POST OFFICE

telecommunications

JOURNAL

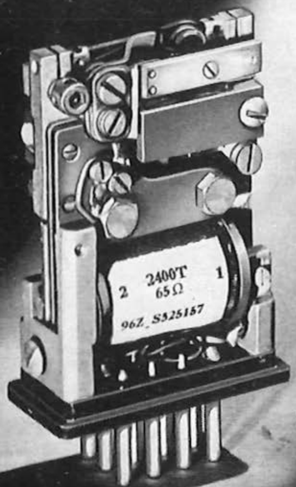
ONE SHILLING

AND

SIXPENCE

SPRING 1963

a sensitive and responsive performer . . . but never temperamental



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Vol. 15 *Spring* 1963 *No.* 1

An Outstanding Achievement

THE leading story in this issue tells of an outstanding British achievement in which the Post Office and the telecommunications industry in this country can take a well-earned pride.

It is the story of the opening for service at Highgate Wood after six years intensive research and development of the first all-electronic public telephone exchange of its type in the world.

Highgate Wood has been hailed as a major breakthrough in telephone communication and as the most important milestone in the history of telephone switching in this country since automatic working was introduced 51 years ago. These may seem bold claims, but they are well founded and no-one who fully appreciates the significance of this brilliant achievement will dispute them.

Nevertheless, Highgate Wood is only a successful experiment—the forerunner of greater things to come. It is a big step forward towards the Post Office's aim to provide the most efficient and speediest telephone service in the world and already three more electronic exchanges of more advanced types are being built.

No less important, the technical lead which British telephone engineers have achieved through Highgate Wood and their studies of possible future electronic switching systems provides industry with an even greater opportunity for boosting its exports.

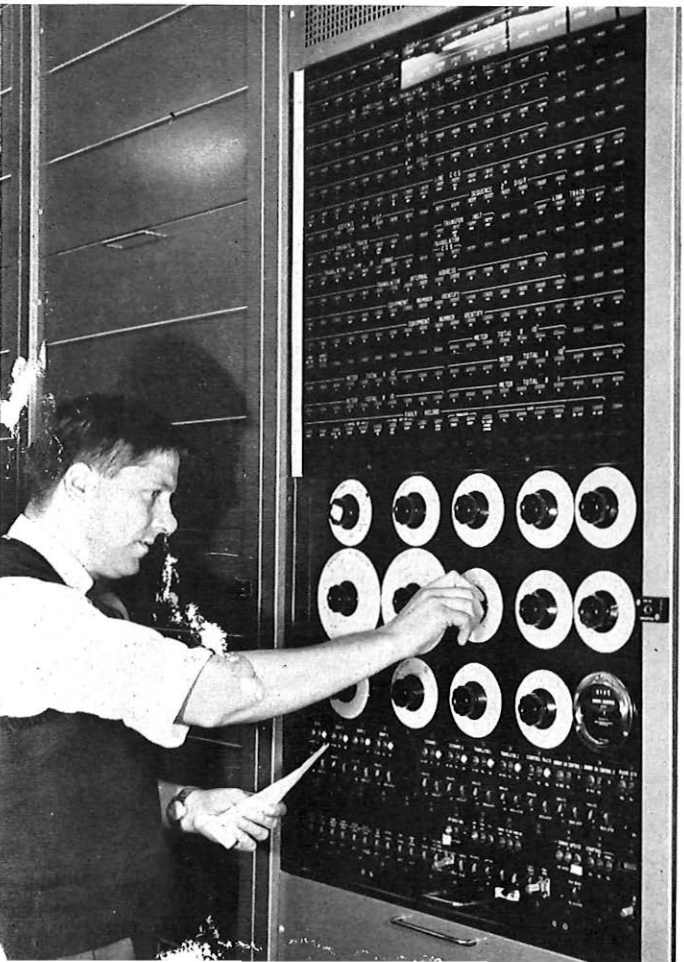
As the pattern of telecommunications of the future takes shape it is clear that electronic exchanges will have a vital part to play, not only in speeding calls but also in keeping pace with the ever-increasing demand for both inland and overseas telephone services. Nor is there any doubt that electronic exchanges will bring much closer the day when the Post Office can realise its ultimate aim of providing a service which will enable any subscriber anywhere to dial a telephone call to anyone anywhere else in the world.

WEDNESDAY, 12 December, 1962, will go down in the history of the Post Office as the day which marked one of the most important technical developments in telephony since the introduction of automatic switching half a century ago.

On that day at Highgate Wood, in London, the Postmaster General, Mr. Reginald Bevins, MP, accepted on behalf of the Post Office from the five manufacturers who had helped to build it, the first all-electronic telephone exchange in Britain and one of the first in the world to go into public service. It had already carried public traffic experimentally for brief periods during the previous few weeks.

And on that day, too, the Postmaster General announced the building of three more advanced electronic exchanges—to be installed and in operation within the next two years at Goring-on-Thames, Pembury, in Kent, and at Leighton Buzzard. If they fulfil the technical promise of Highgate Wood, British electronic switching systems will represent a major breakthrough and

THE HIGHGATE



FIFTY years ago at Epsom the Post Office began its first experimental trial of automatic telephone switching apparatus. Now at Highgate Wood it is testing the first all-electronic telephone exchange to be installed in this country. The 1912 experiment was a field trial of apparatus already proved in the United States but in the Highgate Wood experiment a completely new system, hitherto not tried in public service, is being tested.

Since 1945 there has been a growing interest in electronics, chiefly for computers, and in the switching field it has long been apparent that electronic devices offer possibilities of higher speeds and lower maintenance costs because of the absence of mechanical wear. Since these factors are increasingly demanded as the telephone service grows more complex the Post Office and the telephone industry have, since the end of World War Two, devoted considerable research effort to the application to telephone switching of these new techniques.

The efforts of the Post Office and the industry in this field were pooled by the formation in 1956 of

Mr. D. D. Baker, an engineer of the Automatic Telephone and Electric Company—one of the five manufacturers who helped to build the Highgate Wood electronic exchange—"writes" information on the magnetic drum control track.

give Britain the best telephone exchanges in the world, not only for use at home but also to market abroad.

The Highgate Wood Electronic Exchange—a technical description of how it works appears on the following pages—is the result of six years co-operative research and development between the Post Office and five principal British manufacturers of exchange equipment. The Highgate Wood Exchange is not entirely typical of the systems which will follow it. Each of the three new exchanges, all of which will operate completely on their own, with no stand-by exchange as at Highgate Wood, will be designed to try out under actual service conditions a different approach. Two of them are based on slightly different applications of the time-division pulse-amplitude modulation principle, and the third—at Leighton Buzzard—on space-division switching. All three will be fully transistorised so that they will be much more compact than Highgate Wood, and will need less power. They are also expected to show a significant improvement in reliability.

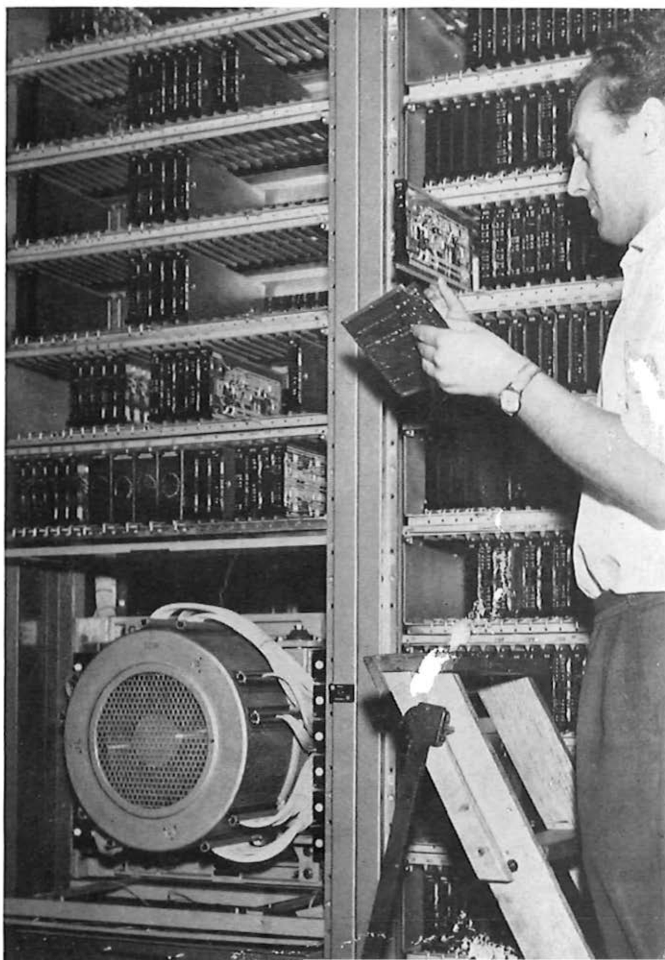
WOOD STORY

By S. W. BROADHURST

the Joint Electronic Research Committee on which sit representatives of the Post Office, Associated Electrical Industries Ltd., Automatic Telephone & Electric Co. Ltd., Ericsson Telephones Ltd., the General Electric Co. Ltd., and Standard Telephones & Cables Ltd. One of the Committee's first decisions was to build an electronic exchange using the "Switched Highways" system which employs time division multiplex techniques, while at the same time continuing research on alternative solutions to the problem of electronic switching.

It was also decided that the experimental equipment should provide the full service and maintenance facilities of a comparable electro-mechanical exchange. At the same time the techniques used had to be demonstrably capable of serving the largest director exchanges. Moreover, the experiment was to be conducted in an exchange giving public service and therefore fully interconnected with the public network. This meant that it would need conversion equipment to enable it to interwork with the existing system and to use the existing subscribers' apparatus and line plant.

OVER

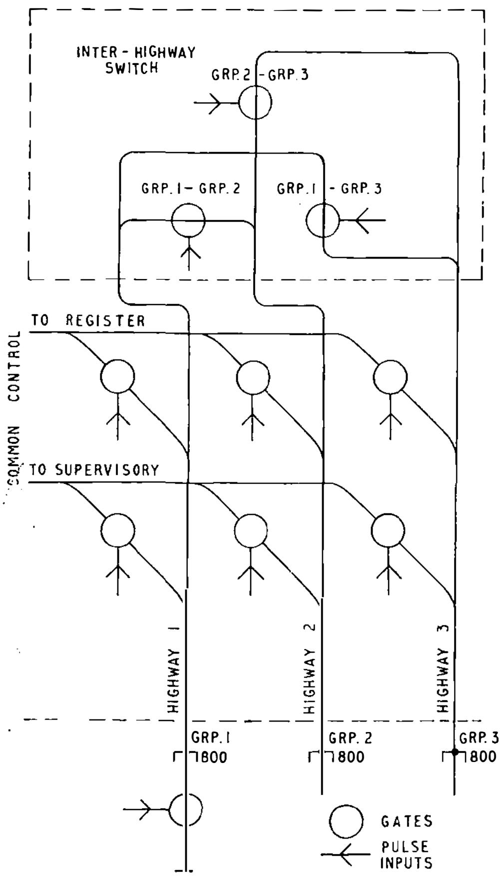


Technical Officer A. L. Ellis at the drum logic rack. The printed circuit cards he is holding "read" and "write" information from and into the magnetic drum (left) which scans subscribers' lines once every quarter of a second.

For these reasons the Highgate Wood installation is bigger than the small number of lines there would seem to warrant and about 400,000 electronic components are fitted. Much of the control equipment could serve an exchange of about 7,000 lines.

Apart from the conception of the use of time division multiplex techniques for the transmission of up to 100 conversations over a common channel, the most interesting feature of the installation is the use of time sharing in the setting-up of calls and in their control. In this installation these techniques have been exploited to the utmost.

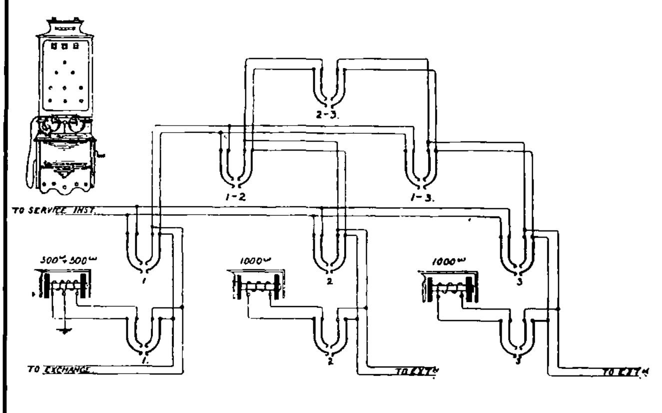
In conventional electro-mechanical systems ranks of selectors are interconnected by means of a complex trunking system dictated by the method of setting up the calls and by the need to economise in the total number of switching points. The trunking of the Switched Highways system is simple because each switch can carry 100 simultaneous conversations; the lines are concentrated into large groups before being connected to the switches; and the calls are set up by a high speed common control apparatus operating quickly enough to deal with the calls on a "one at a time" basis.



In the trunking of the system, the lines (subscribers) and junctions are arranged in groups, the size of each group depending on the traffic. At Highgate Wood there are 800 lines in a group. Each group is connected to a "highway" over which 100 multiplexed conversations can be carried, each conversation using a one microsecond time slot or channel time at a repetition frequency of 10Kc/sec. The "highways" are fully interconnected by electronic switches or gates and gates also connect the "highways" to the common control. The trunking of this advanced system is identical with that of the old National Telephone Company's *Pyramid* switchboard, than which nothing could be simpler. The essential change is that each switch in the electronic system can control 100 simultaneous connections and that the lines are concentrated before being connected to the switch.

Each line in the electronic system is provided with gates which enable it to be connected to its "highway". To set up a call the line gates and the "highway" switch gates are set so that for the duration of the call they open at the channel time allotted to the conversation. The gates connecting the lines to the "highways" will, of course, be closed at all other times but the inter-highway gates, which may be switching many calls, will operate at the pulse channel times of all the conversations in

Left: This diagram shows the trunking of the electronic system which is identical to that of the National Telephone Company's *Pyramid* switchboard (see diagram below).



"THE FUTURE LIES IN ELECTRONIC EXCHANGES"

"There is not the slightest doubt that the future lies in electronic exchanges and it is the Post Office's policy to move straight from our existing automatic exchange systems to fully electronic ones as soon as we possibly can," said the Postmaster General when he accepted Highgate Wood Electronic Exchange.

"We are convinced," he went on, "that no electro-mechanical system can offer us sufficient advantages over our well-tried Strowger system to justify our adopting it when the realisation of commercial electronic systems is in sight."

Mr. Bevins said the public might wonder why we were developing electronic exchanges. The answer was that they would help to make our telephone service more efficient and more adaptable to the needs of our customers and to help British industry boost its exports.

"We already know," he continued, "that electronic exchanges will work faster than conventional ones and greater speed in getting a 'phone call is all-important. And although it is a little too early to be sure we also believe that these exchanges will be cheaper to build and maintain. We also hope they will take up less space and that is a big advantage."

The first step in the research programme, said the Postmaster General, had been to prove experimentally that an all-electronic exchange could be built. We knew now that this could be done and that the principles on which the Highgate Wood Exchange was based were sound. But Highgate Wood was only just the end of the first phase. In fact, it was a research tool, in the building and testing of which we had gained a great deal of information which we could not have obtained in any other way —information which was important in helping us to proceed to the next stage.

"That next stage," he said, "is to develop electronic exchanges which not only work efficiently but which measure up to our requirements in terms of cost, reliability and so on."

These diodes and resistors of the type used in the Highgate Wood electronic exchange can together do the same job as a bulky exchange "relay" switch. ▶

progress on their "highways". All the gates are controlled by delay line stores of the type described in the Spring, 1962, issue of this *Journal.*

The high speeds of electronic equipment allow the use of a single common control to deal with even the largest and most heavily loaded exchange and make possible the use of the "one at a time" principle in the setting up of connections. The control contains "logical" elements which control the sequences, and "memory" elements to store information relating to the switches and calls and permanent and semi-permanent information relating to the lines. These are basic requirements in any type of telephone exchange. In electro-mechanical exchanges the call memories are spread over the equipment in the form of mechanical spring sets and operated relays while the line information is stored in the form of jumpers on the IDF. In manual exchanges much of the memory is in the form of operating instructions which are stored in the operator's brain.

The common control of the electronic exchange more closely resembles that of manual rather than automatic exchanges, but although the electronic "operator" can deal with only one call at a time, it works so fast that only one operator is needed whatever the size of the exchange.

OVER

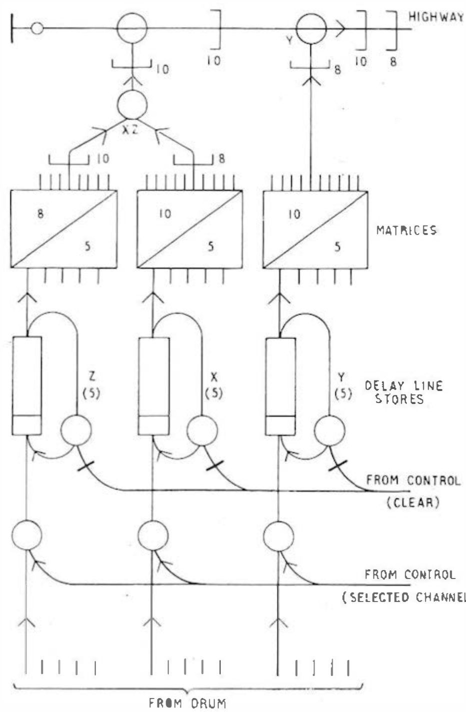
Mr. E. Peddle (left), GEC, and Mr. Bruce Looms, AE at Dollis Hill, at the speech multiplex rack. Each call going through this rack is cut into one-hundredths. Mr. Peddle is plugging in an oscilloscope to monitor pulses as they pass through the equipment.

The first task of the electronic control is to detect when a new call arrives. For this purpose each subscriber's line termination is examined for a period of 280 microseconds every 224 milliseconds—a process known as scanning. Junctions are scanned at eight times this rate. The scanning is carried out by a magnetic drum, each track of which is divided into 100 sections or words, one for each line. Parallel tracks are used for each 100 lines, one track providing the permanent (IDF) information (that is, directory number and class of service), another track giving the semi-permanent information (that is, whether the line is already engaged or parked because of PG conditions). Since the tracks are switched in sequence the information relating to each line can be read sequentially as the drum rotates, the angular position of the word together with the track number defining the equipment position that is, the line apparatus number of the line being scanned.

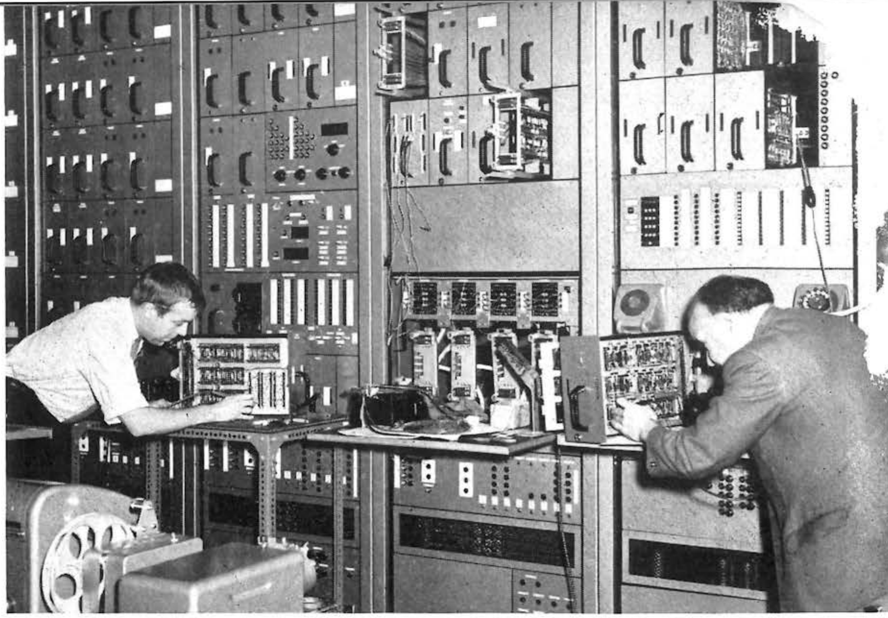
The groups of 800 lines (junctions and subscribers) at Highgate Wood are divided into eight sub-groups, one sub-group for each track of the drum. In each sub-group the line units are arranged in ten columns of ten rows so that any line position can be defined by a ZXY code, Z for the sub-group, X for the column and Y for the rows.

To avoid the use of a separate delay line store for every line termination it is convenient to use, in each group of 800 lines, three sets of five stores to correspond with the ZXY designation of ... As the drum rotates it generates wave- ...responding to the ZXY code of the line

This diagram shows how three sets of five stores coded to correspond with the ZXY designation of the line are used in each group of 100 lines.



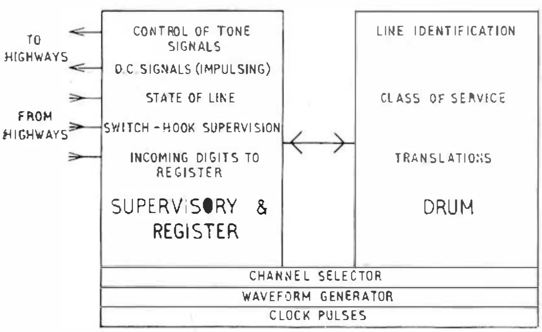
Mr. A. Quartermaine (left) GPO Technical Officer, at the supervisory routiner, part of the test equipment built into the exchange. This equipment reports faults to the exchange fault analyser which then deals with them. Right is Mr. T. Berwick, AE, Eng Dept.



whose information is available at that time. These waveforms indicate the appropriate delay lines and if a call is to be set up a selected pulse is injected into the selected delay lines which causes them to open the line gates repeatedly at the selected pulse time, the pulse continuing to circulate until the connection is cleared.

The common control of the system is divided into two parts. The first is the equipment to store and process the information relating to the setting up and the progress of the calls (the stores used in this part of the equipment are 900 microsecond magnetostriction* delay lines). The second is the permanent memory containing the translators and so on, which uses the magnetic drum store. In addition, various services, such as the waveform generator and the "clock pulse" generator used to time the system, are provided.

This diagram shows how the common control of the Highgate Wood system is divided into two parts.



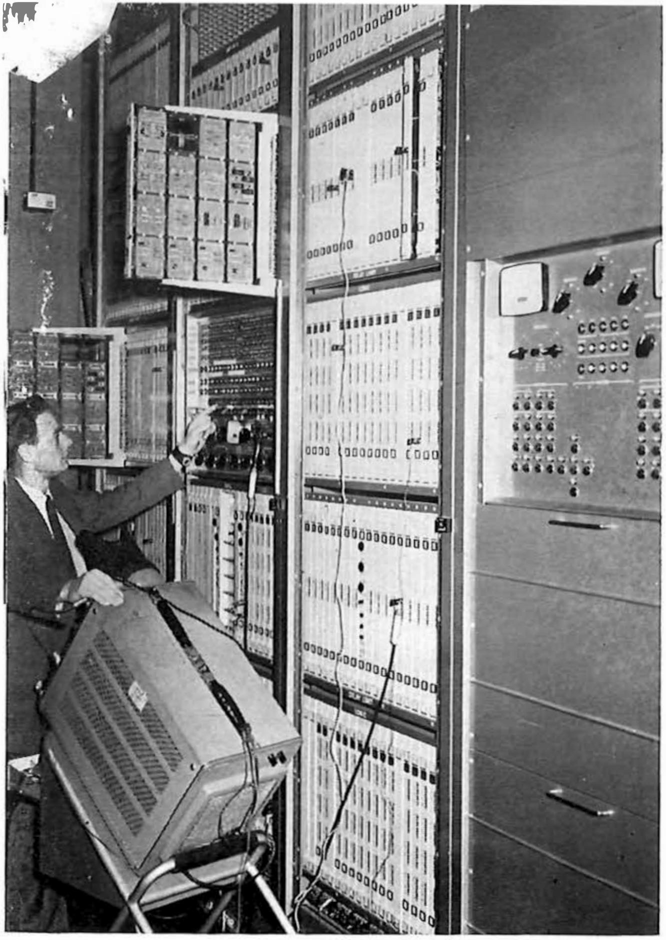
During the progress of a call the setting-up apparatus first connects the caller to a register and later connects the caller to his correspondent by way of the "highway" switch, a channel selector choosing a free channel suitable for the call, that is, one available to both subscribers.

