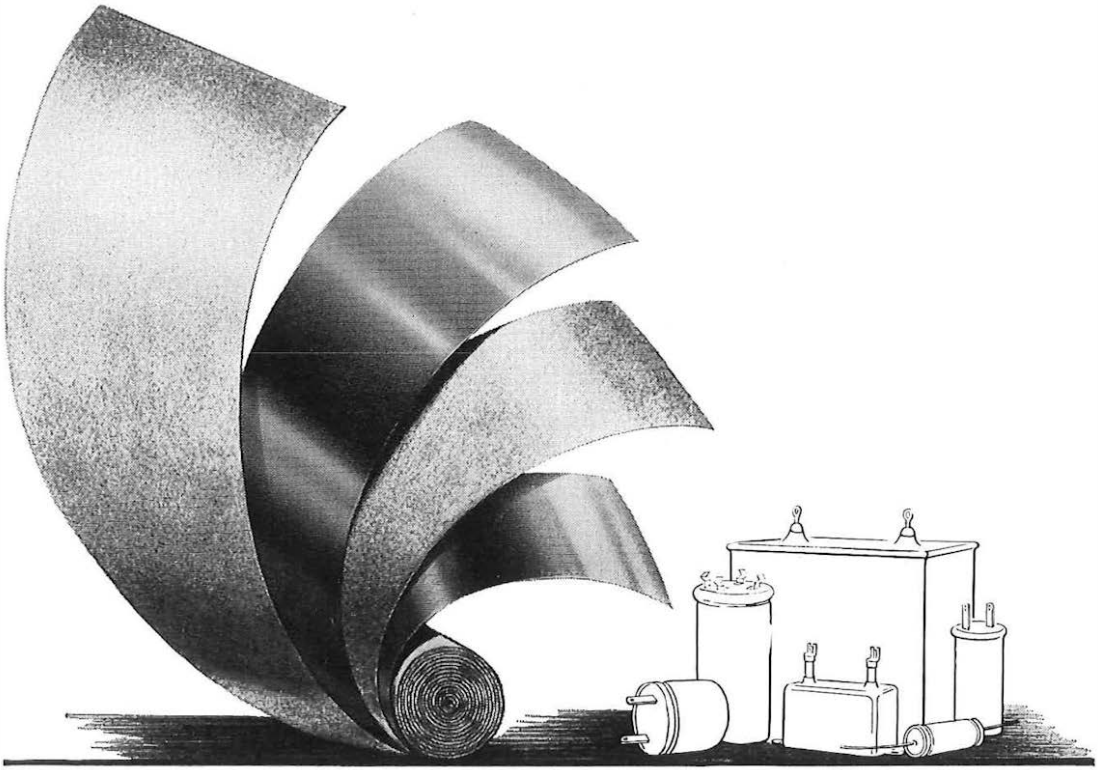

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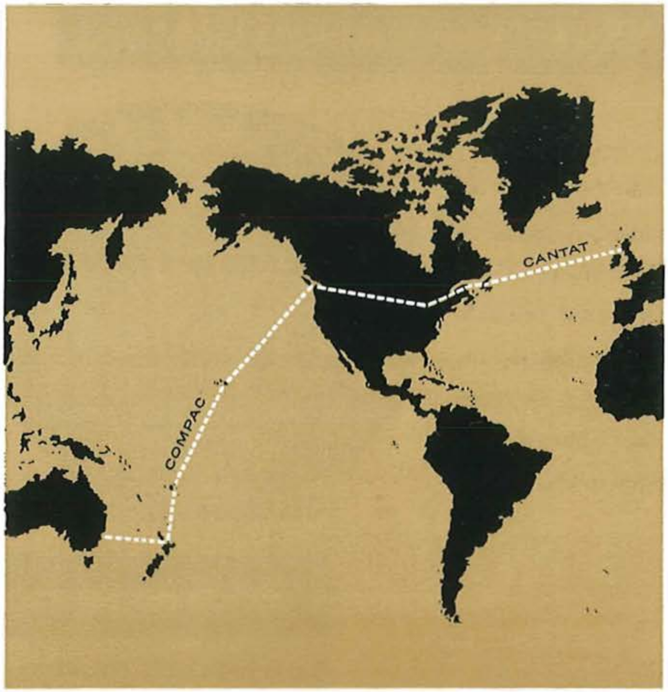
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