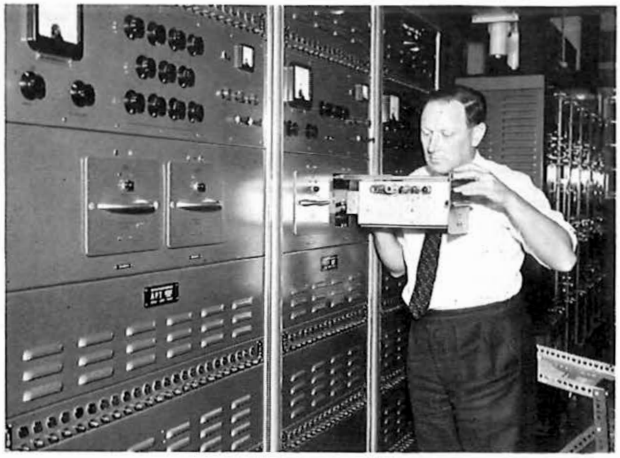
The register which receives the dialled digits can process and store 100 nine digit numbers. This capacity is not fully exploited at Highgate Wood although the register and most of the control equipment is potentially capable of dealing with the traffic from a large metropolitan exchange.

The supervisory equipment monitors the set-up connections and, in addition, controls the application of tones (for example, dial tone), and applies ringing, metering, and release conditions. It monitors the lines by scanning the "highways" successively, examining each pulse channel for a period of one microsecond. In this period the state of the call is registered and, depending on the stage reached by the call and the class of service of the lines concerned, the logical circuits in the equipment decide on the action to be taken, that is, whether ringing should be applied or cut-off or whether the call should be released. Both the register and the supervisory equipment have "persistence timers" which, in effect, substitute the B and C relays and the S and Z pulses of the Strowger system. These timers are also provided on a common basis.

Magnetostriction is the change of dimensions of magnetic material in the presence of a magnetic field.

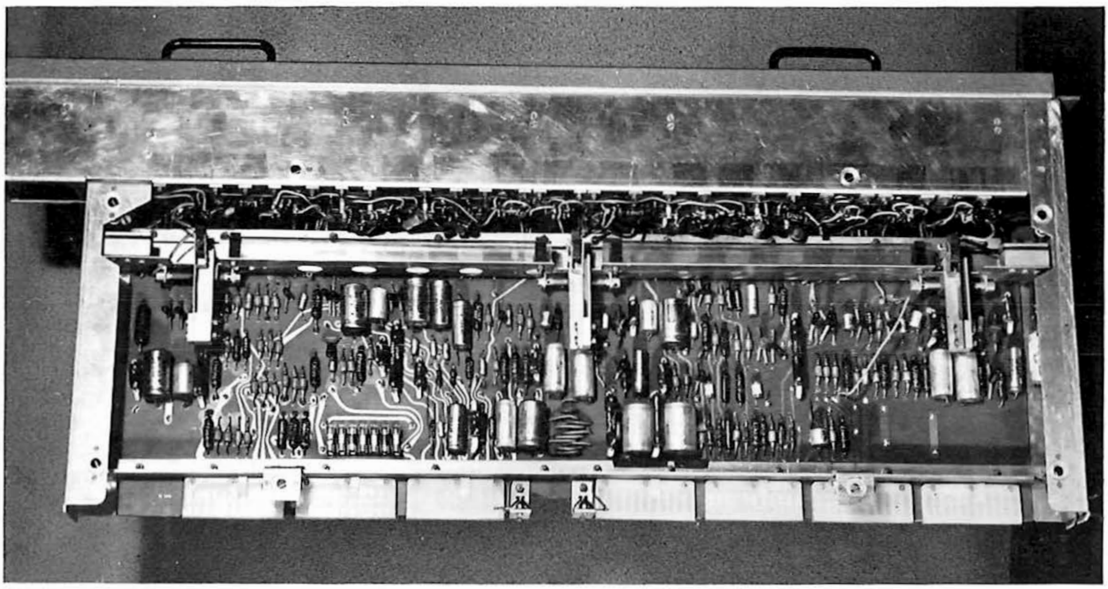
ER



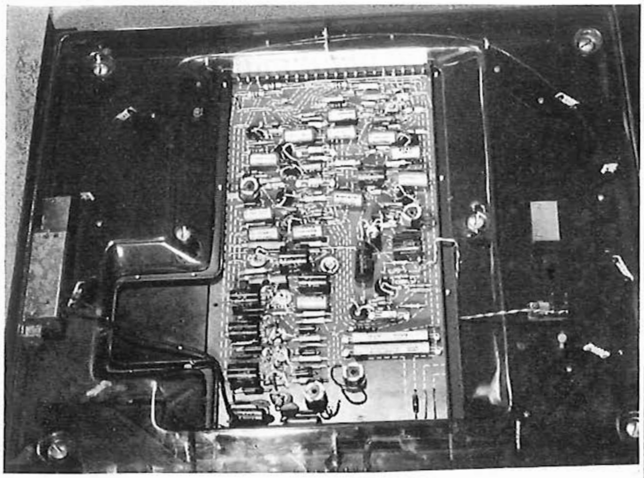


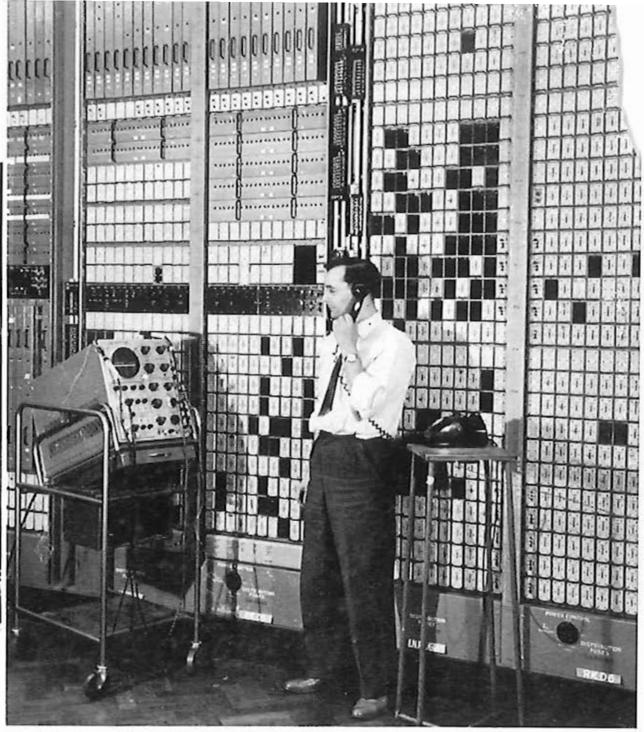
Above: Mr. A. Wilkinson, GPO Technical Officer, adjusts an amplifier in one of the power supply units.

Left: Mr. B. Bowshall, of AEI, at the Common Register equipment which receives instructions from the dial on a caller's telephone and informs the rest of the exchange equipment how to handle the call.



An example of a 100 microsecond delay line store.





Above: A transistorised 900 microsecond delay line store. Right: Subscribers' incoming line terminations with the time division multiplex equipment.

HIGHGATE WOOD—*Continued.*

The system provides for four-wire transmission within the exchange, it is continuously self-routined and all common equipment is duplicated, the spare equipment being switched-in automatically if the routiners detect faults on the worker. The equipment is experimental and experimental verification of the various equipment practices and maintenance aids is perhaps the most important feature of the field trial.

The exchange has been designed to work as a director exchange in the existing director network, and no attempt has been made to introduce new service facilities. This means that conversion equipments have had to be interpolated between the electronic exchange and the outside world and the exchange has to be adapted to suit subscribers' apparatus and manual boards designed to work with mechanical equipment.

Although various sections of the exchange were manufactured by different contractors, the system design, installation and commissioning have been the work of teams drawn from each of the parties to the Agreement. That the work has been successful is due in large measure to the excellent co-operation between the parties and to the exemplary team spirit of the commissioning staffs.

Since 1 September, 1962, the exchange has been subjected to a series of traffic trials and has since been intermittently in public service. It was formally handed over on 12 December, and is now undergoing maintenance trials under live traffic conditions. Since this is one of the prime objects of the experiment it is to be expected that from time to time the exchange will be taken out of service in order to introduce changes or try further experiments. For these reasons the existing electro-mechanical exchange has been retained.

★

Mr. S. W. Broadhurst, *an Assistant Staff Engineer in the Engineering Department's Research Branch, also wrote the article "An Experimental Electronic Telephone Exchange" in the Spring, 1959, issue of the* Journal. *Joining the Research Branch in 1938, Mr. Broadhurst has been concerned with switching problems for most of his career and was involved in the development of the Electronic Traffic Analyser and ERNIE.*

"The development of electronic exchanges is of vital importance to the British telephone industry which exports almost half of its production output," an industry spokesman told the *Journal.* "The success of Highgate Wood and of the second generation of electronic exchanges will influence the reactions of telephone system managements all over the world. Many overseas buyers of exchange equipment follow the lead of the British Post Office and, though electronic switching systems are now being developed in other countries, it is generally conceded that technically, British engineers are in the lead."

Taking the Work out of Work

By W. C. Ward

THE use of mechanical aids is slowly but surely changing the pattern of outdoor work carried out by Post Office engineers. The days of large construction parties composed mainly of labourers are gone. Now a skilled technical staff operating specialised machines carries out all the heavy work.

The proper use of mechanical aids makes the task more interesting, reduces accident risks and saves money. Over the last seven years there has been a steady improvement in the productivity of the external construction staff. While the whole of this improvement cannot be claimed as due to mechanical aids, there is no doubt that it is largely so.

Now a new mechanical aid capable of performing many of the tasks allotted to external construction parties, has appeared on the scene. It is the Line Construction Unit, or Line Construction Vehicle, of which several are now on trial.

The Line Construction Vehicle is designed for normal operation by two men who will probably be provided with 110 volt generator sets and a range of electrically driven tools. They will thus be equipped to carry out a wide range of work normally needing much larger parties.

The new unit comprises a utility vehicle equipped with a versatile derrick, a heavy duty winch, and a pole hole borer. A man-carrying bucket can be fitted to the derrick and all the controls can be extended so that the operator can raise himself aloft.

The chassis of the vehicle is a five-ton BMC diesel unit with a power take-off which enables the engine to drive pumps providing the hydraulic power for operating the auxiliary functions. The body of the vehicle is of the open-well type with a sliding roof so that stores and tools can be loaded and unloaded without heavy manual effort.

The derrick, which is mounted on the nearside corner at the rear of the vehicle, can be rotated under power in either direction through a full circle. Thus the vehicle can operate at the roadside causing minimum obstruction. The boom of the derrick is 15 ft. long and has a telescopic portion which extends to 23 ft. The derrick itself can be lowered to within three-and-a-half feet from the ground and raised to a maximum height of 33 ft. It carries a pulley on the end over which the winch rope passes, thus providing a crane which will lift one ton. The derrick can be used for many purposes, including the handling of stores, erecting poles, supporting dangerous poles while they are being removed, lifting men aloft and steering the pole hole borer.

This pole hole borer is a powerful tool, driven by a 35 horse-power hydraulic motor. Downward pressure is applied by the derrick and, by adjusting the derrick position, holes can be bored at an angle for setting stay anchorages. The borer, which is strapped back to the derrick when not in use, is arranged to stow itself automatically.

A powerful winch capable of a pull of seven tons is built into the vehicle just behind the cab and the rope from the winch runs under a false floor so that it is clear of tools and stores in the body of the vehicle. The winch may be used in conjunction with the derrick or independently of it, and its shaft has an extension through the side of the vehicle to which may be attached a capstan or a reel for winding in recovered overhead wire. Hydraulically-operated stabilisers can be brought into use when additional stability is required.

The hydraulic power take-off is at the rear of the vehicle and operates auxiliary items such as an earth punner, or a heavy duty pole pulling jack. The hydraulic equipment is controlled from a panel at the rear of the vehicle where the operator has clear views of all operations. There are controls for raising, lowering, rotating and extending the boom, for operating the borer, for controlling the stabilisers and the hydraulic power take off and for altering the speed to which the engine is governed.

Performance records of this unit are being kept in the hope that they will show substantial economies over present methods.

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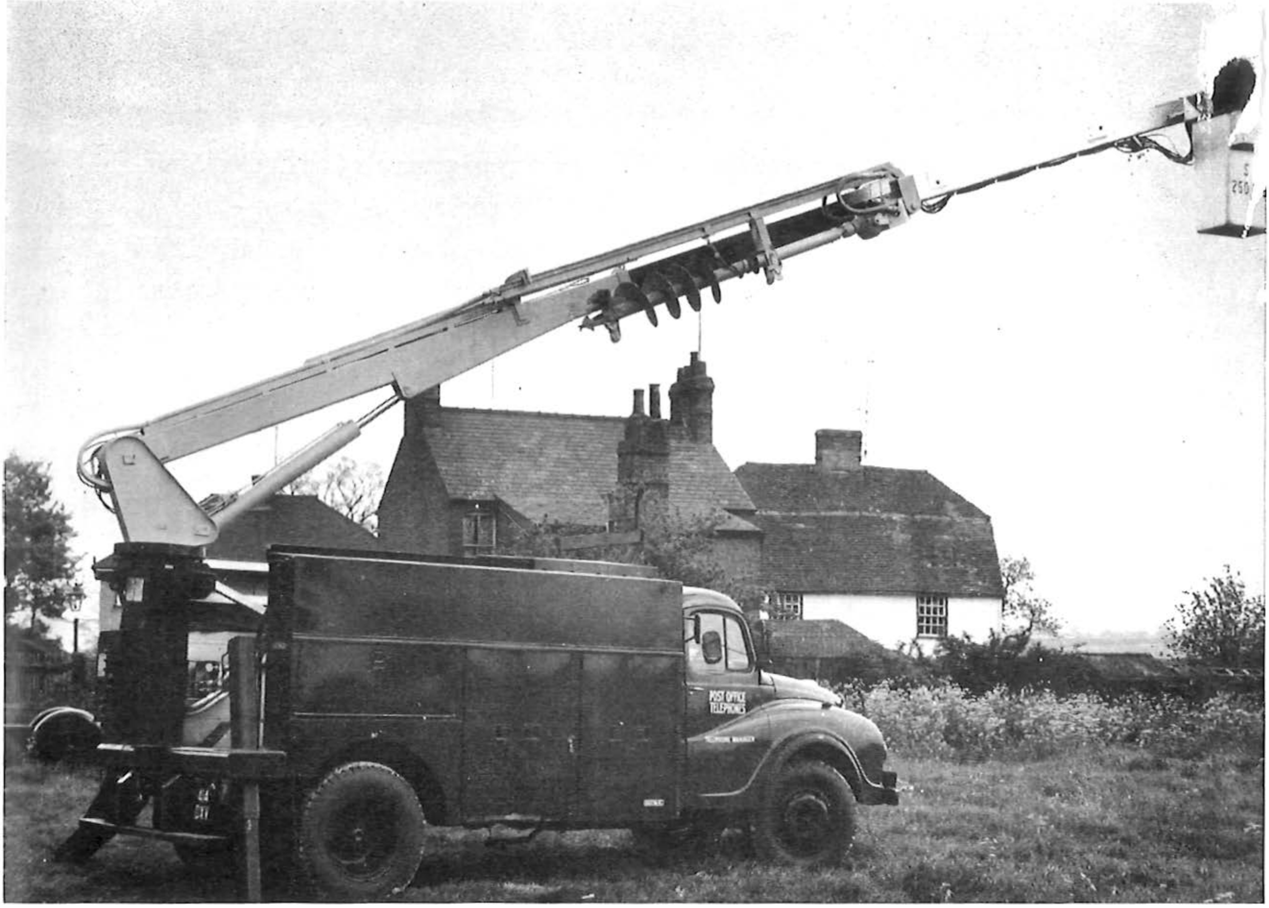
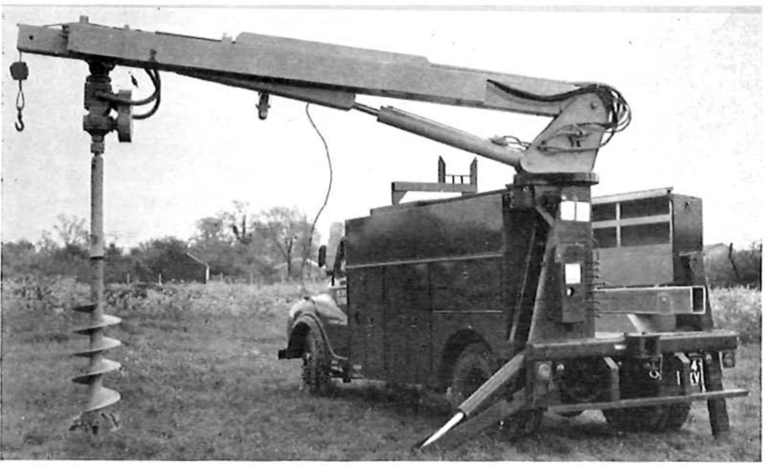
Mr. W. C. Ward, BSc., MIEE, an Assistant Staff Engineer in the External Plant and Protection Branch since 1950, joined the Post Office as a Youth in Training in the London Engineering District in 1924. He was later Assistant Engineer (old style) in Blackburn Section and Area Engineer at Nottingham and wrote the article *More Power to Your Elbow* in the Autumn, 1959 issue.



Perched in a bucket at the end of the derrick an operator demonstrates how he can raise himself aloft. The derrick can also be used for erecting new poles and lifting out old ones, handling stores and steering the pole hole borer.



Above: The derrick places the pole hole borer into position in readiness for boring a hole. The borer can stow itself automatically. Right: A line construction unit lifts a 50-year-old telegraph pole out of the ground at Cardiff.

After a three-year trial in Edinburgh a new way of preparing customers' telephone bills has been perfected. It is the meter photography system—quicker, more accurate and cheaper than the old method—which is to be introduced in all Areas as they change over to the mechanical accounting system

METER PHOTOGRAPHY MAKES ITS DEBUT

★

By A. G. MARTIN and D. H. MAY

THE traditional method by which local telephone calls and units of STD-dialled calls are recorded on meters and then read by engineering, clerical or exchange staff so that customers' bills can be prepared, is on the way out.

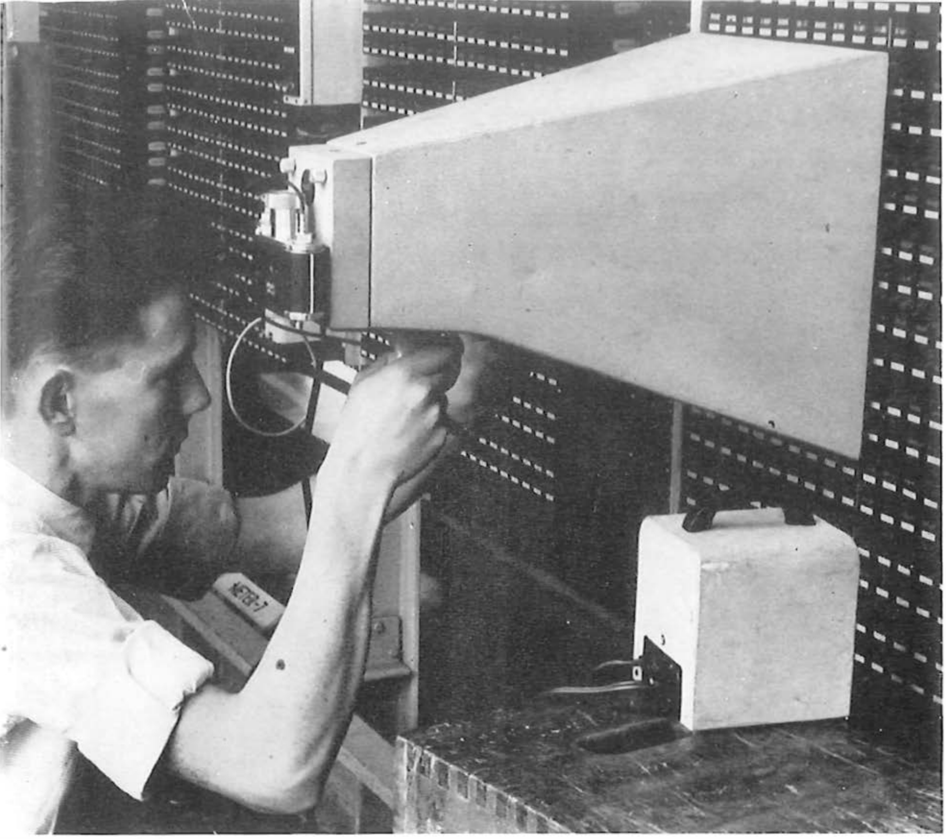
Thanks to the successful completion of a three-year-long trial in the Edinburgh Telephone Area, a system by which meters are photographed and the developed film is used to calculate the charges is to be adopted in all Telephone Areas which have the MATS (Mechanical Accounting for Telephone Service) system for preparing telephone bills. It will be extended to all other Areas as they change over to the MATS system.

The meter photography system has many advantages over the present method. It saves staff time in reading and recording the information on the meters—the recording time for some 28,000 meters on five Edinburgh city exchanges (excluding travelling time) is now only $3\frac{1}{4}$ hours against 120 hours taken by the old method. In addition, fewer repeat readings are needed because of the greater accuracy of photography and this also means fewer queries by customers on the bills they receive.

The Post Office first thought of using meter photography as long ago as 1921 and several experiments—all unsuccessful and prohibitively expensive—were carried out. In recent years, however, improvements in photographic and reading equipment and the inception of MATS combined to offer a system which could prove economically and operationally acceptable.

In June, 1959, therefore, the Post Office bought some equipment, similar to that used by other administrations, from a Swiss firm and launched a trial in the Edinburgh Telephone Area.

Many minor difficulties were encountered early on but, thanks mainly to growing experience and the enthusiasm of the staff in overcoming them, the system has proved to be extremely satisfactory. Today it has been extended throughout the Area



An operator sets up his "monoblitz" camera and prepares to photograph meters in a Scottish exchange. Note how the camera fits easily over 100 meters.

and some 75,000 out of a total of 137,000 meters are being photographed and evaluated each quarter. Now, further supplies of equipment have been ordered from the Swiss manufacturer to equip many more exchanges. Delivery is expected early in 1963.

The photographic equipment used in Edinburgh is known as the "Monoblitz 300". It has four units —a modified 35 mm Robot camera with f/3.5 wide-angle lens; an electronic mono-flash light unit; a detachable hood; and a power pack for 50 c/s AC mains 220 volts. The camera, the shutter of which is operated by a trigger in the pistol grip handle, gives a picture 24 × 24 mm and 50 exposures are obtained at each loading. Film transfer is automatic, motive power being obtained from a clockwork mechanism. The centralised arrangement of the flash tube provides a shadow-free illumination of the meter block and the flash charging time of six to eight seconds means that something like 400 photographs can be taken in an hour. The hood, which is of light metal, is used to locate the camera at the correct distance from, and in alignment with, a block of meters. It is easily fitted over 100 meters (ten by ten) of the type in use at director and most non-director exchanges and in UAXs No. 14. The camera, flash unit and hood are assembled into one unit which is fairly easily handled. The power pack weighs some nine pounds and is normally placed on the floor, sufficient lengths of connecting leads being provided to the power point and camera to allow freedom of movement around the meter racks.

Before meter photographing begins an exchange identification card is photographed. At the end of

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Before meters are photographed an identification card showing the exchange and date pictures were taken is made.

An operator punches the meter readings, displayed in the viewing panel of the autoscope in front of her, into cards.

METER PHOTOGRAPHY *(Cont'd.)*

each 1,000 meter block a blank exposure is made to facilitate easy reading of the developed film. Because of wastage and photographing of identification cards, the camera is usually reloaded after 45 pictures are taken and on each reloading operation identification cards are photographed to indicate the second and any subsequent film strips. A counter built into the camera shows the number of exposures taken.

Standard-type meters at director and non-director exchanges are generally arranged in telephone number order, in horizontal rows of 20, starting at the bottom of a rack and rising numerically to the top. Beginning at the bottom of the rack, the operator first photographs the left hand block of 100 meters (ten by ten), then the adjacent block of 100 meters, and the left hand block immediately above, followed by the adjacent block on the same row and so on to the top of the rack. This sequence is repeated on each rack. The casettes, or film containers, for the camera are loaded in the Regional Drawing Office and, after exposure, the films for each exchange are developed by the same office and passed to the MATS Unit for the accounting processes to be completed.

In the MATS Unit a machine known as an autoscope evaluates the filmed records of meter readings. A magnified image of each meter reading —the numerals are about half an inch high—is automatically displayed on a ground glass screen in correct numerical sequence. The reading is then punched into the appropriate meter reading card by an operator using an automatic key-punch machine which is coupled with the autoscope so that as each punch is completed the reading of the next meter in sequence is automatically shown on the screen. A second operator repeats the operation with the cards previously punched but on this occasion the hole is off-set slightly. These cards are then fed into a machine which automatically checks that the correct reading has been punched into the appropriate card. After verification the punched cards are used in the MATS processes for compiling subscribers' bills.

The Edinburgh photographing equipment is suitable for use with meters in director and most non-director exchanges and in UAXs 14, but the autoscopes have to be specially operated to allow the readings photographed in UAXs 14 to be displayed in numerical sequence. Extension of meter photography to MATS areas generally, therefore, meant that new equipment to be used with the different types of meter arrangement in the Post Office system would be needed. UAXs 5, 6, 7 and 8 have been excluded from any special provisions, because they are being replaced.

The Post Office Engineering Department and the Swiss manufacturer co-operated in producing designs for two additional camera hoods and an autoscope which can view four different meter arrangements. This equipment will be able to deal with the four main types of meter arrangements, at director and non-director exchanges, UAXs 12, 13 and 14 and at manual and older automatic exchanges.

The hood in use at Edinburgh is suitable for meters in UAX 14 exchanges, but the meter arrangement is different. To present photographs in numerical sequence the autoscope will first scan the lower half of two adjacent photographs, then the lower half of the next two, and so on. The process will be repeated for the upper half of the film.

A UAX 12 exchange has "A" units with two horizontal rows of 15 meters and adjacent "B" units with two horizontal rows of ten meters. A UAX 13 has two horizontal rows of 15 meters below two horizontal rows of ten meters. The meters are not in subscribers' number order since

A close-up of the autoscope viewing panel. The meter reading appears at the top, with the subscriber's number below.

they are linked permanently with the calling equipment and generally the higher-calling rate lines are given the earlier positions in the group. A re-arrangement of the meters into subscribers' number order is possible, but it would be costly. Alternatively, the difficulty could be overcome by key-punching the subscribers' numbers and meter readings together, as they are displayed in random order by the autoscope, and then sorting the punched cards into subscribers' number order. Other solutions to this problem are being examined but meanwhile a special hood has been designed to avoid any meter having to be photographed twice because of surrounding obstructions. A facility has also been built into the autoscope to cater for rows of ten photographs, thus minimising the occasions

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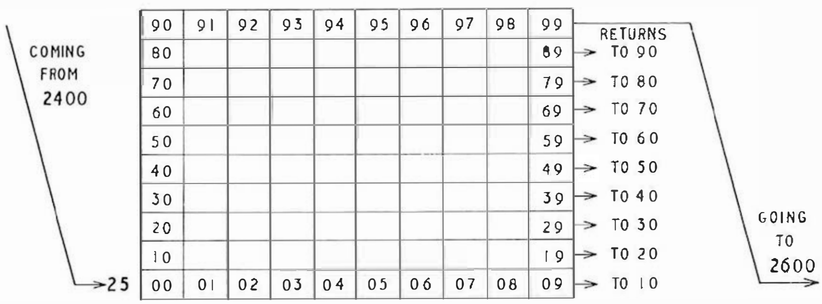
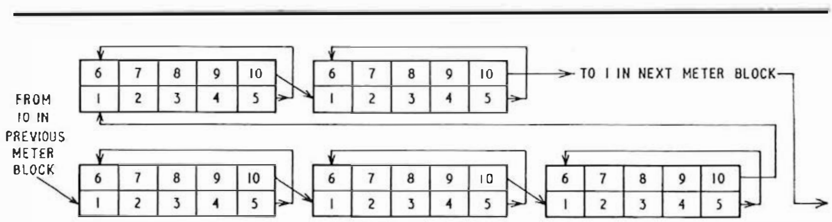
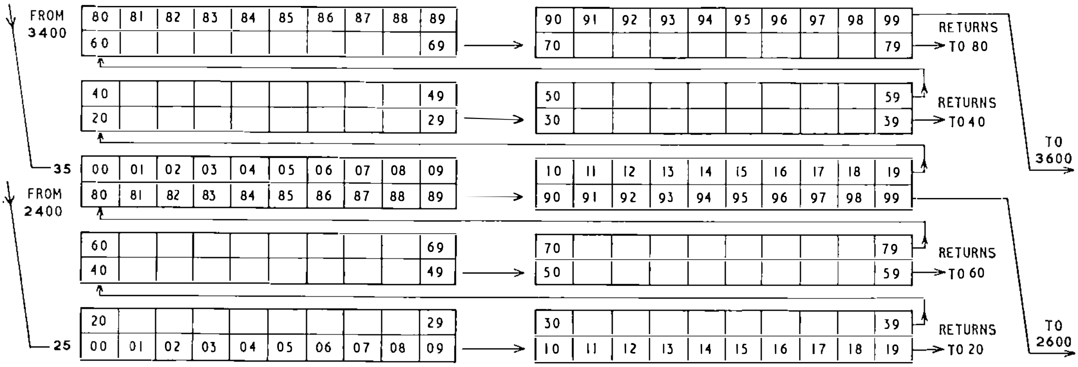
Meter arrangements at a UAX 13, showing the autoscope scanning step.

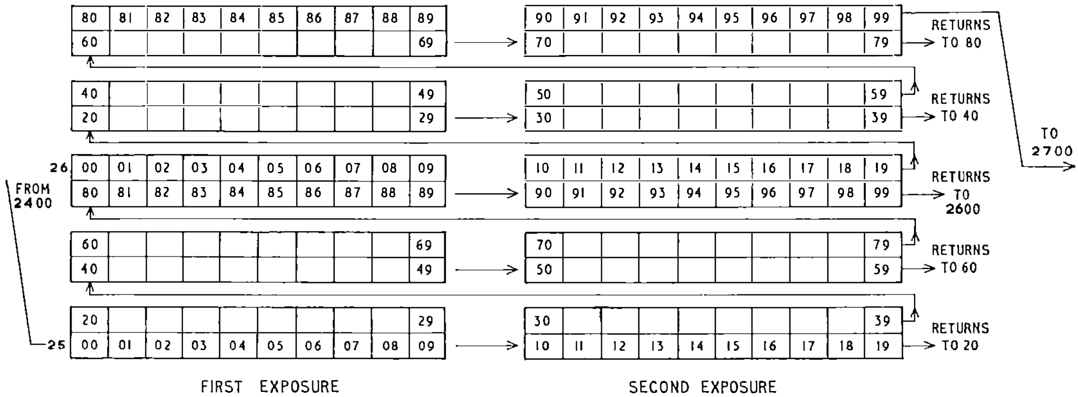


Meter arrangements at manual and older automatic exchanges showing autoscope scanning steps.





Above: Meter arrangements showing the scanning steps made by autoscopes at UAX 14 exchanges and (below) at director and non-director exchanges.



METER PHOTOGRAPHY (*Cont'd.*)

on which a blank position would be presented to the operator.

A larger camera hood is required for meters at manual and older automatic exchanges, the autoscope scanning one exposure before passing on to the next.

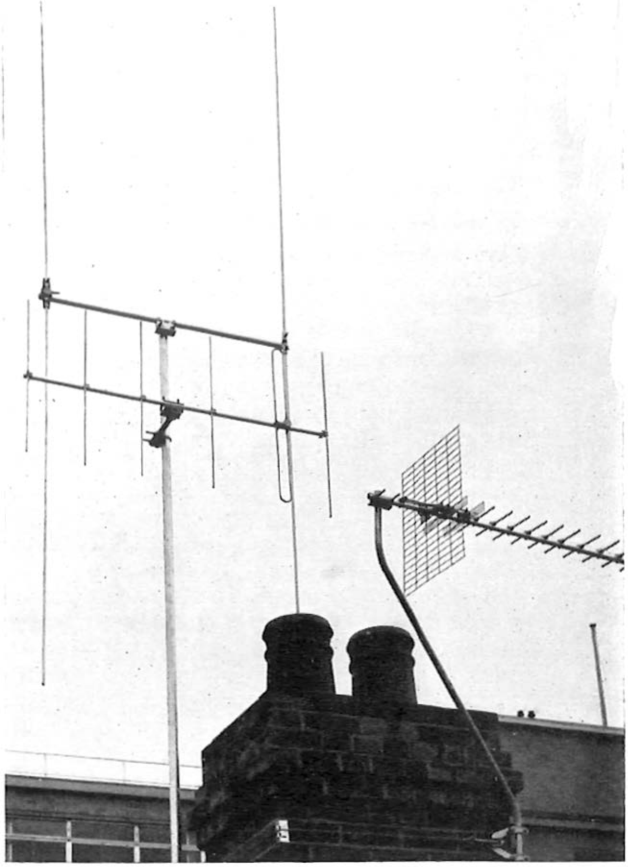
The Robot camera used at Edinburgh is no longer supplied by the manufacturer and has been replaced by a Leica camera which gives a slightly larger picture. But the principles of operation are the same. A number of organisational details, such as the grade of officer to do the photographing, the economical arrangement of journeys and transportation and the frequency with which meters should be photographed, are being studied. By early in 1963 it is anticipated that a scheme will have been evolved for each MATS area which will give the most economical and efficient arrangement for the use of meter photography. Other uses, such as the check of subscribers' meters on conversion to STD, the photographing of traffic recorder meters and STD charge step call count meters suggest themselves, but until the system has proved its success for billing purposes no such extension is proposed.

About the Authors

Mr. A. G. Martin entered the Post Office in 1936 as a Clerical Officer at Manchester. After World War Two, when he served with Royal Signals in France, Middle East, Italy and Germany and was mentioned in dispatches, he returned to Liverpool Telephone Manager's Office and was promoted to Executive Officer with the Central Land Board. In 1957 he came to Post Office Headquarters and in 1961 was promoted Higher Executive Officer in Telephone Mechanisation Branch of ITD.

Mr. D. H. May, who served with the Royal Air Force in World War Two, joined the Post Office as an Assistant Traffic Superintendent in South West Area, London Telecommunications Region, in 1949. Transferred to Regional Headquarters in 1953, he worked on telephone supervisor and other training activities. In 1959 he was promoted Senior Telecommunications Superintendent in Post Office Headquarters, Scotland, and is now employed on general service duty.

The additional structu e (right) needed for each dwelling when two extra services—UHF and colour—are introduced.



As television moves into the Ultra High Frequency range this article describes the new system and how it compares with VHF, the part the Post Office plays in broadcast planning and how the new service is being prepared

MOVING INTO THE UHF RANGE

By R. A. Dilworth

THE first White Paper giving the Government's proposals on some of the recommendations made by the Pilkington Committee's Report on Broadcasting announced two important decisions. The first is that all new television programmes will be on a 625-line standard similar to that used in Europe and in nearly all parts of the world where the mains supply is 50 cps. The second is that the new services will be in the Ultra High Frequency band.

The second decision is really a corollary of the first, since there is insufficient frequency space now available in the Very High Frequency broadcasting bands to provide even one broadband 625-line service to as much as half the population, while still maintaining intact the existing 405-line television services.

The use of the UHF band for television—the BBC has announced that it will start a public service in the spring of 1964 and extend it to the rest of the country as rapidly as possible thereafter—is a new venture in Britain. But it must not be supposed that we are alone in our plans to exploit this band. In fact similar action is being taken by most European countries where television broadcasting is well advanced. The United States has had stations operating at UHF for more than ten years but they have not been a financial success, in

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Moving into the UHF Range *(Cont'd.)*

circumstances peculiar to that country, where they have to compete for audiences with existing VHF stations which viewers are already equipped to receive.

Nevertheless, it is clear that the only scope for further expansion of television in the Unites States lies—as in Europe—in the development of the UHF band. Early this year an extensive experiment was started in New York to compare the grades of service provided by two similar high power transmitters on the Empire State Building—one VHF, the other UHF. Preliminary reports indicate that even in the densely built-up areas the UHF service compares well with the VHF.

The Federal German Republic has also put into service a television network operating exclusively in the UHF spectrum and it is reported that the grade of service is better than had been expected.

It would be useful at this point to give some idea of the capacity of the television bands used in the United Kingdom. At present, programmes are broadcast on 405-lines in the VHF Band I (41-68 Mc/s) and VHF Band III (174-216 Mc/s), the former providing five channels and the latter eight. But only three channels could be used for broadcasting 625-line programmes on VHF Band I and five on VHF Band III, and this only after all 405-line services have ceased some years ahead. On the UHF Band IV (470-582 Mc/s) and UHF Band V (614-854 Mc/s), however, the former could provide 14 channels and the latter 30. It is obvious, therefore, that only in the UHF Bands is there any real scope for future development in Britain.

Since television broadcasting in the United Kingdom is in the hands of the BBC and ITA it may not be apparent why the Post Office is directly

This table shows the capacity of the television bands used in Britain. Clearly, only in the UHF band is there any real scope for future development.

		Frequency Range Mc/s	No. of Television Channels		Present Operation
			405-lines	625-lines	
VHF Bands	Band I	41-68	5	3*	All used by BBC
	Band III	174-216	8	5*	Partly used by ITA
UHF Bands	Band IV	470-582	—	14	—
	Band V	614-854	—	30	—

*Only after all 405-line services have ceased, many years hence.

The Post Office mobile field-strength measuring van during its visit to Germany. The pneumatic telescope mast, 30ft high, simulates an aerial on a domestic chimney.

concerned with broadcasting. The fact is that the Postmaster General has both national and international responsibilities for all radio services in the country. He is responsible for the Broadcasting Vote by which the BBC is financed and he has statutory responsibilities in respect of the ITA. He provides the connecting circuits between studios and transmitters and, since there is no Minister for Broadcasting, he is responsible in Parliament for all broadcasting matters. To exercise these functions properly he must be satisfied that the best use is being made of the frequency spectrum and carefully examine all proposals for new services.

Preliminary plans for a UHF television service were prepared by the Post Office as long ago as 1957 at a time when there was little reliable information about many of the factors that have to be taken into account. These plans differ very little from those now being followed.

More recently the Post Office sent a mobile field-strength measuring vehicle to Germany to make a series of measurements of the new UHF services operating there and obtained data of considerable value in deciding the standard of receiver performance required for our new services. And at the European Broadcasting Conference held at Stockholm in 1961 the Post Office led a strong delegation which obtained international agreement to plans for a UHF network to provide four separate programmes throughout virtually the whole country.

Now that extensive practical experience has been gained of the "old" television bands we can predict with some accuracy what the grade of service will be in any part of an area within range of one of these transmitters. It is useful to recall, however, that when the television service first started in 1936 the radius in which a satisfactory service could be received was quite small, and it had been predicted that as many as ten stations would be required to serve about 50 per cent of the population in this country. Thanks to improvements in receiver performance and greater transmitter power, however, 80 per cent of the population was served by only five stations during the subsequent development in Band I. Again, when Band III was being developed for ITA services in 1955, the range at which satisfactory reception was practicable increased as receiver performance improved.

So far, our experience of the UHF bands is limited and our assessment of the range and grade of service provided by a particular transmitter must be in rather broader terms. There is a further complication in the need eventually to pick up, with one receiving aerial, four separate programmes from the same transmitter site, without any appreciable variation in picture quality. We are, moreover, concerned with the need to transmit colour pictures on UHF, again a field where detailed information is scarce. The BBC is making a series of test transmissions from Crystal Palace to obtain further information about the finer points of these problems and the Post Office is taking an active part in the work using both fixed observation points and field-strength measuring vehicles.

When comparing theoretically the practical range of transmitters in the VHF and UHF bands it is useful to start at the receiver and work back towards the transmitter. In the present state of development a UHF receiver needs an input signal about twice as great as a VHF receiver to give equal picture quality. Interference, particularly man-made, is less at UHF however, and in built-up areas this more than compensates for the inferior receiver characteristics.

Television receiving aerials are usually an assembly of elements which have to be about half a wavelength long. The energy extracted from the radio signal is proportional to the length of these half-wave elements and, to a lesser extent, to the number of elements used in the aerial. Now the average wavelength in Band I is about six metres and in Bands IV and V about 0.5 metres. When subjected to the same radio field strength, therefore, a UHF aerial, being much smaller, delivers to the receiver only about one-tenth of the voltage available from a VHF aerial with the same number of elements. This considerable fall in the energy available to operate the receiver can be partially recovered by using aerials with many elements, say 12 to 20. Since the aerial rods are only about the size of an ordinary pencil this is not as alarming as it sounds.

Field Strengths

We can now estimate the field strengths necessary in the absence of external interference, to provide the same picture quality in UHF as in VHF. These are approximately as follows:—

VHF	**Band I**	**220 microvolts per metre;**
	Band III	**500 microvolts per metre;**
UHF	**Band IV**	**1,250 microvolts per metre;**
	Band V	**2,200 microvolts per metre.**

The directivity of UHF aerials is substantially greater than that of conventional VHF types, thus providing much greater rejection of interference and other signals that do not originate in the direction of the wanted transmission. UHF installations will therefore have exceptional protection against interference and ghost signals caused by reflection from hills, buildings and so on.

Under ideal conditions, that is when the receiving aerial is within line of sight of the transmitting aerial, signals at UHF are as good as those at VHF. Thus in flat country, for example in East Anglia, a high-power UHF station can be expected to provide a first-class service over a substantial area, say to distances of the order of 40 miles.

When the radio wave path is obstructed by high ground or even by buildings there is a reduction in signal strength which is greater as the frequency increases. Viewers living in valleys and behind large obstructions will, therefore, find UHF signals weaker than the equivalent VHF signal. But this is not necessarily serious when close to a powerful transmitter because, after allowing for the loss caused by the obstruction, the signal is still likely to be strong enough to provide a good picture in all but exceptional circumstances. At locations more remote from the transmitter, however, we would

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Moving into the UHF Range (*Cont'd.*)

expect UHF reception to be more "patchy" than VHF.

Most of the factors I have mentioned indicate that a substantially stronger signal is needed at UHF. This can be provided by using more powerful transmitters and siting them closer together than at VHF. The more powerful UHF transmitters can readily have a radiated power of 1,000 kW, which is at least five times more powerful than existing VHF stations. Once again, the small physical dimensions of the aerial elements make it possible to concentrate nearly all the radiated energy into the horizontal plane instead of allowing it to escape in directions away from the earth. By this means a transmitter of less than 50 kW power can be the equivalent of a 1,000 kW transmitter feeding a simple aerial.

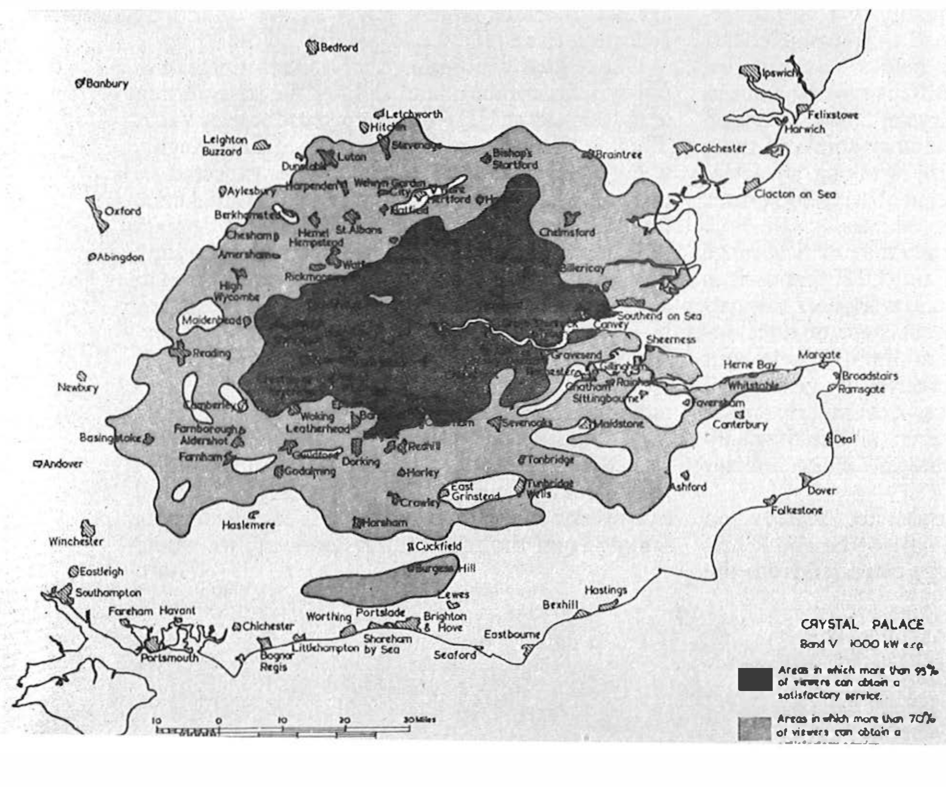
To provide a satisfactory service at UHF there will clearly have to be many more transmitters than for an equivalent VHF service and greater radiated power is necessary. The plan for the locations and approximate service areas of the stations that was agreed at the International Conference in Stockholm in 1961, involves some 64 high and medium power transmitters in Britain, many of which will be sited at existing VHF stations. It may well be subject to amendment in the light of experience but the general framework is unlikely to change.

But even with this considerable number of UHF stations there is still the problem of the "shadow areas" and those areas falling between the nominal service areas of the high-power network. To serve these locations a relatively large number of low-powered unattended translator stations—the preliminary plan includes 131 such stations—will be needed.

Several years ago an experimental UHF transmission was established at Crystal Palace and the grade of service compared with that of the then existing BBC service. From the observations, maps were prepared to illustrate on a percentage basis the likelihood of a satisfactory service being receivable, without special attention to the receiving aerial, both from a 1,000 kW UHF station and the existing VHF station. To assist comparison a similar map has been prepared for the existing ITA service. For the equivalent grade of service, coverage is not markedly different.

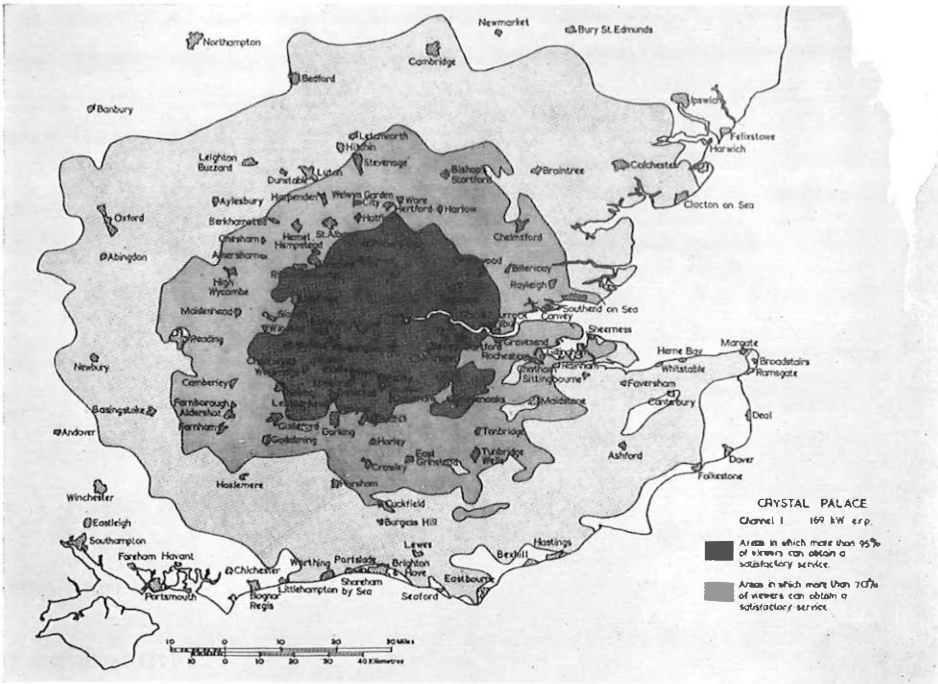
Beyond the contours expressing 70 per cent satisfaction, there is a considerable area in which an acceptable service can be received at VHF, particularly in rural areas, but where the UHF service would be generally unsatisfactory or even non-existent.

What about those people within the service area who represent the statistical percentage receiving an unsatisfactory signal? A substantial proportion is likely to be upgraded to the satisfactory status by greater attention to the height, gain and location of the receiving aerial and at UHF there will generally



This map shows the grade of service planned for the new 1,000 kW UHF station at Crystal Palace. —*Courtesy: BBC.*

A grade of service map for the existing 169 kW Band I VHF station at Crystal Palace.—*Courtesy : BBC.*



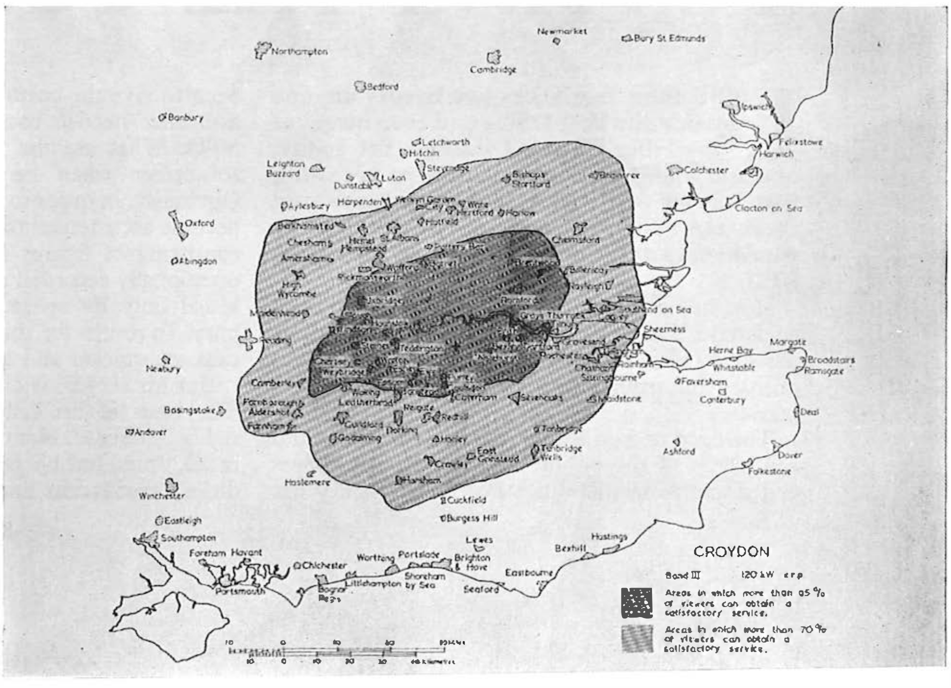
be more scope for improvement than at VHF. Should the difficulty be in city areas, where flat dwellers have no facilities for aerial manipulation, a communal aerial wired-distribution system may offer the most attractive solution. Where the "shadow" patch is too deep and too large for simple measures to cure, a low-power local station must be considered.

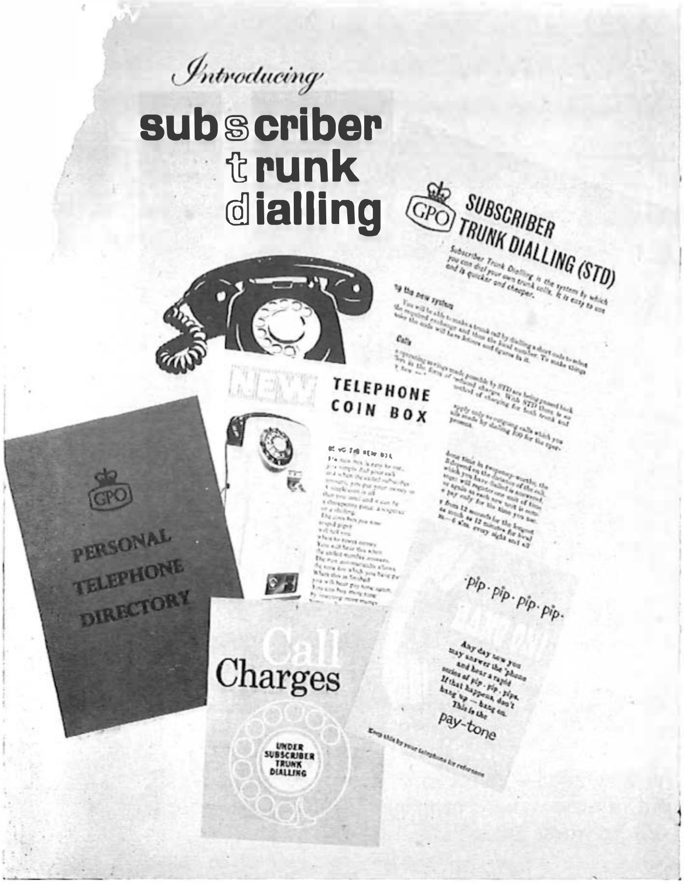
Briefly, the position is: Within the normal service area UHF reception for the majority should be very good—better in some respects than VHF, but in areas where propagation difficulties arise it will be worse than VHF.

★

R. A. Dilworth, AMIEE, *a Senior Executive Engineer concerned with the planning of broadcast sound and television services, joined the Post Office in 1934 and after four years in the South Wales Area was promoted to the E-in-C's office. He later joined the Radio Branch to assist in the planning and installation of radio equipment for the armed Services.*

The grade of service map showing (dark area) the districts in which almost all viewers get a satisfactory service and (lighter area) those in which more than 70 per cent do, from the existing 120 kW Band III VHF Station in Croydon.





A collection of some of the informative leaflets which are issued to all STD subscribers.

If the full benefits are to be obtained from Subscriber Trunk Dialling the Post Office must inform its customers of the facilities the new system offers and ensure that they receive every possible assistance. It is a tremendous task and this article describes how it is done

PUTTING THE CUSTOMER

LESS than five years ago hardly anyone outside the Post Office had even heard of Subscriber Trunk Dialling. Yet today, one and a half million subscribers are using this service with ease and confidence and there can be very few people in the country who do not know the significance of the letters STD.

How has this rapid spread of knowledge been achieved? The answer lies in the immense effort the Post Office has made, and is still making, to prepare and inform its customers about the new service.

The need to gain the support, co-operation and confidence of the public has always been appreciated and from the outset Post Office policy has been to give the customer all the information and assistance needed to reap the full benefits from STD. What are the main problems that face a subscriber when he is provided with STD? Obviously, in order to dial his trunk calls he has to become accustomed to dialling the national codes, consisting of figures and letters, and to hearing occasionally recorded announcements—previously heard only by operators—when trunk lines are busy. In return for this measure of self-service his calls are quicker and cheaper.

But his service is changed in many other ways. The basis of his call charges for trunk calls is radically altered. Not only are the calls charged for in 2d. units, but his bill will no longer itemize his dialled trunk calls and the charges for local and

IN THE STD PICTURE

By R. B. LEIGH

dialled trunk calls will be bulked. There is, of course, no ADC facility on dialled trunk calls and to replace this he may have to adjust himself to the innovation of meters installed in his own premises. Where he has a PBX this may make a substantial difference to the work of his operators. Also there are no personal calls or transferred charge facilities on dialled trunk calls and he must be encouraged to use the cheaper dialling service instead.

He must learn to do without the three-minute "pips" which everyone has become accustomed to hearing on trunk calls, but which are not provided on dialled trunk calls. He has also to be persuaded to accept that for calls via the operator he must continue to pay the old, and generally higher, charges. Then there is the delicate question of the change from untimed to timed local calls which goes with STD. We have to persuade the subscriber that this is really to his advantage and not, as many seemed to suspect just another way of putting up charges. Subscribers have to learn to recognise the "pay-tone" which they hear on answering a call from one of the new STD coin-boxes. And finally there is the new coinbox itself, which involves very different operating methods from the A and B button box that the public has become used to. Putting all this across to the public is a tremendous task, and it is a tribute to the staff and the efficacy of the arrangements that the task has been carried out with a minimum of disturbance to normal routine.

A typical advertisement announcing the introduction of STD and its advantages published in a local newspaper.

The work really began with the issue of the White Paper *Telephone Policy: The Next Steps* in May, 1958, which first announced the details of STD. The next big step forward took place when STD was inaugurated by the Queen at Bristol in December, 1958. Before this, nothing was known about the possible reactions of subscribers to STD and the job had to be tackled as a pilot scheme. In the event the arrangements proved to be so satisfactory that they have since been broadly followed in all areas where STD has been brought into operation.

The chief features of the new service have been mentioned but individual subscribers have their own questions and problems, and it is only reasonable to give subscribers as much time as possible to come to terms with the new outlook.

The first individual notice a subscriber therefore receives about STD is a letter from his Telephone Manager about six months before STD is due, telling him that it is to be introduced at his exchange and enclosing a leaflet setting out the full details of the STD service. The purpose of this communication is to enable subscribers to consider carefully the implications of STD in relation to their use of the trunk service and their accounting

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The Customer and STD—*continued*

arrangements and, in particular, to enable them to assess any requirement for private meters. These preliminary letters always invite the subscriber to seek help from the Telephone Manager's office if they need more information and inquiries are dealt with by telephone or by a personal visit.

The STD charging arrangements high-light the need to eliminate bad telephone practices, and as the STD opening date approaches increasing attention is given to the need for improving the customers' telephone technique. Often, the volume of work is sufficient to warrant organising special classes for PBX operators and these are usually welcomed by employers and are well attended. Travelling Supervisors visit all the larger installations, and as many small ones as practicable, to instruct PBX operators in the use of STD. Sometimes it becomes apparent that a re-arrangement of the customer's installation would be desirable and this is then followed up with the customer by the sales staff. Post Office telephone staff, especially those who meet officially members of the public, are briefed about the new service and the local situation so that they can give helpful answers to subscribers' questions.

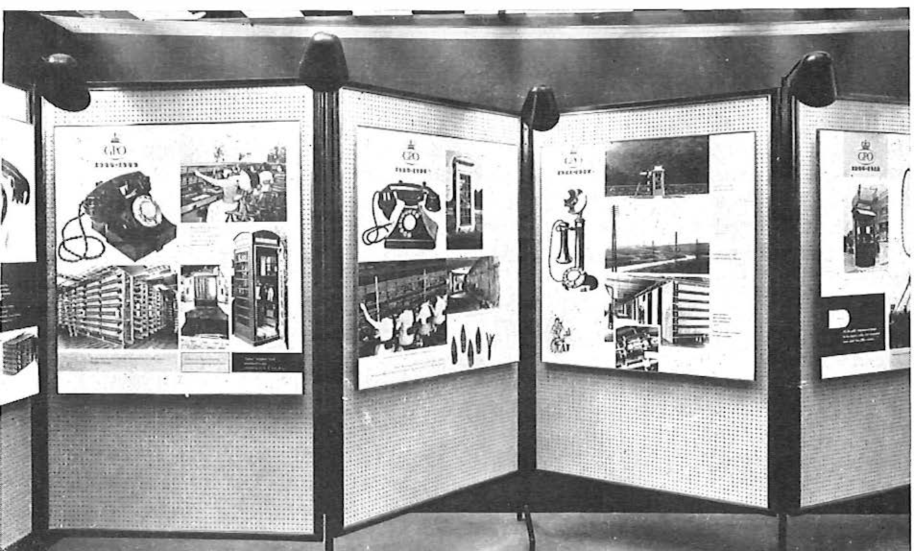
STD makes efficient handling of incoming calls doubly important, and with this in mind a booklet called *The Telephone in Business* was issued some two years ago. This has been welcomed by the business world as filling a long-felt need and there is no doubt that in future increasing attention will be given to the need for continuous effort to obtain the best value from the telephone.

Nearer the date for introduction of STD, an exhibition is arranged to illustrate its working and to give the public an opportunity of sampling the new system. The exhibitions range from a single demonstration set to an elaborate affair covering telephone developments from the earliest days and a wide field of telecommunications activities. Large or small, each exhibition aims to tell the visitor what STD is, explaining simply the charging areas, metering arrangements, the build up of the codes and so on and the visitor is led, step by step, to make a call. The telephones in the exhibition are connected to the local STD equipment. Post Office Answering Sets No. 1 have been provided at selected exchanges throughout the country to which calls may be made to hear a recorded message with an STD flavour. Alternatively, callers may dial an information service or, as at Bristol, a distant exchange telephone answered by telephonist staff.

A special colour film illustrating STD working is shown at larger exhibitions and to local organisations when talks on STD are given by the local staff.

The introduction of STD is usually prominently featured and advertised in the local press. Advertising takes the form of a number of display advertisements which seek to remind subscribers and inform other users of the impending change, to emphasise the advantages of the new system and to help them to use the new service in the most efficient way.

As soon as the conversion date to STD is firm, all subscribers are notified by letter. With the letters go dialling code booklets, personal telephone directories and a further descriptive leaflet on STD. This leaflet, like that sent with the preliminary letter, is produced nationally and can be



Before STD is introduced an exhibition is held to illustrate its working and to give the public the chance to try out the new system. This picture shows part of an exhibition at the Royal Exchange, London, held in July, 1961.

Often the Post Office organises classes of instruction for PBX operators. Here, at the LTR Training Centre, an instructor, Miss M. Smith, explains the use of subscribers meters to a group of operators from private firms.

used in any area, although a special version is issued in London. It illustrates the nation-wide range of dialling access and contains a special section on *Hints to STD Users.*

Preparation and despatch of all these items is a formidable task, particularly since the number of items sent to each subscriber depends on the size of his installation. Its magnitude is illustrated by the case of Glasgow, where the literature sent to 28,500 subscribers weighed over three tons. In London a collating and enveloping machine has been provided which will select, insert and seal the items into an envelope at the rate of some 4,000 an hour. But this machine is costly, and its provision cannot be justified elsewhere, so that in areas outside London the work is done by hand. Although it might be possible for the London centre to handle work for all areas, this has so far been prevented by transport and organisation problems.

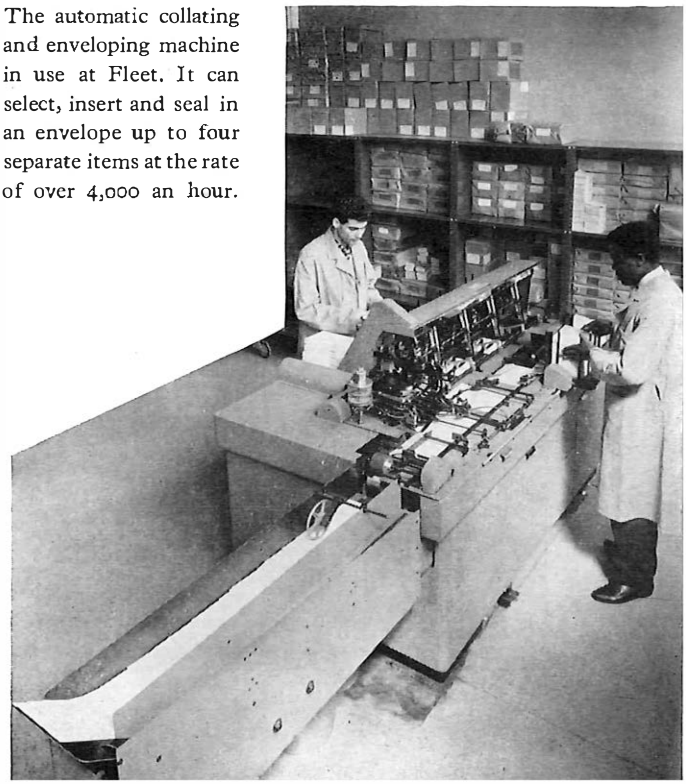
The culmination of all the preparatory work is the opening ceremony, the focal point of which is the making of the inaugural call. The Post Office insists that this should be a genuine call. However, because of the number of tappings to be made for the local address system and so on, it is often necessary to switch to high-grade circuits, although this is done only after the call has been answered.

The new pay-on-answer coin-boxes posed a special problem for the Post Office because the new pay tone is heard by both the user of a new coin-box and the person answering a call from one. Early experience showed that there was a tendency for called subscribers to hang up on hearing the pay-tone when answering their telephones, assuming that something was wrong. A very active publicity campaign involving the widespread use of posters, press advertisements and the despatch of leaflets to subscribers has been necessary to make the public aware of the significance of the new tone.

Leaflets describing the new boxes have been made available to the public in Post Offices and in some instances Post Office staff have patrolled the new boxes to help those in difficulty. Great care

OVER

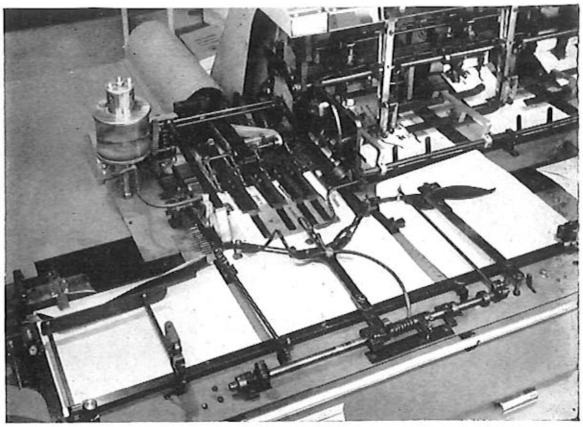
The automatic collating and enveloping machine in use at Fleet. It can select, insert and seal in an envelope up to four separate items at the rate of over 4,000 an hour.



The Customer and STD—*continued*

has also been taken with the wording and layout of the instruction cards about the new coin-boxes in call offices to make them as clear and comprehensible as possible. These measures have been very successful and the public has learned quickly to use the new coin-boxes and to dial their trunk calls from them.

The work of preparing and educating subscribers in the use of STD continues, its success depending very largely on the support and co-operation of the public. The present arrangements seem to be working well but they are under continuous review and will be tailored as necessary in the light of further experience to meet the changing needs of the future.



A close up view of the collating and enveloping machine.

Mr. R. B. Leigh *was concerned, as a Senior Telecommunications Superintendent in the Telephone Mechanisation Branch of the Inland Telecommunications Department, with the operational aspects of STD during the first few years of its introduction. He joined the Post Office as an Assistant Traffic Superintendent in 1949 from the North-west Electricity Board and after serving in Wales and Border Counties for two years moved to the Sheffield Area. In 1958 he came to Headquarters as a Senior Telecommunications Superintendent and since writing this article has been appointed a Senior Executive Officer in the Clerical Mechanisation and Buildings Department.*

The New Golden Voice

A NEW voice which will become one of the best-known in the country will soon be heard giving the time on the Post Office's new TIM speaking clocks.

The voice belongs to Miss Pat Simmons, an assistant supervisor at the Avenue telephone exchange, London, who won the Post Office's Golden Voice competition from five other finalists with whom she had been selected from more than 9,000 men and women telephone operators and supervisors.

Miss Simmons, who joined the Post Office in 1937—a year after Miss Jane Cain, whose voice she replaces, was selected as the first Golden Voice—was voted the winner during a television programme and as her prize received a cheque for £100.

The three judges—Miss Mervyn Pike, the Assistant Postmaster General, Professor D. B. Fry, Head of the Department of Phonetics at University College, London, and Mr. Stuart Hibberd, for many years the BBC's chief announcer—chose Miss Simmons' voice for its purity of tone, clarity of enunciation and naturalness.

The other finalists, all of whom received a cheque for £25, were Mrs. Moira Davidson Fiddler, a telephonist from the Edinburgh Talisman Exchange; Mrs. Olive Fuhrmann, a telephonist from Worthing; Miss Enith Jones, a supervisor from Newport (Monmouthshire); Mrs. Rita Kilburn, a telephonist from Newton Abbot, Devonshire; and Mr. D. Stuart Douglas, telephonist from the Grimsdyke Exchange, London.

Miss Pat Simmons, the girl with the Golden Voice.

THE POST OFFICE IN BUSINESS

The Post Office has good reason to be proud of its financial achievements—but there is still a need for greater economy and efficiency, says the Director of Finance and Accounts

THE need for even greater efficiency and economy was stressed by Mr. E. W. Shepherd, Director of Finance and Accounts, during his recent talk to the Post Office Telegraph and Telephone Society on "The Post Office in Business".

"The more we put capital into the less profitable activities the harder it will be to keep up our performance and the more difficult it will be to carry through future expansion plans," he said. "Of course we cannot refuse to meet demand: the real remedy is to review our price structure and see whether it needs to be quite so uneven.

"But we can do quite a lot within the framework of the present tariffs. We can seek the most profitable kind of business consistent with our obligation to provide universal service. We should also lose no opportunity of cutting out unnecessary expenditure and improving income. Every pound gained in this way is an extra pound available from profits to invest in the business, thus contributing directly towards solving capital shortages.

"We can also help to reduce working capital needs by ensuring that we carry no more than we must in the way of assets not earning revenue. Stocks of stores should be kept to a minimum and outstanding debts should be chased.

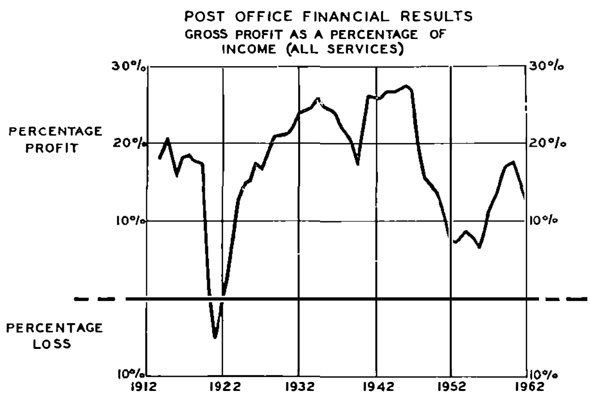
"If everybody looked at the problem in this way we should come even closer than we have already done to running the Post Office as an efficient and expanding business."

After describing how business generally operates and how its expenditure is financed, Mr. Shepherd went on to relate what the Post Office was trying to do against that background. The Post Office as we knew it today, he said, had been in business for 50 years, providing services in return for payment; and in the past year or two it had achieved a separate financial existence.

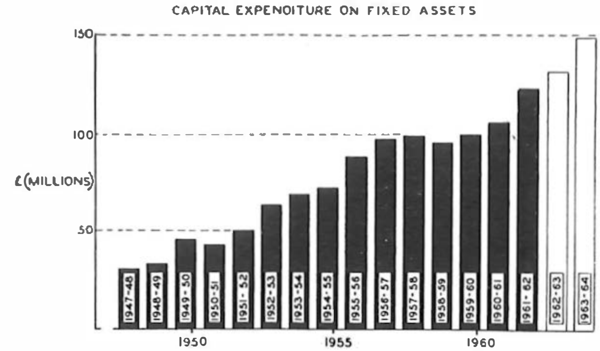
During the past 50 years Post Office income had increased by nearly 17 times. In 1912, when the take-over of telephones was completed, income was £30 million a year. Today it was about £500 million, having approximately doubled every ten years since 1932. Naturally, inflation had played a part in these figures but by any standard the increase was striking. The average rate of growth over the 50 years was about five-and-a-half per cent a year, to which real growth and inflation had contributed almost equally.

The Post Office faced similar financial problems

OVER



This graph shows the rise and fall in percentages profit and loss in the past half century



◀ In 15 years, capital expenditure on fixed assets has increased fivefold to £150 million.

The Post Office in Business—*continued*

to those of private industry and like them it was concerned to study the movements of income and expenditure and to keep them at a relative level which would show an adequate profit. It also had the normal range of capital problems and owned a very large and varied array of fixed assets, valued at about £1,000 million, by means of which it provided the services it sold.

The Post Office also had very large sums locked up in working capital. Stores in stock in March, 1962, accounted for £45 million while other working capital requirements amounted to some £13 million net. This latter figure was made up of a telecommunications requirement of £29 million, offset to the tune of £16 million by money held on the postal side of the business but which was ultimately due to other people. The postal figure resulted from a variety of liabilities both from the Post Office to other people and from them to the Post Office, but the major ingredient was the value of postal orders purchased but not yet cashed. The large telecommunications debit arose from the lag —part inevitable, but part avoidable by prompt billing—between rendering service and collecting dues.

These requirements had been financed partly from within the business and partly by borrowing. Unlike private business, the Post Office did not borrow on the open competitive market but relied on the Bank of England for short-term advances to meet day-to-day fluctuations in working capital and on the Exchequer for longer-term requirements.

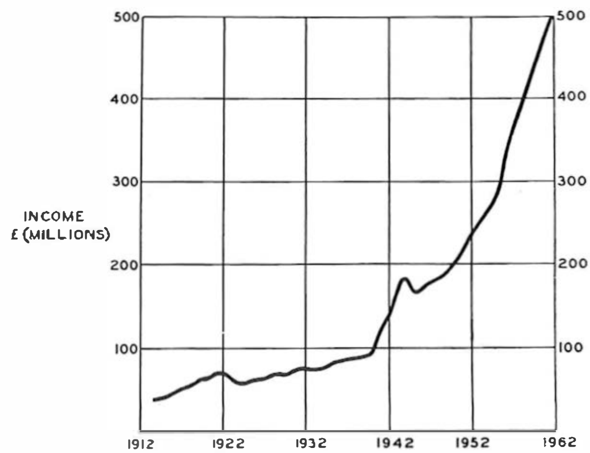
But in spite of this, the Post Office faced the same problem as private firms when planning capital expansion, having to consider how far it could rely on borrowing and how far it should aim at raising money from ordinary income.

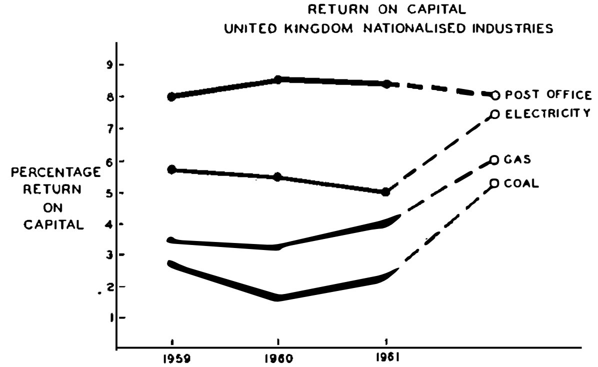
The year-by-year needs of the Post Office for new capital had grown dramatically over the past 15 years, having increased five-fold from £30 million to £150 million. "And today we are moving ahead rapidly on a curve which will have added 50 per cent to our rate of spending in only four years," added Mr. Shepherd.

To match this growing programme, he continued, the Post Office must have a healthy financial performance, just as expanding private businesses must if they were to provide or attract the capital they needed. The rapid rate of growth presented a particular challenge. What then, was the Post Office record of financial performance?

It was usual to measure performance by setting gross profits against capital employed in the business, the resultant percentage being called the return on capital. Alternatively, gross profit could be expressed as a fraction of income and in these terms it was possible to view the whole course of the past 50 years. The picture was that, apart from a period immediately after World War One when prices were drastically reduced, the Post Office had achieved a consistently high performance. There was some falling off in the 1930s and again after World War Two, during which profits

In the past 50 years Post Office income has increased by nearly 17 times to £500 million. ▶





This diagram illustrates how the Post Office leads other nationalised industries in performance.

were inflated by surcharges imposed on normal Post Office prices and also by the immense amount of defence work the Post Office carried out. In the early 1950s Post Office affairs fell to a low ebb but they had climbed again as new financial policies have taken effect.

"So far as we can calculate them," said Mr. Shepherd, "returns on total capital of ten or twelve per cent were being earned before World War Two as against the eight per cent which is familiar to us today. These pre-war returns derive in part from high postal profit. The return on telecommunications alone would certainly be below modern levels."

The question of financial performance in relation to the nationalised industries generally had been of great concern to the Government in the last year or so. The borrowing needs of nationalised industries were so vast that national savings would not cover them and money was actually raised by taxation in order that it might be advanced to the nationalised industries, including the Post Office, at gilt-edge rates of interest.

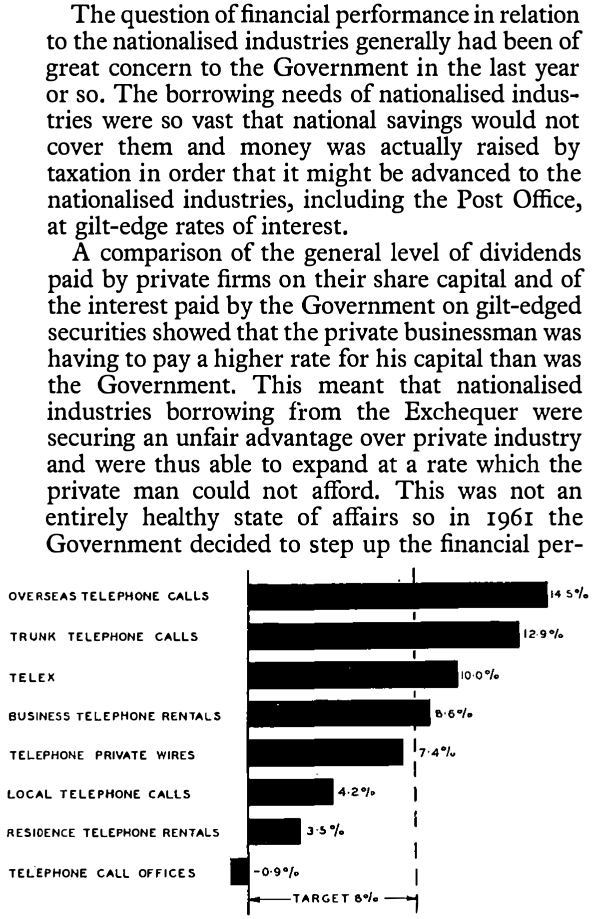
A comparison of the general level of dividends paid by private firms on their share capital and of the interest paid by the Government on gilt-edged securities showed that the private businessman was having to pay a higher rate for his capital than was the Government. This meant that nationalised industries borrowing from the Exchequer were securing an unfair advantage over private industry and were thus able to expand at a rate which the private man could not afford. This was not an entirely healthy state of affairs so in 1961 the Government decided to step up the financial performance of the nationalised industries to a level more nearly comparable with that of private enterprise, thus ensuring that capital was employed more profitably and limiting the amount of money the nationalised industries needed to borrow. The Post Office was regarded as one of the leading performers in this new approach which was set out in a Government White Paper published in 1961.

Among nationalised industries generally the Post Office had a reputation, both in actual financial achievement and in the standard aimed at, for being at the top. The recent Post Office performance of earning an eight per cent on capital could be compared with targets set for the Electricity, Gas and Coal industries of seven and a half, six and five and a half per cent respectively.

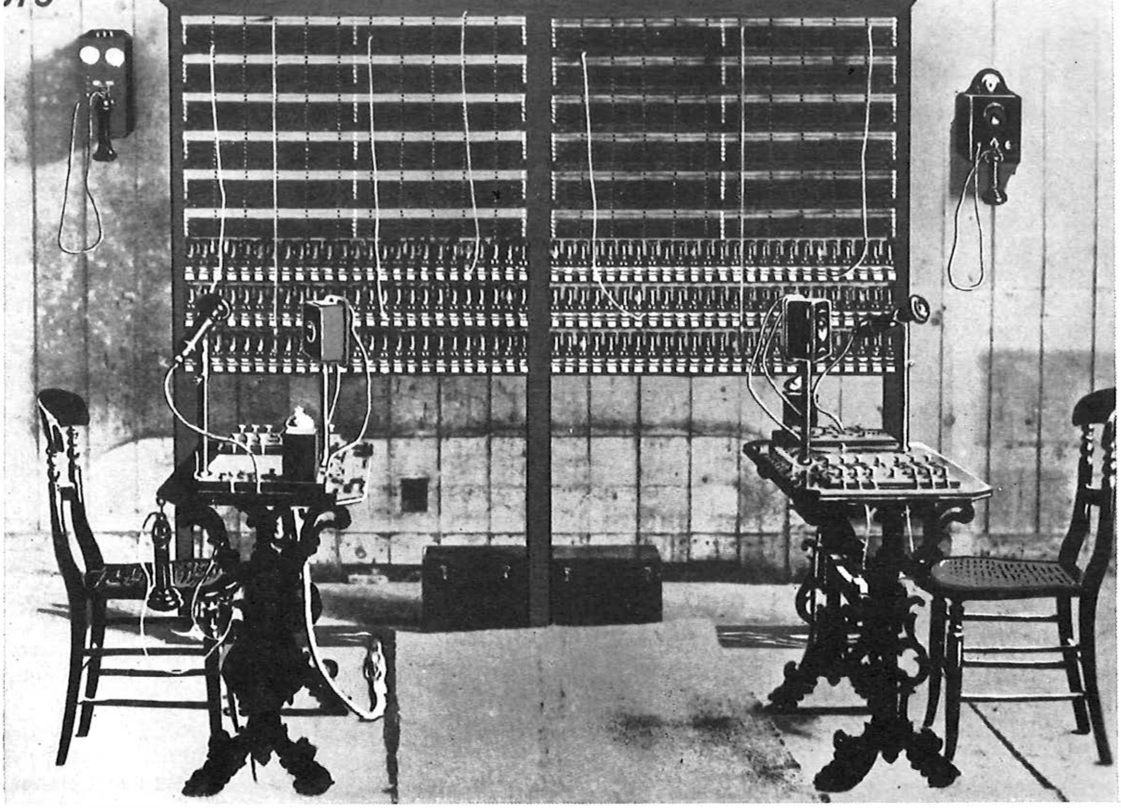
Bearing in mind the large capital needs it was obviously important for the Post Office to keep up a high standard. In that way we would reduce our dependence on Exchequer borrowing and thereby make it easier to carry out our aims. If the demand on the Exchequer was small there must be less danger of Post Office programmes being frustrated as the result of any economy drive the Government decided to introduce.

In relation to a selection of foreign postal and telecommunications administrations the British Post Office was level with the lowest performer—Belgium—while the A. T. and T. Company of America was the highest at 13 and a half per cent. Among private industries in Britain there was, as far as Mr. Shepherd could discover, only one major group earning less than eight per cent. That was the entertainment business which had been passing throughout a very lean time. Most groups had returns ranging from 12 to almost 25 per cent, and on this basis the Post Office could not complain that eight per cent was an undue burden.

The return on capital varied considerably within the Post Office among the various sectors of telecommunications. In 1961-62, for instance, overseas telephone calls, trunk calls, Telex and business rentals earned more than eight per cent but telephone private wires, local calls and residence rentals earned less. Call Offices did not even provide enough to pay the annual running expenses while the loss on inland telegrams at minus 45 per cent was even greater.



The return on capital in 1961-62 varied widely between telecommunications services, with overseas telephone calls the highest.



The first telephone switchboard in Britain was this two-panel affair installed at Coleman Street, London, in 1879.

THE HISTORY OF

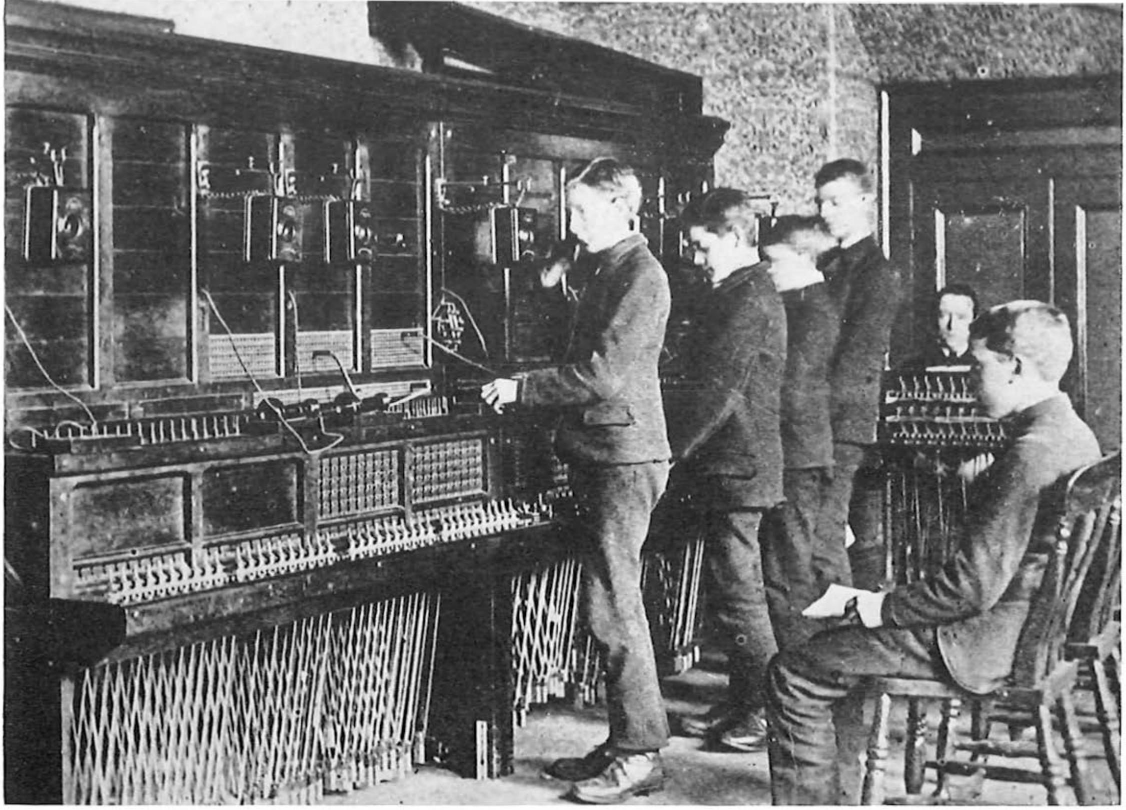
If you want to trace the history of telecommunications there are few better places to do it than at Fleet Building where more than 250 items of equipment and apparatus—some over 100 years old—are on show

NOWHERE is the fascinating story of telecommunications more graphically told than in a room on the ground floor of the Fleet Building in Farringdon Street, London.

Here, set out in glass show cases and on tables, are scores of exhibits ranging from a piece of the first submarine cable to be laid across the Atlantic to an underwater repeater of the type used in the latest trans-Atlantic cables; from an 1890 French Ader telephone with a carbon pencil transmitter to the telephone used by the Queen to inaugurate Subscriber Trunk Dialling at Bristol in 1958; and from a peg-type cordless magneto switchboard of 1876 to a modern PABX.

They are all part of the Post Office Permanent Telecommunications Exhibition—the only one of its type in Britain—which was set up in December 1961, with a small collection of exhibits gathered from the Central Telegraph Office, a number of telephone museums, the Inland Telecommunications Department and a few individuals. Today, the Exhibition boasts more than 250 items on display with more than 100 in reserve, some of them unearthed from the dark corners of Post Office stores rooms, and a few even rescued from rubbish dumps.

The Exhibition is in five main parts, each showing how design and techniques have developed since the earliest days. In the Subscribers' Equip-



The Sunderland switchroom, showing boy operators dealing with the calls, as it was 77 years ago—in 1886.

TELECOMMUNICATIONS

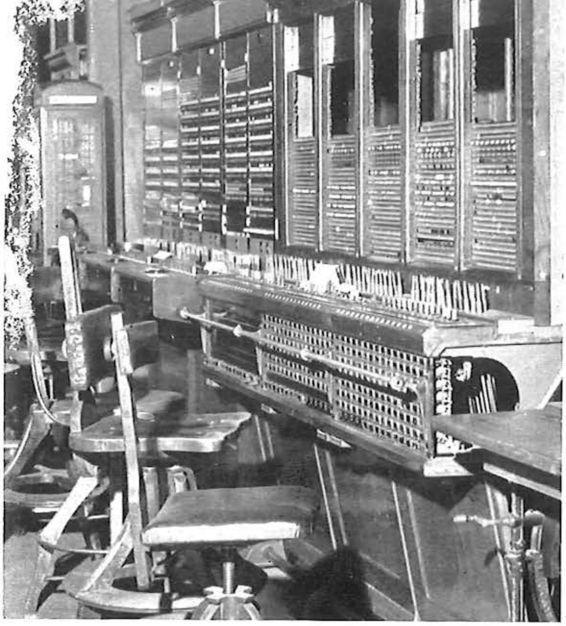
By V. H. Pridden

ment Section there is a wide range of telephones, intercommunication systems, house exchanges, private branch exchanges and extension plans. The Exchange Equipment Section contains items ranging from magneto to electronic and STD apparatus; the Telegraph Equipment Section has a series of instruments going back to a double pedal, single needle sounder of 1840; and the Lines Section a collection of all types of cables with diagrams showing distribution schemes, and equipment between a subscriber and an exchange. In the Miscellaneous Section are those items of historical interest—testing equipment, documents (including the original letters patent granted for Chatterton's compound with Queen Victoria's great seal)—and curiosities, such as part of a telegraph pole from Norman Cross, Northamptonshire, with a fist-size hole made by a woodpecker in 1895 at precisely the same height—16ft from the ground—as the hole made by a woodpecker in the pole it replaced.

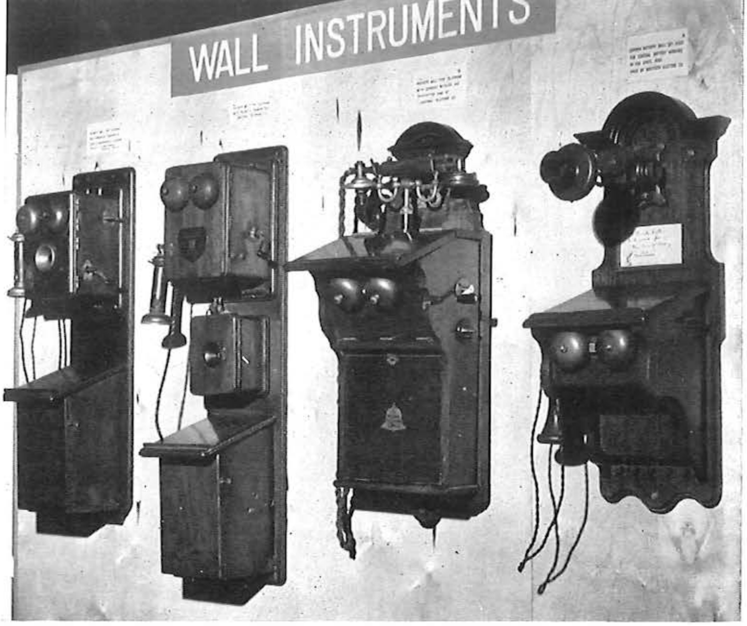
Among the many exhibits which attract great interest from the 80 or so people who visit the Exhibition every day, are a piece of the first trans-Atlantic cable laid between Valentia, in Ireland and Newfoundland in 1857, and a letter which reads: "This is to certify that I have sold the balance of the Atlantic telegraph cable to Messrs. Tiffany and Coy, Jewellers, No 50 Broadway, of the city of New York, and that the piece which accompanies this is a genuine section.—Cyrus W. Field. 21.8.58". The cable, which was insulated with gutta percha, failed early in 1858.

There are also on show the first underwater repeater used in 1943; the switch which operated the first aerial television link between London and

OVER



Two of the oldest switchboards and their chairs. Left, a CBS II used at Framlingham, Suffolk, and right, a magneto exchange employed at Broadstairs. Below: The hole the woodpecker pecked in the pole.



A collection of wall instruments in use 60-70 years ago. Second from the right is an Ericsson magneto telephone introduced in 1905 and on the extreme right the first central battery telephone introduced in the same year.

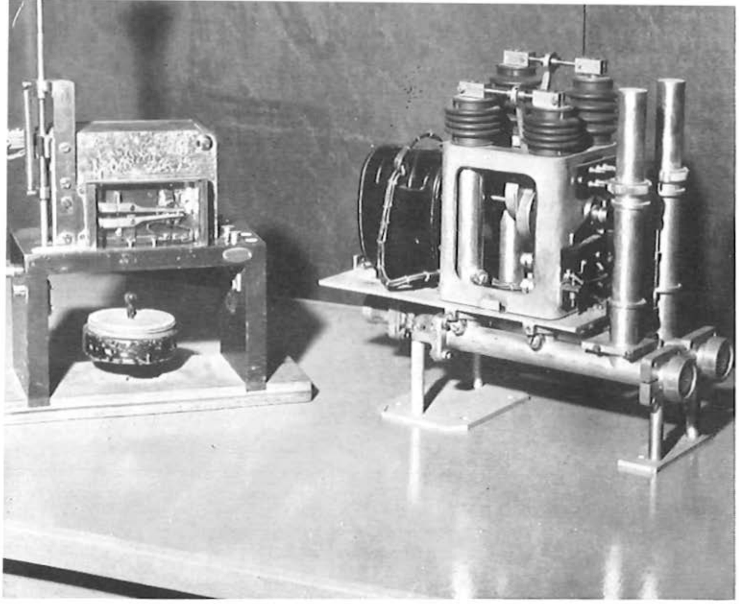
The Gower-Bell telephone introduced in 1880 and the first in standard production for the Post Office.

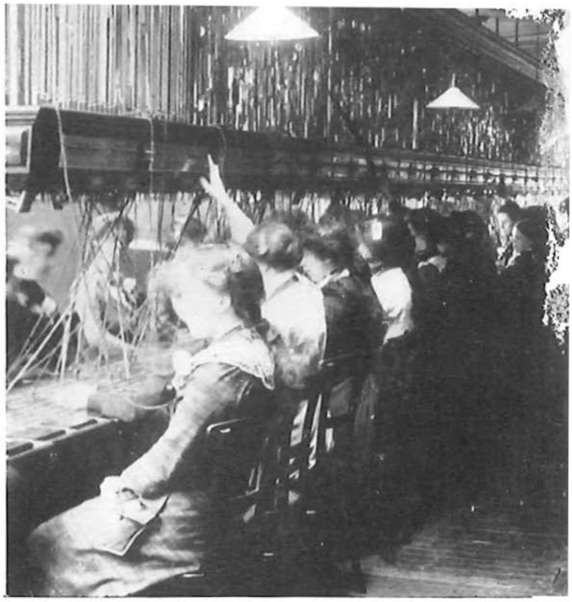
The Story of Telecommunications (*Cont'd.*)

Birmingham in 1949; the telephone presented to King George VI by the city of Brantford, Ontario (where Alexander Graham Bell, inventor of the telephone, lived at one time) during His Majesty's visit to Canada in 1939; and a replica of the switch used for operating the House of Commons division bell which was destroyed by enemy action in World War Two; telephone operators' chairs of the early 1900s; the first clock bought by the Post Office for the Central Telegraph Office in 1856; a Gower Bell telephone—the first subscriber's instrument produced on a large scale for the Post Office; a cup presented to Mr. J. Chapman, champion morse transmitter in 1884; and, for good measure, a club used by Special Constable Taylor when guarding the Central Telegraph Office during the Fenian threats to blow up public buildings between 1885-87.

Some of the more valuable items have been donated by individuals, among them Mr. R. M. Chamney, and Mr. H. N. C. Ellis-Robinson, who presented all his uncle's private collection of 72 pieces of telecommunications equipment.

The Exhibition, which came into being largely through the interest and efforts of Mr. H. M. Turner, Deputy Regional Director of London





Left: A replica of the House of Commons' Division Bell switch, operated by a doorkeeper, and (right) the switch used in the television link from London to Birmingham —the first aerial television link introduced in 1949.

Above: The call-wire system at Glasgow in 1890. Below: A visitor examines an 1851 double-needle telegraph used at Buckingham Palace for transmitting speeches from the throne.

A visitor tries out an 1890 French Ader carbon and pencil transmitter telephone. Left is the latest telephone.

Telecommunications Region, has a permanent curator. He is Major Jan Zieleznik MC, a former Polish Army Officer and now a Telecommunications Traffic Officer, who, with the help of a number of enthusiasts, has carried out all the work of collecting, collating, arranging, listing and captioning every item. Soon, because of the growing number of exhibits and the need to make them fully effective by having them working, he is to have full-time engineering assistance.

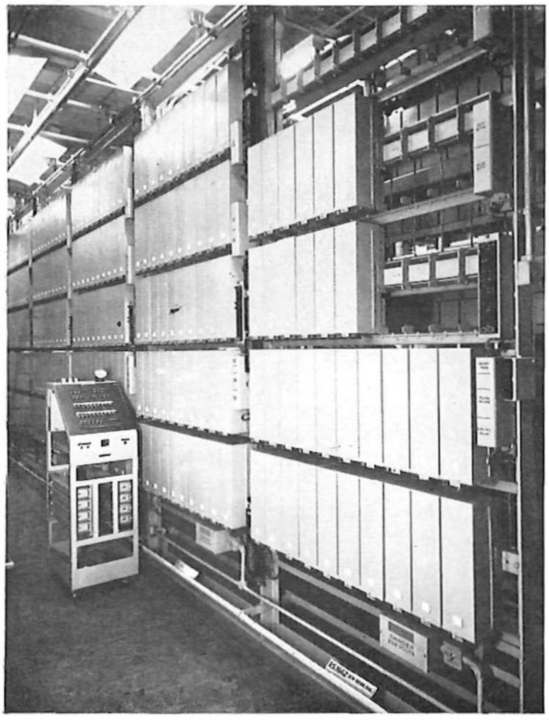
About 25,000 people have visited the Exhibition since it opened some of them students from GPO courses, but a surprising number of the public with a technical interest in telecommunications.

The possibilities for the future of the Exhibition are considerable and its value in terms of Post Office prestige, both nationally and internationally are incalculable. Clearly, it will outgrow its present home and will presumably pass out of LTR's hands into the control of Post Office Headquarters. Meanwhile, LTR is proud to have had the privilege of launching and building this fine representative collection of exhibits which cover the whole field of telecommunications. We hope that all who can will visit it and never let any piece of equipment be thrown away which could add to the story.

The Post Office is to introduce a measure of four-wire switching for certain classes of telephone traffic which will overcome some of the transmission disadvantages from which Britain's two-wire switched network suffers. A step in this direction has already been taken by the introduction of four-wire switching on some international calls switched at London. This article describes the transmission advantages of four-wire switching, outlines the proposals for the new national transmission plan and deals with the equipment installed at the International Exchange in London to provide four-wire switching of certain international calls

FOUR-WIRE SWITCHING

By C. J. Maurer and S. Munday



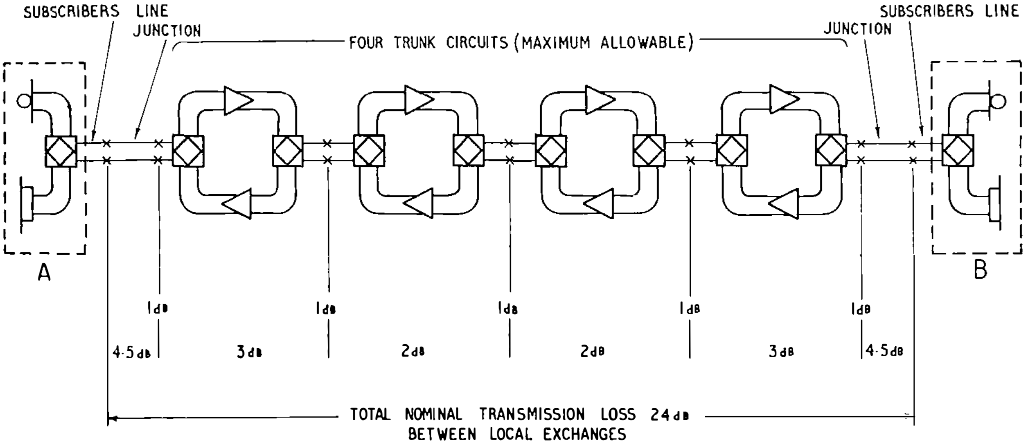
Relay sets associated with four-wire switching units.

Of all the ways to connect two people by telephone the best, so far as transmission is concerned, is by means of two independent uni-directional two-wire circuits. One two-wire circuit is provided between each of the transmitters and receivers making up a four-wire circuit and there may be several four-wire circuits connected in tandem through intermediate local and trunk exchanges, thus making up a four-wire connection. With such a straightforward scheme it is possible to reduce the transmission loss of the circuits to as low a value as desirable or necessary and in speech volume all calls can be made perfect, since almost unlimited gain can be inserted in the two paths without fear of instability or echo—apart from the hazard of acoustic feed-back through the air paths between the transmitter and receiver at each end.

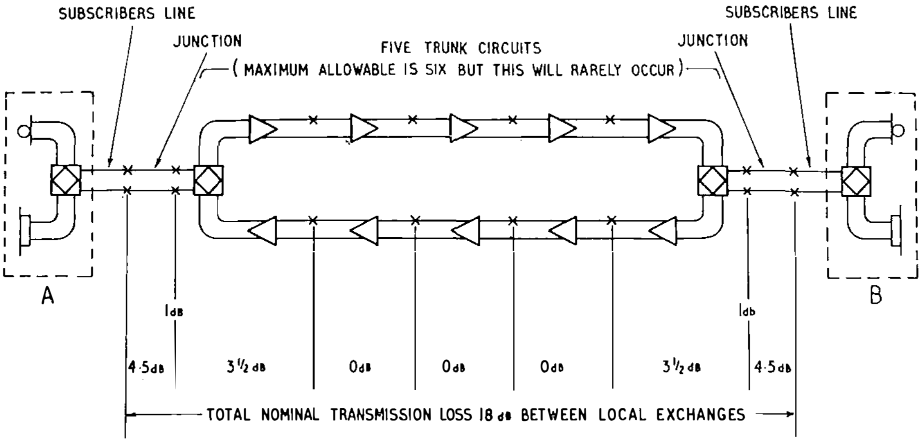
However, such a scheme is prohibitively expensive. It would require two pairs of wires from each subscriber to his local exchange and the apparatus in each of the present 6,000 local and 450 trunk exchanges would have to be able to switch the four transmission wires to other circuits.

To reduce the cost of the network the two directions of transmission are combined in the telephone instrument by means of an induction coil so that only one pair of wires is needed to the local exchange. The induction coil obviously costs less than the provision of an additional pair.

This simple telephone connection allows the use of two-wire switching apparatus in all exchanges



These two diagrams show (above) the maximum connection permitted by the present transmission plan and (below) the five-trunk circuit connection of the new transmission plan.



throughout the network and also two-wire junctions between the local and trunk exchanges. For technical reasons the longer trunk circuits between trunk exchanges are inherently four-wire circuits and these must be equipped with terminating units at each end so that they, too, can be two-wire switched.

The two-wire switching of four-wire circuits suffers from three disadvantages. First, additional losses are introduced because speech power is dissipated in the balance networks of the induction coils and terminating units. Second, the cabling and apparatus in the trunk exchanges introduce a transmission loss. Neither of these disadvantages would be too serious were it not for the third and biggest drawback—that it is no longer practicable to introduce unlimited gain in the circuits comprising the connection because of the risk of instability. The wisest course is to arrange that each individual amplified circuit making up the connection is inherently stable. When this is done, each amplified trunk circuit could then, theoretically, be arranged to introduce zero loss, but this cannot be achieved in practice for a variety of reasons. In particular, echo effects are introduced by speech currents circulating around the four-wire paths of the trunk circuits and, to reduce these to acceptable proportions the amplified trunk circuits must be operated at a finite transmission loss. Under the present transmission plan a switching loss of 1 dB has been assigned to each trunk exchange and the transmission loss introduced between two remote local exchanges by a chain of four amplified trunk circuits and two junction circuits is of the order of 23 dB. This figure is too high for a modern network and a new transmission plan based on four-wire switching at selected trunk exchanges, has been proposed which substantially reduces this loss. It is a compromise between the wholly four-wire switched system and the wholly two-wire switched system.

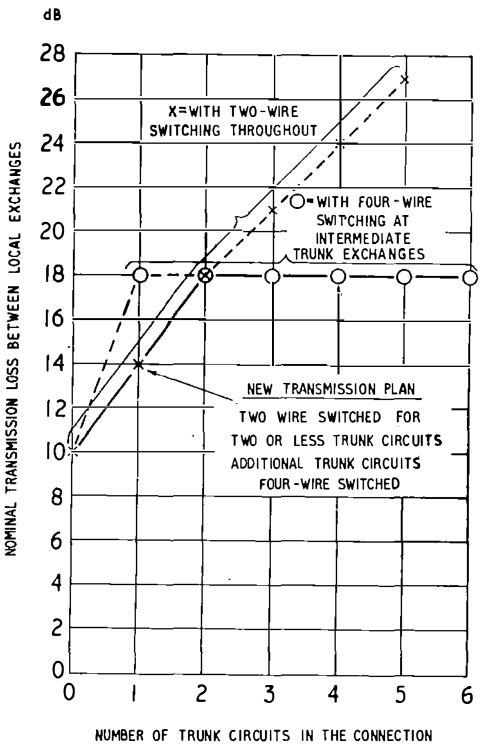
OVER

Four-Wire Switching (*Cont'd.*)

Under the new plan the two-wire circuits and two-wire switched exchanges are retained between the subscriber and the first trunk exchange, which means that that part of the telephone network in which the majority of the capital is invested is left unchanged. Four-wire switching apparatus is fitted at the intermediate trunk exchanges, of which there are 43 in the new network, including the International Exchange in London.

There is now virtually only one amplified four-wire circuit in the connection and this can be operated at less transmission loss than that introduced by the four four-wire amplified trunk circuits (and three intermediate trunk exchanges). The switching losses can now be taken up by the gains in the uni-directional two-wire paths of the intermediate trunk circuit and it is also possible to have more than four trunk circuits in tandem when they are four-wire switched. The maximum envisaged is six, although the need for so many will rarely occur.

The total nominal transmission loss introduced between local exchanges over five trunk circuits under the new plan is of the order of 18 dB which means that the received speech power will be approximately four times as much as a similar connection under the existing plan.



While the existing plan is better than the new when there is only one trunk circuit in the connection, they are equivalent when there are two trunk circuits and the new plan is much better thereafter. Advantage is taken of this by arranging for trunk connections requiring only one or two trunk circuits to be routed over the existing two-wire switched trunk network and for connections needing three or more to be routed via the new four-wire switching exchanges. In this way most trunk traffic is unaffected and maximum use is made of the very extensive two-wire switched trunk network.

Simultaneously with the development of the new national transmission plan a new international transmission plan, also based on four-wire switching, has been proposed and partially implemented. The two plans are not unconnected and the national one has been devised to be fully compatible with the international one.

The new national four-wire plan is not yet implemented but to enable international connections to be established in accordance with the new international plan, a special four-wire network connecting London to the provincial zone centres (Bristol, Birmingham, Glasgow, and so on) has been set up to handle such calls. International circuits arc switched into this special network by the four-wire unit of the International Exchange and in this way international circuits are extended to provincial zone centres with no additional nominal transmission loss. When the national four-wire plan is fully operative it will supplant the special network.

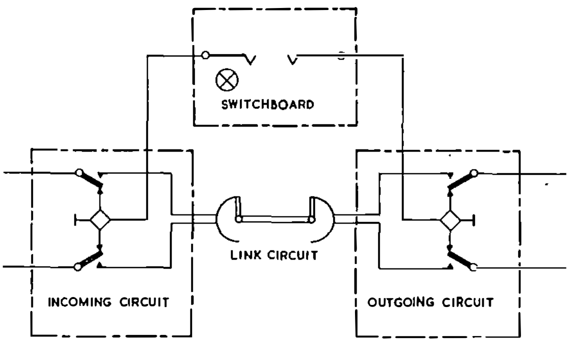
Since many international calls require at some stage the assistance of an operator, an auto-manual switchboard is needed at London to work in conjunction with the international four-wire switching unit. For a variety of reasons it was decided to use the existing two-wire sleeve control automanual board and special arrangements have been made to enable it to control the four-wire switching unit. It was also decided to retain as much of the standard sleeve-control operating procedure as possible. The rest of this article describes how these and other requirements have been met at the London International Exchange.

The standard sleeve-control switchboard in current use in the United Kingdom is a cord-type

Left: This graph illustrates the comparison between two- and four-wire switched trunk circuits. The thick black line indicates the new transmission and switching plan for the United Kingdom network.

board in which each of the cord circuits provides a direct two-wire connection for speech currents between an incoming and an outgoing circuit. Supervisory signals are passed between the outgoing or incoming relay sets and the operator's position through slccvc conductors of the calling or answering cords. Many of these switchboards are now in use and are likely to remain in service for some time.

The basic circuit arrangement of the four-wire switching unit installed at the International Exchange in London for the switching of international and continental calls is shown in the diagram below. On the left hand side is a terminat-



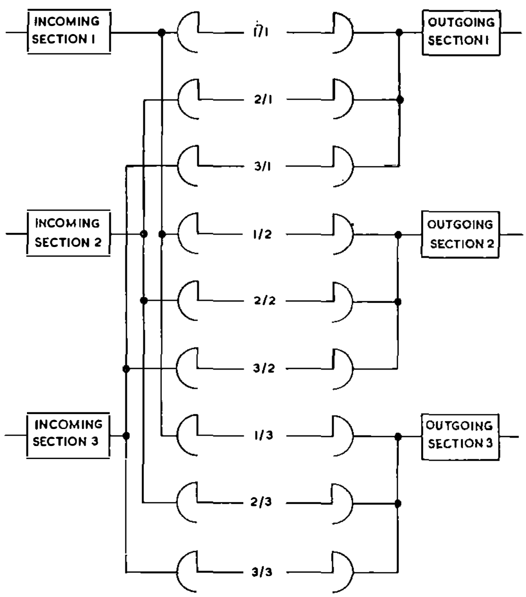
The basic circuit of the four-wire switching unit at the International Exchange, London.

ing relay set of an incoming circuit and on the right the terminating relay set for an outgoing circuit. Each relay set contains a terminating unit, the two-wire connection being extended to a jack in the switchboard multiple while a four-wire connection is extended to the multiple of a uniselector. When the operator is setting up a call the connection remains two-wire switched through the cord circuit but when the operator restores the speak key, a four-wire path is extended through the switches. The two switches shown constitute a link circuit and this provides a four-wire by-path to the cord circuit. A high impedance tapping circuit is included in the outgoing relay set to allow the operator to monitor the connection when it is four-wire switched.

Switches used in the link circuit are motor uniselectors which provide a bank capacity for 100 four-wire circuits. A link circuit can therefore be arranged to connect any one of 100 incoming circuits to any one of 100 outgoing circuits. If more than one call is to be connected simultaneously, more than one link circuit must be provided and an allotter is necessary to allocate a particular link circuit to effect the four-wire connection. When a four-wire connection is to be made, the two circuits already associated through the switchboard cord circuit apply individual marking conditions to their outlets in the incoming and outgoing section link circuit multiples. At the same time a free link circuit is allocated and its two motor uniselectors search for the marked outlets. When both marked outlets have been found, link association takes place and, so long as the operator has restored the speak key, a four-wire path is established between the incoming and outgoing circuits.

The capacity of the four-wire switching unit required for the International Exchange exceeds 100 circuits and to cater for this, further groups of link circuits are needed. For example, a unit with a capacity for interconnecting 300 incoming circuits to any of 300 outgoing circuits would require three incoming sections and three outgoing sections, and link circuit groups would be necessary for interconnecting each incoming section to each outgoing section. Nine groups are necessary and each group has been designated to show the incoming and outgoing sections concerned. A unit with a capacity for interconnecting any one of 1,000 incoming circuits to any one of 1,000 outgoing circuits would need ten incoming and ten outgoing sections and 100 link circuit groups.

OVER

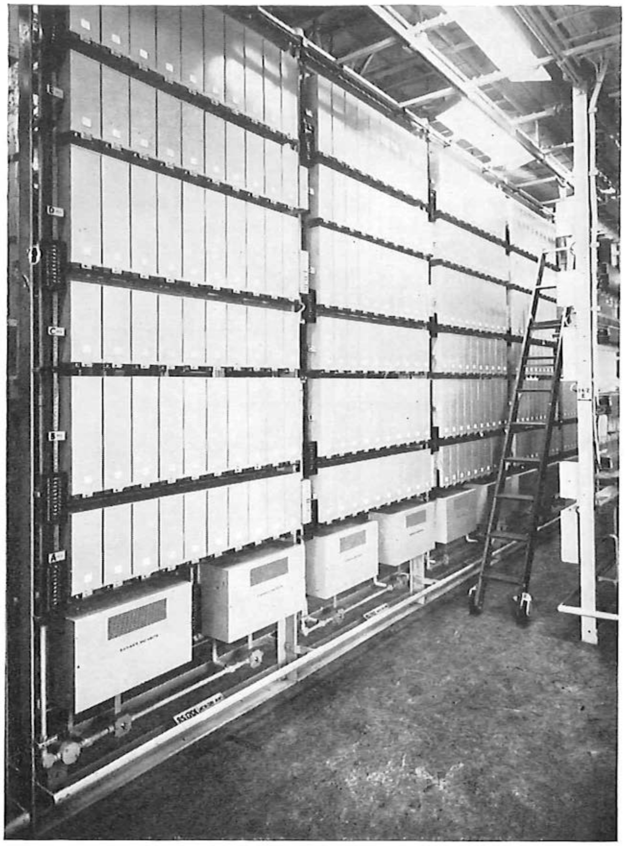


The link circuit grouping.

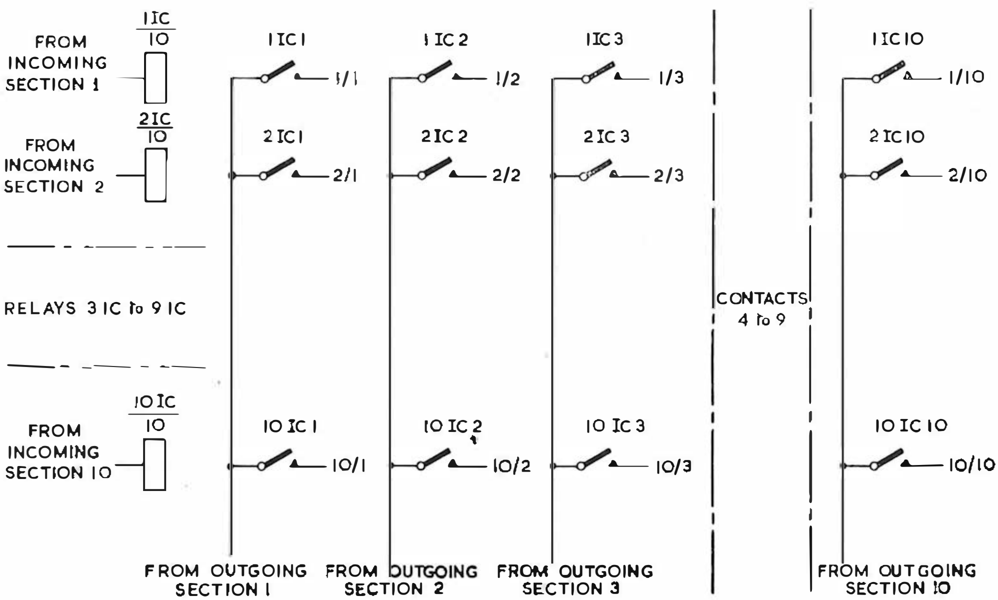
Four-Wire Switching (*Cont'd.*)

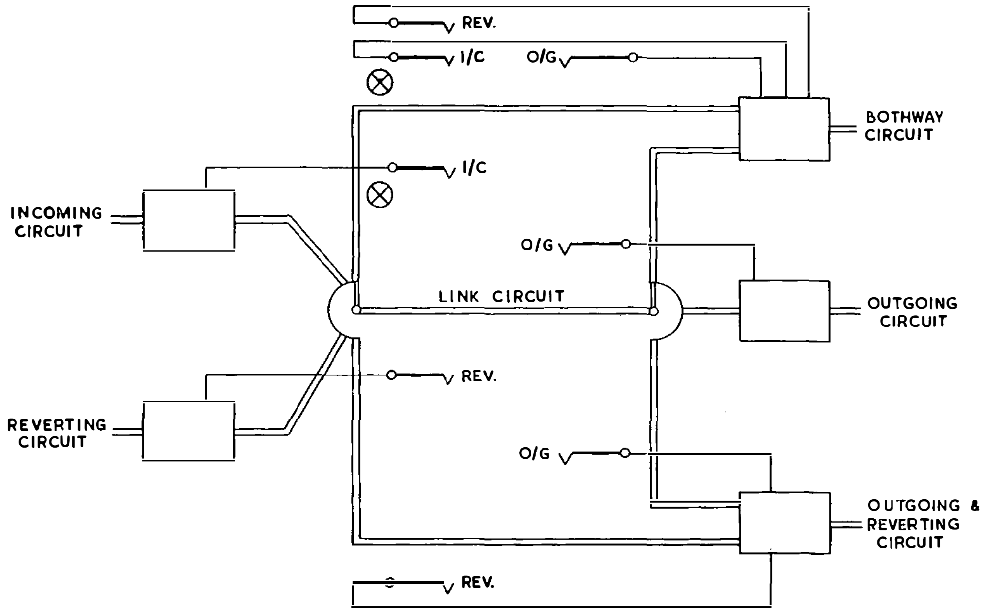
When an operator extends an incoming circuit to an outgoing circuit signals must be passed to a particular link circuit to effect the four-wire connection, and to prevent false switching this operation is permitted on a "one-at-a-time" basis for the whole unit. This is achieved by dividing each incoming section into two groups of 50 and allowing only one circuit in each group to proceed with a four-wire association at that instant. In a large installation of 1,000 incoming circuits this could mean that at any one instant 20 circuits had been permitted to proceed with a four-wire association and only one of these is allowed to proceed further. The selection of this circuit is achieved by an electronic allotter which chooses one of the 20 circuits and passes a start signal to its incoming relay set. Hence, of the 1,000 incoming circuits, at any one moment, only one is permitted to make a four-wire association. However, before link circuit association can take place, the particular link circuit group appropriate to the incoming and outgoing sections containing the incoming and outgoing circuits already associated by the cord circuit must be allotted. This is achieved by repeating the start signal received by the incoming circuit from the electronic allotter over the ring wire of the cord circuit to the outgoing relay set. Both relay sets now extend signals to a selection matrix which indicates the link circuit group required.

The selection matrix for a 1,000-circuit installation has ten relays, each with ten make contacts. One relay is allocated to each incoming section and the contacts of the relays are arranged as a matrix



Above: AC 9 relay sets used in the new international system. Below: Diagram of the selection matrix.





This diagram shows the basic types of relay sets with the link circuit connections.

(see opposite). Should an operator associate an incoming circuit in Section 2, to an outgoing circuit in Section 3, a signal is passed by the incoming relay set to relay 2IC to close contacts 2IC1 to 2IC10. Simultaneously, a signal is extended from the outgoing relay set in Section 3 to the the selection matrix and another is given by way of contact 2IC3 to indicate that link circuit group 2/3 is required. The other contacts of relay 2IC will be ineffective at this stage since the only outgoing circuit proceeding with a four-wire association is in outgoing group 3. The signal extended by way of the selection matrix is extended to a link circuit allotter which allocates a particular link circuit in the required link circuit group. The two motor uniselectors of the allocated link circuit hunt to find the marked outlets, and as soon as these are found the common equipment is released and another link circuit association can proceed. Link circuit association cannot start until the operator has completed the setting up of the outgoing call since, in the sleeve control system, the ring wire connection of the cord circuit connecting the incoming and outgoing relay sets is disconnected during dialling or keysending. The average period for link circuit association is 750 mS and in view of the anticipated calling rate for a 1,000 circuit installation it is unlikely to exceed two seconds. During this period the subscriber is being called.

The four-wire switching unit associates circuits connected to the multiple of an incoming finder to circuits connected to the multiple of an outgoing finder. It follows, therefore, that incoming circuits will be connected to the incoming finder multiple and outgoing circuits to the outgoing finder multiple. Bothway circuits will be connected to both incoming and outgoing finder multiples. However, it is often necessary for an operator to set up a booked call and, since link circuit association is not possible between two outgoing circuits, an additional facility is required. This is provided by a reverting relay set which performs an outgoing function for the line but is connected to the incoming link circuit multiple and acts as an incoming circuit for the four-wire switching unit. Hence, link circuit association is possible between a reverting and an outgoing circuit. Bothway circuits and, where necessary, outgoing relay sets can be provided with a reverting facility.

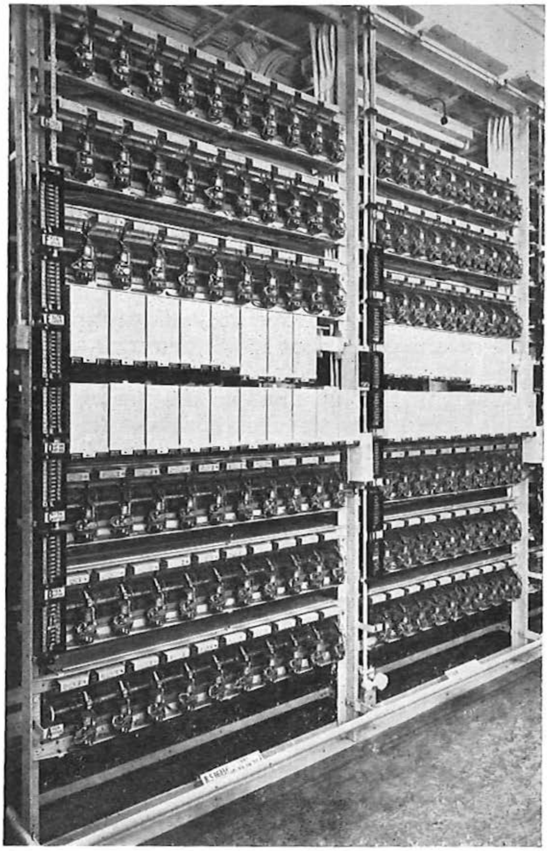
Particular attention has been paid in designing the four-wire switching unit to maintain standard sleeve control operating conditions and four-wire association is achieved automatically at the appropriate time. The only departure from standard sleeve control operating procedure occurs when the controlling operator has to set up a booked call to both the originating and the required subscribers. This necessitates the use of a reverting jack for one of the connections, the other being completed by way of an ordinary outgoing jack. To avoid erorrs of this kind at the International and Continental

OVER

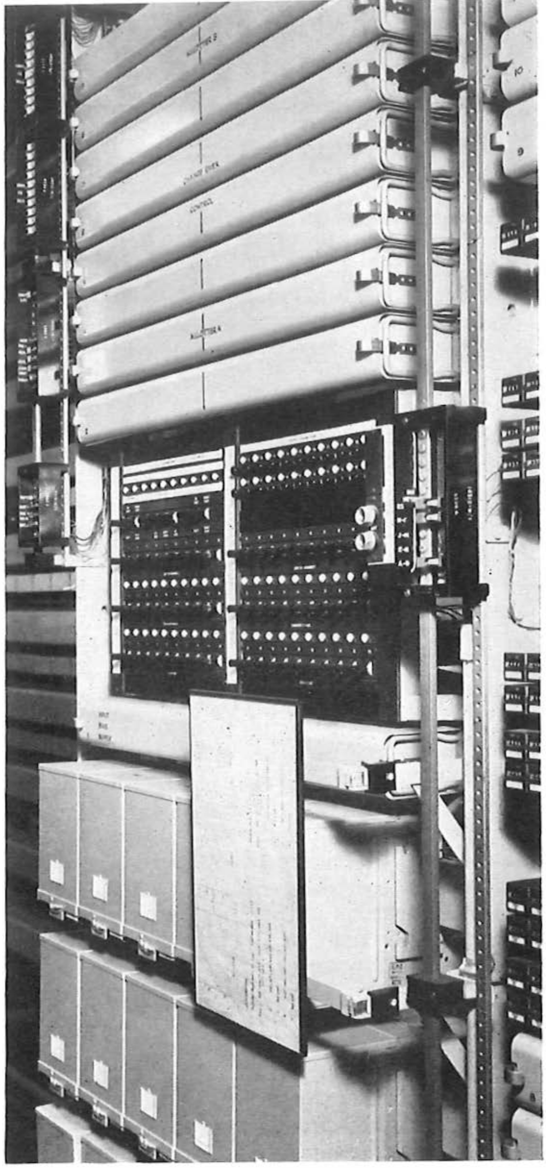
Four-Wire Switching (*Concluded*)

manual exchanges, the multiple has been divided horizontally into three main sections, each clearly marked. The lower section is the normal answering multiple, the middle is the ordinary outgoing multiple, and the top the reverting multiple. Cord circuit connections will, therefore, be between either the lower and middle sections or the middle and upper sections and never between the lower and upper sections.

The four-wire switching unit at the International Exchange was brought into service towards the end of 1961 with a capacity for interconnecting 800 incoming circuits to 800 outgoing circuits. This will be increased to cater for 1,000 incoming circuits to 900 outgoing circuits in the near future as further increases in the number of international circuits occur.



The link circuit racks.



The electronic allotter of a four-wire switch unit showing the control panel in the centre.

* * *

About The Authors

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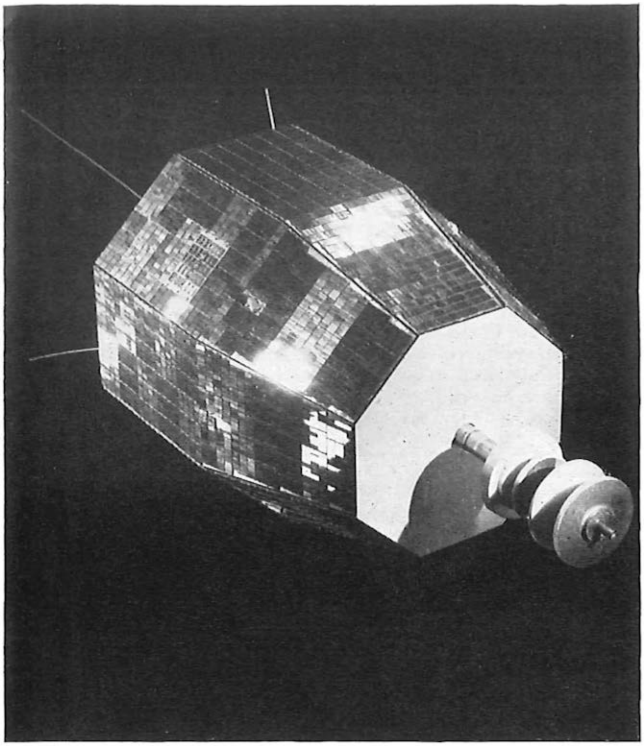
Mr. S. Munday is an Executive Engineer in the Transmission and Main Lines Branch of the Engineering Department. He joined the Post Office in 1947 and is at present concerned with national and international telephony transmission standards. Since 1960, he has attended the CCITT transmission study groups' meetings.



Relay is 33 ins high and weighs 172 lbs. Mounted in the centre panel are solar cells and diodes which will be tested for damage by radiation.

A COMPANION FOR TELSTAR

AFTER an initial failure, *Relay*—a more powerful successor to *Telstar*, the first space communications satellite—has been triumphantly vindicated. As the *Journal* went to press *Relay* was being used successfully not only to transmit television, telephone, teletype and data signals between three continents—North and South America and Europe—but also to measure the effects of radiation and to gather additional technological information for future satellite systems.

Shortly after *Relay* was launched by the National Aeronautics and Space Administration at Cape Canaveral, Florida, on 13 December, part of the electrical system which should have been switched on and off by command from the ground failed. Signals could not be sent until the fault had been cleared.

Then, on 5 January, the fault was corrected and the first test signals were sent from the United States' ground station at Andover, Maine, and monitored by the Post Office ground station at Goonhilly, in Cornwall, by the French and the new Italian and Brazilian ground stations. On the following day the first transmissions were made from Goonhilly.

The biggest triumph came on 9 January when nine minutes of an American television programme transmitted from Andover were picked up by the ground station at Goonhilly and shown on television screens in Britain, France and Italy. Later, viewers were taken to Washington for a film of the unveiling by President Kennedy of Leonardo da Vinci's *Mona Lisa*. The pictures and speech were of first-class quality, comparing very

OVER

*A second communications satellite—*Relay*—has joined* Telstar *in space. As the* Journal *went to press the Post Office ground station at Goonhilly, was sending and receiving trans-Atlantic signals by way of both* favourably with those obtained by way of *Telstar*.

Meanwhile—on 3 January—*Telstar*, which had been out of action through damage by radiation, was re-activated and soon carrying television, telephone and data signals across the Atlantic again.

Thus, faults in two satellites had been rectified by remote control—an exciting prospect for the future.

Relay, like *Telstar*, an active satellite, is circling the earth once every three hours and four minutes at heights of between 800 to 4,500 miles. It weighs 172 lbs., is shaped like a prism and has transmitters four times more powerful than in *Telstar*—ten watts against two-and-a-half. It is the first to link three continents and has the capacity to transmit one-way wideband communications (television, 300 one-way voice channels or high speed data) or two-way narrowband communications (12 two-way telephone conversations, or teletype, photofacsimile and data). The wideband frequencies are 1725 Mc/s (ground to satellite) and 4170 Mc/s (satellite to ground).

The exterior of *Relay* is composed of eight honeycomb aluminium panels studded with 8,215 solar cells which provide power to three nickel-cadmium storage batteries, each containing 20 cells. The satellite carries two identical transponders so that if one should fail the other can carry out the communication tests. Each transponder can handle wideband one-way signals, such as television, or two-way telephone traffic and other narrowband signals.

The most complex electronic system carried in *Relay* is the telemetry and command equipment which consists of an antenna, two command receivers, two subcarrier demodulators, two command decoders, two telemetry transmitters, one command control unit and one telemetry encoder. The duplicate units are carried in case of breakdowns.

The command system has 20 command channels which control the operation of the communication transponders and the telemetry system. Each

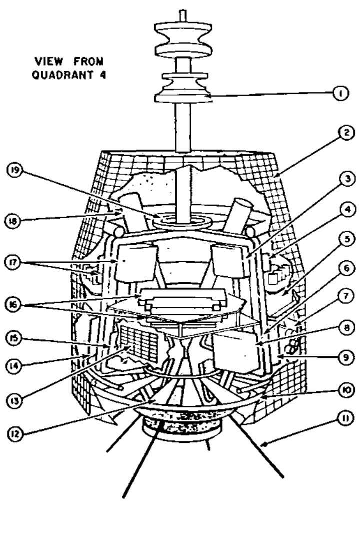
12 words a Second—via Telstar

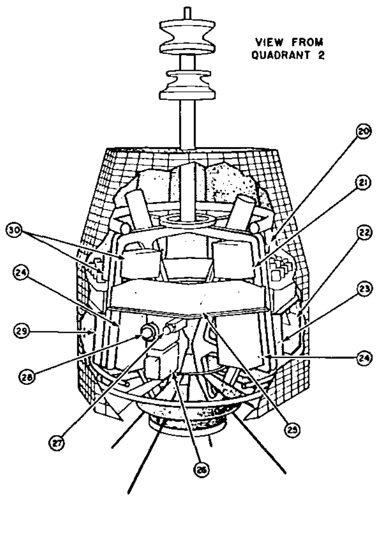
A FEW days before *Telstar* went out of action last October the satellite was successfully used to flash messages across the Atlantic—between London and Seattle—at the rate of 12 words a second.

The messages were transmitted by a new "musical" method—the Tally Parallel System—which, instead of sending separately a tone for each letter of a code, uses groups in the same way as a chord is played on a piano and received as dots punched out on tape.

The Tally Parallel System is claimed to be ten times faster than an ordinary teleprinter and cheaper and more accurate than any other system now in use.

1. WIDE-BAND ANTENNA	11 TT & C ANTENNA	21. SIGNAL CONDITIONER
2. SOLAR PANELS	12 THERMAL CONTROLLER	22 RADIATION DETECTORS E,F
3. TELEMETRY TRANSMITTERS	13 RADIATION DAMAGE PANEL	23. VOLTAGE REGULATOR
4. BATTERY CHARGE CONTROLLER	14. RADIATION EFFECTS CIRCUITRY	24. TWT POWER SUPPLY
5. BATTERY BOX	15. COMMAND RECEIVERS	25. TELEMETRY ENCODER
6. CRUCIFORM STRUCTURE	16. WIDE-BAND RECEIVERS	26 SUN ASPECT INDICATOR
7. RADIATION DETECTORS B,C,D	17. COMMAND DECODERS	27. HORIZON SCANNER
8. COMMAND CONTROL BOX	18. TRAVELING WAVE TUBE	28. RADIATION DETECTOR A
9. RADIATION SWITCH BOX H	19. PRECESSION DAMPER	29. RADIATION SWITCH BOX G
10. TORQUE COIL	20. ONE YEAR TIMER	30 MICROWAVE BEACONS





A cutaway diagram of the *Relay* satellite which is 29 inches in diameter at its broad end. *Relay* is circling the earth once every three hours 4 minutes.

command is repeated five times, demodulated, decoded and then applied to the command control unit which performs the switching function required and initiates a verification signal to be telemetred back to the ground station. The telemetry encoder encodes data from sensors inside the satellite and transmits to the ground through 128 channels at the rate of one a second. It weighs only one pound but has 5,186 parts, including 581 transistors and 1,378 diodes.

Relay spins at 150 revolutions a minute and a sun aspect indicator and horizon scanner provide telemetry data about the satellite's orientation. The spin axis is adjusted by a ground signal which activates a coil in the spacecraft and this in turn reacts with the earth's magnetic field and provides the torque needed to orientate the satellite.

The temperature inside *Relay* is controlled by a shutter system of aluminised mylar vanes at its broad end. When the vanes are closed the temperature is correct. When excessive heat builds up, a bellows, controlled by a temperature-sensitive fluid, opens the vanes and dissipates it.

Although public demonstrations of television, telephone calls, teletype, photofacsimile and high speed data will be transmitted by way of *Relay*, most of the satellite's orbits are being used for technical experiments. In addition, information on antenna pointing accuracy and the effects of time lag on signals are expected to answer important questions which differ between a ground-based microwave communication system and one moving through space at approximately 17,000 miles an hour and as high as 4,500 miles above the earth.

Relay is also equipped to measure the amount of damage to solar cells and diodes in radiation belts, information of vital importance to scientists in planning future operational satellite systems.

As the *Journal* went to press it was announced that a second *Relay* satellite was expected to be launched in the near future.

OVER

New Equipment at Goonhilly

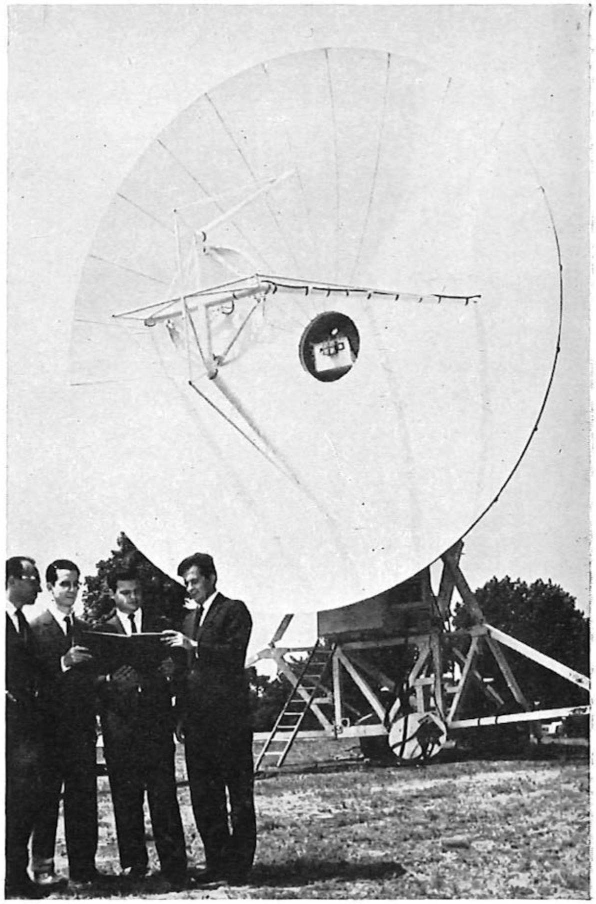
BECAUSE the frequency between the ground and the two satellites is different, new equipment, not used for the *Telstar* experiments, was brought into service at Goonhilly to transmit messages via *Relay*.

It included a powerful transmitter and special high-frequency connections between the transmitter and the aerial.

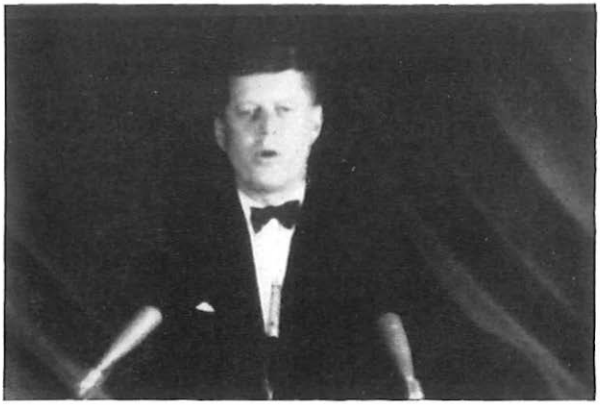
The new transmitter, working at 1725 Mc/s, is capable of delivering 10 kW into the load, and is similar to that used in tropospheric scatter links but modified to take an Eimac five-cavity klystron in its output stage. It is housed side by side with the *Telstar* transmitter in the same turntable cabin which rotates with the steerable aerial and has a new waveguide run connecting the output of the transmitter to the feed unit—also of a new design—at the focus of the dish aerial.

Since the frequency used for satellite-to-ground communication is the same for both satellites there is no major alteration in the receiving chain, although the original maser has been replaced by another version of the same design which is expected to have a wider bandwidth.

Since the periods of mutual visibility are longer for *Relay* than for *Telstar*, modifications have also been made to the paper tape dispensing mechanism.

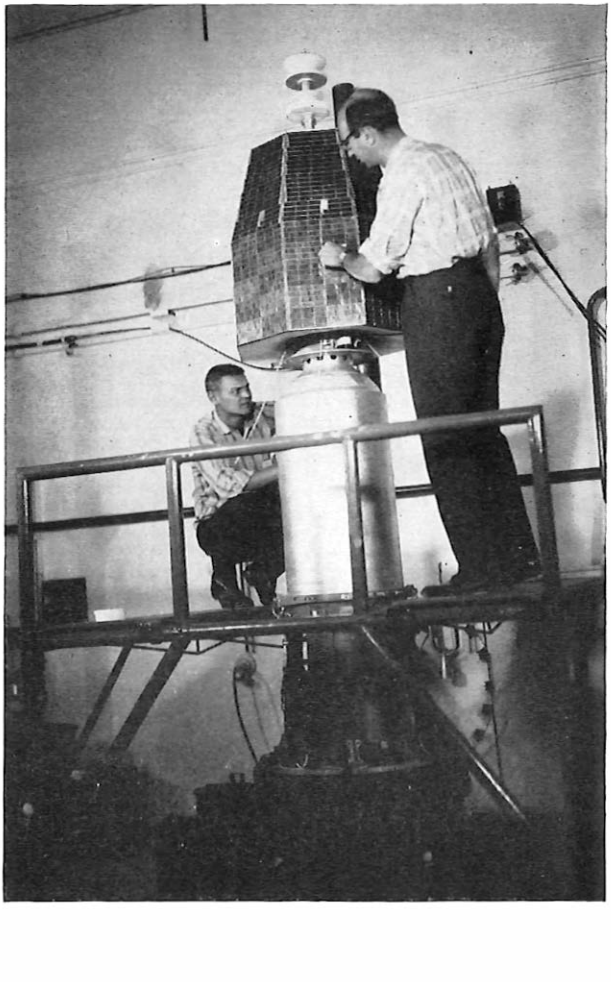


This 30ft antenna is part of a unique transportable space communications terminal which acts as the link via *Relay* between Brazil and USA.



Two of the first television pictures to be sent across the Atlantic by way of *Relay*. They show (left) President Kennedy at the unveiling ceremony of the *Mona Lisa* in Washington and (right) members of the USA *Today* programme.

Technicians put the finishing touches to *Relay* before it is moved to the launching site. They are checking the alignment, spin testing and mating the satellite to the third stage rocket. ▶



And soon Syncom

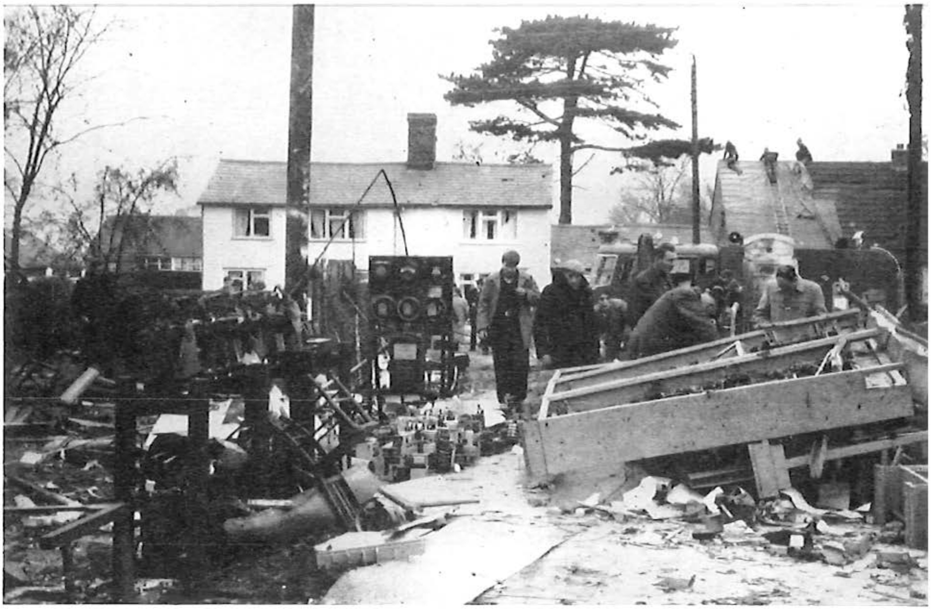
The next big step forward in the science of space communications is likely to be the launching later this year of a satellite called *Syncom* which will hover permanently over the same spot on earth. To do this it will have to be fired to a height of 22,300 miles and travel in the direction of the earth's rotation at exactly the same speed.

It is understood that *Syncom* will first be launched into a low orbit of some 300 miles when a small rocket will spiral it farther away from the earth. When it reaches a height of 22,300 miles it will be stopped by signals sent from the ground which will also make minor adjustments to the satellite's position when necessary.

A MOBILE TO THE RESCUE

An hour after Takeley exchange had been destroyed, Post Office engineers went into action. Three days later full service had been restored

This was the Takeley Telephone Exchange, that was. The exchange was completely destroyed and many adjacent buildings were damaged. Note shattered racks.



WHEN the 300-line UAX 13 at Takeley, Essex, was destroyed by a gas explosion at 7.30 a.m. on Wednesday, 14 November, 1962, the timber building disintegrated, the apparatus racks were laid flat and every cell in the battery was smashed.

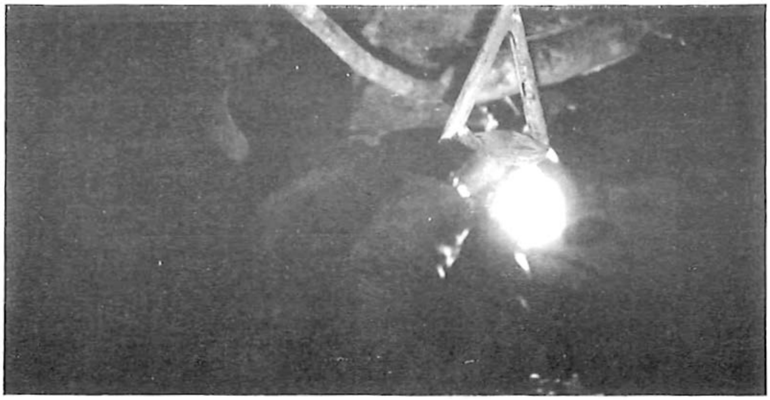
Within an hour after the incident the Cambridge Telephone Area went into action and at noon on the following Saturday, 76½ hours later, full service had been restored with a mobile exchange.

The first report of the explosion was received by the Area Engineer at 8.20 a.m. Immediately staff were sent to the site to investigate and a request was made for a mobile exchange. The first need was for a skeleton service and by 11.45 a.m. this had been provided from four kiosks which were set up and connected direct to Bishops Stortford Exchange.

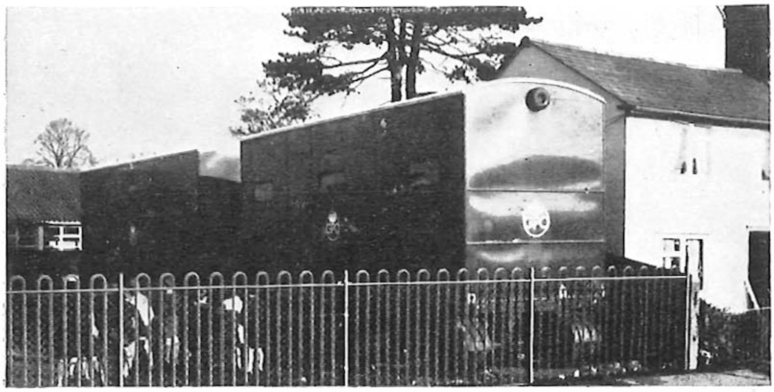
The presence of gas and two further explosions undergound, one of them in the exchange manhole, prevented a complete inspection of damage from being carried out until mid-day. In the meantime, two members of the development group, equipped with a set of external plant records, set up an office in the village schoolroom and prepared diversion schedules, while a third took pictures of Post Office plant and surrounding property which had been damaged.

It was decided that the most suitable site for the mobile exchange, which consists of two vehicles each 25 ft. 6 ins. long, 7 ft. 6 ins. wide and 12 ft. 6 ins. high, was the school playground where there was sufficient space to manoeuvre and to park on hard standings. In addition, it was also possible there to intercept all the cables with a minimum of

OVER



A jointer repairs a cable which was damaged by fire.



There's a mobile at the bottom of our playground. Takeley schoolchildren had unexpected company when the mobile exchange and an office were set up at their school.

Mobile to the Rescue—*Cont'd.*

external work. The local educational authorities agreed to this arrangement on the understanding that permanent restoration should be carried out at all possible speed.

When the mobile exchange arrived on the scene at 7.15 p.m. on the 14th, the ends of the underground cable were already on site for jointing to the cable tails within the exchange, but, although a tractor was available to draw the vehicles into the floodlit area, it was necessary for them to be manhandled into position—a task which would have been easier if the vehicles had been steerable at both ends.

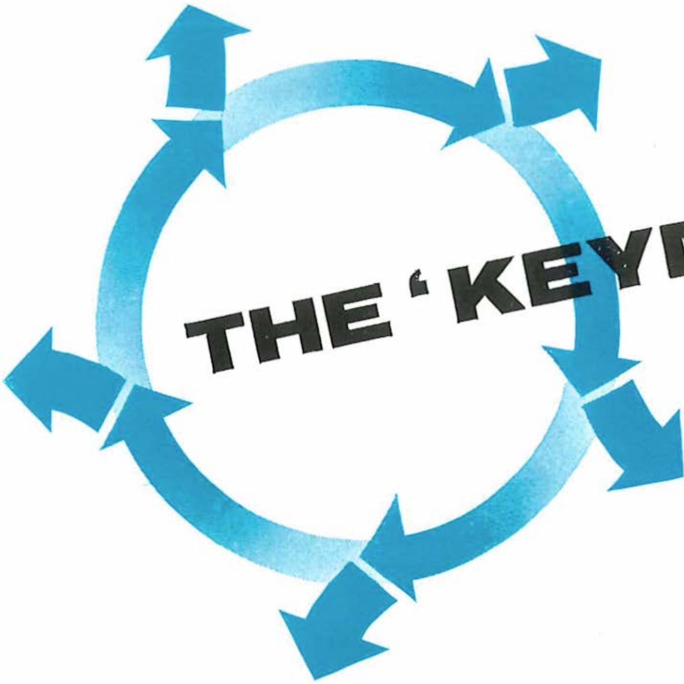
Cabling together the two separate sets of equipment, each contained in its own vehicle, proved to be a bigger task than had been expected, and, disappointingly, it delayed the final restoration of service. However, a great deal of progress was made throughout the night, jointers and fitters operating on a two-tier basis in the mobile, some crouched on the floor with others supported above them on planks and packing cases.

By noon on Thursday service had been restored to the 15 emergency subscribers with seven junctions to Bishops Stortford and by mid-day on the Friday these figures were increased to 245 subscribers and 16 junctions. At mid-day on Saturday restoration of service was complete—a feat which earned the thanks of the Lord Lieutenant of Essex and the chairman of the local Council.

R. C. LAYTON

★

Mr. R. C. Layton, AMIEE, a temporary Executive Engineer, joined the Cambridge Telephone Area as a Youth-in-Training in 1932. He left the Area in 1943 on promotion to Inspector but returned after six months. He is co-author of a newly published book entitled General Engineering Science.



THE 'KEYMASTER'

The 'Keymaster' House Exchange System has a capacity of one exchange line and five multiple-stations. One multiple-station can be replaced by a 2-wire external extension and a second by a 2-wire tie-line to a distant telephone installation. All stations have direct access to the exchange line by press-button operation, and intercommunication is available between all stations over a common circuit. Both the exchange line and intercom. circuits include supervisory lamps to signal the 'circuit engaged' condition. Exchange calls may be transferred within the system and 'night service' facilities are available at any station.

'The Keymaster' telephone, accepted by the British Post Office, is a natural development of an Ericsson design already approved by the Council of Industrial Design, and contains six push-buttons, an a.c. bell, d.c. buzzer and two signalling lamps. Signalling, switching and battery feed relays, common to all stations, are concentrated in a wall-mounted unit. The system operates on 50V d.c., derived from a power unit, and the inter multiple-station cable is 21 wire.

The 'Keymaster' telephone can be wall mounted if required and monitoring and exchange barring facilities are available as optional extras.

ERICSSON TELEPHONES LIMITED
ETELCO LIMITED

HEAD OFFICE: 22 LINCOLN'S INN FIELDS, LONDON, W.C.2. TELEPHONE: HOL 6936

VENUS UNVEILED

THE planet Venus may have much longer days and nights than the earth and its magnetic field may be much smaller. Its surface temperatures may also be much lower than astronomers have always thought —low enough, perhaps, to support some form of life.

These intriguing possibilities are based on the mass of data transmitted back to earth—35 million miles away—by *Mariner II*, the United States spacecraft, as it swept past Venus.

Mariner II (see "A 182 Million Mile Journey to Venus" in the Winter, 1962 issue) passed within 21,600 miles of the planet at 8 p.m. on 14 December and for nearly half a hour, its instruments sent back messages. The information is now being analysed by space scientists—a task expected to take several months before it is fully digested. Already, preliminary studies suggest that a solar wind of electrified gases blows at between 250-450 miles an hour from the sun in all directions and that the intensity of dust particles in distant space is at least 1,000 times less than the intensity measured near the earth. It is also thought that Venus has no radiation belts and no southern or northern lights such as those seen on earth.

Not the least remarkable achievement in *Mariner II's* success was the switching on of the spacecraft's instruments by remote control from earth. It had been planned to switch them on by radio signal at 7 a.m. on 14 December. But this attempt failed as did a second try at 10 a.m. At the third time of asking, however, at 2 p.m., *Mariner II* responded and obediently carried out its orders.

Strong signals from *Mariner II* were picked up by the radio telescope at Jodrell Bank where five miles of magnetic tape recordings of the spacecraft's messages were accumulated and later flown to the United States for analysis.

The National Aeronautics and Space Administration plans to launch a similar spacecraft in the Spring of 1964 to gather additional scientific data, and, in 1965, a much larger *Mariner* will be fired in the direction of Mars and Venus. When the *Mariner* series of missions is completed a new type of spacecraft will take over. This will be *Voyager*, weighing more than a ton, and designed eventually to carry an instrumented capsule to make soft landings on Venus and Mars and to fly towards Mercury and Jupiter.

This impressive building is the new headquarters in West Paris of the French radio and television system. When completed, it will house all the studios and offices at present scattered throughout the city.

MISCE

SPEEDING UP THE CALLS

TWO important steps along the road to the time when telephone subscribers in Britain may be able to dial directly to any number in the world were being taken as the *Journal* went to press.

The first is the decision to instal new automatic equipment which will enable operators at London's International Telephone Exchange and at the White Plains Exchange in New York to dial calls direct to the subscriber on the other side of the Atlantic. In future only one operator will be involved in setting up a call, thus helping to speed up calls between the two countries and keeping pace with the ever-increasing traffic.

When the system comes into operation on 30 March it will be the first time for telephone calls to be dialled regularly on submarine cables over such a long distance.

The second step forward is the inauguration on 8 March of the international subscriber dialling system which opens with London subscribers with STD facilities being able to dial their own calls direct to subscribers in Paris. It is expected that international subscriber dialling will be extended to many European countries in 1964 and subsequent years.

TECHNICAL OFFICER TAKES TOP PRIZE

THE seven guinea first prize in the Institution of Post Office Electrical Engineers' 1962 Associate Section Papers competition was awarded to Mr. J. McCall, Technical Officer, Aberdeen Centre, for his paper entitled "The Television Network Switching Centre".

Four prizes, each of four guineas, went to Messrs. C. H. Collins and H. R. Merry, Technical Officers, Reading Centre; K. W. Guy, Technical Officer, Stoke-on-Trent; J. W. Rowson, Technician Grade I, Colchester Centre; and J. Davidson, Technical Officer, Aberdeen Centre.

Additional prizes of one guinea for papers considered by the local centre committees as worthy of submission to the Judging Committee for the main awards, were won by Mr. L. S. Hurst, Technical Officer, Tunbridge Wells Centre, and by Mr. J. W. Mitchell, Technician Grade II, also of Tunbridge Wells Centre.

The papers were judged by Messrs. R. J. Hines, R. McWhirter and W. E. Adams.

LLANY

NEW YEAR HONOURS

THE *Telecommunications Journal* offers its congratulations to the following members of the telecommunications staffs of the Post Office who were awarded honours in the 1963 New Year's Honours List. They were:

OBE—Captain J. R. Ruddock, of HMTS *Alert*.

MBE—Mr. A. H. Willitt, Assistant Engineer, TMO, Chester; Mr. P. N. Parker, Senior Executive Engineer, Engineering Department; and Mr. F. W. Pedler, Assistant Engineer, TMO, Sheffield.

BEM—Mr. H. H. A. Tyrer, Senior Chief Supervisor, Continental Exchange; Mr. J. P. Loftus, Technical Officer, Grimsby; Miss V. M. Lilley, Chief Supervisor, Eastbourne; Mr. C. W. Brown, Technician Grade I, South West Area; and Miss E. Savery, Chief Supervisor, Cheltenham.

IN BRIEF

The Post Office cable-laying ship, HMTS *Monarch*, went to the rescue on 3 December when she picked up a radio call for help from the German ship *Honkoog*.

Monarch, which carries a doctor and a well-equipped surgery, immediately made full steam ahead to meet the *Honkoog* in mid-Atlantic, took on board an injured member of the German crew and made for the Tyne where she berthed 12 days later.

•

The number of combined television and sound broadcasting licences in Great Britain and Northern Ireland is now about 12 and a half million. Last November, the latest month for which figures are available, the total increased by 57,125 to 12,224,303. Sound licences totalled 3,395,090, including 522,192 for sets fitted in vehicles.

•

In 1962 the Post Office 999 emergency system dealt with some 412,256 calls in London alone. Of these 269,563 were to New Scotland Yard, 117,047 to the London Ambulance Service and 25,646 to the London Fire Brigade.

The 999 service was first installed in London in 1937 since when it has been extended to all large and many small automatic exchanges and is now available to more than 95 per cent of dial telephones.

•

The value of the Post Office Telephone Road Weather Service for London and the south-east of England was proved beyond doubt during the recent bad weather. Normally the Service receives a little over 40,000 calls a week but in the first week in January, 1963, more than eight times this number—347,575—were received.

The number of calls doubled last November and rose sevenfold in the early December fogs to 287,880.

CORRESPONDENCE

Accompanying Mr. S. W. Dabbs' most enjoyable article on the Central Telegraph Office in the Winter, 1962, issue, was an illustration of a picture being fitted to the transmitter drum of a phototelegraph machine "in 1937".

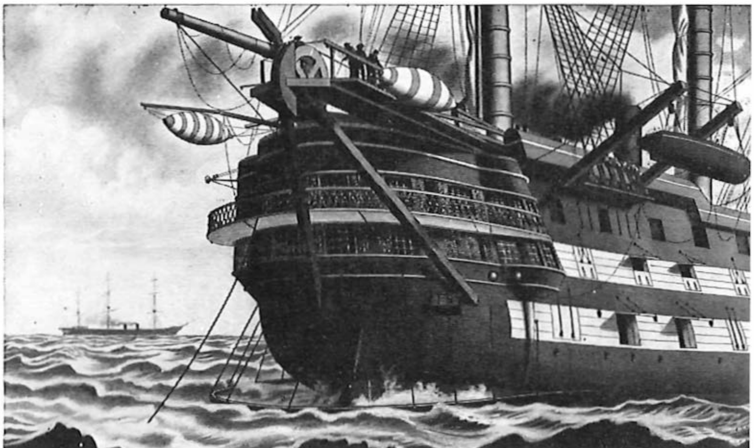
May I point out that although the picture service from the CTO began on 7 January, 1930, and transmissions were taking place in 1937, they were not on the machine depicted.

This machine is a Muirhead-Jarvis Phototelegraph Equipment which was jointly developed in 1946 by Muirhead and Co. Ltd., and the late Mr. F. W. Jarvis, Communications Manager of the Daily Mail.—**R. G. Fidler, Executive Engineer, Engineering Dept, State House**

*Our apologies to Mr. Fidler. The date 1937 should have read 1947.

FLASHBACK TO 1858

The first trans-Atlantic cable was laid between Dowlas Bay, Valentia, in Ireland, and Trinity Bay, Newfoundland, between 28 July and 5 August, 1858, after two previous attempts had failed. In this picture, by Barbosa, HMS *Agamemnon* is shown in mid-ocean just after she had begun her part of the lay. In the background is the United States NS *Niagara* which laid the Newfoundland section.



Telecommunications Statistics

	Quarter ended 30 Sept. 1961	*Quarter ended 30 June 1962*	**Quarter ended 30 Sept. 1962**
Telegraph Service			
Inland telegrams (excluding Press and Railway) ...	3,421,000	2,895,000	**3,253,000**
Greetings telegrams	898,000	714,000	**895,000**
Overseas telegrams:			
Originating U.K. messages	1,616,000	1,570,000	**1,610,000**
Terminating U.K. messages	1,623,000	1,583,000	**1,619,000**
Transit messages	1,304,000	1,320,000	**1,245,000**
Telephone Service			
Inland			
Gross demand	108,000	117,000	**122,000**
Connections supplied	109,000	102,000	**100,000**
Outstanding applications	155,000	146,000	**150,000**
Total working connections	5,141,000	5,241,000	**5,272,000**
Shared service connections	1,139,000	1,117,000	**1,107,000**
Total inland trunk calls	118,714,000	129,034,000	**135,626,000**
Cheap rate trunk calls	30,432,000	30,334,000	**33,784,000**
Overseas			
European: Outward	†843,000	953,000	**981,000**
Inward	845,000	888,000	**980,000**
Transit	4,000	9,000	**10,000**
Extra-European: Outward	71,000	88,000	**84,000**
Inward	87,000	105,000	**105,000**
Transit	18,000	15,000	**15,000**
Telex Service			
Inland			
Total working lines	8,000	9,000	**10,000**
Metered units	17,649,000	23,572,000	**22,333,000**
Manual calls (Assistance and Multelex) ...	3,000	3,000	**2,000**
Calls to Irish Republic	19,000	20,000	**19,000**
Overseas			
Originating (U.K. and Irish Republic) ...	1,007,000	1,251,000	**1,302,000**

Figures rounded to nearest thousand. † Amended figure.

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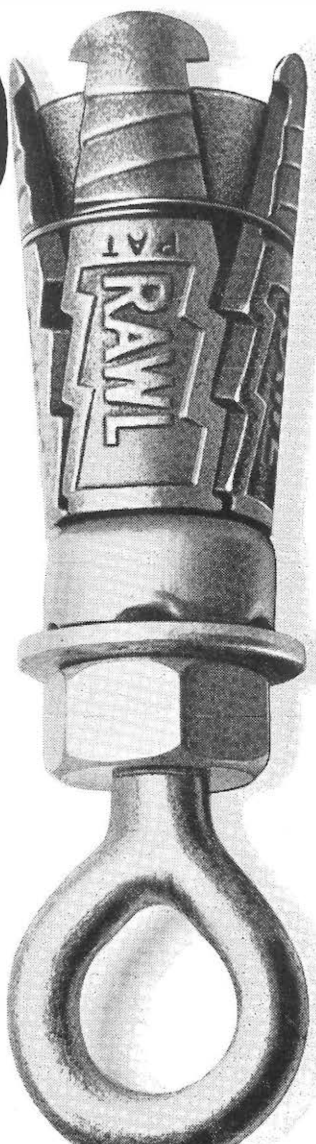
Contributions. The Editorial Board will be glad to consider articles of general interest within the telecommunications field. No guarantee of publication can be given. The ideal length of such articles would be 750, 1,500 or 2,000 words. The views of contributors are not necessarily those of the Board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

GRIPPING



A GRIPPING STORY

Not so much a story as a statement of fact: the Rawlbolt is the fastest, most secure bolt-fixing method in the world. By expansion, it exerts such a tremendous grip on the sides of the hole that the fixing strength is limited only by the strength of the bolt. Increase of load *increases* the grip. The speed is impressive too—a 1″ Rawlbolt was anchored 7″ deep in concrete and ready for load in 3 minutes, including drilling time (Rawlplug make the best and fastest drilling tools too). Debris-clogged threads and other delays do not occur with Rawlbolts.

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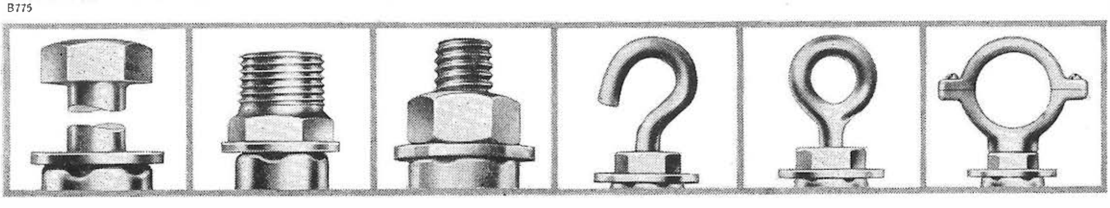

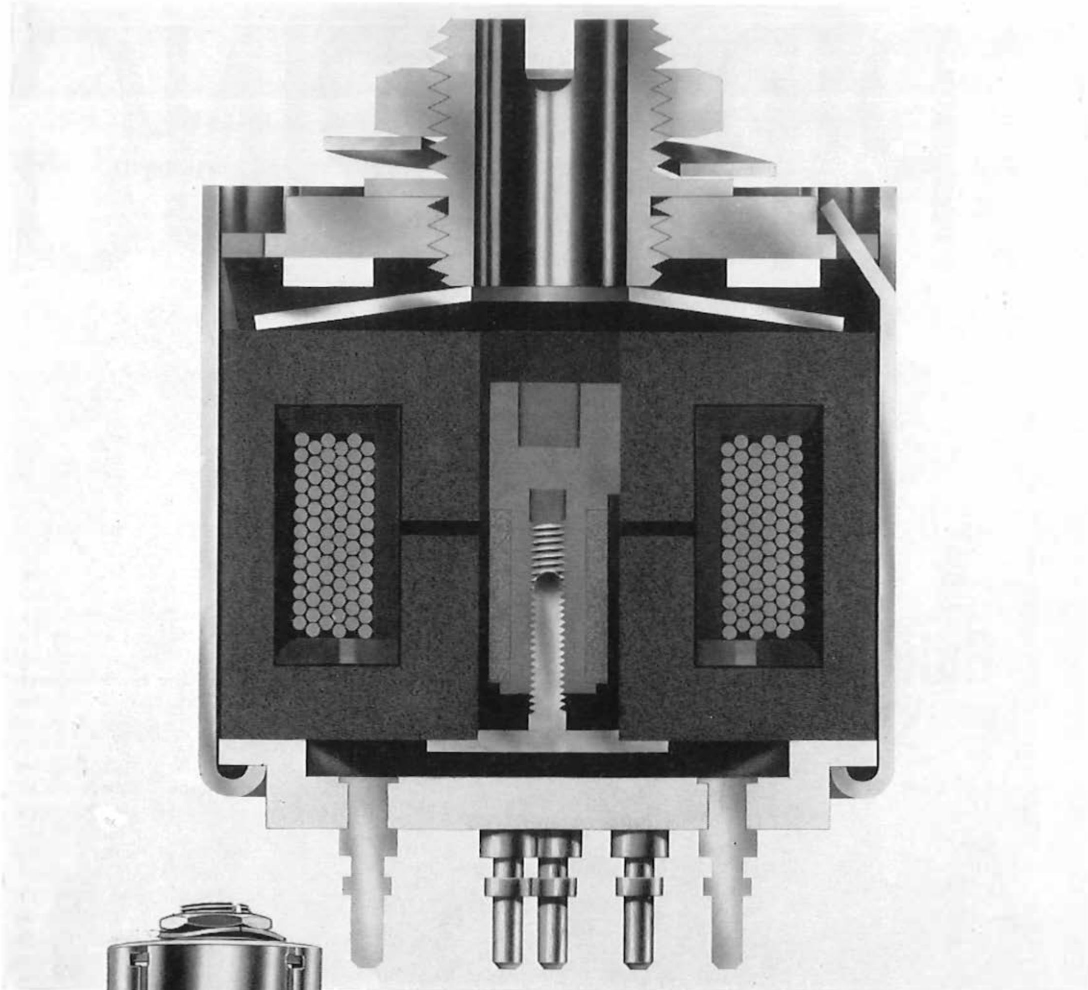


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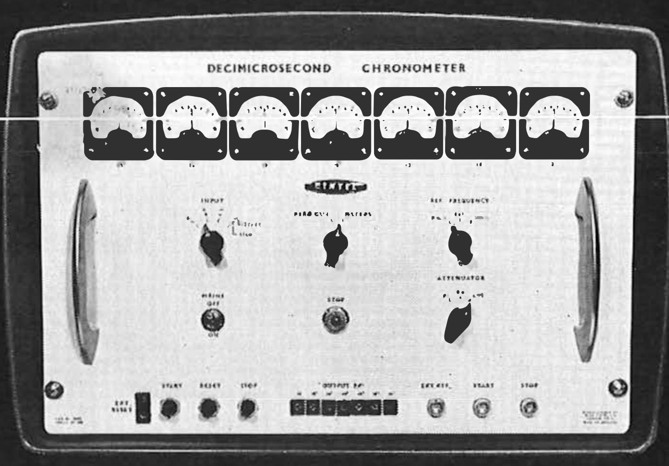

Transductor controlled submerged repeater power feeding equipment with two power units.

POWER FEEDING FOR SUBMERGED REPEATERS

Submarine repeaters for submarine cable telephone systems are specially designed and manufactured to give long life and high reliability, but the maintenance of these qualities in service largely depend on the performance of the shore-based power feeding equipment. STC has developed a new Transductor Controlled Power Feeding Equipment now in operation with NATO and ordered by the British G.P.O. for systems to operate across the North Sea, which has the following features:

Up to 3 power units can operate in parallel, leading to simplification of switching circuits.

Single or double-[illegible] can be employed, using the STC master/slave scheme if required.

Transductor control [illegible] thermionic valves, increasing reliability and redu[illegible] requirements.

Operation from a 40[illegible] c/[illegible] faster response times to be obtained and the size [illegible] of components to be reduced compared with equipm[illegible] working from a 50 or 60 c/s supply.

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